B.Tech
CURRICULUM and SYLLABUS-2015

DEPARTMENT OF
MECHANICAL ENGINEERING

KALASALINGAM UNIVERSITY
(Kalasalingam Academy of Research and Education)
Under sec.3 of UGC Ac,1956. Accredited by NAAC with 'A' Grade
Anand Nagar, Krishnankoil-626126,
Srivilliputtur (via), Virudhunagar (Dt), Tamilnadu, India.
www.kalasalingam.ac.in

KALASALINGAM UNIVERSITY

VISION

To be a Center of Excellence of International Repute in Education and Research

MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be Recognized Globally as a Lead in Mechanical Engineering through Excellence in Education and Innovative Research in Emerging areas

MISSION

To provide quality education and research with the state of the art facilities to the student.

This is accomplished by

- Enhancing the Knowledge and Expertise through Professional Programmes and Research Works.
- Endowing the Students with Academic Leadership, Communication Skills and Professional Awareness towards Social Commitment.

Program Educational Objectives

PEO-1- DIVERSIFIED KNOWLEDGE

Graduates will apply fundamental technical knowledge and skills to find workable solutions to technological challenges and problems in diversified areas such as Production, Design, Thermal, Industrial and allied fields of Mechanical Engineering.

PEO-2: CONTEMPORARY ISSUES & SKILLS

Graduates will have an effective communication skills and will recognize the social impacts of problem solving, decision making and creative skills by understanding contemporary issues.

PEO-3: PROFESSIONAL ATTITUDE

Graduates will gain professional and ethical attitude towards their peers, employers, society and prove as a responsible leader in the establishments in government and private sectors.

PEO-4: PROFESSIONAL DEVELOPEMENT

Graduates will become entrepreneurs to confront business challenges or will continue their professional advancement through their knowledge horizon and inculcate lifelong learning.

Student outcomes as described by ABET

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Program Outcomes (POs)

Program Outcomes:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO1: An ability to utilize the gained knowledge of mathematics and engineering sciences to real time problems involving thermal, design, manufacturing and materials domain.

PSO2: An ability to specify, fabricate, test, operate, validate and complete documentation of any basic mechanical systems or processes.

PSO3: An ability to apply the acquired software's skills to design and analysis of advanced mechanical systems or processes.

B. Tech. MECHANICAL ENGINEERING CURRICULUM

Curriculum Structure

<table>
<tr><th>S.No</th><th colspan="2">Category</th><th>Credits</th></tr>
<tr><td rowspan="2">I.</td><td>Basic Sciences and Mathematics</td><td>25</td><td rowspan="2">31</td></tr>
<tr><td>Basic Science and Mathematics (Free Elective)</td><td>6</td></tr>
<tr><td>II.</td><td colspan="2">Humanities and Social Science</td><td>16</td></tr>
<tr><td>III.</td><td colspan="2">Basic Engineering</td><td>39</td></tr>
<tr><td rowspan="4">IV.</td><td colspan="3">Program Core</td></tr>
<tr><td>a)Core Courses</td><td>66</td><td rowspan="3">79</td></tr>
<tr><td>b)Community Service Project</td><td>3</td></tr>
<tr><td>c)Project work</td><td>10</td></tr>
<tr><td rowspan="3">V.</td><td colspan="3">Elective Courses</td></tr>
<tr><td>a)Major Elective</td><td>12</td><td rowspan="2">18</td></tr>
<tr><td>b)Minor Elective</td><td>6</td></tr>
<tr><td></td><td colspan="2">Total Credits</td><td>183</td></tr>
</table>

Semester I

<table>
<tr><th>Code No.</th><th>Subject</th><th>Course type</th><th>L</th><th>T</th><th>P</th><th>C</th></tr>
<tr><td>HSS101</td><td>English for Technical Communication I</td><td>T</td><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>MAT101</td><td>Mathematics I</td><td>T</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>PHY131</td><td>Physics I</td><td>T</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>CHY106</td><td>Chemistry</td><td>T</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>MEC101</td><td>Engineering Drawing</td><td>T</td><td>1</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>CIV101</td><td>Basic Civil and Mechanical Engineering</td><td>T</td><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>MEC181</td><td>Work Shop</td><td>L</td><td>0</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td>CHY181</td><td>Chemistry Laboratory</td><td>L</td><td>0</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td></td><td colspan="2">Total</td><td>16</td><td>0</td><td>9</td><td>19</td></tr>
</table>

Semester II

Code No.	Subject	Course type	L	T	P	C
HSS102	English for Technical Communication II	T	2	0	0	2
MAT102	Mathematics II	T	3	0	0	3
PHY132	Physics II	T	3	0	0	3
EEE101	Basic Electrical and Electronics Engineering	T	4	0	0	4
CHY102	Environmental Sciences	T	2	0	0	2
CSE102	Programming Languages	T	2	0	0	2
MEC103	Engineering Mechanics (except BT, IT, CSE)	T	3	0	0	3
PHY181	Physics Laboratory	L	0	0	3	1
CSE181	Programming Languages Laboratory	L	0	0	3	1
HSS036	Soft Skills – I	T	1	0	0	1
	Total		19	0	6	22

Semester III

Code No.	Subject	Course type	Pre/Co-requisite	L	T	P	C
MAT201	Mathematics III	T	MAT101	3	0	0	3
HSSxxx	Humanities Elective I	T	--	3	0	0	3
MEC201	Strength of Materials	T	MEC103	3	1	0	4
EEE259	Electrical Drives and Controls	T	EEE101	3	0	0	3
MEC202	Thermodynamics	T	CHY106	3	1	0	4
MEC203	Fluid Mechanics and Machinery	T	MAT101	3	1	0	4
MEC281	Strength of Materials / Fluid Mechanics Laboratory	L	MEC201 MEC203	0	0	3	2
EEE299	Electrical Sciences Laboratory	L	EEE259	0	0	3	2
HSS037	Soft Skills – II	L	--	1	0	0	1
	Total			18	3	6	26

Semester IV

Code No.	Subject	Course type	Pre/Co-requisite	L	T	P	C
MAT211	Numerical Methods	T	MAT102	3	0	0	3
MEC204	Kinematics of Machinery	T	MEC103	3	1	0	4
MEC205	Fluid Power Transmission Systems	T	MEC203	3	1	0	4
MEC206	Material Science*	TP	PHY131	3	0	0	3
MEC207	Manufacturing Technology	T	CIV101	3	1	0	4
MEC209	Thermal Engineering	T	MEC202	3	1	0	4
MEC282	Manufacturing Technology Laboratory**	LP	MEC207	0	0	3	2
MEC283	Thermal Laboratory I	L	MEC209	0	0	3	2
HSS038	Soft Skills – III						1
	Total			18	4	6	27

* Thoery with Practical Component (TP)

** Laboratory with Project (LP)

Semester V

Code No.	Subject	Course type	Pre/Co-requisite	L	T	P	C
MECxxx	Major Elective I	T		3	0	0	3
	Minor Elective I	T		3	0	0	3
MEC328	Advanced Machine Tools And Metrology	T	PHY131	3	0	0	3
MEC303	Design of Machine Elements	T	MEC201	3	1	0	4
MEC304	Dynamics of Machinery	T	MEC204	3	1	0	4
MEC329	Gas Dynamics and Jet Propulsion	T	MEC202	3	1	0	4

MEC387	Machine Drawing Practice Laboratory**	LP	MEC101	1	0	3	2
MEC382	Machine Tools and Metrology Laboratory	L	MEC328	0	0	3	2
MEC383	Dynamics and Vibration Laboratory	L	MEC204, MEC304	0	0	3	2
MEC391	Community Service Project – Phase I	-		0	0	2	1
	Total			19	3	9	28

** Laboratory with Project (LP)

Semester VI

Code No.	Subject	Course type	Pre/Co-requisite	L	T	P	C
HSSxxx	Humanities Elective II	T	--	3	0	0	3
MECxxx	Major Elective II	T	--	3	0	0	3
	Open Elective I	T	--	3	0	0	3
MECxxx	Major Elective III	T	--	3	0	0	3
MEC307	Design of Transmission Systems	T	MEC303	3	1	0	4
MEC327	Heat and Mass Transfer*	TP	MEC202	3	1	0	4
MEC385	Thermal Laboratory II	L	MEC209 MEC327	0	0	3	2
MEC392	Community Service Project – Phase II	P	--			3	2
	Total			18	2	9	24

* Thoery with Practical Component (TP)

Semester VII

Code No.	Subject	Course Type	Pre-requisite	L	T	P	C
HSSxxx	Humanities–Elective III	T	--	3	0	0	3
	Open Elective II	T	--	3	0	0	3
MECxxx	Major Elective IV	T	--	3	0	0	3
	Minor Elective II	T	--	3	0	0	3
MEC401	Power Plant Engineering	T	MEC209	3	0	0	3
MEC402	Automobile Engineering	T	MEC202	3	0	0	3
MEC403	Mechatronics	T	EEE101	3	1	0	4
MEC481	Simulation Laboratory**	LP	MEC320 MEC327	0	0	3	2
	Total			21	1	3	24

** Laboratory with Project (LP)

Semester VIII

Code No.	Subject	Course type	Pre-requisite	L	T	P	C
MECxxx	Self Study Elective	T	-	3	0	0	3
MEC499	Project Work	P	-	0	0	26	10
	Total			3	0	26	13

Total Credits (from 1st semester to 8th semester = 183)

LIST OF MAJOR ELECTIVES

Course Code	Course Name	CT	Pre-requisite	L	T	P	C
MEC309	Design of Jigs, Fixtures and Press Tools	T	MEC303	3	0	0	3
MEC310	CNC Machining	T	MEC207	3	0	0	3
MEC311	Non-Traditional Machining Techniques*	TP	MEC207	3	0	0	3
MEC312	Internal Combustion Engines	T	MEC209	3	0	0	3
MEC313	Turbo Machinery	T	MEC202	3	0	0	3
MEC314	Energy Engineering and Management	T	MEC202	3	0	0	3

MEC315	Design for Manufacture	T	MEC207	3	0	0	3
MEC316	Theory of Metal Cutting	T	MEC207	3	0	0	3
MEC317	Tribology	T	MEC103	3	0	0	3
MEC318	Refrigeration and Air Conditioning	T	MEC209	3	0	0	3
MEC319	Process Planning and Cost Estimation	T	MEC207	3	0	0	3
MEC320	Finite Element Analysis	T	MAT101	3	0	0	3
MEC321	Optimization Techniques	T	--	3	0	0	3
MEC322	Modern Manufacturing Processes	T	MEC207	3	0	0	3
MEC323	Materials Management	T	MEC206	3	0	0	3
MEC324	Plant Layout and Material Handling	T	--	3	0	0	3
MEC325	Welding Technology	T	MEC207	3	0	0	3
MEC330	Robotics and Robot Applications	T	MEC204	3	0	0	3
MEC331	Vibration Analysis and Noise Monitoring*	TP	MEC204	3	0	0	3
MEC332	Renewable Energy Techniques	T	CIV101	3	0	0	3
MEC333	Design of Heat Transfer Equipments	T	MEC327	3	0	0	3
MEC334	Foundry Mechanization and Management	T	MEC207	3	0	0	3
MEC335	Recent Trends in Welding Techniques	T	MEC206	3	0	0	3
MEC336	Mechanical Behaviour of Materials	T	MEC206	3	0	0	3
MEC337	Manufacturing System and Simulation	T	MEC207	3	0	0	3
MEC338	Gear manufacturing and Inspection	T	MEC207	3	0	0	3
MEC339	Tooling for Production	T	MEC207	3	0	0	3
MEC340	Composite Materials Science	T	MEC206	3	0	0	3
MEC341	Principles of Component Design	T	MEC303	3	0	0	3

MEC342	Computational Fluid Dynamics and Heat Transfer	T	MEC203	3	0	0	3
MEC343	Heat treatment and surface treating	T	MEC206	3	0	0	3
MEC412	Micro Electro Mechanical Systems	T	EEE259	3	0	0	3
MEC414	Sensors and Transducers	T	EEE259	3	0	0	3
MEC416	Industrial Safety	T	-	3	0	0	3
MEC417	Work Study	T	-	3	0	0	3
MEC418	Rapid Prototyping	T	MEC207	3	0	0	3
MEC419	Production Planning and Control	T	MEC207	3	0	0	3
MEC420	Industrial Engineering	T	MEC207	3	0	0	3
MEC421	Non-Destructive Examination	T	MEC206	3	0	0	3
MEC424	Industrial Automation and Robotics	T	MEC204	3	0	0	3

* Thoery with Practical Component (TP)

LIST OF MINOR ELECTIVES

Course Code	Course Name	CT	L	T	P	C
BIT307	Environmental biotechnology	T	3	0	0	3
CHE311	Corrosion science and engineering	T	3	0	0	3
CHE405	Computational Heat Transfer	T	3	0	0	3
CIV367	Air pollution and control	T	3	0	0	3
CIV369	Environmental impact assessment	T	3	0	0	3
CIV425	Disaster Management and Thermo Dynamics	T	3	0	0	3
CIV464	Industrial Waste Water Management	T	3	0	0	3
CIV465	Solid and hazardous waste management	T	3	0	0	3
CSE206	Object oriented programming	T	3	0	0	3
CSE314	Digital Image Processing	T	3	0	0	3
ECE301	Digital signal processing	T	3	0	0	3
EEE306	Special Electrical Machines	T	3	0	0	3
EEE410	Neural Network And Fuzzy Logic	T	3	0	0	3

EIE310	Industrial Drives and Controls	T	3	0	0	3
EIE313	Power Plant Instrumentation and Control	T	3	0	0	3
EIE319	Piping and Instrumentation	T	3	0	0	3
INT355	Internet and web technology	T	3	0	0	3

FREE ELECTIVES
(BASIC SCIENCE AND MATHEMATICS)

Course id	Course name	Credits
BPY502	Laser Physics	3
BPY503	Nonlinear Optics	3
BPY504	Radiation Physics	3
BPY506	Nuclear Physics	3
BPY507	Space Physics	3
BCY501	Nano chemistry	3
BCY504	Applied Chemistry	3
BMA332	Mathematical Modeling	3
BCY506	Environmental Chemistry	3
BMA331	Combinatorics	3
BCY505	Instrumental Method of Analysis	3

LIST OF HUMANITIES ELECTIVES

Course Code	Course Name	CT	L	T	P	C
HSS001	Total Quality Management	T	3	0	0	3
HSS002	Engineering Management	T	3	0	0	3
HSS003	Indian Economic Development	T	3	0	0	3
HSS004	Industrial Psychology	T	3	0	0	3
HSS006	Professional Ethics	T	3	0	0	3
HSS008	Basics of Economics	T	3	0	0	3
HSS010	International Trade and Finance	T	3	0	0	3
HSS011	Information Systems for Managerial Decision Making	T	3	0	0	3
HSS013	Cost Analysis and Control	T	3	0	0	3

HSS014	Marketing Management	T	3	0	0	3
HSS015	Management Concepts and Techniques	T	3	0	0	3
HSS016	Organizational Psychology	T	3	0	0	3
HSS017	International Economics	T	3	0	0	3
HSS018	Communication Skills	T	3	0	0	3
HSS019	Operations Research	T	3	0	0	3
HSS020	Human Resource Management	T	3	0	0	3
HSS022	Banking Theory and Practice	T	3	0	0	3
HSS023	Entrepreneurship Development	T	3	0	0	3
HSS024	Industrial Psychology	T	3	0	0	3
HSS031	English Advance Level	T	3	0	0	3

THEORY SUBJECT WITH PRACTICAL COMPONENT (*)

1.	Material Science (MEC206)
2.	Heat and Mass Transfer (MEC327)
3.	Non Traditional Machining Techniques (MEC311)
4.	Vibration Analysis and Noise Monitoring (MEC331)

LABORATORY COURSES WITH PROJECT (**)

1.	Manufacturing Technology Lab (MEC282)
2.	Machine Drawing Practice Lab (MEC387)
3.	Simulation Lab (MEC481)

<table>
<tr><td rowspan="3">HSS101 ENGLISH FOR TECHNICAL COMMUNICATION I</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Humanities and Social sciences Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To help the learner develop listening skills by providing them with inspiring material
- To help the learner acquire the ability to speak comfortably in real-life situations
- To inculcate in students a taste for English so that they take to reading novels, dailies, and motivational books and dailies
- To help learners passionately improve their vocabulary
- To enable students to write all kinds of letters, job applications, and reports
- To help learners sit for the BEC Examinations.

Course Outcome(s)

On their completion of the course, the students will be able to

CO 1: Learn to speak good English covering their day to day activities

CO 2: Understand the importance of Listening in order to communicate well

CO 3: Make Situational Dialogues on emerging multiple situations

CO 4: Learn the importance of Reading aloud Newspapers and other Texts

CO 5: Compose effective error free composition

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3				2	1				
CO2						3	1	1		3	2	1			
CO3										3	1	1			
CO4								1	1	3	2	1			
CO5									1	3	2				

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

UNIT I FOCUS ON LANGUAGE AND COMMUNICATION

What is Communication? Verbal and Non-verbal communication - Extra-linguistic factors for communication. General and Technical Communication. Style in Technical Communication - Questions Framing-Conversation with Questions – Cloze reading – Skimming-Scanning-Letters - Leave , Permission, Apology and Informal Letters - Spoken English – Meeting; parting; Do you speak English?; Daily Activities; Asking about activities; What did you do?; Talking about activities; Evening activities; General activities; Meeting at a train station – Asking questions at the train station; Meeting at the airport; getting information at the airport; getting to the hotel; finding one's hotel; asking direction; getting information; finding one's way; Asking about buses; Traveling by Bus - Personality Development – Basics – A taster; Understanding your motives- understanding your stressors – prioritization – Work/life balance - Definitions - Definitions for terms - Etymology of Scientific Terms - Words with the same roots – Parts of Speech - Tenses

UNIT II LISTENING SKILLS

Listening with Comprehension - Listening to audio – Taking notes while listening - Listening to documentaries, radio broadcasts, TV Newscasts, Pod casts - Types of Listening & Tips for Effective Listening. English in Conversation – To understand short conversations, short lectures, short monologues and announcements--Dialogue Writing - Telephonic Conversation. To help familiarize with Major English Accents - British Accent (BBC) - American Accent (CNN) - Indian Accent (Doordharshan, NDTV, etc). Language Focus – Articles - Prepositions - Numerical Adjectives

UNIT III SPEAKING SKILLS

Class room Seminar - Making Short Speeches - Giving Instructions – Recommendations – Taking part in conversations – Asking and answering questions – Talking freely about opinions – Expressing one's likes and dislikes in areas of general interest – exchanging greetings – Introducing themselves, making requests, asking questions to obtain information about people and places, making comparisons – Asking for and giving personal details – Asking about and discussing jobs, studies and academic responsibilities – Asking about and describing a company – Asking for and giving permission – Asking for and giving opinions – Agreeing and disagreeing - Personality Development – Handling distractions – breaking your goals into manageable items –Spoken English – Going by Taxi; Taking a trip by car; travel plans; How do I get there?; Asking for time – living in an apartment; living in a house; using the telephone; getting help in stores; going shopping; talking about shopping; shopping for clothes; asking about prices; How much does it cost? - Situational Conversations - Role plays - Communicating Politely. Oral Presentation Strategies - Organizing Contents - Body Language/Kinesics – Paralinguistic features. Language Focus – Verbs - transitive & intransitive - Active Voice & Passive Voice - Direct Speech - Indirect Speech

UNIT IV READING SKILLS

Reading Aloud - Reading articles in English News papers, Sport Magazines, Weeklies, Subject-related periodicals. Comprehension - Reading passages and answering questions –Guessing Meaning from context. Converting newspaper headlines into sentences - Reading and Note making - Outline/Linear Method of Note-making - Sentence Method of Note-making - Schematic/Mapping Method of Note-making. Creative Writing - Language Focus - Jumbled Sentences – Summary Writing –- Replacing words with the noun forms of verbs - Conditional Clauses – To read and understand the main points from notices, messages, short reports, notes, time tables, advertisements, leaflets, graphs, charts and e-mails

UNIT V WRITING SKILLS

Dialogue Writing – Telephone conversation - Use of Abbreviations - Avoiding clichés, jargons and foreign words – Framing Sentences - Paragraph development - Kinds of Paragraphs - Effective Construction of Paragraphs - Avoiding needless repetitions - Identifying cluttering phrases - Rearranging words and phrases - - Story Writing – Anecdote- – Producing simple error-free sentences, short messages, letters and paragraphs - Process Description - Language Focus - Comparison of Adjectives

Text Book

1. M. Asraf Rizvi. Effective Technical Communication. Tata McGraw-Hill Publishers, 2005

Reference

1. Meenakshi Raman and Sangeeta Sharma. Technical Communication: English Skills for Engineers. New Delhi: Oxford University Press, 2008
2. Oxford Advanced Learner's Dictionary. OUP, Latest Version
3. Raymond Murphy. Murphy's English Grammar. Cambridge University Press, 2004
4. Kavitha Tyagi and Padma Misra. Advanced Technical Communication. New Delhi: PHI press, 2011.
5. Clegg, Brain. Personal Development. New Delhi: Kogan Page India Private Limited, 2009.
6. Taylor, Grant. English Conversational Practice: New Delhi: Tata McGraw Hill, 1975.

<table>
<tr><td rowspan="3">MAT101 MATHEMATICS - I</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To make the students acquire knowledge in matrix theory a part of linear algebra which has wider applications in engineering problems. To make the student knowledge in the area of infinite series and their convergence so that the students will be familiar with in finite series approximations for a solutions arising in mathematical modeling and to solve first and higher order differential equations and to Laplace transform to solve differential equations using algebraic operations.

Course Outcome(s)

CO1:	Simplify elementary matrix and vector operations and use them in applications
CO2:	Find derivatives of functions and use derivatives to solve applied problems.
CO3:	Make use of polar coordinates in solving the problems.
CO4:	Apply definition, concepts of analytical geometry.
CO5:	Apply differentiation equations to Engineering problems.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2			2	2				2	2			2	2	
CO2	3	2	3	2	3	2	3		2				2	2	
CO3	3		3	3	3		2		2				2	2	
CO4	3		2		2	3			2				2	2	
CO5	3		2		2				2				2	2	

Course Topics

MATRICES

Review of linear algebra - matrix operations - addition, scalar multiplication, multiplication, transpose, adjoint and their properties-special types of matrices - null, identity, diagonal, triangular, symmetric, skew - symmetric, Hermitian, skew - Hermitian, orthogonal, unitary, norma – rank - consistency of a system of linear equations - solution of the matrix equation Ax = b – row - reduced Echelon form.

EIGEN VALUE PROBLEMS

Eigen value and eigen vector of real matrix – properties of eigen values and eigen vectors – Cayley - Hamilton theorem – Orthogonal transformation of a real symmetric matrix to diagonal form – reduction of quadratic form to canonical form by orthogonal transformation – index, signature and nature of quadratic form.

DIFFERENTIAL CALCULUS

Review of limits - continuity and differentiability - curvature – Cartesian and Parametric Co-ordinates – centre and radius of curvature – circle of curvature - evolutes - involutes - envelopes - partial differentiation – Euler's theorem for homogeneous functions - total differential – Taylor's expansion (two variables) - Maxima / Minima for functions of two variables – Method of Lagrangian multiplier – Jacobians.

THREE DIMENSIONAL ANALYTICAL GEOMETRY

Direction cosines and ratios – angle between two lines – equations of a plane – equations of straight line – coplanar lines – shortest distance between two skew lines – sphere – tangent plane – plane section of a sphere – orthogonal spheres.

ORDINARY DIFFERENTIAL EQUATIONS

Solutions of second and higher order linear ODE with constant coefficients – Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients - Method of variation of parameters.

TEXT BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 8th Edn., 2001.
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume I, Scitech Publications (India) Pvt. Ltd., Chennai, 2nd Edn., Reprint 2000, 1999.

REFERENCES

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 37th Edn., 5th Reprint 2004, 2003.
2. Venkataraman, M. K., Engineering Mathematics First Year, The National Publishing Company, Chennai, 2nd Edn., Reprint 2001, 2000.

PHY131 PHYSICS - I	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Basic Sciences **Course Type:** Theory			

Course Objective(s)

To make the students to learn about the basics of types of waves and applications of waves and to make the students learn about the new adapting techniques.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understanding the different types of sound waves and production and application of ultrasonic.

CO2: Understanding the basic concepts, production & applications of different types of laser sources.

CO3: To know the general ideas about optical fibres and their applications in various fields.

CO4: Learning the basic knowledge of crystallography and Single crystalline preparation techniques.

CO5: To gain the knowledge about the fundamentals, theory of quantum physics

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2			2	2				2	2			2		
CO2	3	2	3	2	3	2	3		2				2		
CO3	3		3	3	3		2		2				2	1	
CO4	3		2		2	3			2				2	1	
CO5	3		2		2				2				2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

UNIT I ACOUSTICS AND ULTRASONICS

Classification of sound – decibel – Weber Fechner law - Reverberation theory - Sabine's formula – derivation of Sabine's equation – Acoustic design of a Hall – Common acoustical defects and their remedies - Production of ultrasonics by magnetostriction and piezo electric methods – Acoustical grating – SONAR - depth of sea – pulse echo system through transmission and reflection modes – A, B and C scan displays

UNIT II MODERN OPTICS

Laser and its properties – Spontaneous and stimulated emission - Einstein's coefficients - Population inversion – Pumping – The principle pumping schemes – Gas laser (Co_2 laser) – Solid state laser (Nd-YAG laser) - Hologram -construction and reconstruction process – General ideas of optical fibre – Numerical aperture and Acceptance angle of fibre – Types of optical fibre - Applications.

UNIT III CRYSTALLOGRAPHY

Crystalline and amorphous solids – lattice and unit cell – seven crystal system and Bravais lattices – Miller indices – d-spacing in cubic lattice - Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Crystal preparation by slow evaporation and Czochralski method - Bragg's law for X-ray diffraction – Laue method – Powder method

UNIT IV QUANTUM PHYSICS

Introduction - Black body radiation-Planck's hypothesis- Photo electric effect – Compton effect -Wave nature of matter- de-Broglie waves – Davisson and Germer experiment, Shrodinger's wave equation (Time dependant and time independent equations)- particle confined in a one dimensional potential well – Eigen values and Eigen functions

UNIT V PROPERTIES OF MATTER AND THERMAL PHYSICS

Elasticity- Hooke's law - Relationship between three modulii of elasticity (qualitative) – stress -strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever – Young's modulus by uniform bending- I-shaped girders

Specific heat capacity - definition - determination of specific heat capacity of liquid by Newton's law of cooling. Thermal conductivity – Forbe's and Lee's disc methods

Text Books

1. Dr. S. Selvanayagam, Dr. P. Mani, Engineering physics – I, Dhanam publications, Chennai
2. Gaur. R. K., and Gupta. S. L., Engineering Physics, Dhanpat Rai & Sons,New Delhi, 2009.

Reference books

1. D. Halliday, R. Resnick and J. Waler., Fundamentals of Physics, Wiley and Sons, New York, 2001.
2. William T. Silfvast, Laser Fundamental, Cambridge University Press, New York, 2004.
3. Arthur Beiser, Concepts of Modern Physics, Tata McGraw – Hill Publishing Company Limited, New Delhi, 5th Edition, 2000

<table>
<tr><td rowspan="3">CHY106- CHEMISTRY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To make the students to learn the basic science behind the testing of water and to make the students to gain some basic about the theory behind the corrosion and analyzing using spectroscopy, scale measurements. To make the students to learn about the PVC, polymers and biomolecules.

Course outcome(s)

CO1: Learn the techniques of purification of water

CO2: Explain the principles of chemical & electrochemical reactions and prevention of corrosion of materials

CO3: Explain the principles and generation of polymer materials and composites.

CO4: Discuss the principles, instrumentations and applications of analytical techniques

CO5: Enumerate the structures and properties of bio molecules and learn principle of synthesis of nano particles.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	3	2	2		2		2	2		1	2		
CO2	2	3				1	3		3	3	3		2		
CO3	2	2	1	1	2	2			2	2		1	2		
CO4	2	3	2			1	2		2	2		1	2		
CO5	2	2	1			1							2	2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

WATER

Water quality parameter (Industry and Drinking Water) - Hardness, Definition, Classifications, Expressions, Units of Hardness of Water with respect to $CaCO_3$, Problems -Estimation of Hardness by EDTA Method (Theory Only) - Definition of Alkalinity (Theory Only) - Boiler feed water - Requirements, Disadvantages of using hard water in boilers, Removal of boiler scales and sludge - Water Softening - Zeolite Process, Demineralization (Ion – Exchange Process), Desalination

CORROSION SCIENCE AND CONTROL ENGINEERING

Corrosion - definitions, electrode potential - Principles of Dry and Wet Corrosion, Factors Influencing rate of corrosion, Types of Corrosion - Corrosion Control – Impressed Current Cathodic Protection and Sacrificial Anodic Protection Method - Corrosion Inhibitors – Protective Coatings, Surface conversion coatings, organic coatings (paints)

POLYMERS

Introduction, Classification, Difference Between Thermoplastic and Thermosetting Plastics - Properties of Plastic - Degree of Polymerization –

Types of Polymerization (Mechanism) - Phenol Formaldehyde Resin, Epoxy Resin, polyurethanes, Teflon -Amino Resins (Urea Formaldehyde, Nylon.11, Nylon.66 and Nylon 6), PET, PVC – Composites - Definition, characteristics, Constituent. Types- Fibre reinforced plastics (FRP), Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMMC), Properties and Applications

INSTRUMENTAL METHODS OF ANALYSIS

Electro Magnetic Radiation - Absorption of Radiation, Beer - Lambert's Law – UV-Visible spectroscopy – IR Spectroscopy - Principle and Instrumentation (Black Diagram Only) Estimation of Iron by Colorimetry – Flame Photometry, Principle and Instrumentation (Block Diagram Only), Estimation of Na by Flame Photometry - Atomic Absorption Spectroscopy, Principle and Instrumentation (Block Diagram Only), Quantitative Estimation of Nickel by Atomic Absorption Spectroscopy

BIOMOLECULES AND NANOTECHNOLOGY

Carbohydrates - Classification, Synthesis, Structure and Properties of Glucose and Sucrose – Polysaccharides, Starch and Cellulose - Amino Acids - Polypeptide linkages, Structure and Properties of DNA and RNA - Enzyme Catalysis - Kinetics and Mechanism –Nanotechnology - Introduction, Preparation, Characterization and Application

TEXT BOOKS

1. Jain, P.C., Monika Jain, Engineering Chemistry, Dhanpat Rai Publishing company (P) Ltd., New Delhi, 14th Edition, 2002
2. Sharma, B.K., Industrial Chemistry, Goel Publishing House, Meerut, 12th Edition, 2001

REFERENCES

1. Puri, B.R., Sharma, L.R., Principles of Physical Chemistry, Shoban Lal Nagin Chand and Co., Jalandhar, 40th Edition, 2003
2. Vogel, A.I., A text book of Quantitative Inorganic Analysis, ELBS, London, 3rd Edition, 2000
3. Mick Wilson and Kamali Kannangara, Nanotechnology: Basic science and emerging
4. Technology, Overseas India Pvt. Ltd. Press, New Delhi, Ist Edition, 2005
5. Bandyopadhyay, A.K., Nano Materials, New Age International Publishers, New Delhi, 1st Edition, 2007

MEC101 ENGINEERING DRAWING	Credits			
	L	T	P	Total
	1	0	3	2
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type**: Theory			

Course Objective(s)

This course aims to introduce the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products, Demonstrate skills in interpreting, and producing engineering drawings accurately and to give exposure to national standards relating to engineering drawing

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the basic principle of engineering drawing to read and create an engineering drawing using standard views and convert pictorial (3-D) drawing to orthographic (2-D) drawing.

CO2: Demonstrate the principle of projection in all the four quadrant and apply the knowledge in projection of points, in particular first angle projection for straight lines and planes.

CO3: Illustrate the principle and application of solids and its sectioning.

CO4: Apply the basic concepts of development of surfaces for all types of solids.

CO5: Outline the basic knowledge in isometric projection and convert into pictorial drawings.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2										2	1	
CO2		3			2							3	3	2	
CO3	2		3										3	2	
CO4	1	2										1	3	2	
CO5	3		3									1	3	2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Importance of graphics – use of drafting instruments – BIS conventions and specifications – size, layout and folding of drawing sheets – lettering dimensioning and scales - orthographic principles – missing view - free hand sketching in first angle projection from pictorial views.

PROJECTION OF POINTS, STRAIGHT LINES AND PLANES

Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations, projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes.

PROJECTION OF SOLIDS AND SECTION OF SOLIDS

Projection of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method – types of section – full section and half section -conventional section lines - section of simple solids like prisms, pyramids, cylinder and cone in vertical position by cutting planes inclined to any one of the reference planes, obtaining true shape of section

DEVELOPMENT OF SURFACES

Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones

ISOMETRIC AND PERSPECTIVE PROJECTION

Principles of isometric projection – isometric view and projections of simple solids, truncated prisms, pyramids, cylinders and cones - Orthographic to isometric view – Introduction to perspective projection.

Text Book

1. Basant Aggarwal and C. Aggarwal, Engineering Drawing, Tata McGraw-Hill publishing company,New Delhi , 2008

References

1. Shah, M.B., and Rana, B.C., Engineering Drawing, Pearson Education, New Delhi, 2005.
2. Nataraajan, K.V., A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006.
3. Bhatt, N.D., Engineering Drawing, Charotar publishing House, New Delhi, 46th Edition, 2003.

4. Luzadder and Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt Ltd, New Delhi, XI Edition, 2001.
5. Venugopal, K., Engineering Graphics, New Age International (P) Limited, 2002.

<table>
<tr><td rowspan="3" colspan="2">CIV101 BASIC CIVIL AND MECHANICAL ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="5">Course Category: Basic Engineering
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of undergoing this course is to develop basic understanding the topics in Mechanical and Civil engineering.

Course Outcome(s)

CO1: Ascertain the quality of the building materials and able to identify the building components with ease.

CO2: Describe the basic surveying techniques for measurement of areas and also able to differentiate different transportation system.

CO3: Ability to describe and familiarize with various components in boilers and turbines.

CO4: Ability to familiarize with various energy sources based power plants and IC engines.

CO5: Ability to familiarize with different manufacturing process and machines.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	2		2			2	2			2		
CO2	2	3	3	2	2		2			2	1		2		
CO3	2	2	2	2			1	2		2		2	2		
CO4	2	2	2		2		2					2	2		
CO5	2	2	2	2									2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

CIVIL ENGINEERING BUILDINGS

Characteristics of good building materials such as stones, bricks, plywood and ceramic tiles, timber, cement, aggregates and concrete - Basic functions of buildings – Major components of buildings – Foundations - Purpose of a foundation – Bearing capacity of soils – types of foundations. Proper methods of construction of Brick masonry – Stone masonry – Hollow Block masonry. Beams – Lintels – Columns – Flooring – Damp proof course – surface finishes – Doors and windows – Roofing.

TRANSPORTATION ENGINEERING

Principles and Classification of surveying, Chain surveying, Compass surveying and leveling - Importance of roads – Classification of Highways –water bound macadam, bituminous and cement concrete roads –. Railways - Importance of railways – Gauges – Components of a permanent way. Bridges - Components of Culverts – Causeways, Slab Bridge, T-beam and slab bridge, Suspension bridge

MECHANICAL ENGINEERING BOILERS AND TURBINES

Boilers - boiler mountings and accessories – Cochran boiler, Locomotive boiler, Babcock and Wilcox boiler, fire and water tube boilers - Steam turbine - single stage impulse turbine, Parson's reaction turbine, difference between impulse and reaction turbines.

POWER PLANTS AND INTERNAL COMBUSTION (IC) ENGINE

Classification of power plants – steam, nuclear, diesel and hydro power plants - Alternate sources of energy - solar, wind, tidal, geothermal, ocean thermal energy conversion. – IC engine - components, working of four and two stroke petrol and diesel engines.

PRODUCTION TECHNOLOGY

Metal casting and forming process –patterns, moulding, melting of cast iron, casting – forging – rolling – extrusion – drawing - Metal joining process - welding – arc welding, gas welding, brazing and soldering - Metal machining – lathe, drilling machine, milling machine, shaping machine, planing machine, introduction to Computer Numerical Control machining.

TEXT BOOK

1. Shanmugam, G,, and Palanichamy, M.S., Basic Civil and Mechanical Engineering, Tata McGraw Hill Publishing Co., New Delhi, 1996.

REFERENCES

1. Khanna, K., Justo C E G, Highway Engineering, Khanna Publishers, Roorkee, 2001
2. Arora S.P. and Bindra S.P., Building Construction, Planning Techniques and Method of Construction, Dhanpat Rai and Sons, New Delhi, 1997.
3. Venugopal K., Basic Mechanical Engineering, Anuradha Publications, Kumbakonam, 2000.
4. Shanmugam G., Basic Mechanical Engineering, Tata McGraw
5. Hill Publishing Co.,New Delhi, 2001.

MEC181 WORKSHOP	**Credits**			
	L	**T**	**P**	**Total**
	0	**0**	**3**	**1**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type:** Laboratory Course			

Course Objective(s)

To make the student familiarize with the workshop process and to gain some basic knowledge about the carpentry, fitting and etc

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Develop simple wooden joints using wood working tools..

CO2: Demonstrate and fabricate metal joining with simple sawing process.

CO3: Gain knowledge of development of sheet metal models with an understanding of their application.

CO4: Carry out various machining techniques like drilling, tapping, etc..

CO5: Describe the basis of welding, foundry, smithy and plumbing works.

Mapping of Course Outcome(s):

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2				2								2		
CO2	2				1								2		
CO3	2				2								3		
CO4				2				1					3		
CO5					1								3		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

45 Hours

Course Topics

CARPENTRY

Carpentry tools - practice in marking, sawing, planing and chiseling – making simple joints: lap joint, T-joint, dovetail joint, mortise and tenon joint.

FITTING

Fitting tools - practice in marking, filing, punching, hacksawing - fitting to size and drilling - making of simple mating profiles: V, square, dovetail, half round joints.

SHEET METAL

Study of press, die and tools - sheet metal layout - development of lateral surfaces -simple exercises: blanking, forming, bending and flanging.

DRILLING

Drilling and tapping in drilling machines

DEMONSTRATION ON

- Welding operations like butt joint and lap joints in Arc welding
- Foundry operations like mould preparation for split pattern
- Smithy operations like the production of hexagonal bolt

- Preparation of plumbing line sketches – basic pipe connections involving the fittings like valves, taps, couplings, unions, reducers, elbows and other components used in household fittings.

Reference(s)

1. Suyambazhahan S, “Engineering Practices”, Eastern Economy Edition, 2013.

CHY181 CHEMISTRY LABORATORY	**Credits**			
	L	**T**	**P**	**Total**
	0	**0**	**3**	**1**
Pre-requisite: Nil	**Course Category:** Basic Sciences **Course Type:** Laboratory Course			

Course Objective(s):

Know to carry out basic chemical engineering process

Course Outcomes:

CO1: Estimate the strength of the solution by chemical and instrumental methods.
CO2: Analyze the water quality parameters of given water samples .
CO3: Apply the chemical engineering concepts in solving engineering problems
CO4: Analyze of hydrochloric acid, ferrous iron and mixture of acid using various titration methods
CO5: Analyze of iron by instrument method

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1		2	2					1	2			1	1	
CO2	1		2	2		2	2		1	2			1	1	
CO3	3	1	2	2		2		2		2		1	1	1	
CO4				1	1								1	1	
CO5		1											1	1	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

List of experiments

1. Preparation of standard and buffer solutions.
2. Estimation of hardness of water sample by EDTA method
3. Determination of dissolved oxygen in a sample of water.
4. Estimation of chloride and fluoride ion in water sample.
5. Determination of alkalinity of water sample.
6. Estimation of hydrochloric acid by pH titration
7. Estimation of ferrous ion by potentiometric titration

8. Estimation of mixture of acid by conduct metric titration
9. Estimation of iron by spectrophotometric method.
10. Flame photometry – Determination of Na and K

Reference

Lab Manual prepared by KLU faculty

SEMESTER -II

HSS102- ENGLISH FOR TECHNICAL COMMUNICATION II	**Credits**			
	L	**T**	**P**	**Total**
	2	**0**	**0**	**2**
Pre-requisite: Nil	**Course Category:** Humanities and Social sciences **Course Type:** Theory			

Course Objective(s)

- To help the learner construct simple sentences to express Engineering concepts.
- To help the learner express orally in understandable English.
- To help the learner familiarize in official communications like Notices, Circulars and Minutes.
- To help the learner prepare project proposals, and reports of industrial events like expansion, annexation, lockouts and fire accidents

Course Outcomes

CO 1: Apply the classroom inputs into his/ her day- to- day situations

CO 2: Frame Error- free sentences to demonstrate some experience like watching movies.

CO3: Learn to use Mechanics of writing

CO4: Learn to compose professional writings like Business Letters, Minutes, Circulars, and Notices etc…

CO5: Prepare call letters for conferences, Brochures, Welcome Address, Vote of Thanks etc….

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1										2					
CO2						3									
CO3						3									
CO4						3				2					
CO5								2		2	2				

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

GRAMMAR AND VOCABULARY

Grammar and vocabulary - introduction to grammatical models - proper use of tenses, concord, voice, articles, punctuation, and modal auxiliaries.

RECEPTION SKILLS

Listening and language development - improving listening skills - comprehension practice - comprehend classroom lectures, simple technically oriented passages - listening to news bulletins, pre-recorded talks, different speech styles, comprehending the essential meaning - physical and psychological barriers to listening - steps to overcome the barriers - practice in note-taking while listening.

SPEAKING TECHNIQUES

Speaking practice - improving conversing skills - improving self-expression - developing confidence and fluency in oral communication - physical and psychological barriers to speaking - steps to overcome the barriers - formal and public speaking practice - extemporary talk practice - speech process - fluency and accuracy in speech - developing persuasive speaking skills - conversation in a given milieu, social and cultural surroundings - practice in giving small talks on local topics for a minute or two - goal oriented group discussion - participating in seminars - independent and effective communication.

READING STRATEGIES

Reading comprehension - vocabulary extension methods - speed reading practice - technical and non-technical materials - practice in various reading techniques – skimming - scanning, eye reading - looking for specific information - comprehending the given passages, technical information.

WRITTEN COMMUNICATION

Basic grammatical structures - alphabet of other languages - paragraph writing - expressing the idea in writing - avoiding and correcting common errors - effective writing techniques - brevity, clarity, objectivity and simplicity - discourse writing - definition, description, instruction - note-making - proof reading - mechanics of writing - writing formal, informal letters, technical reports - reference skills - using dictionary better.

TEXT BOOKS

1. Rizvi M Ashraf, Effective Technical Communication, Tata McGraw-Hill, 2005.
2. Rutherfoord Andrea J, Basic Communication Skills for Technology, Pearson Education, 2002.

REFERENCES

1. Deborah C Andrews, Margaret D Bickle, Technical Writing - Principles and Forms, Macmillan, 1978.
2. Manivannan G, English for Engineers - A Book on Scientific and Technical Writing, Govi Publications, 2005.
3. Sarah Freeman, Written Communication in English, Orient Longman, 2000.
4. Thomson A J and AV Martinet, A Practical English Grammar, OUP, 4th Edition, 1986.
5. Tom Hutchinson, Alan Waters, English for Specific Purpose, Cambridge University Press,

<table>
<tr><td rowspan="3">MAT102- MATHEMATICS II</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Acquire knowledge to use multiple integrals to find area and volume of surface and solids respectively Have a good grasp of analytic functions, complex integration and their interesting properties and its applications.

Course Outcomes

CO1: Outline the basic concepts of engineering mathematics.
CO2: Contrast the improved problems evaluation technique.
CO3: Choose an appropriate method tosolve a practical problem.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		2		2								3		
CO2	3		3	2	2								3		
CO3	3	1		2	3								3		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

SEQUENCES AND SERIES

Convergence and divergence of infinite series – series of positive terms – comparison, D'Alembert's ratio, Raabe's and Cauchy's root tests – Convergence of alternating series – Leibnitz's test (proof of theorems and tests not included) – elementary notions of absolute and conditional convergence - Power series – Taylor's theorem(one variable).

ANALYTIC FUNCTION AND CONFORMAL MAPPING

Function of a complex variable – Analytic function – Necessary conditions – Cauchy – Riemann equations – Sufficient conditions (excluding proof) – Properties of analytic function – Harmonic conjugate – Construction of Analytic functions - Conformal mapping - w = z+a, az, 1/z, e^z , sin z, cos z and bilinear transformation – fixed points – cross ratio.

COMPLEX INTEGRATION

Statement and application of Cauchy's integral theorem and integral formula – Taylor and Laurent expansions – Isolated singularities – Residues - Cauchy's residue theorem - Contour integration over unit circle and semicircular contours (excluding poles on boundaries)- evaluation of real integrals using contour integration.

MULTIPLE INTEGRALS

Review of Riemann integrals - Double integration – Cartesian and polar coordinates – change of order of integration – change of variable between Cartesian and polar – area as double integral – Triple integration in Cartesian, cylindrical and spherical polar coordinates – volume as triple integral.

VECTOR CALCULUS

Gradient, Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proof) – Simple applications.

TEXT BOOKS

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore , 8th Edn., 2001.
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume II, Scitech Publications (India) Pvt. Ltd., Chennai, 1st Edn., Reprint 2000, 1999.

REFERENCES

1. Grewal, B.S.,Grewal, J.S., Higher Engineering mathematics, Khanna Publishers, New Delhi, 37th Edn., 5th Reprint 2004, 2003.
2. Venkataraman, M. K., Engineering Mathematics First Year, The National Publishing Company, Chennai, 2nd Edn., Reprint 2001, 2000.
3. Venkataraman, M. K., Engineering Mathematics –III A, The National Publishing Company, Chennai, 11th Edn., Reprint 2002, 1998.

PHY132- PHYSICS II	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: Physics-I	**Course Category:** Basic Sciences **Course Type:** Theory			

Course Objective(s)

- To gain knowledge and understand about the solid state materials, conducting, semiconducting, super conducting, di electric, magnetic, optical materials
- To learn the latest developments on new engineering materials
- To gain some knowledge about the different material characterization techniques

Course Outcomes

- **CO- 1:** Understanding the free electron theories, the electron behavior in solids and cooper pair electron behavior in superconducting materials in developing technologies.
- **CO- 2:** To learn the importance of semiconducting materials in engineering fields by projecting the view of energy bands.
- **CO- 3:** To gain the knowledge about various kinds of magnetic and dielectric materials and applications in advanced technologies.
- **CO-4:** To learn how to prepare some new materials like metallic glasses, nano-materials, shape memory alloys, nonlinear materials to improve the technology.
- **CO-5:** Adaptability to new developments of materials in science and technology by characterizing with sophisticated instruments

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2	2			1						3	2	
CO2	2		2										3	2	
CO3	2		2				1						3	2	
CO4	2		2	2									3	2	
CO5	2		2				1						3	2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

UNIT – I CONDUCTING AND SUPERCONDUCTING MATERIALS

Classical free electron theory of metals – drawbacks - Quantum free electron theory of metals and its importance (Qualitative) - Fermi distribution function – Density of energy states and carrier concentration in metals – Fermi energy – Band theory of solids – classification of solids

Superconductor - definition – Meissner effect – type I & II superconductors – BCS theory (qualitative) – high temperature superconductors – Josephson effect – quantum interference (qualitative) – SQUID – applications.

UNIT – II SEMICONDUCTING MATERIALS

Intrinsic semiconductors - carrier concentration (derivation) – Fermi energy – Variation of Fermi energy level with temperature - Mobility and electrical conductivity – Band gap determination - Extrinsic semiconductors - carrier concentration in n-type (derivation) - Variation of Fermi level with temperature and impurity concentration – Variation of Electrical conductivity with temperature – Hall effect – Experiment and applications of Hall effect

UNIT – III MAGNETIC AND DIELECTRIC MATERIALS

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown

UNIT – IV ADVANCED MATERIALS

Metallic glasses – Preparation, properties and applications - Shape memory alloys –characteristics, properties and applications of Nitinol – Nanomaterials - introduction and properties – synthesis – chemical vapour deposition – pulsed laser deposition – Non linear materials – Harmonic generation - Bio-materials – Classification and applications - Liquid Crystals: types – nematic, cholesteric, smectic – modes: dynamic scattering, twisted nematic – display systems

UNIT – V MATERIALS CHARACTERIZATION

Structural Analysis: X-ray diffraction methods - Powder method – Scherrer formula for estimation of Crystallite size. Morphology: Scanning electron microscopy (SEM) - Atomic force microscopy - Instrumentation and result analysis. Thermal Analytical Techniques: Principles, methodology and use of differential thermal analysis and thermo gravimetric analysis

TEXT BOOKS

1. Selvanayagam. S. & Mani. P., Engineering Physics-II, DHANUM Publications, Chennai, 2014.

REFERENCES

1. Raghavan, V., Materials Science And Engineering: A First Course, 5th Ed, Prentice- Hall of India Pvt. Ltd., 2009
2. William F.Smith, Foundations of Materials Science and Engineering, 3rd Edition, McGraw-Hill, New York, 2003.

3. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiely, 2004
4. Cullity B. D, Stock. S.R., Elements of x-ray diffraction. Prentice Hall, 3rd edition, 2001
5. John C. Vickerman, Ian Gilmore, Surface Analysis: Principle Techniques" John Wiley & Sons, 2nd edition, 2009.
6. Hobarth Willard, Lynne Merritt, John Dean, Instrumental Methods of Analysis, Wadsworth Publishing Company, 7 Sub edition, 1988.
7. Introduction to thermal analysis by M.E. Brown, Springer, 2001.
8. Thin Film Fundamentals, A.Goswami, New Age International Publishers, New Delhi, 2006

<table>
<tr><td rowspan="3">EEE101 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Engineering
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiarize the students on basics of electronics and electrical engineering like working and characteristics of electron devices , electrical machines

Course outcomes

CO1: Interpret the basic estimation of electrical quantities

CO2: Illustrate the basic electrical and electronics circuits

CO3: Contrast the DC and AC single phase and three phase fundamentals

CO4: Demonstrate the working principle of various Electrical AC and DC machines

CO5: Classify various Analog type measuring instruments and house wiring.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										3		3	
CO2	3				3							3		3	
CO3	3											3		3	
CO4	3						3							3	
CO5	3						2							3	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

ELECTRICAL CIRCUITS

Introduction to electric circuits – laws of electric circuits– Ohm's Law, Kirchoff's Laws– analysis of DC circuits–mesh, nodal –introduction to AC circuits– average Value, RMS value, power and power factor– analysis of 3 phase AC circuits – balanced and unbalanced circuits.

ELECTRICAL MACHINES

DC Machines –principle of operation–DC generators–emf equation, characteristics, types– DC motors–shunt, series, compound– single phase transformer – principle of operation, emf equation, phasor diagram – induction motors–single phase, three phase–alternators–principle of operation, emf equation, characteristics

ELECTRICAL MEASUREMENTS

Moving coil –ammeter, voltmeter – moving iron instruments – ammeter, voltmeter – dynamometer – wattmeter, energy meter

BASIC ELECTRONICS

Semiconductor devices – introduction, construction, types – pn junction diode –working principle, characteristics– zener diode– working principle, characteristics uni–junction transistor– operation, characteristics –field effect transistor– operation, characteristics– bipolar junction transistor– operation, characteristics–applications– half wave and full wave rectifiers

DIGITAL ELECTRONICS

Introduction to binary number system–logic gates –AND, OR, NOT, NAND, NOR, exclusive OR–boolean algebra– combinational circuits – half adder, full adder, half subtractor, full subtractor

INTEGRATED CIRCUITS

Operational amplifier–introduction, DC characteristics, AC characteristics–types of operational amplifier–inverting, non–inverting–applications– scalar, adder, Subtractor, differentiator, and integrator

TEXT BOOKS

1. Edward Hughes., Electrical &Electronics Technology, Pearson Education ltd, 9th edition, 2005.
2. Kothari.D.P.,and.Nagrath.I.J., Basic Electrical Engineering,TataMcGraw Hill Second Edition.

REFERENCES

1. Malvino,A P., Electronic Principles, TataMcGraw Hill International, 1998.
2. Vincent Del tora.,Electrical Engineering fundamentals, Prentice hall of India , 2nd edition 2003.
3. Muraleedharan.K.A., Muthusubramanian .R., and Salivahanan .S., Basic Electrical and Electronics and Computer Engineering, Tata McGraw Hill, 1997.

<table>
<tr><td rowspan="3">CHY102- ENVIRONMENTAL SCIENCES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Imparting knowledge on principles of environmental science and engineering Understanding the concepts of eco systems, bio diversity and impact of environmental pollution. Awareness on value education, population and social issues.

Course Outcome (s)

CO1: Know the importance of environmental studies and methods of conservation of natural resources.

CO2: Describe the structure and function of an ecosystem.

CO3: Identity the values and conservation of bio-diversity

CO4: Explain the causes, effects and control measures of various types of pollutions.

CO5: Select the appropriate methods for waste management

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2	3						2		
CO2						1	3	2					1		
CO3	1					3	3						1		
CO4		2				3		1					3		
CO5			2			3	3						2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

NATURAL RESOURCES

Definitions – scope of environmental sciences - forest resource – food resource – land resource – water – mineral resources - utilization of natural resource, impact on environment – conservation of natural resources.

ECOSYSTEM AND BIODIVERSITY

Concept – structure and function – energy flow in ecosystem – ecological succession – food chain – food web, ecological pyramids – biodiversity, definition, values, threats to biodiversity, conservation of biodiversity.

ENVIRONMENTAL POLLUTION

Definition, causes, effects and control measures of air, water and soil pollution – thermal and nuclear pollution.

MANAGEMENT OF ENVIRONMENTAL POLLUTION

Solid waste management – treatment methods adopted for municipal sewage and industrial effluent – hazardous and biomedical waste management.

TOOLS FOR ENVIRONMENTAL MANAGEMENT

Environment impact assessment – precautionary and polluter pay principle - constitutional provision – (air, water and forest) - waste minimization techniques, cleaner technology options, bioremediation.

TEXT BOOK

1. Dhameja, S.K., Environmental engineering and Management, S. K. Kataria and sons, New Delhi, 1st edition 2004.

REFERENCES

1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad, 1st edition 2001.
2. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co. USA, 2nd edition 2004.
3. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media., New Delhi, 2nd edition 2004.
4. Masters, G. M., Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi, 2nd edition 1997
5. Henry, J. G. and Heike, G. W. Environmental Science and Engineering, Prentice Hall International Inc., New Jersey, 1st edition 2005.

<table>
<tr><td rowspan="3">CSE102-PROGRAMMING LANGUAGES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic engineering
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To develop the basic programming skills
- To understand the basics concepts of arrays and pointers To implement the file concepts and operations.

Course outcomes

CO1: Demonstrate the knowledge of the steps in the development of computer program.

CO2: Formulate the structure of C program.

CO3: Apply the control structures, arrays strings, functions and pointers in C programming

CO4: Demonstrate proficiency in computer programming.

CO5: Implement file handling applications and understand the basics of Unix operating systems.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1												2
CO2	3	3	2												2
CO3	3				2										3
CO4			2	2	2	2	2								2
CO5															

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course topics

BASIC ELEMENTS OF C & CONTROL STRUCTURES

Introduction to C programming , **C** character set , Identifiers, keywords, data types, constants, variable, declarations, expressions, statements, symbolic constants-Operators and Expressions, Operator Precedence and associativity of operators-Input and Output Functions, Library Functions –Header Files, Simple Computational problems-Decision Making: if statement - if-else statement - else-if ladder- Looping statements - While –do-while- Still more looping-For statement, Nested control statements , Switch statement, break statement-operator - Continue statement – go to statement – Problems using Control Structures.

FUNCTIONS, PROGRAM STRUCTURES & ARRAYS

Prototypes and Functions – Declaring, defining and accessing Functions- Parameter passing methods-Recursion - Storage Classes - Automatic Variables -External Variables – Static and Register Variables – Programs using functions. Defining and Processing an Array - Passing Arrays to Functions - Multidimensional Arrays - Arrays and Strings - Enumerated data types-Programs using sorting, searching and merging of arrays.

POINTERS, STRUCTURES & UNIONS

Pointer Fundaments - Pointer Declarations - Passing Pointers to Functions - Arrays and Pointers - Pointers and One-Dimensional Arrays - Pointers and Multidimensional Arrays - Operations on Pointers - Pointers and Structures - Dynamic Memory Allocation – Command Line Arguments – Programs using Pointers with Functions, Arrays and & Structures. Defining a Structure - Processing a Structure - User-Defined Data Types – Union – Nested structure - Structures and Pointers - Passing Structures to Functions - Self Referential Structures.

DATA FILES & DATA STRUCTURES

Opening and Closing a Data File - Creating a Data File - High Level File Operations - Processing and Updation of Data Files - Unformatted Data Files - Low Level Programming – File Handling Programs. Linked List – Creation, Insertion and Deletion of elements - Stack and Queue implementation using Linked List.

UNIX BASICS & SHELL PROGRAMMING

Shell Fundamentals - Shell Commands - Shell Decisions and Repetitions - Command line usage - Wildcard expansion - Redirection of I/O, pipes and filters. Shell Programming - Simple scripts - Specifying the interpreter - Shell variables - The Environment - Control flow; test, if, for, while, case - Command substitution - Signal catching - Shell functions - Aliases - Reading from the Standard I/P - Start up Files - basename and dirname - Expression evaluation.

TEXT BOOKS

1. Byron S. Gottfried, Theory and Problems of Programming with C, Tata McGraw Hill, Second Edition, 1996.
2. Lowell Jay Arthur and Ted Burns, UNIX Shell Programming, John Wiley & Sons Canada, Ltd, Fourth Edition, 1997.
3. Deshpande P.S, Kakde O.G, C & Data Structures , Dreamtech Press, First edition, 2004

REFERENCES

1. Brian Kerninghan W, Dennis Richie M, The C Programming language, Pearson Education,2005.
2. Johnsonbaugh R.and Kalin M, Applications Programming in ANSI C, Pearson Education, Third Edition, 2003.
3. Behrouz A.Forouzan and Richard Gilberg F, A Structured Programming Approach Using C, Brooks - Cole Thompson Learning Publications, Second Edition, 2001.
4. Bruce Molay, Understanding UNIX / LINUX Programming: A Guide to Theory and Practice, Prentice Hall, First Edition, 2002.
5. Glass, G., Ables, K. UNIX for Programmers and Users, Prentice Hall, 1999.
6. Stephen Kochan and Patrick Wood, UNIX Shell Programming, Pearson Education, Third Edition, 2003.

<table>
<tr><td rowspan="3">MEC103 ENGINEERING MECHANICS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Engineering
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To understand the vectorial and scalar representation of forces and moments.
- To apply static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions.
- To comprehend the effect of friction on equilibrium.
- To understand the properties of surfaces and solids
- To write the dynamic equilibrium equation

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the vectorial and scalar representation of forces and moments and apply static -equilibrium of particles in 2D and 3D

CO2: Apply static equilibrium of rigid bodies in two dimensions and in three dimensions.

CO3: Contrast the effect of friction on equilibrium.

CO4: Illustrate the importance of properties of surfaces and solids.

CO5: Demonstrate the dynamic equilibrium equation.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1										2		
CO2	3	2	1										2		
CO3	3	2	1										1		
CO4	2	2	2										1		
CO5	2		1												

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

Unit 1: Statics of Particles **9 Hours**

Six Fundamental principles and concepts - vector algebra- basics, concurrent and non-concurrent coplanar forces - resultant and resolution of forces- static equilibrium of particles in 2-D and 3-D

Unit 2: Static of Rigid Bodies **9 Hours**

Moment about point and about axis - Varignon's theorem - Static equilibrium of rigid body in 2-D and 3-D, free body diagram, supports and reactions - Problem formulation concept in 2-D and 3-D-Ball and socket joint.

Unit 3: Friction **9 Hours**

Frictional forces- Types- laws of dry friction- simple contact friction - Sliding block, wedges, ladder friction - rolling resistance – Examples.

Unit 4: Properties of Surfaces and Solids **9 Hours**

Centre of gravity – T section, I section- Centroids of lines - areas, volumes, composite bodies, - Area moment of Inertia – T section, I section-principal moment of inertia

Unit 5: Dynamics of Particles **9 Hours**

Introduction – Kinematics of particles – Displacements, velocity and acceleration, their relationship - Equations of motions– Rectilinear motions - relative motion – Curvilinear motion –Kinetics of particles - Newton's second law – Equations of motion – rectangular components – Work Energy equation of particles

Text Book(s)

1. Beer, F.P., and Johnson, E.R., Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill, Tenth Edition in SI units

Reference(s)

1. Merriam, J.L., Engineering Mechanics, Volume I – Statics, and Volume – II, Dynamics 2/e, Wiley International, Seventh Edition.
2. Irving, H., Shames, Engineering Mechanics, Statics and Dynamics, Prentice Hall of India Ltd., Fourth Edition

PHY181-PHYSICS LABORATORY	**Credits**			
	L	**T**	**P**	**Total**
	0	**0**	**3**	**1**
Pre-requisite: Nil	**Course Category:** Basic Sciences **Course Type:** Laboratory			

Course Objective(s)

To develop an ability to identify, formulate and solve engineering problems using basic physics.

Course Outcome(s)

CO1: Develop the observation and analytical skills
CO2: Explain the various properties of matter
CO3: Analyze the thickness of an object and velocity of uitrosonic waves.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1				2	1			3	3	3			3	2	
CO2	3			1				3	3	3				2	
CO3	3			1	1			3	3	3			2	2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

1. To determine the acceleration due to gravity using Compound Pendulum
2. To determine the Rigidity Modulus of wire using Torsional Pendulum
3. To find thickness of the given two glass plates using single optic lever
4. To determine the thermal conductivity of a bad conductor – Lee's disc method.
5. To determine the refractive index of the material of the prism
6. To find the prominent wave length of mercury spectrum using grating
7. To determine the particle size using Laser
8. To determine the coefficient of viscosity of the liquid by Poiseuille's method
9. To determine the young's modulus of given material using Uniform Bending

10. To Determine the thickness of a given material using Air wedge method
11. To determine the focal length of a biconvex lens using Newton's Rings method
12. To determine the velocity of ultrasonic waves in the liquid using ultrasonic Interferometer

Reference

Lab Manual prepared by KLU faculty

<table>
<tr><td rowspan="3">CSE181-PROGRAMMING LANGUAGES LABORATORY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Basic Engineering
Course Type: Laboratory</td></tr>
</table>

Course Objective(s)

This course provides students with a comprehensive study of the C programming language, which provide programmers with the means of writing efficient, and modular code. This course also emphasis on problem solving and algorithm implementation using a universal subset of the C programming language C has directly or indirectly influenced many later languages such as C++,C#, Java, JavaScript, PHP, Python, and Unix's C Shell.

Course Outcomes

CO1: Develop efficient algorithms for real world problems.

CO2: Demonstrate solutions to real world problems using basic programming concepts in C

CO3: Design solutions to real world problems using advanced programming concepts like pointers, structures and files

CO4: Evaluate solutions in different test cases.

CO5: Apply the C-Programming concept of Array, structures and file management.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3								1	3					3
CO2		2	3	2				2	1						2
CO3					1				1						2
CO4	1		1												
CO5		1									1				

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

List of experiments

1. **Simple Programs in C**
   Simple interest, compound interest calculation-Solving Quadratic Equation Celsius to Fahrenheit conversion and vice versa.
2. **Programs using Control Structure**
   Sorting three numbers-Reversing a number Sum of digits of a numbe-Finding a number is palindrome or notFinding factorial of a number-Amstrong Number-Simple Calculator
3. **Programs using user-defined functions**
   Finding factorial of a number -Finding the smallest & largest number-Finding square root of a number.
4. **Programs using recursive functions**
   Factorial of a number-Fibonacci series generation-Finding GCD.
5. **Programs using Single Dimensional Array**
   Finding the average of ‘n’ numbers-Sorting ‘n’ numbers-Counting no of occurrences of the given no-Merge two arrays into another new array-Searching for an element
6. **Programs using Two Dimensional Array**
   Matrix addition, subtraction, multiplication Sum of rows ,columns, diagonals of a matrix.
7. **Programs on String Manipulation**
   Finding the number of vowels in a group of string-String handling functions-Sorting the string in alphabetical order.
8. **Programs using pointers**
   Finding out the minimum and maximum-values in a list of values using pointers-Sorting ‘n’ numbers- Dynamic memory allocation-Dynamic memory allocation using memory handling functions.
9. **Programs using structure**
   Creating an employee database-Creating Student database

10. **Programs using files**
    Average of n numbers using files-Merging two files

Reference
Lab Manual prepared by KLU faculty

HSS036 SOFT SKILLS - I	**Credits**			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite: Nil	**Course Category:** Humanities and Social Sciences **Course Type:** Theory			

Course Topics

S.No	Course	Module Name	Topics	# hours
1	Remedial English	Foundation	Parts of Speech	2
2			Articles	
3		Delightful Descriptions	Nouns	
4			Adjectives	
5		Double Actions	Verbs	2
6			Adverbs	
7		Meaningful Links	Prepositions	
8			Conjunctions	
9		Yesterday Today Tomorrow	Past Tense	2
10			Present Tense	
11			Future Tense	
12			Special Cases	
13		Matching Blocks	Subject Verb agreement	2
14		Questions and Expressions	Modals	
15			Question Tags	
16	Business English	Professional Communication	Concise Cogent Communication	2
17			Active Listening	2
18			Interact Interpret Respond	2
19		Expositions and discussions	JAM and Extempore-JAM and Extempore- BIKER B {Extempore}- Six Thinking Hats- JAM	2
20	Verbal	Grammar and Vocabulary	Finding Errors Phrase substitution	2
21			Vocabulary	2
22			Idioms and Phrases; Collocations	2
23		Blanks and Jumbles	Fill in the blanks Sentence Completion	2
24			Parajumbles/Jumbled Sentences	2
25		Reading Comprehension	Cloze Passage; Theme Detection	2
26			Reading Comprehension	2

SEMESTER-III

<table>
<tr><td colspan="2" rowspan="3">MAT201 MATHEMATICS III</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MAT101</td><td colspan="5">Course Category: Basic science
Course Type: Theory</td></tr>
</table>

Course Objective(s)
Course Outcome(s)

- To demonstrate how differential equations can be useful in solving many types of problems - in particular, to show how to translate problems into the language of differential equations, to find or numerically approximate the solution of the resulting differential equation subject to given conditions, and to interpret the solutions obtained.
- To study Fourier series and solve boundary values problems.
- To understand Fourier Transform, the convergence issues, relation to Fourier Series.
- To understand the properties of Fourier Transform, use these to derive Fourier Transforms for related signals.
- To know the various definitions of the Fourier Transforms, sufficient conditions for its existence how to compute inverse Fourier Transform.
- To know the various rules (convolution Theorem etc) for the Fourier and z- transform and how to use them

After completing this course, the student will be able to:

CO1: Evaluate integrals and solve boundary value problems using Laplace transform

CO2: Solve standard type of first order partial differential equations and higher order partial differential equations with constant coefficients

CO3: Apply the concept of Fourier series to find the sum of certain series.

CO4: Analyze and evaluate the accuracy of initial value problems.

CO5: Apply the boundary value principles to solving engineering problems.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1		2	2										
CO2	1				1							3			
CO3	2	2			2									1	
CO4	1	2			1								1		
CO5	3	1		2	1							1			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS

Review of open end methods, bracketed end methods - The intermediate theorem (excluding proof) - Iterative method - False position method - Newton – Raphson method for single variable and for simultaneous equations with two variables - Solutions of a linear system by Gaussian, Gauss-Jordan, Jacobi and Gauss – Seidel methods - Eigen value of a matrix by Power method.

INTERPOLATION

Newton forward and backward difference formulae - Newton's divided difference formulae - Lagrange's polynomials - Stirling's Central difference formulae.

NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical differentiation with interpolation polynomials - Numerical integration by Trapezoidal and Simpson's (both 1/3rd and 3/8th) rules - Two and Three point Gaussian quadrature formulae - Double integrals using Trapezoidal and Simpson's rule.

INITIAL VALUE PROBLEMS

Single step Methods – Taylor Series, Euler and Modified Euler, Runge – Kutta method of order four for first and second order differential equations - Multistep Methods-Milne's predictor and corrector method.

BOUNDARY VALUE PROBLEMS

Finite difference solution for the second order ordinary differential equations - Finite difference solution for one dimensional heat equation (both implicit and explicit) , One-dimensional wave equation and two-dimensional Laplace and Poisson equations- Lab assignments for Numerical methods using MatLap / C / C++.

TEXT BOOKS

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 8th Edn. , 2001.
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Numerical Methods, Scitech Publications (India) Pvt. Ltd., Chennai, 2nd Edn., Reprint 2006, 2001.

REFERENCES

1. Jain, M.K., Iyengar, S.R.K., Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd., New Delhi, 4th Edn., 2003.

<table>
<tr><td rowspan="3" colspan="2">MEC201 STRENGTH OF MATERIALS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Engineering Mechanics MEC103</td><td colspan="5">Course Category: Engineering sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Students will be able to understand the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behaviour. Exposures to systematic methods of problem solving techniques. Knowledge on solving structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Analyze the yield strength, ultimate strength, working stresses and thermal stresses in various bars.

CO2: Evaluate two dimensional stresses in shells and cylinders

CO3: Illustrate shear force and bending moment diagram for various types of load.
CO4: Classify bending stress and shear stress distributions in beams.
CO5: Design shafts and springs under torsion.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			2			2							2		1
CO2	1				2	2								2	
CO3	2		2	1							2		1	2	
CO4	3		2	3			2				2	2			
CO5	2		3	1	2										2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

Unit 1: Stress, Strain and Deformation in Solids 12 Hours

Tension, compression and shear stresses – Hook's law – stress-ultimate stress and working stress – elastic constants and relationships between them – composite bars – temperature stresses – strain energy due to axial load – stress due to suddenly applied load and impact load.

Unit 2: Stress and Deformation in 2D Bodies 12 Hours

Two dimensional state of stress at a point – normal and shear stresses on any plane, principal planes and principal stresses – graphical method – two dimensional state of strains at a point, principal strains and their directions – stresses and deformations in thin cylinders and spherical shells due to internal pressure.

Unit 3: Beams and Supports 12 Hours

Types of beams and supports – shear force and bending moment at any cross section, sketching of shear force and bending moment diagrams for cantilever, simply supported and over hanging beams for any type of loading – relationship between rates of loading – shear force and bending moment.

Unit 4: Stresses in Beams 12 Hours

Theory of simple bending – analysis for bending stresses – load carrying capacity of beams – proportioning sections – strain energy due to bending moment – shear stress distribution – strain energy due to transverse shear force.

Unit 5: Torsion and Springs 12 Hours

Elastic theory of torsion – stresses and deformation in solid circular and hollow shafts – stepped shafts – composite shaft – stress due to combined bending and torsion– strain energy due to torsion-deformations and stresses in helical springs – design of buffer springs -leaf springs.

Text Book(s)

1. Popov, E.P., Engineering Mechanics of solids, Prentice Hall of India, New Delhi, 8thEdition 2014.

Reference(s)

1. Kazimi, S. M. A., Solid Mechanics, Tata McGraw Hill Book Co Ltd., 1998.
2. Rajput, Strength of Materials, S. Chand Publications, 2009.
3. Bansal, R. K., Strength of Materials, Laxmi Publications, 4th Edition, 2015

<table>
<tr><td rowspan="3">EEE259 ELECTRICAL DRIVES AND CONTROLS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Basic electrical and Electronics Engineering EEE101</td><td colspan="4">Course Category: Engineering Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To gain knowledge in the operation of classical and modern drives system for both AC and DC Machines. To understand the different starting methods of DC and AC

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Contrast the basic concept of electrical drives, its types and classes of motor duty.

CO2: Outline the basic concepts of different types of electrical machines and their performance.

CO3: Illustrate the different methods of starting D.C motors and induction motors.

CO4: Demonstrate the operation of the converter / chopper fed DC drives and its control.

CO5: Show the conventional and solid-state speed control of AC drives

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	2						2		2			
CO2	3	2	1				2			2		2		2	
CO3	2	3	1	3			2			3		2		2	
CO4	3	1	2				1			1		2	1		
CO5	2	1	2				1			1		2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **12Hours**

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and load variation factors

Unit 2: Drive Motor Characteristics **12 Hours**

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

Unit 3: Starting Methods **12Hours**

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

Unit 4: Conventional and Solid State Speed Control of D.C. Drives **12 Hours**

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.

Unit 5: Conventional and Solid State Speed Control of A.C. Drives **12 Hours**

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

Text Book(s)

1. VedamSubrahmaniam, Electric Drives (concepts and applications), Tata McGraw-Hill, 2001.

Reference(s)

1. Nagrath, I.J., and Kothari, D.P., "Electrical Machines, Tata McGraw-Hill, 1998.
2. Pillai, S.K., A first course on Electric drives, Wiley Eastern Limited, 1998.
3. Singh, M.D., Khanchandani, K.B., Power Electronics, Tata McGraw-Hill, 1998.
4. Partab, H., Art and Science and Utilisation of electrical energy, Dhanpat Rai and Sons, 1994

<table>
<tr><td colspan="2" rowspan="3">MEC202 THERMODYNAMICS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Chemistry CHY106</td><td colspan="5">Course Category: Engineering Sciences
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Enable the students to understand the basic principles and concepts of classical thermodynamics

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the basic concepts of thermodynamics and fundamental laws.

CO2: Interpret the idea of second law of thermodynamics to elaborate simple systems.

CO3: Demonstrate the properties of pure substances and analyze the performance of vapour power cycles

CO4: Apply gas laws to mixtures.

CO5: Comprehend the basics of air-vapour mixture properties and psychrometrics

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1										3		
CO2	3	2	1										3		
CO3	1	3	2	1								2	3		
CO4	3	2	1										3		
CO5		3	2	1								2	2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

Unit 1: Basic Concept, First Law and Second Law 12 Hours

Classical approach, concept of continuum, thermodynamic systems - closed, open and isolated, Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat. First law of thermodynamics for open and closed systems, first law applied to a control volume. Internal energy, specific heat capacities, enthalpy, and steady flow energy equation.

Unit 2: Second Law of Thermodynamics 12 Hours

Second law of thermodynamics – Kelvin's and Clausius statements of second law. Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed carnot cycle, efficiency, COP. Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.

Unit 3: Properties of Pure Substance 12 Hours

Properties of pure substances – thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Standard Rankine cycle, Reheat and regenerative cycle.

Unit 4: Thermodynamic Relations 12 Hours

Equation of state – Properties of mixture of gases – Dalton's law of partial pressure, Use of compressibility – entropy of gas mixtures, Maxwell's equations – Ratio of heat capacities – Energy equation – Joule Thompson co-efficient – Tds equation – Gibbs phase rule – types of equilibrium – Clausius-Claperyon equation – third law of thermodynamics. Use of compressibility chart for real gas mixtures.

Unit 5: Psychrometry 12 Hours

Psychrometry - atmospheric air and psychrometric properties – dry bulb temperature, wet bulb temperature, dew point temperature, partial pressures, specific and relative humidity, enthalpy and adiabatic saturation temperature - construction and use of psychrometric chart - analysis of various processes- heating, cooling, dehumidifying and humidifying-adiabatic mixing of stream, summer and winter air-conditioning - cooling load calculations.

Text Book(s):

1. Nag, P.K., Engineering Thermodynamics, Tata McGraw-Hill Co. Ltd., 2016

Reference(s)

1. Y.A.Cengel, Thermodynamics – An Engineering Approach, Tata Mc Graw Hill, New delhi, Third edition, 2012.
2. Radhakrishnan E., Fundamentals of Engineering thermodynamics, Second edition, Prentice hall, India, 2006.
3. Holman J.P., Thermodynamics, McGraw-Hill, 3rd Edition, 1995
4. Vanwlen and Sontag, Classical Thermodynamics, john wiley, 2000
5. Arora C.P., Thermodynamics, Tata McGraw-Hill, New Delhi, 2003

MEC203 FLUID MECHANICS & MACHINERY		**Credits**			
		L	**T**	**P**	**Total**
		3	**1**	**0**	**4**
Pre-requisite: Mathematics-I MAT101	**Course Category:** Engineering Sciences **Course Type:** Theory				

Course Objective(s): To study the various fluid flow properties and analyze the complexities involved in solving the practical fluid flow problems.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain different properties of fluid and gain the knowledge of different type of pressure measuring devices

CO2: Demonstrate the kinematics and dynamics of fluid flow and apply Bernoulli's equation to real time problems

CO3: Analyze the losses in flow of fluid through pipes.

CO4: Discuss the working principle of different turbines and solve performance calculations

CO5: Elaborate the working principle of different pumps and examine its performance

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2											2		
CO2	3	3	2	2	2								3	2	
CO3	2	3	2	2									3		
CO4		3											2	1	
CO5		3											3	1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit1: Basic Concepts and Properties **9 Hours**

Fluid – definition, distinction between solid and fluid - units and dimensions, properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - fluid statics - concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers.

Unit2: Fluid Kinematics and Fluid Dynamics **9 Hours**

Fluid kinematics - flow visualization, lines of flow, types of flow, velocity field and acceleration, continuity equation (one and three dimensional differential forms) - equation of streamline, stream function, velocity potential function, circulation, flow net, fluid dynamics - equations of motion, Euler's equation along a streamline, Bernoulli's equation, applications - Venturi meter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's theorem applications - similarity laws and models.

Unit3: Incompressible Fluid Flow **9 Hours**

Viscous flow - Navier-Stoke's equation (Statement only) - shear stress, pressure gradient relationship - laminar flow between parallel plates, Laminar flow through circular tubes (Hagen Poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy - Weisback's equation - friction factor minor losses – flow through pipes in series and in parallel - power transmission - boundary layer flows, boundary layer thickness, boundary layer separation.

Unit4: Hydraulic Turbines **9 Hours**

Fluid machines-definition and classification - exchange of energy - Euler's equation for turbo machines - construction of velocity vector diagrams - head and specific work - components of energy transfer - degree of reaction. Hydro turbines- definition and classifications - Pelton wheel, Francis turbine, propeller turbine , Kaplan turbine – working principles - velocity triangles, work done, specific speed, efficiencies, performance curve for turbines.

Unit5: Hydraulic Pumps **9 Hours**

Pumps- definition and classifications - Centrifugal pump - classifications, working principle, velocity triangles, specific speed, efficiency and performance curves - reciprocating pump classification, working principle, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps - rotary pumps - working principles of gear and vane pumps, performance of positive displacement pump.

Text Book(s)

1. Streeter, V.L., and Wylie, E.B., Fluid Mechanics, McGraw-Hill, 2010.

Reference(s)

1. Kumar, K.L., Engineering Fluid Mechanics, Eurasia Publishing House (P) Ltd, New Delhi, 7th edition, 2002.
2. Vasandani, V.P., Hydraulic Machines - Theory and Design, Khanna Publishers, 11th Edition 2010.
3. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd, New Delhi, 9th edition,2010.
4. White, F.M., Fluid Mechanics, Tata McGraw-Hill, c, 5th Edition, 2003.
5. Ramamirtham, S., Fluid Mechanics and Hydraulics and Fluid Machines, Dhanpat Rai and Sons, Delhi, 3rd edition 1998.
6. Som, S.K., and Biswas, G., Introduction to Fluid Mechanics and Fluid Machines, Tata McGrawHill, New Delhi, 3rd Edition, 2011.

MEC281 STRENGTH OF MATERIALS / FLUID MECHANICS LABORATORY	Credits			
	L	**T**	**P**	**Total**
	0	**0**	**3**	2
Pre/Co-requisite: Strength of Materials MEC201/Fluid Mechanics and Machinery MEC203	**Course Category:** Engineering Sciences **Course Type:** Practical			

Course Objective(s):

Students will be able to interpret basic principles, properties of materials and behaviour of materials under loaded conditions. Knowledge will be gained in fluid flow and fluid mechanics.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Illustrate the concept of yield strength, impact strength, double shear stress and torsion test.

CO2: Determine the principles of hardness, deflection, compression in beams and helical springs.

CO3: Classify the usage of strain measurement, effects of hardening, tempering and microscopic examination.

CO4: Calibrate flow measuring devices used in pipes, channels and tanks

CO5: Compile the characteristic curves of different pumps and turbines.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			2			2							3	3	1
CO2	1				2	2							2	2	1
CO3	2		2	1							2		2	3	1
CO4	3		2	3			2				2	2	2	3	
CO5	2		3	1	2								1	2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Strength of Materials Laboratory

1. Tension test on mild steel rod
2. Double shear test on Mild steel and Aluminum rods
3. Torsion test on mild steel rod

4. Impact test on metal specimen
5. Hardness test on metals - Brinell and Rockwell Hardness Number
6. Deflection test on beams.
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Tempering- Improvement Mechanical properties Comparison i) Unhardened specimen ii) Quenched Specimen and iii)Quenched and tempered specimen.
11. Microscopic Examination of Hardened samples and Hardened and tempered samples.

Fluid Mechanics Laboratory

12. Determination of the Coefficient of discharge of given Orifice meter.
13. Determination of the Coefficient of discharge of given Venturimeter.
14. Calculation of the rate of flow using Rota meter.
15. Determination of friction factor for a given set of pipes.
16. Conducting experiments and drawing the characteristic curves of Centrifugal pump / Submergible pump.
17. Conducting experiments and drawing the characteristic curves of reciprocating pump.
18. Conducting experiments and drawing the characteristic curves of Gear pump.
19. Conducting experiments and drawing the characteristic curves of Pelton wheel.
20. Conducting experiments and drawing the characteristics curves of Francis turbine.
21. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

References

1. Strength of Materials and Fluid Mechanics Laboratory Manual prepared by Kalasalingam University

<table>
<tr><td rowspan="3">EEE299 ELECTRICAL SCIENCE LABORATORY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>Pre/Co-requisite: Electrical Drives and Control EEE259</td><td colspan="4">Course Category: Engineering Sciences
Course Type: Practical</td></tr>
</table>

Course Objective(s)

- To Gain knowledge in the operation of classical and modern drives system for both AC and DC Machines.
- To understand the different starting methods of DC and AC

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the various parts of an electrical machine

CO2: Outline the different methods of starting D.C motors and induction motors

CO3: Measure torque and speed of given Machine

CO4: Examine the basic concepts of different types of electrical machines and their performance

CO5: Analyse and demonstrate load test on single phase induction motors.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1		2		1					2		2			
CO2	1		1				1			1		2		2	
CO3	1		1					1		2		1	1		
CO4	1		1				2			1		1		1	
CO5	2	1	2				1			1		2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

List of Experiments:

1. Load test on DC Shunt and DC Series motor
2. C.C and Load characteristics of DC Shunt and DC
3. Series generator
4. Speed control of DC shunt motor (Armature, Field and control)
5. Load test on single phase transformer
6. S.C Test on a single phase transformer
7. Regulation of an alternator by EMF and MMF methods.
8. V curves and inverted V curves of synchronous Motor
9. Load test on three phase squirrel cage Induction motor
10. Speed control of three phase slip ring Induction Motor
11. Load test on single phase Induction Motor.
12. Study of DC and AC Starters

References

1. Laboratory Manual prepared by Kalasalingam University faculty

HSS037 SOFT SKILLS - II	**Credits**			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite: Nil	**Course Category:** Humanities and Social Sciences **Course Type:** Theory			

Course Topics

S.No	Course	Module	Description of learning Imparted	# of hours
1	**Aptitude Training**	Quantitative	Number Theory- Real numbers, Divisibility, HCF and LCM, Remainder theorem, last digit, factorials, recurring decimals	2
2		Quantitative	Percentages, Profit & Loss, Discount	2
3		Quantitative	Ratio, Proportion, Allegation, Mixture, Partnership	2
4		Quantitative	Time, Speed, Distance, Trains, Boats and streams	2
5		Quantitative	Age Problem, Word Problem, Averages	2

6		Quantitative	Time & Work, pipes and cisterns	2
7		Quantitative	Mensuration 2D, Mensuration 3D, Interest calculations	2
8		Quantitative	Algebra, Clocks & Calendar	2
9		Quantitative	Probability, Permutation & Combination	2
10		Reasoning	Blood relations, Figure series	2
11		Reasoning	Series completion, cubes	2
12		Reasoning	Coding decoding, Alphabet test	2
13		Reasoning	Puzzles, Analogies	2
14		Reasoning	Syllogisms, Directions	2

SEMESTER-IV

MAT211 NUMERICAL METHODS	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: Mathematics MAT102	**Course Category:** Basic Sciences **Course Type:** Theory			

Course Objective(s)

- To understand the basic numerical methods to solve partial differential equations.
- To analyze the error for a particular numerical method and appreciate the efficiency in implementation of numerical algorithms.

Course Outcome (s)

CO1: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

CO2: Apply numerical methods to obtain approximate solutions to mathematical problems.

CO3: Develop numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

CO4: Analyze and evaluate the accuracy of common numerical methods.

CO5: Apply the Fourier transforms principles to solving engineering problems.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1		1	2										1
CO2	3		2	2	2								1		
CO3	3		2	2											
CO4	3	1		2	2									2	
CO5	2		2	3	3		2			2		3			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

LAPLACE TRANSFORM

Definition of Laplace transform - Linearity property - condition for existence of Laplace transform - First and second shifting properties - Laplace transform of derivatives and integrals - Unit step functions - Diarc delta-function - Differentiation and integration of transforms - Convolution theorem - Inversion - Periodic functions - Evaluation of integrals by Laplace transform - Solution of boundary value problems

PARTIAL DIFFERENTIAL EQUATIONS

Formation of PDE - Solution of std types of first order PDE - Lagrange's linear equation - Linear PDE of second and higher order with constant coefficients

FOURIER SERIES

Dirichlet's conditions - General Fourier series - odd and even functions - Half range sine and cosine series - complex form of Fourier series - Parseval's identity - Harmonic analysis

Z – TRANSFORM

Z-transform - elementary properties - Inverse Z-transform - Convolution theorem - formation of difference equation - Solution of difference equation using Z-transform.

FOURIER TRANSFORM

Fourier Integral formula - Fourier Transform - Fourier sine and cosine transforms - Linearity, Scaling, frequency shifting and time shifting properties - Self reciprocity of Fourier Transform - Convolution theorem - Application to boundary value problems

TEXT BOOKS

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 8th Edition., 2001
2. Arumugam, S., Thangapandi Isaac, A., Somasundaram, A., Engineering Mathematics Volume II, Scitech Publications (India) Pvt. Ltd., Chennai, 1st Edn., Reprint 2000, 1999

REFERENCES

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 37th Edition, 5th Reprint 2004, 2003
2. Venkataraman, M. K., Engineering Mathematics –III A, The National Publishing Company, Chennai, 11th Edition., Reprint 2002, 1998
3. Venkataraman, M. K., Engineering Mathematics - III B, The National Publishing Company, Chennai, 13th Edition., Reprint 1999, 1998.

<table>
<tr><td rowspan="3">MEC204 KINEMATICS OF MACHINERY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Engineering Mechanics MEC103</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s):

- To understand the layout of linkages in the assembly of a system
- To analyze the motion resulting from a specified set of linkages in a mechanism
- To study the principles of working machines and its motions
- To analyze the motions of cam mechanisms
- To study the different types of gears and their terminology

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Discuss the fundamentals of various mechanisms

CO2: Analyze the velocity and acceleration for the different mechanisms

CO3: Construct the cam profile

CO4: Analyses the gear

CO5: To calculate the speed and number of tooth on gears in gear train problems

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2									3					
CO2	3			2									3		
CO3			2	3									3		
CO4	2	2												3	
CO5	2	2												3	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Basics of Mechanisms **12 Hours**

Kinematic inversions of four bar chain and slider crank - description of common mechanisms - single, double and offset slider crank mechanisms - quick return mechanisms – indexing mechanisms - rocking mechanisms - straight line generators - design of crank rocker mechanisms.

Unit 2: Kinematics **12 Hours**

Displacement, velocity and acceleration analysis in simple mechanisms-relative velocity method – Coriolis acceleration.

Unit 3: Cam Profiles **12 Hours**

Layout of plate cam profiles - derivatives of follower motion - high speed cams - circular arc and tangent cams - standard cam motion - pressure angle and undercutting.

Unit 4: Gears **12 Hours**

Spur gear - terminology and definitions – interchangeable gears - gear tooth action - interference and undercutting - nonstandard gear teeth - helical, bevel, worm, rack and pinion gears - gear trains - parallel axis

Unit 5: Gear Train **12 Hours**

Introduction- type of gear train-Simple Gear trains- compound gear trains – reverted gear trains – epicyclic gear trains - differentials - automotive transmission gear trains.

Text Book (s)

1. Rattan, S.S., Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2015.

Reference(s)

1. Shigley, J.E., and Uicker, J.J., Theory of Machines and Mechanisms, McGraw-Hill, New Delhi, 2010.
2. Thomas Bevan, Theory of Machines, CBS Publishers and Distributors, 3rd Edition, London, 2005.
3. Ghosh, A., and Mallick, A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd., New Delhi, 2007.
4. Rao, J.S., and Dukkipati, R.V., Mechanism and Machine Theory, Wiley-Eastern Ltd., New Delhi, 2006.
5. Robert L Norton. Design of Machinery, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2005

List of Experiments: **15 Hours**

1. Preparation of Simple Mechanism.
2. Cam analysis of a machine
3. Measuring the gear terminologies.
4. Transmission efficiency in gear train.
5. Calculate the velocity and acceleration of Power Hacksaw.

MEC205 FLUID POWER TRANSMISSION SYSTEMS	**Credits**			
	L	**T**	**P**	**Total**
	3	**1**	**0**	**4**
Pre-requisite: Fluid Mechanics and Machinery MEC203	**Course Category:** Program Core **Course Type:** Theory			

Course Objective(s)

To know the advantages and applications of Fluid Power Engineering in Power Transmission System, automation of machine Tools and other equipment's.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Illustrate the basic principles, types and application of fluid power systems.

CO2: Classify and explain the different hydraulic pumps based on application.

CO3: Identify and apply design concepts of hydraulic circuits.

CO4: Apply different pneumatic components for real time equipment.
CO5: Design and develop the different pneumatic circuits for engineering applications

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			2			1									
CO2	1				1	2									
CO3	2		2	1							2			2	
CO4	3		2	3			2				2	2			
CO5	2		3	1	2										1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **12 Hours**

Introduction to fluid power-advantages of fluid power - applications of fluid power system – types of fluid power systems - properties of hydraulic fluids - Pascal’s law - energy, work, and power - transmission of forces through liquids - density and specific gravity

Unit 2: Hydraulic System And Components **12 Hours**

Sources of hydraulic power- pumping theory – pump classification – gear pump, vane pump, piston pump - construction and working of pumps – pump performance – variable displacement pumps - fluid power actuators - linear actuators, rotary actuators – types of hydraulic cylinders – single acting, double acting cylinder – fluid motors - gear, vane and piston motors.

Unit 3: Design of Hydraulic Circuits **12 Hours**

Construction of control components - direction control valve - shuttle valve – pressure control valve – pressure reducing valve, sequence valve - flow control valve – poppet valve, sliding spool valve, check valves, fixed and adjustable valves - electrical control solenoid valves - accumulators - types of accumulators, accumulators circuits, sizing of accumulators-intensifier – applications of intensifier, intensifier circuits.

Unit 4: Pneumatic Systems and Components **12 Hours**

Pneumatic components - properties of air – compressors – filter, regulator, and lubricator unit – air control valves - quick exhaust valves-pneumatic actuators - fluid power circuit design - speed control circuits, synchronizing circuit, penumo hydraulic circuit - sequential circuit design for simple applications using cascade method.

Unit 5: Design Of Pneumatic Circuits 12 Hours

Servo systems – hydro mechanical servo systems - electro hydraulic servo systems and proportional valves - fluidics – introduction to fluidic devices, simple circuits - introduction to electro pneumatic logic circuits - ladder diagrams, PLC applications in fluid power control - fluid power circuits - failure and troubleshooting.

Text Book(s)

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, 8th Edition, New Delhi, 2016.

Reference(s)

1. Majumdar, S.R., Pneumatic systems – Principles and maintenance, Tata McGraw Hill, New Delhi, 2001.
2. Michael J Pinches John G Ashby, J. G., Power Hydraulics, Prentice Hall, 1989.
3. Majumdar, S.R., Oil Hydraulics, Tata McGraw-Hill, New Delhi, 2000.

<table>
<tr><td rowspan="3">MEC206 MATERIAL SCIENCE</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Physics I PHY131</td><td colspan="4">Course Category: Engineering Sciences
Course Type: Theory with Practical Component</td></tr>
</table>

Course Objective(s)

To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Identify the micro-structures and properties of materials.

CO2: Ability to construct the phase diagrams of various solid solutions and to identify the presence of various phases with the addition of alloying elements.

CO3: Discuss various heat-treatment procedures for specific applications.

CO4: Categorize the plastics, ceramics and composites to replace metallic materials in several machineries.

CO5: Classify various properties of materials and to identify appropriate materials for different applications and environmental conditions.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3			2	3	1			2	1			3		
CO2	3		2	3	2				2				2	2	
CO3	3	3	3	3					2				2		
CO4	3	1		3	3								2	2	
CO5	2		1		2				1		2		1	2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

BASICS

Types of bonds in solids, crystal structure of metals, defects in metallic structure, plastic deformation of metals, binary alloys - mechanism of plastic deformation, slip, twinning, stacking faults, deformation bands and strain hardening.

CONSTITUTION OF ALLOYS AND PHASE DIAGRAM

Constitution of alloys – solid solutions - substitutional and interstitial, phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectroid reactions, iron – iron carbide equilibrium diagram - classification of steel and cast iron – microstructure, properties and applications.

HEAT TREATMENT

Annealing - full annealing, stress relief, recrystallisation and spheroidizing – normalizing - hardening and tempering of steel - isothermal transformation diagrams – cooling curves superimposed on I.T. diagram - hardenability, jominy end quench test – austempering, martempering – case hardening - carburising, nitriding, cyaniding, carbonitriding – flame and induction hardening.

ALLOYS AND POLYMERS

Nickel and nickel alloys – inconel, Monel, etc , Copper and copper alloys – brass, bronze and cupronickel – aluminum and al-cu – precipitation strengthening treatment – polymers, composites, ceramics, glasses- their fabrication, processing methods, engineering properties and applications.

TESTING OF MATERIALS AND FRACTURE

Mechanical properties of materials, testing of materials - surface modifications of metals for specific engineering application, tribological properties of metals and non-metals - types of fracture – testing of materials under tension, compression and shear loads – hardness tests (Brinell, Vickers and Rockwell), impact test- Izod and Charpy - fatigue and creep test.

Practical: demo on testing of hardness, fatigue, creep and impact strength, demo on optical microscope

Text Book

1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials, Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.

References

1. William D Callister Jr., Material Science and Engineering, John Wiley and Sons, 6th Edition, Singapore, 2005.
2. Raghavan, V., Material Science and Engineering, Prentice Hall of India Pvt., Ltd., New Delhi, 1999.
3. Sydney H.Avner, Introduction to Physical Metallurgy, McGraw Hill Book Company, New York, 1994.

<table>
<tr><td rowspan="3">MEC207 MANUFACTURING TECHNOLOGY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Basic Mechanical Engineering CIV101</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To get the basic knowledge in the sand casting process and various casting techniques and the defects in casting

- To impart the knowledge in welding, brazing and thermal cutting of metals and alloys
- To describe about the various bulk deformation processes like forging, rolling, extrusion and the equipment's related to it
- To impart knowledge in various sheet metal forming and plastic forming processes

To impart knowledge in various types of cutting tools, tool life, machining processes and machines, work holding and tool holding devices

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Contrast the casting process, to classify the various casting processes and to identify the various casting defects

CO2: Explain various welding, brazing and analyze the effect of thermal cutting process

CO3: Illustrate various bulk deformation processes and able to design bulk deformation components

CO4: Categorize the metal forming manufacturing processes

CO5: Judge the cutting tool to be chosen, to measure the tool life, to compare various machines for machining processes and to choose the working holding and tool holding devices for the machines and machining processes

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												3		
CO2		3		2										2	
CO3			3											3	
CO4	2														
CO5		3													

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Metal Casting Process 9 Hours

Moulding sands - types and properties - patterns – types, selection of patterns, pattern allowances - design of patterns - classifications of castings according to mould materials and moulding methods- forces acting on the molding flasks -short & long freezing range alloys – solidification and cooling – riser and gating design – design considerations - special casting techniques - fettling and finishing of castings - defects in castings.

Unit 2: Fabrication Process 9 Hours

Classification of welding process - principle of gas welding - arc welding - resistance welding - solid state welding - thermo-chemical welding - radiant energy welding - brazing and soldering - Heat affected zones in welding, Methods to minimize HAZ- thermal cutting of metals or alloys.

Unit 3: Bulk Deformation Processes 9 Hours

Forging - classification of forging processes, forging defects and inspection-Strain hardening, Recovery, Recrystallization and grain growth - rolling - classification of rolling processes, rolling mill, rolling of bars and shapes - extrusion - classification of extrusion processes, extrusion equipments.

Unit 4: Forming Process 9 Hours

Sheet metal forming - High velocity forming - explosive forming, electro hydraulic forming - magnetic pulse forming - pneumatic - mechanical high velocity forming.

Plastic forming - Plastics - types of plastics - plastic moulding processes, defects in plastics, Powder metallurgy- Introduction, Production of component.

Unit 5: Machining Process 9 Hours

Mechanics of machining, single and multipoint cutting tool, tool - geometry, life and wear - Lathe - Capstan and Turret lathe - Drilling and Boring machine classification, principles of working - work holding and tool holding devices.

Text Book(s)

1. Jain, R.K., Production Technology, Khanna Publishers, 2002.

Reference(s)

1. Ghosh, A., and Malik, A. K., Manufacturing Science, Affiliated East west Press Pvt. Ltd., 2008.
2. Rao PN, Manufacturing Technology, 3/e, TMH, New Delhi, 2010.
3. Hajra Choudhry, Elements of Workshop Technology-Vol I, Dhanpat Rai and Sons, 1992

<table>
<tr><td rowspan="3">MEC209 THERMAL ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Thermodynamics MEC202</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Enable the students to understand the principles, and concepts of IC engines, compressors, steam nozzles, and refrigeration and air-conditioning systems.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Execute the performance of some gas power cycles
CO2: Summarize the working principle of IC engines
CO3: Demonstrate energy conversion in steam nozzles and turbines
CO4: Analyze the performance of reciprocating air compressors
CO5: Comprehensive study of refrigeration and air- conditioning

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	2									1	3		
CO2	2	2	2	1								1	3		
CO3	1	3	2	2								1	3		
CO4	1	2	1	1								3	3		
CO5	1	2	2									1	2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Gas Power Cycles **12 Hours**

Otto, Diesel, Dual, Brayton cycles, Gas turbine (Brayton) cycle-description and analysis, regenerative gas turbine cycle, inter cooling and reheating in gas turbine cycles Calculation of mean effective pressure, and air standard efficiency - Actual and theoretical PV diagram of four stroke and two stroke engines.

Unit 2: Internalcombustion Engines **12 Hours**

Classification of IC engine, IC engine components and functions. Valve timing diagram and port timing diagram. Comparison of two stroke and four stroke engines. Comparison of petrol and diesel engines. Fuels, Air-fuel ratio calculation, Knocking and Detonation. Fuel supply systems, Ignition Systems, Lubrication system and cooling system. Exhaust gas analysis, pollution control norms.

Unit 3: Steam Nozzles & Turbines 12 Hours

Flow of steam through nozzles, shape of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Steam turbine – impulse and reaction principles, compounding, velocity diagrams for simple and multistage turbines, speed regulations and governors.

Unit 4: Air Compressor 12 Hours

Operation of a single stage reciprocating compressor, work input through p-v diagram and steady state steady flow analysis, effect of clearance and volumetric efficiency, adiabatic, isothermal and mechanical efficiencies, multistage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression.

Unit 5: Refrigeration 12 Hours

Vapor compression refrigeration system- description, analysis, refrigerating effect - capacity, power required, unit of refrigeration, COP, refrigerants and their desirable properties - air cycle refrigeration, reversed Carnot cycle, reversed Brayton cycle, vapour absorption refrigeration system and steam jet refrigeration.

Text Book

1. Rajput, R.K, Thermal Engineering, S.Chand publishers, 2000.

References

1. Rudramoorthy, R., Thermal Engineering, Tata McGraw-Hill, New Delhi, 2003.
2. Kothandaraman, C.P., Domkundwar, S., and Domkundwar, A.V., A course in Thermal Engineering, DhanpatRai and Sons, Fifth edition, 2002.
3. Holman, J.P., Thermodynamics, McGraw-Hill, 1985.
4. Rogers, Engineering Thermodynamics, ELBS, 1992.
5. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw-Hill, New Delhi, 1994.

6. Sarkar, B.K., Thermal Engineering, Tata McGraw-Hill, New Delhi, 1998.

MEC282 MANUFACTURING TECHNOLOGY LAB	Credits			
	L	**T**	**P**	**Total**
	0	0	**3**	**2**
Pre/Co-requisite: Manufacturing Technology MEC207	**Course Category:** Program Core **Course Type:** Laboratory course with Project			

Objective(s)

To develop an ability to operate and perform machining, foundry, welding and plumbing practice

Course Outcome(s)

CO1: Experiment and perform the operations using lathe, drilling, foundry, plumbing and smithy.

CO2: Interpret and compose the various operation performed in the machine tool

CO3: Explain and communicating with in the working group

CO4: Develop the habits of ethics in the work

CO5: Understand the concept of plumbing connections.

CO and PO Mapping

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		2		2	3	1	1				2			2	
CO2				1	2				1		3			2	
CO3		1		1	3								1		
CO4	1			2	2						1	1			2
CO5			2	1	3	1	2							2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

List of Experiment

MACHINING PRACTICE

Lathe: Plain turning, step turning, taper turning, parting off, knurling, thread cutting, eccentric turning, Boring, Counter boring and counter sinking, cutting force measurement, special operations in capstan and turret lathe. Drilling: Inclined hole, reaming, cutting force measurement.

FOUNDRY PRACTICE

Study of moulding tools, equipments, furnaces, preparation of moulding sand, exercise: flange, gland, bush, straight pipe, bend pipe, T - pipe and grooved pulley.

SMITHY PRACTICE

Study of forging tool - making a square out of round rod, making an L-bend, making a hook, square headed bolt, hexagonal headed bolt and V-clamp.

WELDING PRACTICE

Study of welding tools, equipments, exercise in Arc welding and Gas welding: Lap joint, butt joint, V-joint and Tee joint

PLUMBING PRACTICE

Study of plumbing tools – laying pipe connection to the suction side of a pump inlet and the delivery side of a pump outlet – practice in mixed pipe connections: metal, plastic and flexible pipes

Reference

Lab Manual prepared by KLU faculty

MEC283 THERMAL LABORATORY-I	Credits			
	L	T	P	Total

	0	0	3	2
Pre/Co-requisite: Thermal Engineering MEC209	**Course Category:** Program Core **Course Type:** Practical			

Course Objectives(s)

- To apply the acquired knowledge of Thermodynamics and Thermal Engineering Systems to perform experiments.
- To facilitate students measuring thermal properties, temperature effect on other properties of processes and use various working fluids.

Course Outcome(s)

CO1: Evaluate the parameters of various thermal engineering systems.
CO2: Analyze the performance of engines and compressors, and properties of fuels and lubrication oils.
CO3: Function as a team for conducting experiments.
CO4: Understand the concept and working of steam operated machines.
CO5: Understand the concept of fuels.

CO and PO Mapping

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3	2	3									2		
CO2	1	3		3								2	3		
CO3								2	1		1	2			
CO4										3		2			
CO5	1							2				2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

List of Experiment

IC ENGINES LABORATORY

1. Valve timing diagram for four stroke diesel engine
2. Performance test on four stroke diesel engine
3. Performance test on single stage air compressor
4. Heat balance test on four stroke diesel engine
5. Performance test on two stage air compressor
6. Determination of viscosity using Redwood viscometer
7. Port timing diagram for two stroke Diesel engine
8. Valve timing diagram for four stroke petrol engine
9. Determination of flash point and fire point using open cup apparatus
10. Determination of viscosity using Saybolt viscometer
11. Determination of flash point and fire point using closed cup apparatus
12. Retardation test on Four-stroke diesel engine.

STEAM LABORATORY

1. Performance study on steam generator
2. Performance study on steam turbine

FUELS LABORATORY

1. Determination of flash point and fire point using open / closed cup apparatus
2. Determination of viscosity using Saybolt / Redwood viscometer.

Reference

Lab Manual prepared by KLU faculty

<table>
<tr><td rowspan="3">HSS038 SOFT SKILLS - III</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Humanities and Social Sciences
Course Type: Theory</td></tr>
</table>

Course Topics

S.No	Course	Module Name	Topics	# hours
1	Remedial English	Foundation	Parts of Speech	2
2			Articles	
3		Delightful Descriptions	Nouns	
4			Adjectives	
5		Double Actions	Verbs	2
6			Adverbs	
7		Meaningful Links	Prepositions	
8			Conjunctions	
9		Yesterday Today Tomorrow	Past Tense	2
10			Present Tense	
11			Future Tense	
12			Special Cases	
13		Matching Blocks	Subject Verb agreement	2
14		Questions and Expressions	Modals	
15			Question Tags	
16	Business English	Professional Communication	Concise Cogent Communication	2
17			Active Listening	2
18			Interact Interpret Respond	2
19		Expositions and discussions	JAM and Extempore-JAM and Extempore- BIKER B {Extempore}- Six Thinking Hats- JAM	2
20	Verbal	Grammar and Vocabulary	Finding Errors Phrase substitution	2
21			Vocabulary	2
22			Idioms and Phrases; Collocations	2
23		Blanks and Jumbles	Fill in the blanks Sentence Completion	2
24			Parajumbles/Jumbled Sentences	2
25		Reading Comprehension	Cloze Passage; Theme Detection	2
26			Reading Comprehension	2

SEMESTER-V

MEC328 ADVANCED MACHINE TOOLS AND METROLOGY	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: Physics I PHY131	**Course Category:** Program Core **Course Type:** Theory			

Course Objective(s):

- To give detail explanation on different machine tools including special machines and CNC machines with their pros and cons.
- To develop knowledge on quality and importance of measuring systems will be explained.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Ability to illustrate the constructional features and working principle of various advanced machine tools

CO2: Capability to categorize the utilization and limitation of computer numerical control machines.

CO3: Ability to demonstrate a robot and to outline it's engineering applications.

CO4: Capacity to categorize the non-conventional machining Process and to identify their specific applications.

CO5: Ability to classify the various measuring tools and to measure the process capabilities & quality through statistical techniques.

CO and PO Mapping

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	3	2	3									2		
CO2	1	3		3								2	3		
CO3								2	1		1	2			
CO4										3		2			
CO5	1							2				2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

SPECIAL MACHINES

Shaper, Planer, Slotting, milling, hobbing, broaching and grinding machines - classification, principles of working, work holding and tool holding devices.

CNC MACHINES

NC, CNC and DNC machine tools - manual part programming, CAPP and CMPP process planning systems, APT- post processors, APT programming.

ROBOTICS

Robot – Definition – Robot Anatomy – work volume - drives and end effectors –Robot programming - Robot programming Languages– VAL Programming – Applications.

NON-CONVENTIONAL MACHINING PROCESS

Ultrasonic machining – Abrasive jet machining – Water jet machining – Electro chemical machining – Electrical discharge machining – Wire EDM – Electron beam machining – Laser beam machining – Shaped tube electrolytic machining

QUALITY CONTROL AND MEASUREMENTS

Quality control - statistical quality control - control charts - inspection system.

Errors in measurements - calibration - length measurement – angle measurement - surface finish - terminology - optical measurement.

TEXT BOOK

1. Khanna, O.P., and Lal, M., A Text Book of Production Technology - Vol. II, Dhanpat Rai and Sons, 1994.

REFERENCES

1. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill,1986.
2. Choudhry, S.K.H., Elements of Work Shop Technology-VoL II, MPP,1994.
3. HMT, Production Technology, Tata McGraw Hill, New Delhi,1994.
4. Gupta, I., Engineering Metrology, Dhanpat Rai and Sons, 2004.
5. Jain, R.K., Engineering Metrology, Khanna Publications, 2006.

MEC303 DESIGN OF MACHINE ELEMENTS	Credits			
	L	T	P	Total
	3	1	0	4
Pre-requisite: Strength of Materials MEC201	**Course Category:** Program Core **Course Type:** Theory			

Course Objective(s)

Students will be able to demonstrate the fundamentals of stress analysis, theories of failure and material science.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understand the purpose, procedures, materials, standards and conventional symbols used in designing the standard machine components.

CO2: Apply the fundamental design concepts on power transmission systems in a systematic and logical manner.

CO3: Analyze the various fasteners design and its failure analysis.

CO4: Analyze the different types of spring for various loading conditions different systems.

CO5: Analyze the different types of friction and lubrication methods to select bearings for suitable applications.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	2		2	2	2		3		2	3		1
CO2	3	3	3	3		2	3	2		3		2	3		1
CO3	3	3	2	2		3	3	2		3		2	3		1
CO4	3	2	2	2		3	2	2		3		2	3		1
CO5	3	2	1	1		1	1	1		3		2	3		1

3- Strong Corre1ation; 2 - Medium Corre1ation; 1 – 1ow Corre1ation

Course Topics

Unit 1: Simple Stresses **12 Hours**

Mechanical Engineering Design- A Broad Perspective - Types of simple stresses - static and varying loading- theories of failures - allowable stress - factor of safety - stress concentration factor- curved beams -

fluctuating stresses- S-N diagram - design for combined fatigue loading- Soderberg, Goodman and Gerber relations.

Unit 2: Design of Shafts, Keys and Couplings 12 Hours

Design principles of shafts - static, fatigue loading- critical speed - design of keys - design of couplings

Unit 3:Design of Threaded Fasteners and Permanent Joints 12 Hours

Threaded fasteners - design of welded joints, eccentric loading of welded and bolted joints - design of riveted joints – Adhesive joints

Unit 4: Design of springs and Levers 12 Hours

Design of helical springs - compression and tension – Torsion springs - Leaf springs –Belleville springs - Design of Levers

Unit 5: Design of Flywheels and Bearings 12 Hours

Design of flywheels, Design and selection of journal and antifriction bearings

Text Book(s)

1. Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke,RichardBudynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill , 2011.

Reference(s)

1. Design Data book– PSG College of Technology, Coimbatore., 2016
2. Sundararajamoorthy, T. V. Shanmugam.N, "Machine Design", Anuradha Publications, Chennai, 2012.
3. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design",4th Edition, Wiley, 2005 4.Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co. (Schaum's Outline), 2010
4. Bernard Hamrock, Steven Schmid,Bo Jacobson, "Fundamentals of Machine Elements", 2 nd Edition, Tata McGraw-Hill Book Co., 2006.
5. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Prentice Hall, 2003

<table>
<tr><td rowspan="3">MEC304 DYNAMICS OF MACHINERY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Kinematics of Machinery MEC204</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To understand the concept of static and dynamic force analysis.
- To study the undesirable effects of unbalances in rotating mechanism.
- To analyze the vibration characteristics and its effect.
- To understand the governor mechanism for governing of machines.
- To give insight of application of gyroscope and its effect.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Analyze the forces in mechanisms and flywheels.
CO2: Ability to design static and dynamic balancing
CO3: Acquire knowledge of vibrations in different types of systems..
CO4: Evaluate the speed of an engine to control it.
CO5: Analyze the control mechanisms in gyroscopes.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		2										
CO2						1		2				1			
CO3	3	2	3		1										
CO4		1										2	2		
CO5	3	1	3		3					2			2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Basic **9 Hours**

Applied and constraint forces - Static force analysis in simple mechanisms - Dynamic force analysis in reciprocating engines – gas forces - equivalent masses - bearing loads - fly wheels - engine shaking forces - cam dynamics

Unit 2: Balancing of Masses 9 Hours

Static and dynamic balancing - balancing of rotating masses - balancing a single cylinder engine, balancing of multi cylinder engines - partial balancing in locomotive engines - balancing linkages - balancing machines

Unit 3: Vibration Analysis 9 Hours

Free vibration - equations of motion , natural frequency - types of damping - damped vibration - critical speeds of shaft - Torsional systems - force transmissibility and amplitude transmissibility -vibration isolation.

Unit 4: Governors 9 Hours

Governors - types - centrifugal governors - gravity controlled, spring controlled centrifugal governors - characteristics - effect of friction - controlling force, other governor mechanisms.

Unit 5: Gyroscope 9 Hours

Gyroscopes - gyroscopic forces and torques, gyroscopic stabilization – effects on ship, aero plane, automobiles – automatic control

Text Book(s)

1. Rattan, S.S., Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2014.

Reference(s)

1. Thomas Bevan, Theory of Machines, CBS Publishers and Distributors, 2005.
2. Ghosh, A., and Mallick, A.K., Theory of Mechanisms and Machines, Affiliated East-West Press Pvt. Ltd., New Delhi, 2006.
3. Shigley, J.E., and Uicker, J.J., Theory of Machines and Mechanisms, McGraw-Hill, Inc., 1995.
4. Rao, J.S., and Dukkipati, R.V., Mechanism and Machine Theory, Wiley-Eastern Limited, New Delhi, 1992.
5. Robert L Norton. Design of Machinery, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2005.
6. Ambekar A. G., Mechanism and Machine Theory, Prentice Hall of India, New Delhi, 2007.

<table>
<tr><td colspan="2" rowspan="3">MEC329 GAS DYNAMICS AND JET PROPULSION</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="1">Pre-requisite: Thermodynamics MEC202</td><td colspan="5">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To study the basic concepts of compressible fluid dynamics, and gain some knowledge in various types of flow and flow visualization devicecs.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply the concepts of compressible fluid flow for variable geometry ducts.

CO2: Analyze one-dimensional flows with shock waves.

CO3: Solve first order solutions for compressible internal flows with friction and heat transfer.

CO4: Apply the various methods of measurement used in compressible fluid flow experiments .

CO5: Examine simple the performance of Air breathing and rocket propulsion systems

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3											2	3	2	
CO2	3				2							2	3	2	
CO3	3		3			2						2	3	2	
CO4	3		3				2			1		2	3	2	
CO5	3		3				2			1		2	3	2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit-I ISENTROPIC FLOW

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility, Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers

Unit-II NORMAL SHOCKS

Flow with Normal Shock Waves: Fundamental equation for normal shock, normal shock equation for a perfect gas, Prandtl relation for normal shock, tables for computation of normal shock, normal shock on T-S diagram. Flow with Oblique Shock waves: Fundamental Relations, Prandtl's equation, Rankine-Hugoniot equation, Variation of flow parameters, Mach Waves.

Unit-III FANNO AND RAYLEIGH FLOW

Effects of friction in one dimensional flow: Adiabatic flow in constant area duct with friction, Fanno line, Effects of heat exchange in one dimensional flow: frictionless flow in constant area duct with heat transfer, Raleigh line, Rayleigh equations for a perfect gas, and tables for computation of Rayleigh flow.

Unit-IV METHODS OF FLOW MEASUREMENT AND FLOW VISUALIZATION

Pressure probes, Prandtl probe, Pitot tube, Prandtl pitot static tube, Supersonic pitot tube, Shock tube. Rayleigh supersonic pitot formula, temperature recovery factor, hot wire anemometer, working principles of shadow graph, Velocimeter, Schlieren apparatus and interferometer. Wind Tunnels – Subsonic and Supersonic Wind tunnels.

Unit-V PROPULSION

Aircraft Propulsion – Jet propulsion – types of jet engine, Performance analysis - rocket propulsion – types of rocket engines, performance analysis. Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants, comparison of different propulsion systems

TEXT BOOK

1. Balachandran P., "Fundamentals of compressible fluid dynamics", PHI learning Pvt, Ltd, New Delhi, 2014.
2. Yahya, S.M., "Fundamental of compressible flow", New Age International (p) Ltd., New Delhi, 2016.
3. Patrich.H. Oosthvizen, William E.Carscallen, "Introduction to

Compressible Fluid Flow", second edition, CRC press (Taylor and Francis group), 2013.
4. A.H.Shapiro, "The Dynamics and Thermodynamics of Compressible Fluid flow", Vol I and II, the Ronald Press NY, 1995.
5. Maurice J. Zucrow and Joe D. Hoffman, "Gas Dynamics", Vol I and II, Wiley, 1976.

REFERENCES

1. Cohen, H., Rogers, R.E.C., and Saravanamutoo, "Gas turbine theory", Addison Wesley Ltd., 1987.
2. Ganesan, V., "Gas Turbines", Tata McGraw-Hill, New Delhi, 2010.
3. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, New Delhi, 2013.

<table>
<tr><td rowspan="3">MEC387 MACHINE DRAWING PRACTICE LABORATORY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>Pre-requisite: Engineering Drawing MEC101</td><td colspan="4">Course Category: Program Core
Course Type: Laboratory course with project</td></tr>
</table>

Course Objective(s)

To develop skill to use CAD software to create 2D and 3D drawings.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply the principles of proper dimensioning and tolerances.
CO2: Make use of Orthographic projection of solids in first angle of projection.
CO3: Develop 2D components in AutoCAD drafting.
CO4: Model the mechanical components such as bolts, screws, keys, riveted joints, coupling and bearings.
CO5: Design and assemble the machine components such as engine parts, screws jacks, machine vices plummer block, tailstock and valves using AutoCAD

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			2			2		1					2		1
CO2	1				2	2								2	
CO3	2		2	1					1		2		1	2	
CO4	3		2	2			2			1	2	2			
CO5	2		3	1	2										2

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics: **45 Hours**

I. Machine Drawing Conventions

a. **Need for drawing conventions** –Introduction to IS conventions
b. Title boxes, their size, location and details - common abbreviations & their liberal usage
c. Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.
d. Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.
e. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centres, curved and tapered features.
f. Fits and tolerance - allocation of fits for various mating parts - tolerance data sheet - tolerance table preparation - Geometric tolerance
g. Types of Drawings – working drawings for machine parts.

II. Reading of Industrial drawings

a. Reading industrial drawing and write a report on it.
b. Assembly view and detailed view of Tail stock, Machine Vice, Screw jack using manual drawing.

III. Drawing of Machine Elements and simple parts

Selection of Views, additional views for the following machine elements and parts with every drawing proportion

a. Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
b. Keys, cottered joints and knuckle joint
c. Riveted joints for plates
d. Shaft coupling, spigot and socket pipe joint
e. Journal, pivot and collar and foot step bearings

IV. Assembly Drawings and Detailed drawing

Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

a) Engine parts – stuffing boxes, cross heads, Eccentrics, Petrol Engine connecting rod, piston assembly.
b) Other machine parts - Screws jack, Machine Vice, Plummer block, Tailstock
c) Valves : Steam stop valve, spring loaded safety valve & feed check valve

NOTE: First angle projection to be adopted.

Text Book(s)

1. Machine Drawing – R.K Dhawan, S.Chand Publications,1998.
2. Machine Drawing –K.L.Narayana, P.Kannaiah& K. Venkata Reddy, New Age International Publishers, 2007.
3. Machine Drawing – N.D. Bhatt, Charotar Pub. House, 2002
4. Machine Drawing practice Laboratory manual.

Reference(s)

1. Machine Drawing – P.S.Gill, S.K.Kataria& Sons(publishers), 2010
2. Machine Drawing – K.R Gopalakrishna, Subhas publications, 6th eedition, 1992.

MEC382 MACHINE TOOLS AND METROLOGY LABORATORY	**Credits**			
	L	**T**	**P**	**Total**
	0	**0**	**3**	**2**
Pre/Co-requisite: Advanced Machine tools and Metrology MEC328	**Course Category:** Program Core **Course Type:** Practical			

Course Objective(s)

- To know about the various special purpose machines and their operation**.**
- To study about the metrology about liner measuring and angular measuring Instruments
- To give exposure to various precision measuring instruments.

Course Outcome (s)

CO1: Apply and practice the basic machining process
CO2: Identify and inspect various measuring components
CO3: Ability to improve the quality of mechanical components
CO4: Summarize the general propose of machining process
CO5: capable of doing reverse engineering with the help of CMM equipments.

CO and PO Mapping

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2		2										1	1	
CO2		3										1	1	1	
CO3	2		3		3		3					2	3	2	3
CO4	1	2			3		3					3	3	2	3
CO5	3		3		3		3					3	3	2	3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

MACHINES LABORATORY

1. **Shaping:** Rectangular block, V-Groove, Dovetail – internal and External
2. **Planing:** Rectangular block, V-Groove, Dovetail– Internal and External
3. **Slotting:** Step-cutting, Keyway cutting
4. **Milling:** Plain, Hexagonal, Angular, T - Slot, Gang, Spur gear bevel gear and Cam
5. **Tool and Cutter Grinder:** V-tool and parting tool grinding
6. **Cylindrical and Surface Grinding:** Cylinder grinding, Tapered cylinder grinding, Rectangular surface grinding
7. **Gear Hobbing:** Spur, Worm and Helical gear generation

METROLOGY LABORATORY

1. Use of precision measuring instruments like micrometer, Vernier height and depthgauges, surface plate, etc.
2. Checking dimensions of a part using slip gauge
3. Use of sine bar for measuring angles and tapers
4. Calibration of plug and dial gauges, Micrometer

5. Measurement of tooth thickness by gear tooth Vernier
6. Testing squareness of a try square using slip gauges.
7. Checking straightness of a surface plate using auto-collimator
8. Measurement of thread parameters using floating carriage micrometer
9. Gear Inspection using profile projector
10. Use of Electronic and Mechanical comparator
11. Measurement of taper angle using tool makers microscope
12. Study and use of coordinate measuring machine

Refernce

Lab Manual prepared by KLU faculty

<table>
<tr><td rowspan="3">MEC383 DYNAMICS AND VIBRATION LABORATORY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>Pre-requisite: Kinematics of Machinery MEC204, Dynamics of Machinery MEC304</td><td colspan="4">Course Category: Program Core
Course Type: Laboratory</td></tr>
</table>

Course Objective(s)

- Student will be able to synthesis basic mechanism.
- Ability to control the speed and to measure the vibration damping.

Course Outcome(s)

CO1: Determine moment of inertia of flywheel and connecting rod
CO2: Evaluate speed variation in Hartnell and Porter Governor
CO3: Test the natural frequency of compound pendulum
CO4: Analyse the Springs stiffness.
CO5: Measure single and multi-degrees of freedom in forced vibrations

CO and PO Mapping

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		2						2		2	3		
CO2	3	3	1	2						2		2	3		
CO3	3	2	1	2						2		2	3		
CO4	3	3	1	2						2		2	3		

CO5	3	2	1	2						2		2	3		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

1. Moment of inertia on flywheel and connecting rod
2. Governor-Porter, Proell and Hartnell - determination of speed and sensitivity
3. Whirling speed of shaft – determination of critical speed
4. Transverse vibration – determination of deflection
5. Undamped free vibration spring mass system
6. Forced vibration system – single and multi degree of freedom
7. Vibration analyzer
8. Cam study - jump phenomenon –determination of critical speeds
9. Vibrating Table – determination of transmissibility ratio
10. Compound Pendulum – determination of torsional and natural frequencies – system with lumped moment of inertia.

Reference

Lab Menual prepared by KLU faculty

SEMESTER-VI

MEC307 DESIGN OF TRANSMISSION SYSTEMS	Credits			
	L	**T**	**P**	**Total**
	3	**1**	**0**	**4**
Pre-requisite: Design of Machine Elements MEC303	**Course Category:** Program Core **Course Type:** Theory			

Course Objective(s)

To impart knowledge to provide the participant with intensive training in the design of transmission systems and components.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Develop and design flexible transmission elements such as Belt, Chain and Wire ropes.

CO2: Interpret and design spur gear drive for different application and to evaluate forces on gear.

CO3: Design helical, bevel and worm gear drives for different applications and to evaluate forces on gear tooth.

CO4: Develop a new set of gear box for different applications

CO5: Select and Design suitable materials for clutches and brakes.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1	3	2	3					2		3	3		2
CO2	3	1	3	2	3					2		3	3		2
CO3	3	1	3	2	3					2		3	3		2
CO4	3	1	3	2	3					2		3	3		2
CO5	3	1	3	2	3					2		3	3		2

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Design of Flexible Elements **12 Hours**

V belts and pulleys - flat belts and pulleys - wire ropes and pulleys - link chains and pulleys – transmission chains and sprockets - silent chains - ribbed V belts.

Unit 2: Spur Gear **12 Hours**

Gear terminology – module – force analysis- tooth stresses – fatigue strength – Lewis and Buckingham design – limitations – dynamic effects.

Unit 3: Bevel, Worm and Helical Gears **12 Hours**

Parallel helical gears - kinematics - force analysis in crossed helical gears - worm gearing - force analysis in straight bevel gears - kinematics bevel gear - force analysis in gear blank - Cross Helical gears

Unit 4: Design of Gear Box **12 Hours**

Gear box-geometric progression, standard step ratio, Ray diagram, kinematics layout -design of sliding mesh gear box - constant mesh gear box. Couplings, Torque Converters for automotive applications

Unit 5: Design of Clutches and Brakes **12 Hours**

Clutches –internal expanding rim clutches- external contracting rim clutches - frictional contact axial clutches, cone clutches – brake- energy considerations - temperature rise - friction materials.

Text Book(s)

1. Shigley, J.E., and Mischke, C.R., Mechanical Engineering Design, McGraw-Hill International, Eighth Edition, 2008.
2. Bhandari V.B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 2007.

Reference(s)

1. Maitra, G.M., Prasad, L.V., Hand book of Mechanical Design, II Edition, Tata McGraw-Hill, 1985.
2. Shigley, J.E., and Mischke, C.R., Mechanical Engineering Design, McGraw-Hill International Editions, 1989.
3. Prabhu, T.J., Design of Transmission Elements, Mani Offset, Chennai, 2000,
4. Norton, R.L., Design of Machinery, McGraw-Hill Book Co Ltd, 2004.

5. Hamrock, B.J., Jacobson, B., Schmid, S.R., Fundamentals of Machine Elements, McGraw-Hill Book Co., 1999.
6. Khurmi, R.S. Machine design, S. Chand and Co., New Delhi, 2006

Hand Book

1. Design Data book, PSG College of Technology, Coimbatore, 2006.

<table>
<tr><td rowspan="3" colspan="2">MEC327 HEAT AND MASS TRANSFER</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite: Thermal Engineering MEC209</td><td colspan="5">Course Category: Program Core
Course Type: Theory with practical component</td></tr>
</table>

Course Objective(s)

To understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply knowledge on conduction heat transfer and perform its calculations

CO2: Solve free and forced convection real time problems.

CO3: Analyze and design the heat exchangers

CO4: Examine the factors influencing radiation heat transfer

CO5: Invetigate the various forms of mass transfer and its analogy with heat transfer.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	3	2								1	3	
CO2	1	2		3	2								3		
CO3	1	3	2	2	3								2	2	
CO4	1	2		2	2								1	2	
CO5	1	2		2	2								2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Conduction 9 Hours

Conduction – Fourier law of heat conduction, heat generation, pin fins, transient conduction, lumped capacitance model-numerical method for 1D and 2D steady state heat conduction

Unit 2: Convection 9 Hours

Convection – Introduction, governing equations, boundary layer concept, free convection - vertical plate, horizontal cylinder, horizontal plate - forced convection – natural convection inside an enclosure – laminar flow, turbulent flow, Reynolds analogy.

Unit 3: Convective Phase Change Heat Transfer and Heat Exchangers 9 Hours

Condensation and boiling – boiling modes, correlations, forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation - heat exchangers – design procedure for heat exchanger-LMTD and NTU analysis, fouling factor, effectiveness.

Unit 4: Radiation 9 Hours

Radiation – laws of radiation, black body radiation, shape factor, radiation exchange between gray surfaces, radiosity and irradiation.

Unit 5: Mass Transfer 9 Hours

Mass transfer – Fick's law of diffusion, forced convective mass transfer, heat and mass transfer analogies.

Text Book(s):

1. Sachdeva, R.C., Fundamentals of Engineering Heat and Mass Transfer, New Age International, 1995.
2. Y. A. Çengel and R. H. Turner, "Heat Transfer", McGrew-hill, 2nd Ed

Reference(s)

1. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.
2. Ozisik, M.N., Heat Transfer, McGraw-Hill Book Co., 1994.
3. Nag, P.K., Heat Transfer, Tata McGraw-Hill, New Delhi, 2002.
4. Holman, J.P., Heat and Mass Transfer, Tata McGraw-Hill, 2000.
5. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 1998.
6. Frank, P., Incropera and David, P. D., Fundamentals of Heat and Mass Transfer, John Wiley and Sons, 1998.

<table>
<tr><td rowspan="3">MEC385 THERMAL LABORATORY-II</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>0</td><td>0</td><td>3</td><td>2</td></tr>
<tr><td>Pre/Co-requisite: MEC209 Thermal Engineering, MEC327 Heat and Mass Transfer</td><td colspan="4">Course Category: Program Core
Course Type: Practical</td></tr>
</table>

Course Objective(s)

To study various parameters involved in the modes of heat and mass transfer.

Course Outcome (s)

CO1: Ability to measure the thermal conductivity of diverse common metallic materials

CO2: Analyze the difference between natural and forced convection

CO3: Analyze the performance of heat exchangers and demonstrate in practice.

CO4: Ability to carry out simple experimental work in irradiative heat transfer

CO5: Analyze the performance of experiment on refrigerant test rig

CO and PO Mapping

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2		3					1				3	3	
CO2	1	3	2						1				3	3	
CO3	3	3	2	1	2				2			2	3	3	
CO4	1	3							1				3	3	
CO5	1	2							2				3	3	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

List of Experiments

1. Determination of thermal conductivity of insulating powder.
2. Determination of overall heat transfer coefficient using composite wall apparatus.
3. Determination of emissivity using emissivity apparatus.
4. Determination of heat transfer coefficient in natural convection mode.

5. Determination of heat transfer coefficient in natural and forced convection mode in pin-fin apparatus.
6. Determination of Stefan Boltzmann constant using test rig.
7. Determination of effectiveness of Parallel flow and counter flow heat exchanger.
8. Determination of heat transfer coefficient in forced convection mode.
9. Determination of thermal conductivity using Lagged Pipe apparatus.

Referece

Lab Manual prepared by KLU faculty

SEMESTER-VII

<table>
<tr><td rowspan="3">MEC401 POWER PLANT ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Thermal Engineering MEC209</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To acquire knowledge on operation, performance analysis and environmental effects of power plants.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the principle of operation of thermal power plant and its accessories

CO2: Illustrate nuclear and hydel power plants, and its environmental impact

CO3: Analyze performance of gas turbine and diesel engine power plants, and its environmental consequences

CO4: Discuss various types of power plants using renewable energy sources

CO5: Apply the cost benefit analysis to power generation and distribution

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3											2	2		
CO2	3							2				1	2		
CO3		3					2						2	2	
CO4		3					1						3		
CO5		3									2				

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Thermal Power Plant **12 Hours**

Thermal power plant- boilers and cycles, high pressure boilers - coal and ash handling systems, fluidized bed combustion, condensers, cooling towers, electrostatic precipitator, pulverized fuel firing ,burners, boiler feed water treatment.

Nuclear and Hydel Power Plant **12 Hours**

Principles of nuclear energy – nuclear power plant, fission and fusion reactions, reactor types – pressurized water reactor, boiling water reactor – hydro electric power plants – runoff storage and pumped storage type, draft tube, layout , selection of water turbine, nuclear waste disposal.

Gas Turbine and Diesel Power Plant **12 Hours**

Gas turbine power plant- Brayton cycle, types, selection of material, performance of gas turbines, combined cycle - diesel engine power plant – components and lay-out, selection of engine type, environmental hazards.

Other Power Plants **12 Hours**

Unconventional power plants – solar, wind, ocean thermal energy conversion, tidal and geothermal power plants, MHD concepts of energy conversion, Fuel Cell power systems, underground coal gasification power plant.

Plant Economics **12 Hours**

Load curve – definition – fixed and operating costs, comparison of economics of different types of power plants, tariff types.

Text Book(s)

1. Rajput, R.K., Power Plant Engineering, Laxmi Publications, 2008.

Reference(s)

1. EI- Wakil, M.M., Power Plant Technology, McGraw-Hill, 2010.
2. Nag, P.K., Power plant Engineering, Tata McGraw-Hill, 2014.
3. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 1998.
4. Ramalingam, K.K., Power Plant Engineering, Scitech Publications, 2010.
5. Rai, G.D., Introduction to Power Plant Technology, Khanna Publishers, 1996.
6. Frank D.Graham, Power Plant Engineers Guide, D.B. Taraporevala Sons and Co, New Delhi, 1993.
7. Morse Frederick, T., Power Plant Engineering, Prentice Hall of India, 2006.
8. Culp, A.W., Principles of Energy Conversion, McGraw Hill, 2000.

<table>
<tr><td rowspan="3">MEC402 AUTOMOBILE ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Thermodynamics MEC202</td><td colspan="4">Course Category: Program Core
Course Type: Theory</td></tr>
</table>

Course Objective(s)

This Course helps the Students to learn the operation of various systems in a vehicle

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Identify and distinguish different systems and components of an automobile systems

CO2: Interpret and demonstrate the working principles of basic elements automobile transmission system

CO3: Understand the Carburetion and injection in Engines

CO4: Distinguish the various basic electrical systems of an automobile

CO5: Ability to understand the importance of Alternative Fuels, its properties and their application.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2				2							2		
CO2	3	2											1		
CO3	3		2										3		
CO4	3	2											3		
CO5	3	2				3							3	3	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

ENGINES

General classification of vehicles, power unit, all components of power unit,steering systems-power steering, wheel and suspension systems.

TRANSMISSION SYSTEMS

Axles, differentials, mechanical, hydraulic and pneumatic brakes, power brakes, four wheel drive-clutches, couplings, gear boxes and torque converters.

ENGINE AUXILIARY SYSTEMS

Electronic fuel injection systems, CRDI system.

ELECTRICAL SYSTEMS

Electrical systems- construction, operation and maintenance of batteries, generators, relays, starter motors, lighting, ignition, electrical accessories- panel board instruments, automobile air conditioning, troubleshooting.

ALTERNATE ENERGY SOURCES

Electric and hybrid vehicles, fuel cells.

TEXT BOOK

1. Heitner, J., Automotive Mechanics Principle and Practice, Affiliated East-West Press Ltd., 2nd ed., 1974.

REFERENCES

1. Newton, K., Steeds, W., and Garrett, T.K., the Motor Vehicle, Butterworths, 1989.
2. Kirpal Singh, Automobile Engineering, Vol. I and II, Standards Publishers, New Delhi, 2000.

MEC403 MECHATRONICS	Credits			
	L	T	P	Total
	3	1	0	4
Pre-requisite: Basic electrical and Electronics engineering EEE101	**Course Category:** Program Core **Course Type:** Theory			

Course Objective(s)

The aim of undergoing this course to involve in integrated approach for the design of complex engineering systems and provide knowledge of sensors, actuators and selection for engineering application.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Recognize the basic elements of Measurement and Control Systems.

CO2: Identify the various sensors and transducers that can be used for mechanical applications

CO3: Demonstrate intelligent microprocessor 8085 system employed in real life scenario for Various Domestic applications.

CO4: Develop a controller using Programmable Logic Controller for Mechatronics system.

CO5: Design an electronic based mechanical system for domestic applications

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		3			2			2						3
CO2	3	2	2				1				3	1	2	2	
CO3	3		3	2	3								3	3	2
CO4	3	2	3		2								3	3	3
CO5	3	3	3		3								2	3	1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction toMechatronics 9 Hours

Introduction to Mechatronics systems - measurement systems-control systems-types-automatic control system-microprocessor based control system- Introduction of bio mechanics, Bio-mircro electrical mechanical system.

Unit 2: **Sensors and Transducers** **9 Hours**

Introduction-performance terminology-displacement, position and proximity-velocity and motion fluid pressure-temperature sensors-light sensors-selection of sensors.

Unit 3: 8085 Microprocessor and Digital Logic Control **9 Hours**

Introduction – architecture - pin configuration - instruction set - programming of microprocessors using 8085instructions-interfacing input and output devices-interfacing D/A converters and A/D converters applications-temperature control-stepper motor control-traffic light controller-digital logic control-review of number system-code conversion-boolean algebra.

Unit 4: Programming Logic Controllers **9 Hours**

Introduction-basic structure-input / output processing-programming - mnemonics-timers, internal relays and counters-data handling-analog input/output-selection of a PLC.

Unit ***5:*** **Design of Mechatronic Systems** **9 Hours**

Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions-case studies of mechatronic systems - pick and place robot - automatic car park system engine management system.

Text Book(s)

1. Bolton, W., Mechatronics, Longman, Fourth Edition, 2017.

Reference(s)

1. Michael, B.H., and David, G.A., Introduction to Mechatronics and measurement systems, McGraw Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D., Buru, N.C., and Loader, A.J., Mechatronics, Chapman and Hall, 1993.
3. Ram, K., Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, Fourth Revised Edition, 1999.
4. Singh M.D., Joshi J.G., Mechatronics, PHI 2009.

MEC481 SIMULATION LABORATORY	**Credits**			
	L	**T**	**P**	**Total**
	0	**0**	**3**	**2**
Pre-requisite: Finite Element Analyses MEC320, Heat and Mass Transfer MEC327	**Course Category:** Program Core **Course Type:** Laporatory Cource with Project			

Course Objective(s):

- To acquire the skills needed to analyze and simulate engineering systems.
- To give exposure to software tools needed to analysis engineering systems.
- To expose the students to different applications of simulation and analysis tools.

Course Outcome (s)

CO1: Identify the simulation model for common engineering problems.
CO2: Construct the simulation model for structural applications.
CO3: Design and analyze the pressure vessels in real time engineering situation.
CO4: Develop the finite element formulation for problems in vibration
CO5: Ability to perform problems in thermal field.

CO and PO Mapping

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	1	2									2		
CO2	3	2	3		1								1		
CO3	3		3		1								1		
CO4	3		1	1	1								3		
CO5	3	2	2										1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

SIMULATION (ANALYSIS) (SIMPLE TREATMENT ONLY)

a) Stress analysis of a plate with a circular hole.
b) Stress analysis of rectangular L - bracket
c) Stress analysis of an axi-symmetric component
d) Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
e) Mode frequency analysis of a 2D component
f) Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
g) Harmonic analysis of a 2D component
h) Thermal stress analysis of a 2D component
i) Conductive heat transfer analysis of a 2D component
j) Convective heat transfer analysis of a 2D component

Referece

Lab Manual prepared by KLU faculty

LIST OF MAJOR ELECTIVES

MEC309 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: MEC207 Manufacturing Technology, MEC303 Design of Machine Elements	**Course category:** Major Elective **Course Type:** Theory			

Course Objective

- To provide basic knowledge jigs and fixtures and its need for various applications
- To provide the knowledge in design of jigs and fixtures for various components and machines
- To familiarize in press working terminology and selection of dies for press working operation
- To equip the students in designing the dies for the various press work operations

Course Outcome (s)

CO1: Demonstrate the purpose and functions of jigs and fixtures.
CO2: Develop jig designs and also jig-less manufacturing concepts.
CO3: Explain various fixture assemblies, design, develop and inspect fixtures.
CO4: Analyze the press working and strip layout process.
CO5: Evaluate the design and development of progressive and compound dies for various applications.

CO and PO Mapping

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1									3			1
CO2	3	2	3							2		2			
CO3	3	2	3									2			1
CO4	3	2	3		2			2		2		1			
CO5	3	2	3									1			3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

PURPOSE, TYPES AND FUNCTIONS OF JIGS AND FIXTURES

Tool design objectives - production devices - inspection devices - materials used in jigs and fixtures – types of jigs - types of fixtures - mechanical actuation - pneumatic and hydraulic actuation-analysis of clamping force-tolerance and error analysis.

JIGS

Drill bushes – different types of jigs - plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs - automatic drill jigs - rack and pinion operated - air operated jigs components - design and development of jigs for given components – Jigless manufacturing concept

FIXTURES

General principles of - boring, lathe, milling, broaching, grinding, planning and shaping fixtures - assembly - inspection and welding fixtures - modular fixtures - design and development of fixtures for given component.

PRESS WORKING

Press working terminology-presses and press accessories, computation of capacities and tonnage requirements, element of progressive combination and compound dies - die block - die shoe, bolster plate, punch plate, punch holder, guide pins and bushes – strippers knockouts - stops – pilots - selection of standard die sets strip lay out - strip lay out calculations.

DESIGN AND DEVELOPMENT OF DIES

Design and development of progressive and compound dies for blanking and piercing operations - bending dies – development of bending dies, forming and drawing dies -development of drawing dies.

TEXT BOOK

1. Edward, G., Hoffman, Jigs and Fixture Design, Thomson Delmar Learning, Singapore, 2004.
2. Joshi, P.H., Jigs and Fixtures, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2004

REFERENCES

1. Donaldson, C., Tool Design, Tata McGraw-Hill, New Delhi, 1986.
2. Kempster, Jigs and Fixtures Design, The English Language Book Society, 1978.
3. Hiram E Grant, Jigs and Fixture, Tata McGraw-Hill, New Delhi, 2003.
4. Fundamentals of Tool Design, ASTME, CEEE Edition, 1983.
5. James,. Nevins, Danie .E. Whitney, Thomas. . DeFazio, Concurrent Design of products and processes, McGraw-Hill, 1989.

HAND BOOK

Design Data book, PSG College of Technology, Coimbatore, 2006.

<table>
<tr><td rowspan="3">MEC310 CNC MACHINING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC 207 Manufacturing Technology</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

This course introduces you to modern manufacturing with two areas of emphasis: computer aided manufacturing, and computer aided process planning.

This course has two goals.

The first goal is to learn the important theory, concepts, technology, and the state-of-the-art development in CAD/CAM. It is very important to understand how the CAD/CAM systems work and know the current industry status.

The second goal is understand the part design specification, NC programming, process planning, and Computer aided process planning (CAPP), CAD and CAM systems, and CAD/CAM data exchange.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Ability to apply the concepts of manufacturing science in the field of advanced manufacturing systems

CO2: Analyze the complex engineering linkage, machine and structure of the CNC machine

CO3: Analyze the different types of drive systems used in CNC for mechanical engineering field

CO4: Identify and analyze the effect of different types of co-ordinate system used in CNC machining

CO5: Demonstration of different types of cutting tools and materials

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2														1
CO2		3						1							
CO3			3						2			2			1
CO4	2	3								1					
CO5		3													

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

Development of CNC technology - principles, features, advantages, economic benefits, applications - CNC, DNC concept - classification of CNC machine- types of control, CNC controllers, characteristics, interpolators- current trends in programming, Human Machine Interface software

Unit 2: CNC Machines **9 Hours**

CNC machine building, structural details, configuration and design, guide ways - friction and antifriction and other types of guide ways - elements used to convert the rotary motion to a linear motion- screw and nut - re-circulating ball screw, planetary roller screw, re- circulating roller screw - rack and pinion - torque transmission elements- gears, timing belts, flexible - couplings and bearings. ATC and Tool Magazines, and Machine Control Units

Unit 3: Drives **9 Hours**

Spindle drives- DC shunt motor, 3 phase AC induction motor - feed drives - stepper motor servo principle, DC and AC servo motors- open loop and closed loop control - axis measuring system - synchro, synchro revolver, gratings, moiré fringe gratings, encoders, inductosyn laser interferometer.

Unit 4: Coordinate System 9 Hours

Coordinate system - structure of a part program, G and M codes - manual part programming for Fanuc, Sinumeric control system – CAPP - APT part programming using CAD/CAM, parametric programming. Introduction to Computer assisted part programming -Step turning and thread cutting operations.

Unit 5: Cutting Tool Materials 9 Hours

Cutting tool materials - carbide inserts classification - qualified, semi qualified and preset tooling, tooling system for machining centre and turning centre work holding devices -maintenance of CNC machines.

Text Book(s)

1. HMT, Mechatronics, Tata McGraw –Hill Publishing company Ltd., New Delhi, 2008.

Reference(s)

1. James Madison, CNC Machining Hand book, Industrial Press inc., 2004.
2. Sadasivan, T. A., and Sarathy, D., Cutting tools for Productive Machining, Widia (India) Ltd., August, 2005
3. Radhakrishnan, P., Computer Numerical Control Machines, New Central Book agency, 2006

<table>
<tr><td rowspan="3">MEC311 NON-TRADITIONAL MACHINING TECHNIQUES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Manufacturing Technology MEC207</td><td colspan="4">Course Category: Major Elective
Course Type: Theory with Practical component</td></tr>
</table>

Course Objective(s)

This course provides students with The machining principles and processes in the manufacturing of precision components and products that use in unconventional manufacturing environment.

Basic understandings of the machining capabilities of the processes, advantages, disadvantages, limitations, and productivity of advanced machining processes.

Course Outcome(s)

After completing this course, the student will be able to:

After completing this course, the student will be able to:

CO1: Investigation of abrasive water jet machining of real time mechanical components

CO2: Design the appropriate electrochemical machining process for the various materials

CO3: Analyze the electrical energy based process for making complex profile in hard metals.

CO4: Understand the tool and workpiece temperatures and their effect on quality based on thermal energy allied machining processes.

CO5: Ability to identify the process parameters, their effect and applications of hybrid machining process.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			3		3						2	3	
CO2	3	2			2								2	3	
CO3	3	2			2								2	3	
CO4	3	2			2								2	3	
CO5	3				2								2	3	3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Mechanical Energy Based Machining 9 Hours

Overview, need, classification of non-conventional machining processes –Abrasive water jet machining- ultrasonic machining - principle, machining unit, tool materials, tool size, process characteristics, advantages, limitations, applications. Abrasive flow machining - introduction, principle, equipment, process details, advantages, limitations, and applications.

Unit 2: Electro Chemical Machining 9 Hours

Electro-chemical machining - introduction, principle, elements, machine, chemistry of process, metal removal rate, tool design, accuracy, surface finish, economics, advantages, limitations, applications - electrochemical grinding - electrochemical deburring, electrochemical honing, shaped tube electrolyte machining - chemical machining - introduction, advantages, limitations, applications.

Unit 3: Electro Thermal Based Machining 9 Hours

Electrical Discharge Machining - introduction, principle, machine dielectric fluid, spark erosion generators, EDM tools, electrode holders, tool design, flushing, process characteristics, applications, electrical discharge grinding, wire cut EDM.

Unit 4: Thermal Process 9 Hours

Plasma Arc Machining - introduction, principle, plasma, non-thermal generation of plasma, mechanism of metal removal, PAM parameters, equipment, safety precautions, advantages, limitations, applications - Electron Beam Machining, laser beam machining, Ion Beam Machining - introduction, principle, equipment, parameters, characteristics, types of lasers.

Unit 5: Hybrid Machining 9Hours

Hybridization of non-conventional processes and micro and nano-manufacturing ECDG, overview of micro and nano- manufacturing and applications.

PRACTICAL COMPONENT (NOT FOR EXAMINATION)

Demo on operation of Electrical Discharge machining (EDM) and Abrasive water jet machining (AWJM).

Text Book(s)

1. V. K. Jain Advanced Machining Processes, Allied Publishers, 2009.
2. Machining of Stainless Steels and Super Alloys: Traditional and Nontraditional Techniques, Helmi A. Youssef, ISBN: 978-1-118-91956-9, 304 pages November 2015

Reference(s)

1. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2000.
2. Ghosh Amitabh, Malik Ashok, Manufacturing Science, East West Press Pvt Ltd, 1985. Lindberg Roy, A., Processes and Materials of Manufacture, Prentice Hall of India, New Delhi, 1990.

<table>
<tr><td rowspan="3">MEC 312 INTERNAL COMBUSTION ENGINES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : MEC209 Thermal Engineering</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of undergoing this course is to develop basic understanding on working of SI and CI engines and their performance and knowledge on emission control.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Distinguish various components of IC engines and analyzing the key factors influencing engine performance

CO2: Analyze the performance of compression ignition engine using fuel injection characteristics.

CO3: Identify the sources and types of pollutants in IC engines.

CO4: Elaborate the methods and measurement of emission controls

CO5: Evaluate the suitability of alternate fuels for IC engines and measurement techniques

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	2	3								2		1	
CO2	1	3	3	3	2							2	1		
CO3	3	1			2							2			2
CO4	1	2			2			2				1			
CO5	1	3			2							2		1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Unit 1: Spark Ignition Engine **12 Hours**

Spark ignition engine mixture requirements, feedback control, carburetors, fuel injection systems - monopoint and multipoint injection, stages of combustion - normal and abnormal combustion - factors affecting knock, combustion chambers - introduction to thermodynamic analysis of SI engine combustion- reason for ignition and ignition advance.

Unit 2: Compression Ignition Engine **12 Hours**

Stages of combustion in CI engine, direct and indirect injection systems, combustion chambers, fuel spray behaviour, spray structure, spray penetration and evaporation - air motion, turbo charging, introduction to thermodynamic analysis of CI engine combustion-governing of IC engines-necessity of governing –recent trends in injection system

Unit III: Pollutants **12 Hours**

Pollutants - sources and types, formation of NO_x, hydrocarbon emission mechanism, carbon monoxide formation.

Unit IV: Emission Control **12 Hours**

Particulate emissions - methods of controlling emissions- catalytic converters and particulate traps, methods of measurements and driving cycles- engine modification to reduce emission.

Unit IV: Fuels **12 Hours**

Duel fuel, natural fuel and wanked rotary engine- free piston engine-alcohol, hydrogen, natural gas and Liquefied Petroleum Gas - properties, suitability, engine modifications, merits and demerits as fuels, lean burn engines, stratified charge engines, gasoline direct injection engine, homogeneous charge compression ignition, plasma ignition , measurement techniques.

Text Book(s)

1. John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill, 1988.

Reference(s)

1. Mathur, R.B., and Sharma, R.P., Internal Combustion Engines,Dhanpatrai,2000.
2. Rowland S Benson and Whitehouse, N.D., Internal combustion Engines, Vol.I and II, Pergamon Press, 1983.
3. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc., 1987.

<table>
<tr><td rowspan="3">MEC313 TURBO MACHINERY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC202 Thermodynamics</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Enable the students to understand the concepts and working of turbo machinery.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the fundamentals of turbo machines and solve mathematical expressions.

CO2: Analyze the performance of fans and blowers.

CO3: Examine the working of centrifugal compressors and its performance.

CO4: Demonstrate the construction of axial compressors and solve simple performance calculations.

CO5: Compare and discuss the performances and characteristics of axial and radial flow turbines.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1		2						2				2	
CO2		3	3				2						3		
CO3		3		1	2			3			1				3
CO4		1		3			2		3		2			2	
CO5		3					1		2		2			2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **12 Hours**

Stages of turbo machines – energy transfer between fluid and rotor, stage velocity triangles, thermal turbo machines, classification, general energy equation, modified turbo machines, compression and expansion process.

Unit 2: Fan and Blowers **12 Hours**

Fan, blowers – blade design, velocity triangles, stage parameters, flow analysis in impeller blades, design parameter, volute and diffusers, efficiencies and losses, fan noises, causes and remedial measures.

Unit 3: Centrifugal Flow Compressors **12 Hours**

Centrifugal compressors - definition and classifications, stage parameters, performance characteristics - cascade of blades, cascade tunnel, blade geometry, cascade variables, energy transfer and loss in terms of lift and drag.

Unit 4: Axial Flow Compressors **12 Hours**

Axial flow compressors - definition and classifications, constructional details, stage velocity triangles, stage work, stage pressure rise, H-S diagram, stage efficiencies and losses, degree of reaction, radial equilibrium, surging and stalling, performance characteristics.

Unit 5: Axial and Radial Flow Turbines **12 Hours**

Axial and radial flow turbines - construction details, 90° IFR turbine, stage work, stage velocity triangles, stage pressure rise, impulse and reaction stage, effect of degree of reaction, H-S diagram, efficiencies and losses, performance characteristics.

Text book(s)

1. Yahya, S.M., Turbines, Compressors and Fans, Tata McGraw-Hill Publishing Company, 2010.

Reference(s)

1. Dixon S.L, Fluid Mechanics, Thermodynamics of turbo machines, Pergamon press, 2nd Edition, 2014.
2. Kadambi, V., and Manohar Prasad, An Introduction to energy conversion - Vol. III, Turbo machines- Wiley Eastern India Ltd, 1977.
3. Shepherd, D.H., Principles of Turbo-machinery, The Macmillan Company, 1969.
4. Seppo A. Korpela , Principles of Turbomachinery, John Wiley & Sons, 2011. 5. Erik Dick, Fundamentals of Turbo machines, Springer, 2015.

<table>
<tr><td rowspan="3">MEC 314 ENERGY ENGINEERING AND MANAGEMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC202 Thermodynamics</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Enable the students to understand the basic concepts of Energy Engineering and Management

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Recognize the basics of demand side management of fossil fuel

CO2: The student will learn to improve energy conservation implementation

CO3: Know the basic principles involved in thermal powerplant.

CO4: To Learn the basic of energy auditing with application on different sectors

CO5: Apply the knowledge to evaluate energy efficiency through the use of cost effectiveness test.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2													2	2
CO2		3				3									
CO3	3	3													
CO4						3		1							
CO5	2			2	3										

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Basics **9 Hours**

Introduction - fossil fuels reserves, world energy consumption, greenhouse effect, global warming, renewable energy sources, environmental aspects utilization, energy prices, energy policies. Climate change problem and response.

Unit 2: Energy Conservation Schemes **9 Hours**

Energy conservation schemes - industrial energy use, energy surveying and auditing, energy index, cost index, energy conservation in engineering and process industry, in thermal systems, in buildings and non-conventional energy System.

Unit 3: Thermal Energy System **9 Hours**

Fuels and consumption - boilers, furnaces, waste heat recovery systems, heat pumps and refrigerators, storage systems, insulated pipe work systems, heat exchangers.

Unit 4: Energy Management Principles **9 Hours**

Energy management principles - energy resource management, energy management information systems, instrumentation, measurement and ICT (information and communication technology in energy management)

Unit 5: Costing Techniques **9 Hours**

Costing techniques - cost optimization, optimal target investment schedule, financial appraisal and profitability, project management.

Text Book(s)

1. Murphy, W.R., and Mc KAY, G., Energy Management Butterworths, London, 2000.

Reference(s)

1. Callaghn, P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 2004.
2. David Merick and Richard Marshal, Energy, present and future options, Vol. I and II, John Wiley and Sons, 2009.
3. Chaigier, N.A., Energy Consumption and Environment, McGraw-Hill, 2007.
4. Ikken, P.A., Swart, R.J., and Zwerves, S., Climate and Energy, 2008.
5. Ray, D.A., Industrial Energy Conservation, Pergamaon Press, 2004.

<table>
<tr><td rowspan="3">MEC315 DESIGN FOR MANUFACTURING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC207 Manufacturing Technolog</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To enable the students to understand the principles of manufacturability and factors to be considered for the various manufacturing process

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Outline the design features to be considered for manufacturing process

CO2: Identify the influence of materials on form design

CO3: Facilitate the design features of machining processes.

CO4: Analyze and design the cast components.

CO5: Evaluate the quality of component design

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2												2	2	
CO2		3	3										1	2	
CO3		3	3										2		1
CO4		3	3											2	

CO5	1	2			3										

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit-1 Introduction 9 Hours

General design - principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method - process capability - feature tolerances - geometric tolerances - assembly limits – datum features - tolerance stacks.

Unit-2 Factors Influencing Form Design 9 Hours

Working principle - material, manufacture, design - possible solutions - materials choice- influence of materials on form design of welded members, forgings and castings.

Unit-3 Component Design –Machining Consideration 9 Hours

Design features to facilitate machining - drills, milling cutters, keyways - doweling procedures - counter sunk screws - reduction of machined area - simplification by separation - simplification by amalgamation –design for fixtures- design for machinability - design for economy - design for clampability - design for accessibility - design for assembly.

Unit-4 Component Design – Casting Considerations 9 Hours

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores.

Unit-5 Redesign for Manufacture And Case Studies 9 Hours

Identification of uneconomical design - modifying the design - group technology - computer applications for DFMA.

Text Book(s)

1. Harry Peck, Design for Manufacture, Pittman Publication, 1983.

Reference(s)

1. Robert Matousek, Engineering Design - A systematic approach, Blackie and sons Ltd., 1963.
2. James G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Co., 1986.
3. Swift, K.G., Knowledge based design for manufacture, Kogan Page Ltd., 1987.

MEC 316 THEORY OF METAL CUTTING			Credits			
			L	**T**	**P**	**Total**
			3	**0**	**0**	**3**
Pre-requisite: MEC207 Manufacturing Technology	**Course Category:** Major Elective **Course Type:** Theory					

Course Objective(s)

To provide knowledge about the basics of metal cutting, chip formation and its Mechanism.

To understand the nomenclature of single point and multi point cutting tool.

To provide depth knowledge on various micromachining processes and also briefs the importance of machining economics.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Describes the basic mechanism of metal cutting and chip formation.

CO2: Explain the different aspects of single point cutting tools and their selection procedure.

CO3: Demonstrate the nomenclature and selection of multi point cutting tool.

CO4: Explain the concepts of micromachining process.

CO5: Apply and analyze the concepts acquired to determine the machining time and product cost.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1												2		
CO2	2	3	2										2		
CO3	2	3	2										2	1	
CO4	1				2								2		
CO5	2	1			3								2		2

3- Strong Corre1ation; 2 - Medium Correlation; 1 – low Corre1ation

Course topics

Unit 1: Introduction 9 Hours

Theory of metal cutting- chip formation- Types of chips-chip breaker-orthogonal Vs oblique cutting - specific cutting energy - shear angle - theory of Merchant, Lee and Shaffer - friction in metal cutting - temperatures in metal cutting - measurement of cutting temperature-Cutting fluids. Demo on Measurement of cutting temperature using thermal image analyzer.

Unit 2: Single Point Cutting Tools 9 Hours

Cutting tool material, properties, insert and coated tools, tool wear, tool life - single point cutting tool nomenclature, type and styles- design and manufacture of tools - HSS and carbides-brazed and clamped insert tools for turning, boring, shaping operations

Unit 3: Multipoint Cutters 9 Hours

Multi-point cutters- nomenclature, classification and selection, construction methods, cutter setting, design and manufacture of drills, reamers, taps, milling cutters, grinding wheel specification, lapping, dressing and truing.

Unit 4: Micromachining and Chatter in Machining 9 Hours

Theory of micromachining – chip formation - surface finish – Size effect in micromachining – microturning, micromilling, microdrilling - tool design. Chatter in machining-factors effecting chatter in machining-types of chatter-mechanism of chatter.

Unit 5: Economics of Machining 9 Hours

Introduction to economics of machining, Machining Time- Estimation of machining time in different machining operations, estimation of cost and optimum cutting conditions.

Text Book(s)

1. Shaw .M.C., " Metal cutting Principles ",Oxford clarendon Press, 2nd edition, 2005.
2. Juneja. B. L and Sekhon.G.S, "Fundamentals of metal cutting and machine tools", New Age International(p) Ltd., 2003.

Reference(s)

1. Geoffrey Boothroyd and Knight. W.A "Fundamentals of Machining and Machine tools", CRC Press, New York, 2006.
2. Bhattacharya. - " Metal Cutting Theory and Practice ", New central Book Agency pvt. Ltd., Calcutta, 2000.

MEC317 TRIBOLOGY	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: MEC103 Engineering Mechanics	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

The aim of undergoing this course is to provide broad based understanding of the interdisciplinary subject 'tribology' and its technological significance

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the surface friction properties and various types of wear of materials.

CO2: Outline of the principles of lubrication, lubrication regimes, theories of hydrodynamic, elasto hydrodynamic etc.,

CO3: Identify tribo testing and experimental techniques in tribology

CO4: Analyze the awareness of tribological issues in the design of machine components, such as rolling contact bearings, journal bearings etc.,

CO5: Examine tribo measurement using various instruments with international standards

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2								1			2		
CO2	3	2		1						1				3	
CO3	3	3	2	2	2					1	1	1		2	
CO4	3	3	3	2	2					1	1	1	2		2

CO5	3	3	2	2	2					1	1	1		2	2

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1:Surface Friction and Wear 9 Hours

Topography of the surfaces - surface features - surface interaction - theory of friction - sliding and rolling friction, friction properties of metallic and non-metallic materials, friction in extreme conditions - wear- types of wear - mechanism of wear - wear resistance materials - surface treatment - surface modifications - surface coatings.

Unit 2: Lubrication Theory 9 Hours

Lubricants-physical properties, lubricants standards, lubrication regimes - hydrodynamic lubrication - Reynolds equation - thermal, inertia and turbulent effects - elasto hydrodynamic, plasto hydrodynamic and magneto hydrodynamic lubrication - hydro static lubrication - gas lubrication.

Unit 3: Wear Testing Method 9 Hours

An abrasive wear tester-A rolling sliding wear tester- A pin-on-disc wear tester-Three body wear test.

Unit 4: Application of Tribology 9 Hours

Introduction-Rolling Contact Bearings- Gears- Journal Bearings – Off shore bearing, wind turbine sliding bearing

Unit 5: Tribo Measurement In Instrumentation 9 Hours

Surface Topography measurements – Electron microscope and friction and wear measurements – Laser method – instrumentation - International standards – bearings performance measurements – bearing vibration measurement.

Text Book(s)

1. Sahoo, Engineering Tribology, PHI, New Delhi, 2007.

Reference(s)

1. Kenneth Holmberg Allan MatthewsBasu, S.K., Senguta, S.N., Fundamentals of Tribology, PHI, New Delhi, 2006.
2. Stachowiak, G.W.,Batchelor, A.W , Engineering Tribology, Butterworth-Heineman UK, 2005

3. Basu, S.K, Sengupta,.Ahuja,B,B, Fundamentals of Tribology, Prentice –Hall of India Pvt Ltd , New Delhi,2010
4. Williams, J.A., Engineering Tribology, Oxford Univ. Press, 2005

MEC318 REFRIGERATION AND AIR CONDITIONING	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC209 Thermal Engineering	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

Enable the students to understand the principles and concepts of refrigeration and air conditioning.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain the basic concepts of various refrigeration systems.

CO2: Knowledge about the types of refrigerants suitable for the applications

CO3: Apply the acquired knowledge to provide solution for space cooling applications.

CO4: Evaluate the cooling load for a given space and suggest the cooling requirements.

CO5: Understand and air conditioning equipment and its application.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										1	3		
CO2	3						1					2	2		
CO3		3	3											2	
CO4	1	3	2	2									2		1
CO5	3													2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

Review of thermodynamic principles of refrigeration, concept of aircraft refrigeration system, Vapour compression refrigeration cycle, use of P-H charts, multistage and multiple Evaporator systems, cascade system, COP comparison, vapour absorption refrigeration system, ammonia water and lithium bromide water systems, steam jet refrigeration system.

Unit 2: Refrigerants And Applications 9 Hours

Refrigerants - properties - selection of refrigerants, alternate refrigerants, refrigeration plant Controls testing and charging of refrigeration units- applications to refrigeration systems.

Unit 3: Psychrometry And Cooling Load Calculation 9 Hours

Psychrometric processes-use of psychrometric charts, grand and room sensible heat factors, By pass factor, requirements of comfort air conditioning, comfort charts, factors governing optimum effective temperature, recommended design conditions and ventilation standards.

Unit 4*:* Load 9 Hours

Types of load-design of space cooling load, heat transmission through building, solar radiation, Infiltration, internal heat sources (sensible and latent) ,outside air and fresh air load, estimation of total load-domestic, commercial and industrial systems-central air conditioning systems.

Unit 5: Air Conditioning Equipments 9 Hours

Air conditioning equipment – air cleaning and air filters, humidifiers, dehumidifiers, air washers, Condenser, expansion devices, evaporator, cooling tower and spray ponds, elementary treatment of duct design, air distribution system-Thermal insulation of air conditioning systems–applications-car, industry, stores and public buildings

Textbook(s)

1. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 2011.

Reference(s)

1. Arora,C.P.,Refrigeration and AirConditioning,TataMcGraw Hill, NewDelhi,2014.
2. Roy.J Dossat, Principles of Refrigeration, Pearson Education, NewDelhi,1997.
3. Jordon and Prister ,Refrigeration and Air Conditioning, Prentice Hall of India Pvt Ltd.NewDelhi,1985.
4. Stoecker, N.F.,and Jones, Refrigeration and Air Conditioning ,TMH, NewDelhi,2009.

MEC319 PROCESS PLANNING AND COST ESTIMATION	**Credits**			
	L	**T**	**P**	**Total**
	3	**1**	**0**	**4**
Pre-requisite: MEC207 Manufacturing Technology	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

To introduce the process planning concepts and to make cost estimation for various products after process planning

Course Outcome(s)

CO1: Outline various processes planning analysis with its design and selections.

CO2: Demonstration of various functions of Estimation and Costing with references to productions and control.

CO3: Estimation of various cost estimation associated with machining operations.

CO4: Measure of various manufacturing products with their cost and estimations.

CO5: Outline of estimation on various machining time of manufacturing operations.

Mappingof COswithPOs

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2					2						1			1
CO2	2			3								2			2
CO3		3			2										
CO4			3		3					2					
CO5	2									3					

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Process Planning 9 Hours

Types of production - standardization, simplification - production design and selection - process planning, selection and analysis - steps involved in manual experience based planning and computer aided process planning - retrieval, generative - selection of processes analysis - breakeven analysis.

Unit 2: Estimating and Costing 9 Hours

Importance and aims of cost estimation - functions of estimation - costing - importance and aims of costing - difference between costing and estimation - importance of realistic estimates - estimation procedure.

Unit 3: Element of Cost 9 Hours

Introduction - material cost - determination of material cost labour cost - determination of direct labour cost - expenses - cost of product (Ladder of cost) - illustrative examples - analysis of overhead expenses - factory expenses - depreciation - causes of depreciation - methods of depreciation - administrative expenses - selling and distributing expenses - allocation of overhead expenses.

Unit 4: Product Cost Estimation 9 Hours

Estimation in forging shop - losses in forging - forging cost - illustrative examples - estimation in welding shop - gas cutting - electric welding - illustrative examples - estimation in foundry shop - estimation of pattern cost and casting cost - illustrative examples- estimation for micro machining-

Unit 5: Estimation of Machining Time 9 Hours

Estimation of machining time for lathe operations – maching time calculation for non-traditional machining (EDM, ECM)-estimation of machining time for drilling, boring, shaping, planning, milling and grinding operations - illustrative examples.

Text Book(s)

1. Adithan, M., and Pabla, B.S., Estimating and Costing, Konark Publishers Pvt. Ltd., 1989.

Reference(s)

1. Chitale, A.K., and Gupta, R.C., Product Design and Manufacturing, Prentice Hall Pvt. Ltd., New Delhi, 1997.
2. Nanua Singh, System approach to Computer Integrated Design and Manufacturing, John Wiley and Sons, Inc., 1996.
3. Joseph G Monks, Operations Management, Theory and Problems, McGraw Hill Book Company, 1982.
4. Narang, G.B.S., and.Kumar, V., Production and Costing, Khanna Publishers, 1995.
5. Banga, T.R., and Sharma, S.C., Estimating and Costing, Khanna Publishers, 1986.

<table>
<tr><td rowspan="3" colspan="2">MEC320 FINITE ELEMENT ANALYSIS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : Nil</td><td colspan="5">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To equip the students with the Finite Element Analysis fundamentals.
- To enable the students to formulate the design problems into FEA.
- To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply the concept of numerical methods to find the approximate solution for partial differential equation.

CO2: Evaluate the significance of coordinate measurement system for the one dimensional finite element problems.

CO3: Develop the finite element formulation to solve structural application problems such as bar, trusses and beam

CO4: Perform analysis of 2D structures using plane stress and plane strain condition.

CO5: Analyze the dynamic characteristics of structural members using FEM.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3	2									3		1
CO2	3	3	3	2									3		3
CO3	3	3	2	2									3		1
CO4	3	3	2	2									3		1
CO5	3	3	3	2									3		1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction 9 Hours

Historical background – matrix approach – application to the continuum – Discretization matrix algebra –governing equations for continuum – classical techniques in FEM – weighted residual method – Ritz method

Unit 2: One Dimensional Problems 9 Hours

Finite element modeling – coordinates and shapes functions potential energy approach – Galerkin approach – assembly of stiffness matrix and load vector – finite element equations– bending of beams – finite element formulation of stiffness matrix and load vectors-one dimensional heat transfer.

Unit 3: Two Dimensional Problems – Scalar Variable Problems 9 Hours

Introduction – finite element modeling – scalar valued problem – CST element-stiffness matrix – force vector – stress calculation – temperature effects – applications to scalar variable problems.

Unit 4: Two Dimensional Problems – Vector Variable Problems 9 Hours

Vector variable problems – elasticity equation – plain stress and strain - Axisymmetric formulation – element stiffness matrix and force vector - boundary conditions – applications to cylinders under internal or external pressures – rotating discs.

Unit 5: Isoparametric Elements Formulation 9 Hours

The four node quadrilateral – shape functions – element stiffness matrix and force vector numerical integration – Gaussian quadrature – Examples –uses of FEA software.

Text Book(s)

1. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Pearson Education, New Delhi, 4TH Edition, 2012.
2. P. Seshu, Textbook of Finite Element Analysis, PHI Publication, 14th Edition ,2015.

Reference(s)

1. David V Hutton, Fundamentals of Finite Element Analysis, McGraw-Hill Int. Ed., 2005.
2. Rao, S.S., The Finite Element Method in Engineering", Elsevier, 2013.
3. Logan, D.L., A First course in the Finite Element Method, Thomson Learning, sixth Edition, 2016.
4. Robert D Cook., David.S, Malkucs Michael E Plesha, Concepts and Applications of Finite Element Analysis, Wiley, 4th Edition, 2003.
5. Reddy, J.N., An Introduction to Finite Element Method, McGraw-Hill International Student 3rd Edition, 2005.

<table>
<tr><td rowspan="3">MEC321 OPTIMIZATION TECHNIQUES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : Nil</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

This course will focus on mathematical modelling. Strong emphases will begiven to model formulation.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understand the basic concepts of optimization and its application..

CO2: Demonstrate the effectiveness of unconstrained optimization techniques.

CO3: Apply the Nonlinear Equations for problem solving.

CO4: Apply Constrained optimization methods for the solving problems with more than one constraint.

CO5: Construct a various types of networks.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3				2			1					2		
CO2	1	1			1									2	2
CO3	2			3	3								2		2
CO4		2	3		2								2		
CO5	3		3	1	2									2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1:Introduction To Optimization 9 Hours

Classification of optimization problems - applications of optimization - concepts of design vector- design constraints - constraint surface - objective function surfaces and multi -level optimization - quadratic programming- non-linear programming – unconstrained optimization techniques- basics of constrained optimization.

Unit 2: Unconstrained Optimization 9 Hours

Steepest-descent method-Newton methods - Quasi-Newton methods-linear/nonlinear conjugate gradient methods-interval reduction methods-line-search methods- trust-region methods-local and global convergence.

Unit 3: Nonlinear Equations 9 Hours

Newton's method - modified Newton’s methods; Brayden’s (quasi-Newton) method-Inexact Newton methods - the bisection method - line-search methods and merit functions- trust - region methods- local and global convergence.

Unit 4: Constrained Optimization 9 Hours

Lagrange multipliers- Karush - Kuhn-Tucker conditions - line-search methods and merit functions active-set methods (for inequality constraints) - penalty function methods (for equality constraints) - reduced-gradient and gradient-projection methods - augmented Lagrangian and projected Lagrangian methods - Barrier methods (for inequality constraints) - interior-point methods (for inequality constraints) - sequential linearly constrained programming- sequential quadratic programming.

Unit 5: Recent Techniques In Optimization 9 Hours

Convexity; linear programming, simplex and duplex method-quadratic programming- duality-nonlinear least-squares problems-variational calculus- nonsmooth optimization-dynamic optimization and the maximum principle of pontryagin- dynamic programming and the Hamilton- Jacobi-Bellman equation neural networks and the back propagation algorithm- stochastic optimization- simulated annealing-genetic algorithms- neural network based optimization- optimization of fuzzy systems – introduction to use of mat lab and other software used in optimization.

Text Book(s)

1. Edwin, K. P., Chong, and Stanislaw, Zak, H., An Introduction to Optimization, Wiley Interscience, 2nd Edition, 2001.

Reference(s)

1. Jorge Nocedal and Stephen Wright, Numerical optimization, Springer, New York, Springer Series in Operations Research and Financial Engineering, Second edition, 2006.
2. Numerical methods for unconstrained optimization and nonlinear equations by John E. Dennis and Robert B. Schnabel, Prentice Hall, Englewood Cliffs, NJ, 1988, reprinted by SIAM publications, 1993.
3. Fletcher, R., Practical methods of optimization, John Wiley and Sons, Chi Chester, New-York, Second edition, 1987.

MEC322 MODERN MANUFACTURING PROCESSES	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: Manufacturing Technology MEC207	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

- To study Machining principles and processes in the manufacturing of precision components and products that use conventional, nonconventional, and surface engineering technologies,
- To understand the machining capabilities, limitations, and productivity of advanced manufacturing processes

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply the basic production techniques in powder metallurgy for fabricating the components.

CO2: Understand the basic concept of CNC controller and robots specification

CO3: Understand the concept of semiconductor components manufacturing.

CO4: Apply the knowledge of unconventional machining process to calculate MRR, machining time and surface finish

CO5: Understand the fabrication techniques used in electronic devices.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		3		2						2	3	
CO2	3	2	3	2	3								2	3	
CO3	3	2	3	2	3								2	3	
CO4	3	2	3	2	3	2							1	2	
CO5	3	2	3	3	2		1						2		

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Course Topics

POWDER METALLURGY

Processing of powder metals, ceramics, glass and super conductors-introduction -production of metal powders - compaction of metal powders-sintering-secondary and finishing operations- design considerations of powder metallurgy - process capabilities -shaping ceramics - forming and shaping of glass - design consideration for ceramics and glass - metal injection moulding.

NC MACHINES AND ROBOTICS

Numerical control and robotics - background of numerical control - basics of numerical control - motion control- point to point and contouring - linear interpolation and circular interpolation - contouring control - positioning system - absolute and incremental - control loops - open and closed loop control - cartesian coordinate conventions - left and right hand-programming numerically controlled machines - G and M codes - basic concepts of robotics - programming of robots - initial robot specification - introduction to rapid prototyping.

SUPER CONDUCTORS

Processing of superconductors-forming and shaping plastics and composite materials – introduction – extrusion – injection moulding – blow moulding – casting – processing of reinforced plastics – processing metal-matrix composites – processing ceramic composites – design consideration and economics of forging and shaping plastics.

ADVANCED MACHINING

Advanced machining processes and nanofabrication – introduction - chemical machining - electrochemical machining - electrical discharge machining - wire EDM - laser beam machining - water jet machining-abrasive jet machining - nano fabrication -micro machining-the economics of advanced machining processes.

MICRO ELECTRIC DEVICES

Fabrication of microelectronic devices – introduction - semiconductors and silicon - crystal growing and wafer preparation-film deposition-oxidation-lithography - etching - diffusion and ion implantation, metallization and testing - bonding and packaging - yield and reliability - printed circuit boards.

Total Number of Hours-45

Text Book(s)

1. Serope Kalpakjain, and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education, Fourth Edition, 2002.

Reference(s)

1. Fundamentals of Morden Manufacturing Mikell.P.Groover ,Wiley, 2007.
2. Principles of Modern Manufacturing,5th Edition Version, Mikell P. Groover ,Wiley 2011.
3. Introduction to Modern Manufacturing Processes, Pandey and Shah, Tata McGraw Hill 2004.
4. Fundamentals of Material Science and Engineering an Integrated Approach, William D. Callister John Wiley & Sons, 2005.

<table>
<tr><td rowspan="3">MEC323 MATERIALS MANAGEMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiarize in the area of materials flow inside the industries and give wide knowledge on JIT.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Demonstrate the functions of materials management.

CO2: Apply the concepts of purchase management in industrial sectors.

CO3: Design of Stores Management System

CO4: Design of Inventory Systems

CO5: Outline about JIT, MRP I, MRP II, Vendor Evaluation, etc..

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2		1					2				1	2		
CO2	2		2		2		2	1		1	1		1		2
CO3	2	1	1		3		2	2				1	2		
CO4	2				2								2		
CO5	2				2							1			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Unit-I Functions Of Materials Management **9 Hours**

Introduction - objectives - organizations - functions - administration - integrated approach - relationship with other department-make or buy decision- buying process.

Unit-II Purchasing Management **9 Hours**

Purchasing policies and procedures - legal aspects - selection of sources of supply - forms and records - methods of purchasing - capital purchasing ethics-vendor evaluation and rating, cost analysis

Unit-III Stores Management **9 Hours**

Store function - location - layout - materials handling and movement - stock taking-procedures and records – ABC and VED system of stock control-ware housing and distribution management

Unit-IV Inventory Management **9 Hours**

EOQ - inventory systems - periodic - deterministic and probabilistic models - static inventory model – reorder point – lead time analysis – safety stocks-ABC analysis

Unit-IV Value Analysis **9 Hours**

Standardization - variety reduction - JIT - MRP I, MRP II - vender evaluation and rating - inventory audit and information systems.

Text Book(s)

1. Lamer Lee and Donald W Dobler, Purchasing and Materials Management, Tata McGraw-Hill, New Delhi, 1996.

Reference(s)

1. Gopalakrishnan, P., Purchasing and Materials Management, Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2001.
2. Gopalakrishnan, P, Abid haleem.,Handbook of Materials Management, Prentice Hall of India, New Delhi, 2015.
3. Starr and Miller, Inventory Control Theory and Practice, Prentice Hall of India, NewDelhi, 1989.
4. Ahuja, K.K., Material Management, CBS Pub., New Delhi, l992.
5. Spencer B.S., Computer Based Production and Inventory Control, Prentice Hall, 2002.
6. Joseph S.M., Production and Operations Management, John wiley and sons, 1999.
7. Datta, A.K., Integrated Materials Management: A Functional Approach, Prentice Hall of India Ltd., New Delhi, 1999.

<table>
<tr><td rowspan="3">MEC324 PLANT LAYOUT AND MATERIAL HANDLING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of undergoing this course is to develop basic understanding of plant layout and material handling.

Course Outcome(s)

After completing this course, the student will be able to:

1. Define the various plant layout and facilities requirement in process planning.
2. Identify the service requirements and selection of sites pertaining to plant location.
3. Classify various space requirements and layout techniques for various production plants.
4. Analyze various production flow problems related to industrial scenario.
5. Outline various machines and material handling equipment.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3											2	2	
CO2		3	3										2	2	
CO3		3	2										2	3	
CO4				3							3		2	3	
CO5		3											2	2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction to Facility Design 9 Hours

Facilities requirements- need for layout study – types of layout- Symptoms of poor layout, Technique and procedure to determine plant layout.- facilities design - sources of information for facilities design - process design - flow analysis techniques.

Unit 2: Plant Layout- Workstation Design 9 Hours

Site selection- plant location analysis – factors- costs - location decisions- Pitfalls in selection of site location, Economic versus social significance – auxiliary -plant cost – land – building and production – equipment - material cost - services requirement- employee services- space requirements- activity relationship analysis.

Unit 3: Space Requirements 9 Hours

Office layout techniques and space requirements - area allocation - application of computer simulation and modeling - simple problems in single facility location models - network location problems.

Unit 4: Production Flow Design 9 Hours

Organization chart - activity relationship chart - production routing sheets - flow process chart - worksheet for activity relationship chart- nodal diagram- operation chart - assembly chart for product - package design unit load design - departmental layout - production flow analysis (PFA) - line balancing - financial analysis - design cycle – SLP procedure manpower - machinery requirements – computer algorithms – ALDAP, CORELAP, CRAFT.

Unit 5: Machines and Material Handling 9 Hours

Computations of machine requirements - area and cost of production equipments- Manual and mechanical handling, Handling ratio, Effects of handling on productivity - unit load concept - material handling system design - handling equipment types - selection and specification - containers and packaging - receiving and shipping areas - storage analysis - plant services - total space requirements.

Text Book(s)

1. Meyers, Fred, E., and Stephens, Matthew, P., Manufacturing Facilities Design and Material Handling, Prentice-Hall, Inc., Fourth Edition, 2014.

Reference(s)

1. James Apple, M., Plant layout and Material Handling, John Wiley, 1977.
2. Tompkins, J.A., and White, J.A., Facilities and Planning, John Wiley, 1984.
3. Richard Francis, L., and John, A., White, Facilities Layout and Location - an Analytical Approach, Prentice Hall Inc. New Delhi, 1984.

<table>
<tr><td rowspan="3">MEC325 WELDING TECHNOLOGY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC207 Manufacturing Technology, MEC209Thermal Engineering</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of this course is to develop knowledge on joining process and skill to select processes based on materials.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Illustrate the welding process, appropriate tools and equipment.
CO2: Analyse the effect on weld ability and heat flow.
CO3: Identify the welding solidification, strength and microstructure.
CO4: Select welding process for ferrous and test methods
CO5: Contrast welding methods and procedure for non-ferrous metals.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3		2		3								2		
CO2	3	2	3		2										3
CO3	3		3										2	2	
CO4	3		2										2		
CO5	3		3		2									2	

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Unit 1: Welding Process and Equipment's 9 Hours

Welding processes and grouping, welding nomenclatures. Equipment's, parameter controls, Electrode specification and filler metals. Special welding process - Resistance welding, high energy density welding, Thermit welding, and solid state welding.

Unit 2: Heat Flow in Welding 9 Hours

Heat transfer in weldments, dissipation of welding heat, cooling rates and weld metal cooling curves. Calculation of HAZ width, solidification rate and effects of heat input.

Unit 3: Welding Metallurgy 9 Hours

Weld solidification, phase transformation in weldments, strengthening due to welding.

Microstructures of HAZ, PMZ, and fusion line. Weld cracking, residual stresses and distortion. Use of constitution diagram (Schaffler, Delong, and WRC 92).

Unit 4: Welding of Ferrous Materials 9 Hours

Welding of Stainless steels, and cast irons – Welding procedure qualification, Microstructures of weldments, electrode and filler material selection, defects and remedies.

Unit 5: Welding of Non Ferrous Materials 9 Hours

Welding of Aluminium, Nickel, and Titanium alloys - Welding procedure qualification, Microstructures of weldments, electrode and filler material selection, defects and remedies.

Text Book(s)

1. Howard B Cary, "Modern Welding technology", Prentice Hall, New Jersy, 2002.

Reference(s)

1. American Society of Metals, " Metals hand book, Vol. VI" ASM Metal park Ohio, USA, 1991.
2. AWS Welding Handbook, Vol 1 & Vol 2, AWS New York, 1997.
3. Lancaster J F, "Metallurgy of Welding", George Allen Co, Boston, 1980.

MEC330 ROBOTICS AND ROBOT APPLICATIONS	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC204 Kinematics of Machinery	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

- Students will gain knowledge in automation with brief history of robot and its applications.
- Basic knowledge acquired in robot end effectors and their design.
- Robot Programming methods & Languages of robot.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Classify the different types of robots and its anatomy.
CO2: Construct the kinematic motions of robot and its design.
CO3: Develop programming for a robot control system.
CO4: Compile and discuss the importance of robot in industries.
CO5: Discuss various applications of industrial robot systems

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3												1		
CO2	3	1			2								1		
CO3	3		3									1	2	1	
CO4	3	2										2	3		
CO5		3										3	3	3	

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Course topics

Unit 1:Introduction **9 Hours**

Fundamentals of Robotics- robot anatomy, robot classification.

Unit 2:Robot Kinematics **9 Hours**

General characteristics - classification - special purpose tools - assembly fixtures – Typical designs, compliance in wrists - end effectors multiple end effectors systems.

Unit 3:Robot Programming **9 Hours**

Robot programming and languages - robot language development, language classification.

Unit 4:Robot Industrial Applications **9 Hours**

Robot applications - robot applications in manufacturing: material transfer and machine loading / unloading - processing operations like welding and painting - assembly operations – inspection, Safety considerations.

Unit 5:Robot Developments **9 Hours**

Recent developments in advanced robotics - special applications of robotics - nuclear industry, surgery, food manufacturing - miniature and micro robotics: technologies and applications.

Text Book

1. Harry Colestock, Industrial Robotics, McGraw Hill Book Co., New Delhi, 2005.

References

1. Groover, M.P., "Industrial Robotics: Technology, Programming, and Applications" 2nd Edition, Mcgraw Hill Education, 2012.
2. Deb, S.R., Robotics Technology and Flexible Automation, Tata McGraw Hill Pub., New Delhi, 2010.
3. Lee, C.S.G, Fu, K.S.; Ralph Gonzalez., Robotics Control Sensing Vision and Intelligence, 1st Edition, 2008.

MEC331 VIBRATION ANALYSIS AND NOISE MONITORING	Credits			
	L	T	P	Total
	3	0	0	3

Pre-requisite: MEC204Kinematics of Machinery	**Course Category:** Major Elective **Course Type:** Theory with practical component

Course Objective(s)

The aim of undergoing this course is to develop knowledge on advanced technologies in vibration analysis and noise monitoring.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Analyze the causes for vibration discriminate according to degrees of freedom.

CO2: Analyze the source of noise levels in various automotive components.

CO3: Recognize the various noise controlling techniques in engine parts for safe operation of engine

CO4: Ability to justify a project in vibration of engine noise and control in a formal report and present n a neat and organized manner.

CO5: Construct various techniques for noise control.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1				2						1			2	2
CO2	2		3			1	2		1					2	2
CO3		3	2	3									2		
CO4	2	3			2	1					2		3		
CO5	1		3	2									2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Fundamentals of Vibration **9 Hours**

Introduction - classification of vibration - free and forced vibration, undamped and damped vibration, linear and non linear vibration - response of damped and undamped systems under harmonic force analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

Unit 2: Basics of Noise **9 Hours**

Introduction - amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation -measurement and analysis of noise - measurement environment -equipment, frequency analysis, tracking analysis, sound quality analysis source ranking, noise control effectiveness.

Unit 3: Automotive Noise Sources **9 Hours**

Noise Characteristics of engines - engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise.

Unit 4: Control Techniques **9 Hours**

Vibration isolation - tuned absorbers, untuned viscous dampers, damping treatments- application of dynamic forces generated by IC engines - engine isolation - crank shaft damping - modal analysis of the mass elastic model shock absorbers.

Unit 5: Source of Noise and Control **9 Hours**

Methods for control of engine noise - combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures - automotive noise control principles -sound in enclosures, sound energy absorption, sound transmission through barriers. Case studies in automobile applications

Text Book(s)

1. SingiresuS.Rao, Mechanical Vibrations, Pearson Education, New Delhi, 2004.

Reference(s)

1. KewalPujara, Vibrations and Noise for Engineers, DhanpatRai and Sons, 2001.
2. Bernard Challen and RodicaBaranescu, Diesel Engine Reference Book, SAE International, Second edition, 1999.
3. Julian Happian and Smith, An Introduction to Modern Vehicle Design, Butterworth - Heinemann, 2004.
4. John Fenton, Handbook of Automotive body Construction and Design Analysis - Professional Engineering Publishing, 1998.

<table>
<tr><td rowspan="3">MEC332 RENEWABLE ENERGY TECHNIQUES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Civ101 Basic Mechanical Engineering</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To sensitize on the importance of alternate energy sources, technology and its evaluation

Course Outcome (s)

On successful completion of this subject, students should be able to:

CO1: Demonstrate the general aspects of world energy scenario and renewable energy.

CO2: Elaborate the concepts of utilization of solar energy and the components used for recovering energy.

CO3: Estimate and analyze the wind data and energy for various types of wind energy systems

CO4: Understand the various biomass application and special focus on cogeneration.

CO5: Develop the other energy techniques such as tidal, geothermal and fuel cell systems.

CO and PO Mapping

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3				3	3						2		
CO2	3	3				3	3						2		
CO3	3		3								2		2		2
CO4	2	1				3					1		2		
CO5	2	1				3					1			3	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INTRODUCTION

World energy use – reserves of energy resources, environmental aspects of energy utilization, renewable energy scenario in India.

SOLAR ENERGY

Solar – flat plate and concentrating collectors, solar heating and cooling techniques, solar desalination, solar pond, solar cooker, solar thermal power plant, solar photo voltaic conversion, solar cells, PV applications

WIND ENERGY

Wind data and energy estimation – types of wind energy systems, performance, details of wind turbine generator, safety and environmental aspects.

BIO MASS

Biomass direct combustion – biomass gasifier, biogas plant, ethanol production, bio diesel, cogeneration, biomass applications.

OTHER ENERGY TECHNIQUES

Tidal energy, open and closed OTEC cycles, geothermal energy – fuel cell systems.

TEXT BOOK

1. Rai, G.D., Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.

REFERENCES

1. Sukhatme, S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
3. Twidell, J.W., and Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
4. Tiwari, G.N., Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.
5. Freris, L.L., Wind Energy Conversion systems, Prentice Hall, UK, 1990.
6. Johnson Gary, L., Wind Energy Systems, Prentice Hall, New York, 1985

MEC333 DESIGN OF HEAT TRANSFER EQUIPMENTS	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: MEC327 Heat and Mass transfer	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

Study about the fundamentals of heat exchanger mechanisms and design of heat exchangers as per the industrial needs

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Outline different types of shell and tube heat exchangers and different methods of heat exchanger analysis

CO2: Discuss about resource parameters effecting the performance of heat exchangers

CO3: Analyze the effects of baffles and types of flow for heat exchangers

CO4: Design various types of condenser and evaporator

CO5: Selection of accessories for heat exchangers

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1											2		2
CO2		3	2	2									2		
CO3		3	3	2											2
CO4		2	3	3								1	2	2	
CO5	1	3	1	2										2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Heat Exchangers **12 Hours**

Types, shell and tube heat exchangers, regenerators and recuperators, industrial applications, temperature distribution and its implications, LMTD, effectiveness

Unit 2: Friction Factor **12 Hours**

Heat exchanger components design (tube- sheet, bonnet and channel, etc.) with ASME and TEMA codes, Effect of turbulence, friction factor, pressure loss, channel divergence, thermal stress in tubes, and types of failures

Unit 3: Heat Transfer and Pressure Loss **12 Hours**

Heat transfer and pressure loss, flow configuration, effect of baffles, effect of deviations from ideality, design of typical liquid, gas-liquid heat exchangers, plate heat exchangers

Unit 4: Condensers **12 Hours**

Design of surface and evaporative condensers, design of shell and tube, plate type evaporators

Unit 5: Accessories **12 Hours**

Material selection, packing's, spray design, selection of pumps, fans and pipes, testing and maintenance, experimental methods.

Text Book(s)

1. Kern, D.Q., Process Heat Transfer, Tata McGraw Hill, New Delhi, 1997.

Reference(s)

1. Arthur P Frass, Heat Exchanger Design, John Wiley and Sons, New York, Second Edition, 1996
2. Taborek, T., Hewitt, G.F., and Afgan, N., Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
3. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980
4. Nicholas Cheremisioff, Cooling Tower, Ann Arber Science pub., 1981.

<table>
<tr><td rowspan="3">MEC334 FOUNDRY MECHANIZATION AND MANAGEMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC207 Manufacturing Technology</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

In this course you will develop skills across a range of processes and materials which are commonly used in automobile industries.

The course will be introduced to discuss the different methods and materials through specific projects, with an emphasis on the relation to individual concepts in making automobile components.

Some of these include; conventional casting stir casting, centrifugal casting, lost wax casting (aluminium), fabrication in metal and timber pattern making.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply knowledge of fundamental techniques used in the production of sand casting and stir casting

CO2: Evaluate and identify the specific methods, furnace and materials in order to materialize the specific individual concepts

CO3: Identify the materials and methods in order to develop an effective automobile components with the help of advanced casting techniques

CO4: Demonstrate the casting processes

CO5: Identify and apply the mechanism behind the solidification of metals and check for the soundness of the components

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3													2	
CO2		3											2		
CO3				3									2	2	
CO4		3												3	
CO5	2												2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

Introduction to casting and foundry industry- basic principles of casting processes-sequence in foundry operations- patterns- moulding practice- Modern techniques used in insert and removal of different kinds of cores made of other than sand- ingredients of moulding sand and core sand- sand testing- different moulding processes.

Unit 2: Furnaces **9 Hours**

Types of furnaces used in foundry-furnaces for melting, melting practice for steel, cast iron, aluminium alloys, copper alloys and magnesium alloys- Furnaces withstanding higher temperature - Fuels and combustion techniques to improve resident temperature in furnaces- safety considerations- fluxing, degassing and inoculation

Unit 3: Special Casting Technique **9Hours**

Sand casting- permanent mould casting, die casting, centrifugal casting, plaster mould casting, investment casting, continuous casting, squeeze casting, full mould process, and strip casting.

Unit 4: Casting Process **9 Hours**

Overview of pouring and solidification- concept of shrinkage- Chvorinov's rule- chilling-gating systems- functions of riser- types of riser- bottom pouring and top pouring -yield calculations- visualization of mould filling (modeling).

Unit 5: Solidification **9 Hours**

Concepts of solidification, directional solidification- role of chilling- filtration of liquid metals, consumables- details of inoculation and modification – with respect to cast irons and Al-Si system- casting defects- soundness of casting and its assessment.

Text Book(s)

1. Foundry Manual, Fredonia Books, 2006.

Reference(s)

1. Heine, R. W., Loper, C. R., Rosenthal, P. C., Principles of Metal Casting, Tata McGraw Hill Publishers, 2nd Edition, 1985

2. Wulff, B., Taylor, H. F., Fleming, M. C., Foundry Engineering, Wiley Eastern, 1959.
3. Jain, P. L., Principles of Foundry Technology, Tata McGraw Hill, New Delhi, 3rd Edition,1995.
4. Srinivasan, N. K., Foundry Technology, Khanna Publications, 1986.

MEC335 RECENT TRENDS IN WELDING TECHNIQUES	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC206Material Science	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

The aim of undergoing this course is to develop knowledge on the trends and techniques in the welding processes.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Classify fusion welding process, its heat sources and shielding methods.

CO2: Categorize pressure welding and resistance welding.

CO3: Identify recent trends in welding techniques. (meaning same)

CO4: Compare soldering process with brazing process and identify the inspection procedures.

CO5: Analyze welding metallurgy and assessing weldability.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1		1								2		
CO2	3	1	1		1								2		
CO3	3	1	1		1								1		
CO4	3	1	1		1							1		2	
CO5	1	3	1		1								1		2

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Course topics

Unit 1: Fusion Welding 9 Hours

Classification of welding processes- heat sources and shielding methods –fusion welding processes- oLy - acetylene welding, arc welding processes, electroslag and electrogas welding.

Unit 2: Pressure Welding and Resistance Welding 9 Hours

Cold and hot pressure welding, friction, friction stir, ultrasonic, induction pressure, eLplosive and diffusion welding, Principles of resistance welding, Spot welding and Seam welding.

Unit 3: Newer Welding Techniques 9 Hours

Electron beam, plasma arc and laser beam welding principles, advantages, limitations and applications of the electron beam, plasma arc and laser beam welding processes, Welding Symbols.

Unit 4: Soldering and Brazing 9 Hours

Soldering- soldering materials, applications of soldering- brazing, filler materials and fluxes, Visual and Oral inspecting procedures.

Unit 5: Welding Metallurgy 9 Hours

Weld thermal cycles and their effects- structural changes in different materials- effects of pre and post heat treatments- concept of weldability and its assessment - Welding of different materials- defects in welds, their causes and remedies

TeLt Book(s)

1. William A Bowditch, Welding Technology Fundamentals, Good Heart WillcoL Publishers, 2006.

References(s)

1. J.L.Lancaster, Metallurgy of welding, Woodhead Publishing Ltd, 2007.
2. Welding handbook, American Welding Society.
3. Messler R.W., Principles of welding, John Wiley & Sons, 2003
4. R.S.Parmar, Welding Engineering and Technology, Khanna Publishers, 2005.

<table>
<tr><td rowspan="3">ME336 MECHANICAL BEHAVIOUR OF MATERIALS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC206 Material Science</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The central theme of this course is the mechanical behaviour of engineering materials, such as metals, ceramics, polymers, and composites. The main objectives are to provide students with basic understanding of mechanical properties and testing of the materials and find out the suitability of the materials for different applications.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Describe the elastic/plastic deformation and failure criteria.

CO2: Applydislocationtheoriesforworkhardeningandstrengtheningmecha ism

CO3: Analyze the stress-strain behaviour of materials and flow properties of materials

CO4: Ability to demonstrate the various hardness testing machine and analyze the hardness of materials

CO5: Analyze the torsion testing of various materials and understand the types of torsion failures.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	3	2					1			2		
CO2		3	2	2	2					1	1		2		
CO3		2	2		1					1					3
CO4	3	3	2	2						1	1		2		
CO5	3	3	2		2						1				3

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Unit 1: Deformation **12 Hours**

Elastic and plastic deformation -Stress-strain relationship, plastic deformation of metallic materials - Mohr's circle - Yielding criterion - Von Mises and maximum shear stress, tresca yielding criterion Failure criteria under combined stresses

Unit 2: Theory of Plasticity 12 Hours

Elements of theory of plasticity - dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions - application of dislocation theory to work hardening and strengthening mechanisms.

Unit 3: Tensile Properties 12 Hours

Engineering stress-strain curve - true stress- strain curve - instability in tension, stress distribution at the neck, ductility measurement, effect of strain rate and temperature on flow properties, testing machines - Fiber reinforced polymer(FAP) Composite material based on ASTM standards.

Unit 4:Hardness Testing 12 Hours

Introduction - Brinell, Vickers, Rock well and Meyer hardness test, analysis of indentation by an indenter - Relationship between hardness and the flow curve – micro hardness tests- hardness conversion, hardness at elevated temperatures - Shore – D Hardness testing of composite material**.**

Unit 5: Torsion 12 Hours

Introduction - mechanical properties in torsion, torsional stresses for large plastic strains- types of torsion failures - torsion test vs. tension test - hot torsion testing.

Text Book(s)

1. Thomas H. Courtney, Mechanical Behavior of Materials, Waveland PrInc; 2nd edition, 2005.

Reference(s)

1. Dieter, G. E., Mechanical Metallurgy, McGraw Hill Publications, 3rd Edition,1988.
2. Suryanarayana, Testing of Metallic Materials, Prentice Hall India, New Delhi, 1979.
3. Rose, R.M., Shepard, L.A., Wulff, J., Structure and Properties of Materials, Volume III, John Wiley, 4th Edition, 1984.
4. Mallicak, P.K., Fiber-reinforced composites, MonalDeklar Inc., New York, 1988

MEC337 MANUFACTURING SYSTEM AND SIMULATION	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC207 Manufacturing Technology	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

To involve in integrated approach for the design of complex engineering systems

To provide knowledge of statistical techniques for engineering application

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understand the main principles of Monte-Carlo and discrete event simulation

CO2: Apply various random number generation techniques to generate and test random number variates and apply them to develop simulation models.

CO3: Examine and study the different types of random variable generation technique and analyse their performances..

CO4: Solve and interpret the experimental problems by using distribution theories.

CO5: Classify the components of continuous and discrete event system and simulate them according to the applications.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2				1					1	2		
CO2	3	2	2	2	2						1		2		
CO3	3	2	2	2	2		2						2		2
CO4	3	3	3	2	2	2					1		2		
CO5	3	3	3		2	2	2				3		1		2

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Course Topics

Unit 1: Computer Modeling And Simulation Systems 9 Hours

Monte carlo simulation-nature of computer modelling and simulation - limitations of simulation, areas of application - components of a system - discrete and continuous systems. models of a system - a variety of modeling approaches-simulation languages arena and awesim.

Unit 2: Random Number Generation 9 Hours

Techniques for generating random numbers - mid square method-the mid product method-constant multiplier technique - additive congruential method linear congruential method-tests for random numbers-the Kolmogorov-Smirnov test-the Chi-Square test.

Unit 3: Random Variable Generation 9 Hours

Inverse transform technique-exponential distribution-uniform distribution - Weibull distribution - emprical continuous distribution - generate approximate normal variates - Erlang distribution-basics of SPSS.

Unit 4: Distribution And Evaluation Of Experiments 9 Hours

Discrete uniform distribution - poisson distribution - geometric distribution - acceptance rejection technique for poisson distribution - gamma distribution - simulation experiments - variance reduction techniques - antithetic variables - verification and validation of simulation models.

Unit 5: Discrete Event Simulation 9 Hours

Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, two server queue simulation of inventory problems - programming for discrete event systems in GPSS-Case studies.

Text Book(s)

1. Jerry Banks and John S Carson, Discrete – Event System Simulation, Prentice Hall Inc, New Delhi, 2016.

Reference(s)

1. Gordon, G., Systems simulation, Prentice Hall of India Ltd, New Delhi, 2016.
2. Narsing deo, Systems simulation with digital computer, Prentice Hall of India Ltd, New Delhi, 2015.

3. Francis Neelamkovil, Computer Simulation and Modeling, John Wiley and Sons, 2015.
4. Ruth, M.D., and Keefe, M.O., Simulation and Modeling with Pascal", Prentice Hall Inc., New Delhi, 2015.

MEC338 GEAR MANUFACTURING AND INSPECTION	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC207 Manufacturing Technology	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

This course provides the gear design engineer with a broad understanding of the methods used to manufacture and inspect gears and how the resultant information can be applied and interpreted in the design process.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Review the various definitions and terms used in gearing.

CO2: Identify methods of manufacturing external and internal spur, single and double helical, and bevel and worm gears.

CO3: Explain practical gear measurement and inspection techniques, tools and equipment.

CO4: Appraise preliminary design considerations and the gear system design process.

CO5: Discuss some of the new gear and automated gear design systems.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2			3									2		
CO2		2											2		
CO3		1											3		
CO4			2											2	
CO5					2								2		

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Unit 1: Gear Geometry 9 Hours

Principles of gear tooth action, geometry of spur and helical gears. Gear terminologies

Unit 2: Gear Manufacturing 9 Hours

Gear manufacturing – types – forming gear teeth by milling – gear generation by planning, shaping and hopping process – applications.

Unit 3: Gear Inspection 9 Hours

Parkinson gear testing, Gleason gear testing, sources of errors in manufacturing gears, gear measurements, measurement of individual element, rolling test, composite method of gear checking.

Unit 4: Design and Analysis 9 Hours

Design considerations, materials treatments and methodology - gear tooth failure mode analysis, stresses and load calculation.

Unit 5: Bevel and Worm Gears 9 Hours

Principles of geometry and design of bevel and worm gearing.

Total Number of Hours-45

Text Book(s)

1. Merritt, H.E., Gear Engineering, A. H. Wheeler and Co. Pvt. Ltd.,
2. H.M.T Production Technology, Tata McGraw Hill, 2002.
3. R.L. Norton, Machine Design, Tata McGraw Hill, 2005.

Reference(s)

1. Maitra, G.L., Hand Book of Gear Design, Tata McGraw-Hill, 2nd ed., 2005.
2. Jain, R.K., Engineering Metrology, Khanna Publishers, Delhi, 2006.
3. P.S.G. Tech, Design Data, Kalaikathir Publishers, 2006.

<table>
<tr><td rowspan="3">MEC 339 TOOLING FOR PRODUCTION</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC207 Manufacturing Technology</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To understand the basic concepts of cutting mechanism used in manufacturing Industry and Tools used for production Technology.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Illustrate the nomenclature of single and multipoint cutting tools.

CO2: Describe and identify the various types of chip formation and its mechanics during machining, able to explain the working of tool dynamometers.

CO3: Select the appropriate cutting tool for the situation, optimized machining conditions, able to measure the tool wear, tool life, Machinability, productivity of machine tools

CO4: Explain about the various types of jigs and fixtures and their usage and application in related machines

CO5: Explain the principle, operation and selection of various pressures, describe about the various sheet metal operations, design and calculation the allowance of dies

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2			2		2						2		1
CO2	1	2			2		2						3		
CO3	1			1	2					1	2		2	1	
CO4		2			2								2		
CO5		2		2	2	1	1						3		

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Course Topics

Unit 1: Cutting Tools **9 Hours**

Geometry of cutting tools and tool nomenclature - single point and multiple point cutting tools and used for turning – milling - drilling and broaching - cutting tool materials and their properties - grinding wheels and their selections.

Unit 2: Machinability **9 Hours**

Machinability - variables affecting machinability - machinability index - economics of machining - selection of optimal machining conditions - productivity of machine tools

Unit 3: Tool Life **9 Hours**

Tool wear and tool life- Types of tool wear, Factors affecting tool life tool life equations - tool life specification and criteria - tool life testing - effect of machining parameters on tool life.

Unit 4: Jigs and Fixtures **9 Hours**

Basic principle - elements of jigs and fixtures - location and clamping - 3-2-1 method of location-principles of pin location - radial location - V-location - cavity location - types of clamps - strap - cam - screw - latch – wedge and toggle clamps- hydraulic and pneumatic clamps - design considerations common to jigs and fixtures - drill jigs – leaf – box - plate and indexing jigs - milling fixtures.

Unit 5: Press Working **9 Hours**

Different types of presses - principles of operation and selection - computation of capacities and tonnage requirements - shear action in die cutting operations - blanking and piercing – clearances - die block design - punch dimensions- punch support - stops and strippers - calculation of blank size and press tonnage for drawing.

Text Book(s)

1. Boothroyd, Fundamentals of Metal Machining and Machine Tools, McGraw Hill publications, 2001.

Reference(s)

1. Sen and Bhattacharya, Metal cutting Theory and Practice, New central book agency,Calcutta, 2000.

2. HMT, Production Technology,Tata McGraw – Hill Publishing Company Limited, New Delhi, 2000.
3. Paul H Black, Theory of metal cutting, McGraw Hill book Co. 1961.
4. Ranganath, B.J., Metal Cutting and Tool Design, second edition, Vikas Publishing House.
5. Sharma, P.C., A text book of Production Engineering, 11th edition, S Chand publishing
6. Pandey and Shah, Modern machining processes, Tata McGraw-Hill Education, 1980
7. Koeingberg, Machining Science and their application, Pergamon Press.
8. Cyril Donaldson, George H. Lecain and V. C. Goold, Tool Design, 4th Edition, McGraw Hill Education, 2012.

MEC340 COMPOSITE MATERIAL SCIENCE	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC206 Material Science	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

- To impart knowledge to provide the participant with intensive training in the design and fabrication of various types of composite materials.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Compare the composite materials with conventional materials and to classify the types of composite materials for their applications.

CO2: Analyze the microstructures and micro-mechanics of metal and polymer matrix Composites.

CO3: Make use of major manufacturing processes and to study the quality of the products.

CO4: Ability to interpret various mechanical properties and appropriate test methods in composites materials.

CO5: Examine the failure of the composites laminates by means of Finite Element Method

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2		2				2			3		2	2		1
CO2		3			2			3		2		3			3
CO3	2		3	1					2		2		2	2	
CO4	1	2							2			1	2		2
CO5	3			2	2				2			1			3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Unit 1: **Introduction to Composite** **9 Hours**

Introduction to material science - conventional materials - limitations of conventional materials - definition of composite materials - types and characteristics - applications.

Unit 2: Metal Matrix Composites (MMC) and Polymer Matrix Composites (PMC) **9 Hours**

MMC – Introduction – processing - microstructure characterization - micromechanics and mechanics of deformation – applications – PMC – introduction – types – fillers – manufacturing processes – applications.

Unit 3: **Fabrication Processes** **9 Hours**

Fundamentals - bag moulding - compression mouldingpultrusion-filament winding - other manufacturing process - quality inspection and non-destructive testing.

Unit 4: Testing of Composites **9 Hours**

Introduction to micro-mechanics-unidirectional lamina - laminates – inter-laminar stresses - static mechanical properties - fatigue properties - impact properties - environmental effects - fracture mechanics and toughening mechanisms, damage prediction, failure modes.

Unit 5: Failure Predictions **9 Hours**

Failure predictions - design considerations - joint design - codes - design examples - optimization of laminated composites - application of FEM for design and analysis of laminated composites.

Text Book(s)

1. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, New Delhi, 1994.

Reference(s)

1. Micaelhyer, Stress Analysis of Fiber - Reinforced Composite Materials, Tata McGraw Hill, New Delhi, 1998.
2. Mallicak, P.K., Fiber-reinforced composites, Monal Deklar Inc., New York, 1988.
3. Agarwal, B.D., and Broutman, L.J., Analysis and Performance of Fiber Composites, John Wiley and Sons, New York, 1980.
4. Autar K. Kaw, Mechanics of Composite Materials, Taylor & Francis, 2006.
5. Krishnan K. Chawla, Composite materials science and engineering, Springer Publications, Second Edition, 2002.

<table>
<tr><td rowspan="3" colspan="2">MEC341 PRINCIPLES OF COMPONENT DESIGN</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC303Design of Machine Elements</td><td colspan="5">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of undergoing this course is to develop knowledge on the principles of designing a mechanical component.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Identify and understand in designing the engineering component design.

CO2: Create and evaluate conceptual design.

CO3: Analyze the component design by mathematical modelling and simulation

CO4: Apply the knowledge in designing manufacturing processes.

CO5: Evaluate design quality by using design of experiments.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	1				2	3				2	2		
CO2	2	2	2				3	2						2	2
CO3	3	2	3		3		1	2		2		3	2		2
CO4	3	2	2		3	2		2					2		
CO5	3	2	2		3							2	2	2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Product Design Process **9 Hours**

The design process - morphology of design - design drawings - computer aided engineering - designing of standards - concurrent engineering – product life cycle - technological forecasting – market identification competition bench marking - systems engineering - life cycle engineering - human factors in design industrial design.

Unit 2: Conceptual Design **9 Hours**

Creativity and problem solving - product design specifications - conceptual design - decision theory embodiment design - detail design. Rapid prototyping methods- Clay models, Computer Numerically Controlled (CNC) models, SLA/SLS.

Unit 3: Modelling and Optimization **9 Hours**

Mathematical modeling - simulation - geometric modeling - finite element modeling – Data Modeling - optimization - search methods - geometric programming - structural and shape optimization.

Unit 4: Material Selection and Design for Assembly **9 Hours**

Material selection process - economics - cost vs performance - weighted property index - value analysis role of processing and design - classification of manufacturing processes - design for manufacture - design for assembly- consideration in design of assembly and manufacture - design for castings, forging, metal forming, machining and welding - residual stresses – fatigue.

Unit 5: Quality in Design **9 Hours**

Total quality concept - quality assurance – quality tool-QFD-statistics process control - Taguchi methods - robust design - failure model effect analysis- fool proof system-poka yokeanalysis**.**

Textbook(s)

1. Dieter George, E., Engineering Design - A Materials and Processing Approach, McGraw Hill, International Edition Mechanical Engg. Series, Third Edition, 2000.

Reference(s)

1. Karl, T., Ulrich and Steven, Product Design and Development ,McGraw Hill, 2003.
2. Richard G.budynas and J.Keith Nisbett, Mechanical Engineering Design, McGraw Hill , 9th edition, 2016.
3. John R. Karsnitz,Stephen O'Brien,John P. Hutchinson. Engineering Design-An Introduction, Prentice Hall Inc, 2015.
4. Zena O'Connor. Elements and Principles of Design, Kindle Edition, 2014.

<table>
<tr><td colspan="2" rowspan="3">MEC342 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC203 Fluid Mechanics and Machinery</td><td colspan="5">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The course introduces the various methods to solve the complex problems in fluid flow and heat transfer

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Apply the theory of computational fluid dynamics for different types of fluid flow.

CO2: Apply finite difference methods in real time applications.

CO3: Create algorithm for fluid flow problems using finite volume approach.

CO4: Solve one and two dimensional flow problems using finite element method.

CO5: Analyze the flow situations using CFD results

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	3	2								2		2
CO2	1	2	2	3	3								2	2	
CO3	1	2	3	3	3								1		2
CO4	1	3	3	3	3								2		2
CO5	1	3	3	3	3										3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

Physical phenomena governing differential equation, - conservation of mass, momentum and energy equation- special form of Navier-Stokes equations –boundary layer theory- Buoyancy driven flow-compressible flow - turbulent flow –classification of governing equations - initial and boundary conditions- grid independence test.

Unit 2:Finite Difference Method **9 Hours**

Basics of finite difference method – finite difference approximations for derivatives – explicit and implicit method – consistency, stability, numerical errors – upwind differencing-application of FDM to heat transfer conduction and convection– SOLA method - mixed boundary condition - Gauss- Siedel and SOR Methods – ADI method to solve ψ-ω form of NS equation-ADI method.

Unit 3: Finite Volume Method **9 Hours**

Control volume approach - steady and unsteady one dimensional conduction - two dimensional problems – FVM applied to advection diffusion equation - predictor – corrector step- pressure correction technique- SIMPLE algorithm – upwind scheme - power law scheme- source term linearization-implementation of boundary condition.

Unit 4:Finite Element Method 9 Hours

Finite element method an introduction – Basic concepts – Galerkin's method - steady state diffusion – transient diffusion - one dimensional and two dimensional regions – FEM to 1D problem – 2D problems – finite element formulations – validation of CFD results - benchmark problems – cavity flow - inflow outflow problems –open domain problems-enclosure problems.

Unit 5:Grid Generation and Post Processing 9 Hours

Physical domain – computational domain – algebraic method – differential equation methods – adaptive grids – body fitted co-ordinates system – stream line contours – vector plots - Turbulent flow an introduction – modeling of turbulent flow - Turbulent flow k-ε model.

Text Book(s)

1. Muralidhar, K., Sundararajan, T., Computational fluid flow and heat transfer ,Narosa publishing house, New Delhi,2nd edition,2003
2. Anderson,D.A., Tannehill,J.C and Pletcher,R.H., Computational fluid mechanics and heat transfer, Hemisphere publishing corporation ,New York,1984.

Reference(s)

1. Versteeg. H.K. and Malalasekara. W., An Introduction to Computational Fluid Dynamics, Longman Publishers, 1995
2. Suhas Patankar., Numerical Heat Transfer and Fluid Flow, (Hemisphere Series on Computational Methods in Mechanics and Thermal Science), Taylor and Francis, 1st Edition, 1980.
3. Jaluria and Torrance, Computational Heat Transfer, Hemisphere Publishing Corporation, New York, 1986.

<table>
<tr><td rowspan="3">MEC343 HEAT TREATMENT AND SURFACE TREATING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC206 Materials Science</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of this course is to understand the topics of heat treatment process and function of furnace along materials nature of ferrous and non-ferrous materials.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Outline the knowledge on heat treatment and its phase transformations.
CO2: Explain the heat treatment process for different ferrous alloy.
CO3: Illustrate the heat treatment process for different nonferrous alloy.
CO4: Explain the various surface and special treatment processes.
CO5: Apply the heat treatment process for engineering components.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1												2		
CO2	1	1	1										3		
CO3	2	1	1										2		
CO4	2	3	2										2		
CO5	3	3	2											2	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Unit 1: Heat Treatment Atmosphere and Principles 9 Hours

Furnaces and heat treatment atmosphere, quenching media, fixtures, temperature measurements and controllers. Phase transformations – Austenitic, Pearlitic, bainitic, martensitic transformations.

Unit 2: Heat Treatment of Ferrous Alloys 9 Hours

Heat treatment of steels - stainless steels, Tool steels, Maraging steels, HSLA steels, and cast irons – processes, heat treatment defects, causes, remedies, inspections and quality control.

Unit 3: Heat Treatment of Non Ferrous Alloys 9 Hours

Heat treating of Aluminium, copper, nickel, titanium and magnesium alloys – processes, heat treatment defects, causes, remedies, inspections and quality control

Unit 4: Surface and Special Treatment 9 Hours

Ferritc nitro carburizing, Laser refractive surgery., PVD and CVD process, sputter coating, ion plating, electron beam and laser beam hardening, ion implantation, spray coatings, thermo-mechanical treatments – mechanisms, structural changes, and property relations.

Unit 5: Heat Treatment of Engineered Components 9 Hours

Heat treatment of wrought steel components – auto body sheets, plates, bars, and shafts. Heat treatment of cast and forged steel components – gears, couplings, and valves - Heat treatment procedure qualification.

Text Book(s)

1. Rajan and Sharma, "Industrial Heat treatment", Oxford and IBH, New delhi.1995.

Reference(s)

1. American Society of Metals, "Metals hand book, Vol. IV" ASM Metal park Ohio, USA, 1991. 2. Karl Eric Thelning, "Steel and its Heat treatment", Butterworth Publications, 2000. 3. Sudharsan, T.S, "Surface Engineering", Ohio State University, 1992.

MEC412 MICRO ELECTRO MECHANICAL SYSTEMS	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: EEE259 Electricals Drives And Controls	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

The objective of this course is to make students to gain the knowledge in MEMS (Micro electro Mechanical System) and various fabrication techniques. It enhances the students to design, and fabrication and evaluating different MEMS micro-actuator concepts.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Identify methods of the basics of MEMS and Illustrate the overview of Micro Electrical Mechanical Systems.

CO2: Understand the Demonstrate and classify the various fabrication processes of MEMS.

CO3: To study Construct and design a Micro Machining Process using MEMS.

CO4: Ability to understand the Categorize the design process and Make use of Various Mechanical Process.

CO5: Understand the features and Utility of the MEMS System and solving the real time problems by using Reliability.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1			3										2		
CO2				2										3	
CO3				3									2		
CO4						1							2		1
CO5							3						2		

3- Strong Correlation; 2 - Medium Correlation; 1 – low Correlation

Unit 1: Fundamentals of MEMS **9 Hours**

Introduction, history, development and need of micro-electro - mechanical systems, Components of MEMS-overview of MEMS technology.

Unit 2: Materials and Fabrication Processes **9 Hours**

Different electro-physical processes used for machining - dealing with MEMS materials - relevant non - conventional processes - IC fabrication processes used for MEMS - MEMS sensors and actuators.

Unit 3:Nano Electro Mechanical System **9 Hours**

Introduction to Design of NEMS biological and bio systems analogies - Devising and Synthesis of MEMS AND NEMS - MEMS Motion Micro devices Classifier – Synthesis Nano electromechanical Systems Modeling of Micro- and Nano-scale Electromechanical Systems – Devices, Structures and its Applications

Unit 4: Design Consideration **9 Hours**

Design consideration –process design-mechanical design –design of silicon die-design of micro fluidic network systems-capillary electrophoresis network system.

Unit 5: MEMS and NEMS **9 Hours**

Design and Fabrication Analysis of Translational Micro-transducers - Single-Phase Reluctance, Micro-motors -Modeling, Analysis, and Control - Three-Phase Synchronous Reluctance Micro-motors Micro-fabrication Magnetization, Dynamics of Thin Films Microstructures – Micro-transducers With Permanent Magnets.

Text Book(s)

1. Tai Ran Hsu, MEMS and MICRO SYSTEMS Design and Manufacture, TMH, New Delhi, 2001.

Reference(s)

1. Vijay K Varadan, Micro Sensors, MEMS, and Smart Devices, John Wiley and sons, 2001. Marc Madou, Fundamentals of micro Fabrication, CRC Press, 1997

<table>
<tr><td rowspan="3">MEC414 SENSORS AND TRANSDUCERS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: EEE259 Electrical drives and control</td><td colspan="4">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

This course aims to disseminate the concept of various sensors with the recent developments, principles of measuring parameters in sensors and transducers.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Recognize the concepts of measurement system and error analysis..
CO2: Classify or group of transducers into a variety of categories.
CO3: Identify the potentiometer and the use of thermocouple device in mechanical.
CO4: Inspect the piezoelectric crystal and capacitance transducers used for measurement systems..
CO5: Identify and apply of sensors for robotic application.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1											2		1
CO2		2		1									2		
CO3	2	2	1										2		
CO4	2	2	1											2	
CO5	2	2			3								2	1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction & Basics of Instruments **9 Hours**

Definition of mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics. Measurement systems – significance of measurements- methods of measurements – direct and indirect methods - classification of instruments – deflection and null type - generalized measurement system - characteristics of instruments

Unit 2: **Transducers** **9 Hours**

Transducer – definition - classification of transducer – analog and digital transducer - primary and secondary transducer - active and passive transducer-inverse transducer - characteristics and choice of transducer - factors influencing choice of transducer - resistance transducer - basic principle

Unit 3: Potentiometer and Thermocouple **9 Hours**

Potentiometer – loading effects- resolution- linearity- non-linear potentiometer- noise in potentiometer - resistance strain gauge – types- resistance thermometer - thermistors – characteristics - thermocouple – compensation circuits – junction and lead – compensation - merits and demerits. Inductance transducer - basic principle- linear variable differential transformer

Unit 4: Capacitance and Piezoelectric Crystals 9 Hours

Capacitance transducer – basic principle- Transducers using change in - area of plates - distance between plates - variation of dielectric constants- frequency response - merits - demerits and uses - piezoelectric transducer - basic principle - mode of operation - properties of piezoelectric crystals - loading effects - frequency response and impulse response uses.

Unit *5:* CNC Technology &Robot Sensors 9 Hours

CNC machines and part programming. Industrial Robotics. Pressure sensors – bourdon tube- bellows- and diaphragm - digital transducer – shaft encoder - optical encoder - digital speed transducer - Hall Effect transducer - sound sensors - vibration sensors – seismic transducer - chemical sensor – PH sensor - velocity transducer- introduction to smart sensors.

Text Book(s)

1. Sawhney, A.K., A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai and Co., (Pvt) Ltd., 2000.

Reference(s)

1. Renganathan, S., Transducer Engineering, Allied publishers Limited, 1999.
2. Ernest O Doeblin, Measurement Systems – Application and Design, McGraw – Hill. Publishing Company, 1990.
3. Woolvert, G.A., Transducer in Digital Systems, Peter Peregrinus Ltd., England, 1998.
4. Patranabis, D., Principles of Industrial Instrumentation, Tata McGraw – Hill Publishing Company Limited, New Delhi, 1996.
5. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman, Singapore, 1999.(Reprint 2014)
6. Deb, S. R., Robotics technology and flexible automation, Tata McGraw-Hill, New Delhi, 1994

MEC416 INDUSTRIAL SAFETY	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

This course aims to acquaint with the idea of Safety Rules followed in Industries and recognize the safety legislation, OHS, safety management and Human factors Issues.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Contrast the representation of various Safety theories and Principles followed in Real Time Industries.

CO2: Explain the work permit systems and Safety report Investigation Implemented in an industry.

CO3: Develop the human behavior in industries and recommend the ergonomic suggestions in the Workplace.

CO4: Identify the various types of hazards in workplace and causes of biological hazards in various Industries.

CO5: Remember the legal requirements of state and Central governments to protect the Workers Health Safety and Environment.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3			1		2	1	1			2	2	2		
CO2	3	1		3		2	2		1		2	1	4		
CO3	3	1		3		3	1		2		2		1		
CO4	3	1		3		3	2				2		1		1
CO5	3					3	2	2							

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

ACCIDENT PREVENTION

Definitions - history of safety movement - ILO – NSC – BSC – LPA - theories and principles of accident causation - cost of accidents - accident reporting and investigation - safety committee - safety suggestion scheme - safety education and training -safety management techniques.

SAFETY MANAGEMENT

Safety systems - safety information system – safety control system - hazard and risk analysis – risk assessment methodologies - Fault Tree Analysis (FTA) and Event Tree Analysis (ETA) – total loss control - risk management.

HUMAN FACTORS ENGINEERING

Man machine system- human behaviour- principles of ergonomics- factors impeding safety and personal protective equipment.

OCCUPATIONAL HEALTH AND HYGIENE

Physical hazards - chemical hazards – recognition of hazards – evaluation – control measures - occupational health – concept and spectrum of health – industrial toxicology – definitions – hazard – toxicity – local and systemic effect – routes of entry

SAFETY REGULATION

History of legislations related to safety - factories act and rules - workmen compensation act - OSHA standards.

TEXT BOOKS

1. John V Grimaldi and Rollin H Simonds, Safety management, All India Travelers book seller, New Delhi, 1989.
2. Occupational Safety manual, BHEL, 2002.

REFERENCES

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
2. Brown, D.B., System Analysis and Design for Safety, Prentice Hall Inc., New Jersy, 1976.
3. Encyclopedia of Occupational Health and Safety, Vol. I and II, International Labour Organization, Geneva, 1985.
4. Handbook of Occupational Health and Safety, NSC Chicago, 1982.
5. Heinrich, H.W., Industrial Accident Prevention, McGraw-Hill, 1980.
6. Lees, F.P., Loss Prevention in Process Industries, Butterworths, New Delhi, 1986.
7. McCornick, E.J., and Sanders, M.S., Human Factors in Engineering and Design, Tata McGraw-Hill, 1982.

<table>
<tr><td colspan="2" rowspan="3">MEC417 WORK STUDY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: Nil</td><td colspan="5">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

This course will focus on mathematical modelling. A strong emphasis will be given to model formulation.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understand the relationship between productivity, work content and time.

CO2: Analyze the operations and ineffective time in shop floor.

CO3: Correlate the data related to process and time study.

CO4: Identify the problems associated with the job and incentive schemes.

CO5: Design of Ergonomics in shop floor.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			3	2							2	1		
CO2	2	2		1	3									2	
CO3	2	2			3							1	1		
CO4	1	3			2							2		2	
CO5	1	3					3				2		1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1:Introduction **9 Hours**

History of work study - Purpose of work study, its objective, procedures & applications- productivity and living standards - productivity measurement - work design and the organization- work content and time.

Unit 2:Operations Study **9 Hours**

Objectives and basic procedure of work measurements -Total time for a job or operation - total work content and ineffective time - methods and motions - graphic tools.

Unit 3:Process and Time Study **9 Hours**

Process analysis - process and activity charts - operation analysis - basic procedure- micro motion study - principles of motion economy - work measurement - stop watch time study - standard data - methods time measurement (MTM) - development of production standards - work sampling - rating and allowances - setting standard times for jobs - standard data - and predetermined time standards.

Unit 4:Job Evaluation **9 Hours**

Basic concepts - objective and subjective methods - Gantt incentive plans standard data system - compensation schemes - relationship of work study to incentive schemes- wage incentive plans.

Unit 5:Ergonomics **9 Hours**

Fundamental concepts- issues in design of systems - human performance in physical work - measuring work by physiological means- work posture - fatigue measurement and evaluation - environmental factors and work systems- industrial product design.

Text Book(s)

1. Introduction to work study, International Labor Organization, Geneva, 4th edition, 2012.

Reference(s)

1. Curri and Faraday, Work Study, ELBS, 4th edition, 2000.
2. Benjamin W. Niebel, Motion and Time Study, Richard, D. Irwin Inc., Seventh Edition, 2004.
3. Barnes, R.M., Motion and Time Study, John Wiley, 2002.
4. Bridger, R.S., Introduction to Ergonomics, McGraw-Hill, 2006.

<table>
<tr><td rowspan="3" colspan="2">MEC418 RAPID PROTOTYPING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: MEC207 Manufacturing Technology</td><td colspan="5">Course Category: Major Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

The aim of undergoing this course is to obtain a complete focus on Rapid Prototyping on the ground of emerging state of process, tooling and system representations

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Demonstrate the importance of rapid prototyping.

CO2: Explain the product development, conceptual design, prototype tooling etc.

CO3: Identify the cad processes, solid modeling and modify desired format.

CO4: Build the applications, advantages of rapid prototyping and explain all types of RPT process (SLS, FDM).

CO5: Compare the LOM process, FDM process, direct shell producing and casting process between them and know the ADV application.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2		3								1		
CO2	3	2			2								3		
CO3	2		3		2									1	
CO4	2	3	2		2								2	2	
CO5	3	2	3		3								1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

Introduction - basic concept - overview of existing technologies of proto type tooling - need for speed design to market operations.

Unit 2: Basics of Tooling **9 Hours**

Product development - state of the technology- conceptual design - prototype tooling - engineering pilot - limitations.

Unit 3: Development of Data Representation **9 Hours**

CAD Processes - data requirements for solid modeling - data representation - part orientation and support - STL format - slicing – post processing

Unit 4: RPT Process **9 Hours**

Rapid prototyping systems - selective laser sintering - working principles - advantages and limitations - stereolithography - working principles - applications, advantages and limitations.

Unit 5: Other Systems **9 Hours**

Laminated object modeling - waving principles, applications - advantages and limitations – fused deposition, modeling - direct shell production casting - applications

Text Book(s)

1. Soenen, R., and Olling, Advanced CAD/ CAM Systems, Narosa Publishing house, 1995.

Reference(s)

1. Duvvent, W. R, The Lithography Hand book, Narosa Publishing house, 1995.
2. Rapid News, University of Warwick, UK, 1995.

MEC419 PRODUCTION PLANNING AND CONTROL	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite: MEC207 Manufacturing Technology	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

- To introduce the Production Planning concepts and to make Control for various

Course Outcome(s)

CO1: Outline various Produciton planning analysis with its design and selections.
CO2: Analyze about the product planning to execute in industries.
CO3: Examine the product data management and Enterprise application integration
CO4: Summarize the various inventory control methods.
CO5: Estimate scheduling and reporting the progresses and expediting.

Mapping of COs with Pos

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2											1			
CO2	2			3								2		1	
CO3		3			2									1	
CO4			3		3					2				2	
CO5	2									3					

3-Strong Correlation; 2-Medium Correlation; 1-Low Correlation

Course Topic(s)

BASICS

Objectives - types of production - product development and design - standardization- simplification and specialization - break even analysis – forecasting - need and its use - market share - sales trend analysis - use of indicators and correlation analysis - effects - accuracy of forecasts.

PRODUCT PLANNING

Extending the original product information - value analysis - process planning and routing - steps in process planning

PRODUCT DATA MANAGEMENT

Product data management (PDM) - Enterprise application integration (EAI).

INVENTORY CONTROL

Material and tool control - physical control - record keeping - two-bin material control system – the super market concept - procurement and control of tools - inventory control - determination of economic order quantity and economic lot size- ABC analysis - reorder point and lead time - MRP I and II - JIT and KANBAN.

SCHEDULING AND DISPATCHING

Loading and scheduling information rearranging for loading and scheduling - master scheduling - perceptual loading - order scheduling devices – dispatching - progress reporting and expediting.

TEXT BOOK

Samuel Eilon, Elements of Production Planning and control, Universal Book Corp., 1984.

REFERENCES

1) Buffa, E.S., Modern Production/Operations Management, John Wiley sons, 7th edition, 1983.
2) Scheele, Principles and Design of Production Control Systems, Prentice Hall Inc., New Delhi, 2000.
3) Jain, K.C., and Aggarwal, L.N., Production planning control and Industrial Management, Khanna Publishers, 1997.
4) Martand Telsang, Industrial Engineering and Production Management, S. Chand and Company, 1st edition, 2000.
5) Jain, K.C., and Aggarwal, L.N., Production Planning Control and Industrial Management, Khanna Publishers, 1990.
6) Hajra Choudhury, S.K., Nirjhar Roy and Hajra Choudhury, A.K., Production Management, Media Promoters and Publishers Pvt. Ltd., 1998.
7) Chary, S.N., Theory and Problems in Production and Operations Management, Tata McGraw Hill, New Delhi, 1995.

MEC420 INDUSTRIAL ENGINEERING		L	T	P	Credit
		3	0	0	3
Pre-requisite: MEC207 Manufacturing Technolohy	**Course Category:** Major Elective **Course Type:** Theory				

Course Objective(s)

The aim of undergoing this course is to develop, implement, and improve integrated systems that include people, materials, formation, equipment, and energy using appropriate analytical, computational and experimental practices.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Design of Plant layout and material handling system.
CO2: Define the productivity management system
CO3: Know the function of reliability Engineering.
CO4: Explain the ergonomics of manufacturing.
CO5: Construct a various types of networks.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1		3									2		
CO2		2		2								2	3		
CO3						2			1						
CO4	3									1			2		
CO5		2						1			2			3	

3- Strong Corre1ation; 2 - Medium Corre1ation; 1 – 1ow Corre1ation

Course Topics

Unit 1: Plant Layout and Materials Handling 9 Hours

Plant location, - classification of layout – layout design procedures - CRAFT, ALDEP, CORELAP - materials handling systems – principles - classification of materials handing equipments - production and operation decisions.

Unit 2: Productivity Management and Work Study 9 Hours

Introduction, productivity models, organizational transformation, re-engineering, process improvement models, re-engineering tools and implementation, reverse engineering - work study - time study - method study - tools – methods.

Unit 3: Reliability Engineering 9 Hours

Reliability concept - reliability data analysis - prediction models - reliability management - risk assessment.

Unit 4: Ergonomics of Manufacturing 9 Hours

Introduction - human performance - work space design - design of equipments - design of environment.

Unit 5: Project Management 9 Hours

Phases of project management – network constructions – CPM – PERT – crashing – resource leveling - resource allocation.

Text Book(s)

1. ILO, Introduction to work study, Geneva, 1974.
2. Richard Francis L. and John A.White, Facilities layout and location an analytical approach, Prentice Hall Inc,1984.

Reference(s)

1. Barnes, raeph.M, Motion and time study -design and measurement work, John wiley, Newyork, 1990
2. Khanna, O.P., Industrial Engineering and Management, Dhanpatrai Publication, 2004.
3. Gopalakrishnan, P., and Banerji, A.K., Maintenance and Spare Parts Management, Prentice Hall Of India, New Delhi, 1991.
4. Edosomwan, J.A., Organisational Transformation and Process Re-engineering, British Library Cataloging In Pub. Data, 1996.
5. Rastogi, P.N., Re-Engineering and Re-Inventing the Enterprise, Wheeler Publications, New Delhi, 1995.
6. Fiegenbarum, A.V., Total Quality Control, Mcgraw-Hill, Inc., 1991.
7. Modarres, Reliability and Risk Analysis, Maral Dekker Inc., 1993.
8. James Apple, M.., Plant Layout and Material Handling, John Wiley, 1977.
9. Lee J Krajewski, Larry P Ritaman, Operations Managements, Addison-Wesley, 2000.
10. Prasannachandra, Project management, Tata Mcgraw Hill, 1986.

MEC421 NON DESTRUCTIVE EXAMINATION	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: MEC206 Material Science	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

By the end of this course you should become familiar with a wide variety of Non-destructive testing techniques for use in design, manufacturing and industrial service. You will able to know how each technique works, how you can apply it, when and where it can be used and the technique's capabilities and limitations.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Explain various mathematical and logical techniques involved in Non Destructive Examination.

CO2: Explain the principles of operation of liquid penetrant and magnetic particle tests.

CO3: Identify the method of finding internal defects and other properties through radiography technique

CO4: Discuss and correlate ultrasonic and acoustic emission techniques with other widely used NDE methods.

CO5: Elucidate various advanced NDE techniques.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			1	2				2	1		3	2		
CO2	2			3	1				2	1		2	2		
CO3	2			3	1				2	1		2		2	
CO4	2			3	3				2	1		3		2	
CO5	2			2	3				2	1		3			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Unit 1: Introduction Non-Destructive Testing and Liquid Penetrant 9 Hours

Basic Principles of non-destructive testing – technical backgrounds – destructive and non-destructive testing comparisons-statistical measures and tools - process capability - theory of probability - sampling - ABC standard- Characteristics of liquid penetrants - different washable systems - developers - applications -

Unit 2: Magnetic Particle Tests 9 Hours

Methods of production of magnetic fields - principles of operation of magnetic particle test - applications - advantages and limitations-Eddy current testing

Unit 3: Radio Graph 9 Hours

Sources of ray - X-ray production - properties of X–rays - film characteristics - exposure charts - contrasts - operational characteristics of X-ray equipment - applications.

Unit 4: Ultrasonic and Acoustic Emission Techniques 9 Hours

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - principles of acoustic emission techniques - advantages and limitations - instrumentation - applications.

Unit 5: Advances in NDT and Equipments 9 Hours

Inspection management - conventional non destructive testing - pre and post weld - heat treatment - pressure testing - vessel inspection - sub-sea inspection - long range ultrasonics - tube inspection- personnel resourcing ultrasonic immersion inspection systems - analytical equipment - lab scanners, profilometers, gas analyzers and leak detectors - industrial X-ray systems, exposure cabinets, X-ray tubes - magnetic particle and fluorescent penetrant inspection - optical inspection systems - mass spectrometers - UV inspection.

Text Book(s)

1. Barry Hull and Vernon John 'Non Destructive Testing', MacMillan, 1988.

Reference(s)

1. American Society for Metals, Metals Hand Book, Vol.II, 1976.

2. Progress in Acoustic Emission, Proceedings of 10th International Acoustic Emission Symposium, Japanese Society for NDI, 1990.

MEC424 INDUSTRIAL AUTOMATION AND ROBOTICS	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite : MEC204 Kinematics of Machinery	**Course Category:** Major Elective **Course Type:** Theory			

Course Objective(s)

To produce engineering graduates who are competent and able to apply principles of science and engineering for solving current problems related to industrial automation and robotics.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Illustrate the production concept and strategies of automation.
CO2: Construct the CIM architecture and FMS.
CO3: Design of flow lines and line balancing methods.
CO4: Examine the function of material handling systems and Inspection.
CO5: Design of industrial robots.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2				3			3							
CO2	2				1			2							
CO3	3	2			2										
CO4	2				3			2							
CO5	3		2		2										

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction to Automation 9 Hours

Classification of Manufacturing Industries – Types of Production – Functions in Manufacturing – Organization and Information processing in Manufacturing – production concepts and mathematical models – concepts, definition, objective, arguments and strategies of automation.

Unit 2: CIM and FMS 9 Hours

Nature role and development of CIM Architecture- computers in CIM-simulation software - Group technology-part families-parts classification and Coding-Production Flow analysis-cellular manufacturing cell design-benefits MRP I and II -computer aided quality control.

Definitions – classifications – flexibility – typical configurations – computer control systems – planning the FMS – analysis methods for flexible manufacturing systems – applications and benefits.

Unit 3: Automated Flow Lines and Assembly Systems 9 Hours

General terminology – analysis of transfer lines with and without storage buffers – partial automation – computer simulation of automated flow lines – assembly systems and line balancing – methods of line balancing – computerized line balancing methods.

Unit 4: Automated Materials Handling and Storage Systems 9 Hours

Functions – types of equipment, analysis and design of conveyor systems and automated guided vehicle systems, automated storage/retrieval systems, carousel storage systems, work-in progress storage, interfacing handling and storage with manufacturing - Inspection - Principles and methods – sensor technologies – coordinate measuring machines, contact and noncontact inspection methods – machine vision.

Unit 5: Industrial Robotics 9 Hours

Introduction to robot programming- Robot definition and types – Robot anatomy - Mobile Robot and its advantages – Case studies – pick and place robot – automatic camera – washing machine – Application of robots in industries.

Text Book(s)

1. Mikell. P. Groover, Automation Production Systems, and Computer Integrated Manufacturing, Prentice Hall of India Ltd., New Delhi, 1998.

Reference(s)

1. D. M. Considine and G. D. Considine, Standard Hand Book of Industrial Automation, Chapman and Hall, NJ, 1986.
2. Radhakrishnan and S. Subramaniyan, CAD/CAM/CIM, New Age International (P) Limited, New Delhi, 1998.
3. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).

LIST OF MINOR ELECTIVES

BIT307 ENVIRONMENTALBIOTECHNOLOGY	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To understand about environmental issues, soil microbiology and microbial techniques employed for waste water management and treatment.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Describe ecosystem and soil microbiology

CO2: Describe xenobiotics and the strategies to eliminate them from the environment

CO3: Explain the microbial techniques employed for wastewater management and treatment

CO4: Describe the methods of effluent treatment in various industries

CO5: Explain the role of microorganisms in the extraction of metals, coal and petroleum.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3						2						2		
CO2	2	1			2		3			3	2		2		
CO3							3		3	3		3	2		
CO4	2	2		3			3		2						
CO5	1	1					3				3	1	2		

3 Strong Correlations; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Introduction to ecosystem - Microbial flora of soil – Interaction among Soil microorganisms – Bio geochemical cycle - Role of soil microorganisms

DEGRADATION OF XENOBIOTICS

Xenobiotics - Simple aromatics, chlorinated polyaromatic compounds, petroleum products, pesticides and surfactants - Mechanism of detoxification, oxidation, dehalogenation - Degradation of metals - Biotransformation of metals – Bioremediation

MICROBIAL TECHNOLOGY FOR WASTE WATER TREATMENT

Waste water characteristics - Biological waste water treatment – Unit operation - Design and modeling of activated sludge process - Anaerobic digested dynamics

TREATMENT OF INDUSTRIAL WASTES

Dairy, pulp, dye, leather and pharmaceuticals - Solid waste management

MICROBIAL LEACHING

Extraction of metals from ores, recovery of metals from solutions - Microbes in petroleum extraction - Microbial desulphurization of coal - Degradative plasmids and genetically engineered microbes in environment

TEXT BOOKS

1. Karnely, Chakrabarty, D., Omen, G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol I, Gulf Publications Company, London, 1st Edition, 1989
2. Foster, C.F., John Ware, D.A., Environmental Biotechnology, Ellis Harwood Ltd,1st Edition, 1987

REFERENCES

1. Young, M.Y., Comprehensive Biotechnology (Vol. 1- 4),Pergamon Press, Oxford, 1st Edition, 1985
2. Wanwright, M., An Introduction to Environmental Biotechnology, Springer Verlag, London, 1st Edition, 1999

CHE311 CORROSION SCIENCE AND ENGINEERING	Credits			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To familiarize the students about corrosion classification, forms of corrosion and expressions for corrosion rate.

Course Outcome (s)

CO1: Understand the basic concepts of corrosion.
CO2: Acquire the knowledge of corrosion prevention methods
CO3: Understand methods of corrosion testing
CO4: Obtain knowledge about Polarization
CO5: Know the purpose of electroless plating and Anodizing

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2					2							2		
CO2	3			2									2		
CO3		1			2				1			1	2		
CO4													1		
CO5	1			1								2	2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

CORROSION

Corrosion - Definition, classification, forms of corrosion, expressions for corrosion rate, emf and galvanic series , merits and demerits, Pourbaix diagram for iron, magnesium and aluminium - Forms of corrosion, Uniform, pitting, intergranular, stress corrosion - Corrosion fatigue - Dezincification - Erosion corrosion – Crevice corrosion - Cause and remedial measures, Pilling Bedworth ratio, High temperature oxidation

BOILERS

Boiler water corrosion by carbon dioxide and unstable salts - Corrosion prevention methods by treatment cooling water, specification, types of scales and causes, use of anti scalant – Water treatments - Maintenance of boilers - Protection of boilers during off loading, high temperature, corrosion, turbine corrosion – Corrosion inhibitors, principles and practice, inhibitors for acidic neutral and other media - Corrosion failure - Inspection and analysis of corrosion damage.

CORROSION TESTING

Purpose of corrosion testing, classification, susceptibility tests for intergranular corrosion, stress corrosion test, salt spray test, humidity and porosity tests, accelerated weathering tests - ASTM standards for corrosion testing.

POLARIZATION

Polarization - Exchange current density, Activation polarization, Tafel Equation, Passivating metals and nonpassivating metals, Effect of oxidizing agents

ELECTROLESS PLATING AND ANODISING

Electroless plating and Anodizing - Cathodic protection, metallic,organic and inorganic coatings, corrosion inhibitors – Special surfacing processes - CVD and PVD processes, sputter coating -Laser and ion implantation, arc spray, plasma spray, flame spray, HVOF

TEXT BOOKS

1. Fontana and Greene., Corrosion Engineering, McGraw Hill Book Co, New York, 1983
2. Raj Narayan ., An Introduction to Metallic Corrosion and its prevention, Oxford and IBH, New Delhi, 1983

REFERENCES

1. Budinski, K.G., Surface Engineering for Wear Resistance, Prentice Hall Inc., Engelwood Cliff, New Jersey, USA, 1988
2. Uhlig, H.H ., Corrosion and Corrosion Control , John Wiley and Sons, New York, USA, 1985

<table>
<tr><td colspan="2" rowspan="3">CHE405 COMPUTATIONAL HEAT TRANSFER</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="5">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

Basic Knowledge in heat transfer and Thermodynamics

Course Outcome (s)

CO1: Describe the basic governing equations of heat transfer and discretization methods.

CO2: Solve various parabolic equations using different numerical methods.

CO3: Understand and apply the concepts in 1D, 2D and 3D heat transfer in conduction and convection situations.

CO4: Apply the various solution methods to solve heat transfer situations.

CO5: Learn and use the commercial packages to simulate the heat transfer situations.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3														
CO2	2	3		3								1			
CO3	2	3	3	3								3	1		2
CO4		3	2	3								3	2		3
CO5			2	2	3	1									3

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Physical phenomena governing differential equation, energy equation, momentum equation, nature of coordinates, Discretization methods.

PARABOLIC EQUATIONS

Parabolic equations - explicit, implicit and Crank Nicholson Methods - Cartesian and Polar Coordinates - mixed boundary condition -

Jacobi - Gauss, siedel and SOR Methods.

HEAT CONDUTION AND CONVECTION

Heat condition and convection - control volume approach - steady and unsteady one dimensional conduction - two and three dimensional - power law scheme - simpler algorithm.

GENERAL APPLICABILITY OF THE METHOD

General applicability of the method - approximate analytical solution - Raleigh's Method- Galerkin Method, solution methods.

CONDUCTION AND DIFFUSION EQUATIONS

Isoparametric element formulations conduction and diffusion equations, heat transfer Packages, Heat 2, HEATAX, RADIAT, ANSYS.

TEXT BOOKS

1. Muralidhar, K., Sundararajan, T., Computational fluid flow and heat transfer ,Narosa publishing house, New Delhi,2nd edition,2003.
2. Anderson,D.A., Tannehill,J.C and Pletcher,R.H., Computational fluid mechanics and heat transfer, Hemisphere publishing corporation ,New York,1984.

References

1. Mitchell,A.R,Grifths,D.F., Finite Difference Method in Partial Differential Equations , John Wiley and Sons,Singapore,1980.
2. SuhasPatankar., Numerical Heat Transfer and Fluid Flow, (Hemisphere Series on Computational Methods in Mechanics and Thermal Science), Taylor and Francis,1st Edition ,1980.
3. Jaluria and Torrance, Computational Heat Transfer, Hemisphere Publishing Corporation, New York, 1986.

CIV367 AIRPOLLUTION AND CONTROL	Credits			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To understand about environmental issues and microbial techniques employed for air pollution and control.

Course Outcome (s)

CO1: Know about airpollution and its problems

CO2: Familiar with automobile air pollution and control.

CO3: Obtain knowledge about gaseous contaminants.

CO4: Knowledge in biological air pollution.

CO5: Know the purpose of noise control.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3						3							2	1
CO2	2	3			2		2	2						2	3
CO3			3				2							2	1
CO4			2	3										1	1
CO5			2	2	3		1	2				1		3	1

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Air resource management system - Air quality management – Scales of air pollution problem - Sources and classification of pollutants and their effect on human health vegetation and property – Global implications of air pollution - Meteorology Fundamentals - Atmospheric stability – Atmospheric turbulence - mechanical and thermal turbulence - Wind profiles – Plume rise - Ambient air quality and emission standards – Air pollution indices – Indoor Air Pollutants – Models – Air Quality Sampling and Monitoring.

CONTROL OF PARTICULATE CONTAMINANTS

Settling chambers - Filters, gravitational, Centrifugal – multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory – ESP design – Operational Considerations – Process Control and Monitoring – Automobile air pollution and control.

CONTROL OF GASEOUS CONTAMINANTS

Absorption – principles - description of equipment-packed and plate columns - design and performance equations – Adsorption - principal adsorbents - Equipment descriptions – Design and performance equations – Condensation - Incineration – Equipment description.

BIOLOGICAL AIR POLLUTION

Biological Air Pollution - Control Technologies – Bio-Scrubbers, Biofilters – Operational Considerations – Process Control and Monitoring.

NOISE CONTROL

Noise Standards - Measurement – Modeling - Control and preventive measures.

TEXT BOOKS

1. Noel de Nevers, Air Pollution Control Engg., McGraw-Hill, New York, 2000.

REFERENCES

1. Lawrence Kwan, Norman C Perelra, Yung-Tse Hung, Air Pollution Control Engineering, Tokyo, 2004.
2. David H.F Liu, BelaG.Liptak, Air Pollution, Lewis Publishers, 2000.
3. Singal, S.P., Noise Pollution and Control Strategy, Narosa Publishing House, New Delhi, 2005.

<table>
<tr><td colspan="2" rowspan="3">CIV369 ENVIRONMENTAL IMPACT ASSESSMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="5">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiarize on Assessment of Impact on land, water and air, noise, social and plan for mitigation of adverse impact on environment.

Course Outcome (s)

CO1: Develop the major problems in Environmental impact and control, regulations

CO2: Familiar with regulations pertinent to environmental problems.

CO3: Describe general environmental impact problems, meteorological definitions

CO4: Illustrate the results as a report in the record notebook.

CO5: Ability to learn from the mistakes ethically and increase the quality of design.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3			1		3								
CO2	1			2			3						2		
CO3		2					3					2			
CO4							2	3						2	
CO5			3		1	2	1			1					

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Impact of development projects under Civil Engineering on environment - Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS) – EIA capability and limitations – Legal provisions on EIA.

METHODOLOGIES

Methods of EIA –Check lists – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives – Case studies.

PREDICTION AND ASSESSMENT

Assessment of Impact on land, water and air, noise, social, cultural flora and fauna; Mathematical models; public participation – Rapid EIA.

ENVIRONMENTAL MANAGEMENT PLAN

Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the Project Affected People – ISO 14000.

CASE STUDIES

EIA for infrastructure projects – Bridges – Stadium – Highways – Dams – Multi-storey Buildings – Water Supply and Drainage Projects

TEXT BOOKS

1. Canter,L., Environmental Impact Assessment, McGraw-Hill Inc., New Delhi, 1996.
2. Shukla, S.K. and Srivastava, P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.

REFERENCES

1. John G. Rau and David C Hooten (Ed)., Environmental Impact Analysis Handbook, McGraw-Hill Book Company, New York, 1990.
2. Environmental Assessment Source book, Vol. I, II & III. The World Bank, Washington, D.C., 1991.
3. Judith Petts, Handbook of Environmental Impact Assessment Vol. I & II, Blackwell Science, 1999.

CIV425 DISASTER MANAGEMENT AND THERMODYNAMICS	**Credits**			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To familiarize about the Disaster, Geology and topography, Weather and climate, Ecosystems, Human factors.

Course Outcome (s)

CO1: Describe the knowledge and understanding of the disaster phenomenon and its factors.
CO2: Interpret the relationship of hazard, risk and vulnerability.
CO3: Obtain the skills in role of education and training in disaster prevention.
CO4: Ensure skills in post disaster management activities.
CO5: Illustrate the various disaster prone zones in India.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1					2	3	2	2							
CO2	1						2	1				2			
CO3	2					2	1						1		
CO4							3	3	1		2				
CO5						1	2	1							

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

ESSENTIAL COMPONENTS AND CO-ORDINATION IN DISASTER RESPONSE

Disaster Response Plan - Communication, Participation and Activation of Emergency - Preparedness Plans - Search, Rescue, Evacuation and other logistic management - Needs and Damage Assessment; Types and Technique - Disaster Response: Central, State, District and Local Administration - Armed Forces in Disaster Response: Role and Responsibility - Disaster Response: Police and Other organizations - Role of Multiple stakeholders in Disaster Response

HUMAN BEHAVIOR AND RESPONSE MANAGEMENT

Psychological Response and Psychological Rehabilitation - · Trauma and Stress Management - Rumour and Panic Management - Medical and Health Response to Different Disasters - Role of Information and Communication Technology in Response Management

RELIEF MEASURES

Minimum Standard of Relief - · Relief Management- essential components - · Funding Relief - short term and long term - · Disaster Site Management - Recovery

ENERGY AND IRREVERSIBILITY

Review of fundamental concepts and definitions - Review of first and thermodynamics – entropy - properties of substances - quality of energy, maximum work in a reversible process – reversible work by an open system exchanging heat only with surroundings - useful work -

dead state – availability - irreversibility and Gouy-Stodala Theorem - Mathematical conditions for exact differential - Maxwell's equation - Tds equation - Thompson coefficient and Inversion curve - coefficient of volume expansion

GAS POWER CYCLES AND GAS COMPRESSORS Gas power cycles: Carnot cycle - Stirling cycle - Ericsson cycle - Air standard cycles - Otto cycle - Diesel cycle - Limited pressure cycle or Dual cycle - comparison of Otto, Diesel and Dual cycles - Brayton cycle - Aircraft propulsion - Brayton-Rankine combined cycle Gas compressors: Compression processes - work of compression - single stage reciprocating air compressor - volumetric efficiency - multi stage compression - air motors - rotary compressors - blowers and fans

TEXT BOOKS

1. Jagbir Singh, Disaster Management: Future Challenges and Opportunities, I K International Publishing House Pvt. Ltd, 2007.
2. Kapoor Mukesh, Disaster Management Paperback, Saurabh Publishing House, 2010
3. Tushar Bhattacharya, Disaster Science and Management Paperback, McGraw Hill Education (India) Private Limited, 2012
4. Engineering thermodynamics by Jones and Dugans, PHI Learning Pvt. Ltd.
5. Gas turbine Theory & Practice, by Cohen & Rogers, Addison Weslay Longman Ltd.

REFERENCE BOOKS

1. Taori, K (2005) Disaster Management through Panchayati Raj, Concept Publishing Company, New Delhi.
2. Fundamentals of thermodynamics by Sonntag, Wiley India
3. Fundamentals of Classical Thermodynamics by Van Wylen, John Wiley and Sons.

<table>
<tr><td rowspan="3" colspan="2">CIV464 INDUSTRIAL WASTE WATER MANAGEMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="5">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To know about the design concepts, and constructional aspects of industrial structure, toxicity of industrial effluents and bio assay tests.

Course Outcome (s)

CO1: Describe about industrial waste water generation rates.

CO2: Discover the need to learn about the design concepts, and constructional aspects of waste water system.

CO3: Evaluate the importance of wastewater treatment in plant.

CO4: Describe the reuse of waste water and disposal of waste residuals.

CO5: Remember the case studies for the treatment of waste water.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2						2	2	3						
CO2		1	3	2	2		3			2			2		
CO3				1			1					2		2	
CO4	2		3			2	2	1				1		1	
CO5				1			1							2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Industrial activity and Environment – Sources and types of industrial wastewater – Industrial wastewater and environmental impacts – Industrial waste survey – Industrial wastewater generation rates, characterization and variables – Population equivalent – Toxicity of industrial effluents and Bioassay tests.

INDUSTRIAL POLLUTION PREVENTION

Prevention Vs Control of Industrial Pollution – Benefits and Barriers – Source reduction techniques – Waste Audit – Evaluation of Pollution prevention options – Environmental statement as a tool for pollution prevention – Waste minimization

INDUSTRIAL WASTEWATER TREATMENT

Equalization - Neutralization – Oil separation – Flotation –

Precipitation – Aerobic and anaerobic biological treatment – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies

WASTEWATER REUSE AND RESIDUAL MANAGEMENT

Individual and Common Effluent Treatment Plants – Joint treatment of industrial wastewater - Quality requirements for Wastewater reuse – Industrial reuse – Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – management.

CASE STUDIES

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – Sugar and Distilleries

REFERENCES

1. Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 1999.
2. Arceivala, S.J., Wastewater Treatment for Pollution Control, Tata McGraw-Hill, New Delhi, 1998.
3. Frank Woodard Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
4. World Bank Group Pollution Prevention and Abatement Handbook – Towards Cleaner Production, World Bank and UNEP, Washington D.C.1998.
5. Paul L. Bishop Pollution Prevention: - Fundamentals and Practice, McGraw-Hill International, 2000.

<table>
<tr><td rowspan="3" colspan="2">CIV465 SOLID AND HAZARDOUS WASTE MANAGEMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="5">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiarize about the waste processing and material separation and processing technologies.

Course Outcomes

CO1: Explain municipal solid waste management systems with respect to its physical properties and associated critical considerations in view of emerging technologies.
CO2: Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.
CO3: Select the appropriate method for solid waste collection, transportation, redistribution and disposal.
CO4: Illustrate various waste processing technologies.
CO5: Describe methods of disposal of hazardous solid waste.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2						3		3						
CO2			2	1			2				2		1		
CO3		2					2				2		1		
CO4	2		3				3	2	2			2		1	
CO5	2		3				3		1						

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Elements of solid waste management - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes.

WASTE CHARACTERISATION AND SOURCE REDUCTION

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – Source reduction of wastes – Recycling and reuse.

STORAGE, COLLECTION AND TRANSPORT OF WASTES

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Transfer and transport –compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport.

WASTE PROCESSING TECHNOLOGIES

Objectives of waste processing – material separation and processing technologies –methods and controls of Composting – incineration – solidification and stabilization of hazardous wastes

WASTE DISPOSAL

Waste disposal options – Disposal in landfills – Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills

REFERENCES

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil “Integrated Solid Waste Management, McGraw- Hill International edition, New York, 1993
2. CPHEEO “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
3. Micheael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, McGraw-Hill International edition, New York, 2001
4. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.

1. Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 1999.
2. Arceivala, S.J., Wastewater Treatment for Pollution Control, Tata McGraw-Hill, New Delhi, 1998.
3. Frank Woodard Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
4. World Bank Group Pollution Prevention and Abatement Handbook – Towards Cleaner Production, World Bank and UNEP, Washington D.C.1998.
5. Paul L. Bishop Pollution Prevention: - Fundamentals and Practice,

McGraw-Hill International, 2000.

CSE206 OBJECT ORIENTED PROGRAMMING	Credits			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To get a clear understanding of object-oriented concepts. To understand object oriented programming through C++. To demonstrate adeptness of object oriented programming in developing solutions to problems demonstrating usage of data abstraction, encapsulation and inheritance.

Course Outcomes

CO1: Demonstrate the object oriented concepts with suitable examples..

CO2: Apply the object oriented concepts using C++ to real world problems.

CO3: Design reusable components for project development using inheritance.

CO4: Create programs to handle run time errors.

CO5: Implement abstract data types using STL

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		1	1		2								1		1
CO2	1								1			2	2		2
CO3	1	2	2							1			1		2
CO4			2					2	3				1		2
CO5		1						1	2				2		2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION

Introduction to OOP – Basic Concepts of OOP – Applications of OOP- Introduction to C++ - Introduction to C++ stream I/O – declarations in C++ - Creating New data types in C++ - function

Prototypes – Inline functions – Reference Parameters – Const Qualifier – Dynamic memory allocation – default arguments – Unary Scope resolution operator – Linkage specifications.

CLASSES, CONSTRUCTORS AND FRIEND CLASS

Introduction – Comparing class with Structure – Class Scope – Accessing Members of a class – Constructor – Destructor – Const objects – Const member functions – Friend class – Friend function – This pointer – Data abstraction and Information hiding – container classes and Iterators.

OVERLOADING & INHERITANCE

Operator Overloading – Fundamentals – Restrictions – Overloading stream – Insertion and stream extraction operators – Overloading unary & binary operators – Converting between types – Overloading ++ and --. Inheritance – Introduction – Protected members – Casting base _class pointers to derived _class pointers – Overloading Base class members in a Derived class – Public, Protocols and Private inheritance – Direct base classes and Indirect Base Classes – Using Constructors and Destructors in Derived classes – Implicit Derived class object to base class object conversion.

VIRTUAL FUNCTIONS, STREAMS AND FILES

Introduction – Type fields and switch statements – Virtual functions – Abstract base classes and concrete classes – Polymorphism – Dynamic binding – Virtual destructors. C++ Stream I/O: Streams – Stream Input – Stream Output – Unformatted I/O – Stream manipulators – Stream format states – Stream error – States. Files: File Operations, File pointers, Error Handling during file Operations.

TEMPLATES & EXCEPTION HANDLING

Templates – Function templates – Class templates – Overloading template functions – Class template and non type parameters – Templates with Multiple parameters. Exception Handling – When exception handling, Basic of C++ exception, Catching an exception, re throwing an exception, exception specifications.

TEXT BOOK

1. GoranSvenk, Object-Oriented Programming Using C++ for Engineering and Technology, Thomson Delmer Learning, 2003

REFERENCES

1. BjarneStruoustrup, The C++ Programming Language, Addison Wesley, 2000.
2. John R.Hubbard, Programming with C++, Schaums outline series, TMH 2003.
3. Deitel H.M., and Deitel P.J., How to program C++, PHI 2003.

CSE314 DIGITAL IMAGE PROCESSING	Credits			
	L	T	P	Total
	3	0	0	3
Pre-requisite: Nil	Course Category: Minor Elective Course Type: Theory			

Course Objective(s)

To understand the theoretical knowledge of digital image processing techniques and applications.

Course Outcomes

CO1: Understand the image analyse and processing

CO2: Understand the Transform domain and its significance and problems related to computational complexity.

CO3: Analyse the image and compressions by various models.

CO4: Understand the concept of image segmentation techniques.

CO5: Understand the concept of image representation and description representation schemes.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1		1								1		
CO2			2	1									1		1
CO3		2											1		1
CO4	2		2		1							2	1		3
CO5			3		1							1	1		3

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

REVIEW OF IMAGE FUNDAMENTALS

The fast Fourier transform - other separable image transforms.

Image Enhancement: Background - Enhancement by point processing - spatial filtering - Enhancement in the frequency Domain - generation of spatial masks from frequency domain specifications - color image processing.

IMAGE RESTORATION

Degradation model - Diagonalisation of circulant and Block Circulant Matrices - Algebraic approach to Restoration - Inverse filtering Least mean square filter - Constrained Least Squares Restoration - Interactive Restoration - Restoration in the spatial domain - Geometric Transformation.

IMAGE COMPRESSION

Fundamentals - Image Compression Models - Elements of Information theory - Error Free Compression - Lossy Compression - Compression Standards.

IMAGE SEGMENTATION

Detection of Discontinuities - Edge linking and Boundary Detection - Threshold - Region Oriented segmentation - The use of motion in segmentation.

IMAGE REPRESENTATION AND DESCRIPTION REPRESENTATION SCHEMES

Boundary Descriptors - Regional Descriptors - Morphology - Relational Descriptors Recognition and Interpretation - Elements of Image Analysis - Patterns and Pattern Classes - Decision - Theoretic Methods - Structural Methods - Interpretation.

TEXT BOOK

1. Rafael C., Gonzalez and Richard. E., Woods, Digital Image Processing, Addison Wesley, 1992.

REFERENCS

1. Pratt, Digital Image Processing, Tata McGraw Hill, 1991.
2. Anil K. Jain, Fundamentals of Digital Image processing, Prentice Hall of India, 1st Edition, 1998.

<table>
<tr><td rowspan="3">ECE301 DIGITAL SIGNAL PROCESSING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="4">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiarise the students with

- The basic concepts and techniques for processing signals on a computer.
- Signals, systems, time and frequency domain concepts which are associated with the mathematical tools (i.e.) fundamental to all DSP techniques.
- To provide a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.

- To study various sampling techniques and different types of filters and will also understand Basic principles of Estimation Theory.
- The most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.

Course Outcome (s)

CO1: Analyze and process signals in the discrete domain

CO2: Design IIR Filters to suit specific requirements for specific applications

CO3: Design FIR Filters to suit specific requirements for specific applications

CO4: Compute statistical analysis and inference on random signals

CO5: Design multi rate signal processing algorithms to suite specific needs

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2		3	2											
CO2	2		2									1	1		1
CO3		2	2			2						1	1		1
CO4			3	2					1						1
CO5			3	3											1

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

BASIC ELEMENTS

Digital Signal Processing System —advantages of digital over analog signal processing - Applications of DSP, FFT algorithms – Radix–2 FFT algorithms – decimation in time – decimation in Frequency algorithms –Applications of FFT algorithms

IIR FILTERS

Design of Butterworth filters - Chebyshev Type I and Type II filters - IIR filter design using bilinear transformation - impulse invariant transformation - frequency transformation in analog and digital domain

FIR FILTERS

Design of Linear phase FIR filters using Rectangular, Hamming, Kaiser windows – Design of linear phase FIR filters using frequency sampling techniques

FINITE WORD LENGTH EFFECTS

Number representations – fixed point and floating point numbers - Quantization of fixed and floating point numbers, coefficient of quantization - over flow error – truncation error – co–efficient of quantization error - limit cycle oscillation – signal scaling

MULTIRATE DSP

Decimation by a factor D - Interpolation by a factor I – Filter design and implementation for sampling rate conversion – multistage implementation of sampling rate conversion – Sampling rate conversion by an arbitrary factor – applications of multirate signal processing.

TEXT BOOK

1. John G Proakis, Dimtris G Manolakis, Digital Signal Processing Principles, Algorithms and Application, PHI, 3rd Edition, 2000.

REFERENCES

1. Oppenhein and Schafer, 'Discrete Time Signal Processing', PHI, 1992.
2. S.K.Mitra, "Digital Signal Processing– A Computer based approach", TMH, 1998

<table>
<tr><td rowspan="3">EEE306 SPECIAL ELECTRICAL MACHINES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="4">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To expose the students to concepts of D.C. Machines, transformers and their applications.
- To impart industry oriented learning.

Course Outcome(s)

CO1: Explain the construction, working principle and performance of Synchronous Reluctance Motor.

CO2: Explain the construction, working principle and performance of Stepper Motor.

CO3: Explain the construction and working principle of Switched Reluctance Motor

CO4: Explain the construction and working principle of Permanent Magnet Brushless DC motor and induction machines.

CO5: Develop the phasor diagram of Synchronous Reluctance Motor and Permanent Magnet Synchronous Motor.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			3								2	1		
CO2	3			3								2	1		
CO3	3			3								2	1		
CO4	3		3	3								2	1		
CO5	3			2								2	1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

SYNCHRONOUS RELUCTANCE MOTORS

Constructional features – types – axial and radial air gap motors – operating principle – reluctance – phasor diagram – characteristics – Vernier motor.

STEPPING MOTORS

Constructional features – principle of operation – variable reluctance motor – hybrid motor – single and multi stack configurations – theory of torque predictions – linear and non-linear analysis – characteristics – drive circuits.

SWITCHED RELUCTANCE MOTORS

Constructional features – principle of operation – torque prediction – power controllers – non-linear analysis – microprocessor based control – characteristics – computer control.

PERMANENT MAGNET BRUSHLESS DC MOTORS AND INDUCTION MACHINES

Principle of operation – types – magnetic circuit analysis – EMF and torque equations – power controllers – motor characteristics and control – induction voltage regulator –synchronous induction motor – power selsyn – position selsyn – linear motors.

PERMANENT MAGNET SYNCHRONOUS MOTORS

Principle of operation – EMF and torque equations – reactance – phasor diagram – power controllers – converter – volt–ampere requirements – torque speed characteristics – microprocessor based control.

TEXT BOOKS

1. Miller, T.J.E., Brushless Permanent Magnet and Reluctance Motor Drives,Clarendon Press, Oxford, 1989.
2. Aearnley P., Stepping Motors – A Guide to Motor Theory and Practice, PeterPerengrinus, London, 1982.

REFERENCE BOOKS

1. Kenjo, T., Stepping Motors and Their Microprocessor Controls, Clarendon Press London, 1984.
2. Kenjo,T., Nagamori,S., Permanent Magnet and Brushless DC Motors, Clarendon Press, London, 1988.

EEE410 NEURAL NETWORK AND FUZZY LOGIC	Credits			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

The main objective of this course is to provide the students with the basic understanding of neural networks and fuzzy logic fundamentals program the related algorithms and design the required and related systems.

Course Outcome (s)

CO1: Explain the principles of neural networks and fuzzy logic

CO2: Design the feed forward architecture

CO3: Analyze and working of feedback network

CO4: Develop Neural fuzzy system using MATLAB tool box.

CO5: Interpret fuzzy logic and artificial neural network to engineering problems

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3		3								2	1		2
CO2	2	1		3								1			2
CO3	3														2
CO4	2	1											3	1	3
CO5	3	1		3								1	3	1	3

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

INTRODUCTION TO NEURAL NETWORKS

Overview of biological neuro-system – mathematical models of neurons – learning rules – learning paradigms – supervised – unsupervised and reinforcement learning.

FEEDFORWARD AND FEEDBACK NETWORKS

Perceptron networks – training rules – multilayer perceptron – back propagation algorithm – associative memories – Hopfield networks – Boltzman machine – self organizing map.

FUZZY LOGIC

Overview of classical sets – introduction to fuzzy logic – membership function – fuzzy rule generation – operations on fuzzy sets – compliment – intersections – unions – combinations of operations – fuzzy if-then rule – fuzzy inferencing –Mamdani, TSK – defuzzification.

NEURO FUZZY SYSTEM

Adaptive neuro fuzzy inference systems (ANFIS) – architecture – hybrid learning algorithm – parameter identification – rule base structure identification – input selection – input space partitioning – neuro-fuzzy control.

APPLICATIONS OF NEURAL NETWORK AND FUZZY LOGIC

Applications of neural network – pattern recognition – fuzzy logic control – inverted pendulum – image processing – home heating system – biomedical applications – applications of neuro fuzzy system – character recognition – channel equalization – noise cancellation.

TEXT BOOKS

1. Jang,J.S.R., Sun.C.T., E.Mizutani., Neuro-Fuzzy and Soft Computing, Prentice Hall of India (P) Ltd,New Delhi,2005.
2. Timothy J. Ross., Fuzzy Logic with Engineering Applications, Tata McGraw Hill, 1997.
3. Sivanandam S, Sumathi S, Deepa, Introduction To Neural Networks Using Matlab6.0, Tata Mgraw Hill,2009.

REFERENCE BOOKS

1. LauranceFausett, Englewood cliffs, N.J., Fundamentals of NeuralNetworks, Pearson Education, 1992.
2. Zimmermann, H.J., Fuzzy Set Theory & its Applications, Allied Publication Ltd., 1996.
3. John Yen & Reza Langari., Fuzzy Logic – Intelligence Control & Information, Pearson Education, New Delhi, 2003.
4. Timothy Ross, Fuzzy Logic with Engineering Applications, Second Edition, John Wiley & Sons, Ltd, 2004.
5. B.Yegnanarayana,Artificial neural networks,Prentice-hall Of India Pvt Ltd, 2008.

<table>
<tr><td rowspan="3">EIE310 INDUSTRIAL DRIVES AND CONTROLS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="4">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To gain knowledge in the operation of classical and modern drives system for both AC and DC Machines.
- To understand the different starting methods of DC and AC motors.
- To understand the Control concepts of classical and modern drives via power electronics converters.

Course Outcome (s)

CO1: Describe the basic concept of electrical drives, its types and classes of motor drives

CO2: Explain the basic concepts of different types of electrical machines and their performance.

CO3: Analyze the different methods of starting D.C motors and induction motors.

CO4: Interpret operation of the converter/chopper fed DC drives and its control.

CO5: Describe the conventional and solid-state speed control of AC drives.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3												1		
CO2		1		1									2		
CO3													1		
CO4	2			3											
CO5	2				2							3	2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

INTRODUCTION

Basic elements – types of electric drives – factors influencing the choice of electrical drives – heating and cooling curves – loading conditions and classes of duty – selection of power rating for drive motors with regard to thermal overloading and load variation factors

DRIVE MOTOR CHARACTERISTICS

Mechanical characteristics – speed - torque characteristics of various types of load and drive motors – braking of electrical motors – DC motors - shunt, series and compound - single phase and three phase induction motors.

STARTING METHODS

Types of D.C motor starters – typical control circuits for shunt and series motors – three phase squirrel cage and slip ring induction motors.

CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C DRIVES

Speed control of DC series and shunt motors – armature and field control, ward - Leonard control system - using controlled rectifiers and DC choppers – applications.

CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES

Speed control of three phase induction motor – voltage control, voltage / frequency control, slip power recovery scheme – using inverters and AC voltage regulators – IGBT - applications

TEXT BOOKS

1. VedamSubrahmaniam, Electric Drives, Tata Mcgraw-Hill,New Delhi, 2001
2. Nagrath. I. J. and Kothari.D. P, Electrical Machines, Tata Mcgraw-Hill, New Delhi, 1998.
3. Pillai.S.K , A first course on Electric Drives, Wiley Eastern Limited, 1998

REFERENCES

1. M. D. singh, K. B. Khanchandani, Power Electronics, Tata Mcgraw-hill, 1998
2. H.partab, Art and Science and Utilisation of electrical energy, Dhanpatrai and Sons, 1994.
3. Power Electronics, Circuits, Devices and Applications Rashid (Muhammad H), Pearson Education Private Limited, II Edition., 1995.

EIE313 POWER PLANT INSTRUMENTATION AND CONTROL	**Credits**			
	L	**T**	**P**	**Total**
	3	0	**0**	**3**
Pre-requisite: NIL	**Course Category:** Minor Elective **Course Type:** Theory			

Course Objective(s)

To introduce the concept of controlling various equipments in all kind of power plants, study the concepts for measuring various data related to power plant, get familiarize in the field of functions of various instruments in power plant and to educate mechanical students, an inter-disciplinary approach to gain knowledge about various electrical and electronic instruments.

Course Outcome (s)

CO1: Explain the working of various power plants and know the purpose, procedures for measuring using instruments.

CO2: Identify best suited technique for measuring both electrical and non Electrical parameters.

CO3: Describe the principles of monitoring, controlling and regulating inlet and exhaust.

CO4: Explain the principle and control of boilers in power plant.
CO5: Explain the working of turbines and its control systems

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2				3		2	1					1	1	
CO2	3			2	1								2	1	
CO3	3		1										1	1	
CO4	3	1	1					1					1		
CO5	3			2	3								2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

OVERVIEW OF POWER GENERATION

Brief survey of methods of power generation-hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation – thermal power plants – building blocks – details of boiler processes ÛP and I diagram of boiler – cogeneration.

MEASUREMENTS IN POWER PLANTS

Electrical measurements – current, voltage, power, frequency, power-factor, non-electrical parameters – flow of feed water, fuel, air and steam with correction factor for temperature – steam pressure and steam temperature-drum level measurement – radiation detector – smoke density measurement – dust monitor.

ANALYZERS IN POWER PLANTS

Flue gas oxygen analyser – analysis of impurities in feed water and steam – dissolved oxygen analyser – chromatography – PH meter-fuel analyser – pollution monitoring instruments.

CONTROL LOOPS IN BOILER

Combustion control – air/fuel ratio control – furnace draft control – drum level control – main steam and reheat steam temperature control – super heater control – attemperator – deaerator control – distributed control system in power plants-interlocks in boiler operation.

TURBINE-MONITORING AND CONTROL

Speed, vibration, shell temperature monitoring and control-steam pressure control – lubricant oil temperature control – cooling system.

TEXT BOOKS

1. Sam G. Dukelow, The control of Boilers, Instrument Society of America, 1991.
2. Modern Power Station Practice, Vol.6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.

REFERENCES

1. Elonka, S.M.andKohal A.L. Standard Boiler Operations, McGraw Hill, New Delhi, 1994.
2. R.K.Jain, Mechanical and industrial Measurements, Khanna Publishers, New Delhi, 1995.

<table>
<tr><td rowspan="3" colspan="2">EIE319 PIPING AND INSTRUMENTATION</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="5">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To introduce the concept of controlling various equipment's in all kind of natural gas pipelines and refrigeration system ducts in industries**.**

Course Outcome (s)

CO1: Explain the working of various pipelines in power plants and know the purpose, procedures for measuring using instruments.

CO2: Identify best suited technique for measuring both electrical and non electrical parameters.

CO3: Illustrate the principles of monitoring, controlling and regulating inlet and exhaust fluids.

CO4: Explain the concept of instrument line diagram.

CO5: Describe the principle and control of boilers in power plant.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3				2								2		
CO2	2	3		3	2								1	2	
CO3	2		1	1									1		
CO4	1		2	3									1		
CO5	1		1	2									1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

FLOW SHEET DESIGN

Types of flowsheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet, flowsheeting software.

PIPING AND INSTRUMENTATION DIAGRAM EVALUATION AND PREPARATION

P and I D symbols, line numbering, line schedule, P and I D development, various stages of P and ID - P and ID for pumps, compressors process vessels, absorber, evaporator.

CONTROL SYSTEMS AND INTERLOCKS FOR PROCESS OPERATION

Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander.

INSTRUMENT LINE DIAGRAM

Line diagram symbols, logic gates, representation of line diagram.

APPLICATION OF P ID'S

Applications of P and ID in design state, construction stage, commissioning state, operating stage revamping state, applications of P and ID in HAZAPS and risk analysis.

TEXT BOOKS

1. Ernest E.Ludwig, Applied Process Design for Chemical and Petrochemical Plants Vol-I, Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K.D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 4th Edition, McGraw Hill Inc., New York, 1991.

REFERENCES

1. Anil Kumar, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill, New Delhi, 1982.
2. A.N Westerberg et al., Process Flow sheeting, Cambridge University Press, New Delhi, 1979.

<table>
<tr><td rowspan="3">INT355 INTERNET AND WEB TECHNOLOGY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite: NIL</td><td colspan="4">Course Category: Minor Elective
Course Type: Theory</td></tr>
</table>

Course Objective(s)

To familiar about the computer networks, webcasting techniques, java programming.

Course Outcome (s)

CO1: Describe the computer networks

CO2: Explain the method of creation of website

CO3: Interpret the knowledge in JAVA programming

CO4: Analyze the work under JAVA components/network programming

CO5: Describe the dynamic functionality in web pages

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1										2			3
CO2	2	1	3		2	3				2		2			3
CO3	2	1	3		2				1			2			3
CO4	2	1	2									2			3
CO5	2	1			2	3				3		2			3

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics

BASICS OF NETWORKS

Introduction to Internet and Web – Basics of computer networks – Topologies – signaling methods – Internet and its basics – Web servers – Browsers – Issues for the design of networking – Security issues.

WEBSITE AND WEBCASTING TECHNIQUES

Introduction – Creation of a website – Hyper text and HTML – Document structuring tags – Dynamic HTML – XML – Search Engines – Tools – Channels Push Technology.

JAVA PROGRAMMING

Language basics – Java classes – constructors – Java objects and their creations – Interfacing methods – Classes – Data encapsulation techniques – Java IO.

JAVA COMPONENTS / NETWORK PROGRAMMING

Computer Interface – Creation of GUI – Applets – Java Beans – CORBA – EJBs – Network Programming – Socket creation – URL classes – Socket classes – Programming for security.

DYNAMIC FUNCTIONALITY IN WEB PAGES

CGI – Four steps for CGI – Script specification – CGI Script languages – Dynamic page functionalities using servelets – JSPs – ASPs – COMs – DCOMs,.

TEXT BOOK

1. RajKamal, Internet and Web Technologies, TMH, 2005.

REFERENCE

1. Markur Pope, Mastering Internet Programming ,Galgotia Publications, 1996.

FREE ELECTIVES
(BASIC SCIENCE AND MATHEMATICS)

<table>
<tr><td rowspan="3">BPY503 NON-LINEAR OPTICS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>4</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="5">Course Category: Free Electives (Basic Science And Mathematics)</td></tr>
</table>

Course Objective(s)

This paper deals with physics of non-linearity and their applications.

Course Outcome (s)

CO1: At the end of the course, students should be able to:
Get the basic ideas on information in light.

CO2: Get the basic ideas on the electromagnetic phenomena

CO3: Acquire the knowledge on photophysical phenomena

CO4: Find out the applications in non linear optics

CO5: Get the ideas on Fiber optics

Course Topics

Unit 1 Information in Light

Semiconductors for optoelectronics - Optoelectronic semiconductor devices - Bright light from cool solids - Seeing The Light- The human eye - Color vision - Color blindness - Polarization sensitivity - Speed of response - Optical illusions - Contemporary Optics- Waveguides - Optical fibres - Optical amplification - Conveying sound by light - The long and the short of optical communication.

Unit 2 Fundamental Tools

Electromagnetic Phenomena - Gauss' Law - Gauss Law For Magnetic Fields - Faraday's Law - Ampere's Law - Maxwell's Adjustment To Ampere's Law - Polarization of Materials - Plane Wave Solutions To The Wave Equation - Complex Plane Waves - Real And Complex Indices of Refraction - The Lorentz Model of Dielectrics - Poynting's Theorem - Irradiance of A Plane Wave - Energy Density of Electric And Magnetic Fields.

Unit 3 Photophysical Phenomena

Optical Propagation in Media - Diffraction and Dispersion effects - Wave Propagation in Homogeneous Linear Isotropic Media - Anisotropic media - The Origin and Modeling of Optical Nonlinearity - A Simple Physical Model for Optical Nonlinearity - Physical Effects of Nonlinear Polarization - Mathematical Modeling of Optical Nonlinearities - An Alternative Approach For Reflection And Refraction:-Refraction at an

Interface - The Fresnel Coefficients' - Reflectance - Transmittance - Double-Interface Problem Solved Using Fresnel Coefficients' - Beyond Critical Angle: Tunneling of Evanescent Waves - Multiple Interfaces - Multilayer Coatings.

Unit 4 Physics of Non-Linearities

The Physics of Second Harmonic Generation - SHG in Crystals - Frequency Doubling and

Mixing - Optical Parametric Generation Amplification - Oscillation - Mathematical Formulation - Phase Matching in Anisotropic Crystal – Nonlinear Transverse Effects in Second Harmonic Generation - Self-Refraction of Optical/Gaussian Beams - Optical Bistability phenomena - Optical Phase conjugation effects.

Optical Communication Today

Components - Fabrication And Materials - Light Sources – Coupling-Micro Components Tapers - Splices/Connectors - Characteristics of optical fibers - Diameter Control And Measurement - Attenuation - NLO Properties In Media - Fiber-Optic Solitons - Magnetic Solitons - Optical Shocks And Self-Steepening Of Pulses - Two-Wave Mixing In Photorefractive Materials - Four-Wave Mixing And Phase Conjugation In Photorefractive Materials - Self-Phase Conjugation And Edge Enhancement - Non-Linearities In Nematic Liquid Crystals - Photonic Bandgap Structures

Text Books

1. Richard L Sutherland, *Handbook of Nonlinear Optics, 2nd Edition (Revised and Expanded)*, Marcel Dekker, Inc, 2003.

2. Newell, Alan C., and Jerome V. Moloney, *Nonlinear optics,* Addison-Wesley, 1992.

References

1. Justin Peatross and Michael Ware, *Physics of Light and Optics,* 2013.

2. David A. Boas, Constantinos Pitris and Nimmi Ramanujam, *Handbook of Biomedical Optics,* CRC Press, Taylor and Francis Group, 2011.

3. David Greene, *Light and Dark* Institute of Physics Publishing Ltd, 2003.

4. Goure P and Verrier I, *Optical Fibre Devices Series in Optics and Optoelectronics,* Institute of Physics Publishing Ltd, 2002.

BMA331 COMBINATORICS	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Free Electives (Basic Science And Mathematics)				

Course Objective(s)

This paper deals with physics of non-linearity and their applications.

Course Outcome (s)

CO1: At the end of the course, students should be able to:
Get the basic ideas on information in light.

CO2: Get the basic ideas on the electromagnetic phenomena

CO3: Acquire the knowledge on photophysical phenomena

CO4: Find out the applications in non linear optics

CO5: Get the ideas on Fiber optics

Course Topics

Unit I Basic Combinatorial Numbers – Stirling Numbers of the First Kind – Stirling Numbers of the Second Kind.

Unit II Generating Functions and Recurrence Relations – Symmetric Functions.

Unit III Multinomials – Multinomial Theorem – Inclusion and Exclusion Principle.

Unit IV Euler Function – Permutations with Forbidden Positions – The ‘Menage’ Problem – Problem of Fibonacci.

Unit V Polya Theory – Necklace Problem and Burnside’s Lemma – Cycle Index of a Permutation Group – Polya’s theorems and their Immediate Applications.

Text Book:

1. Kenneth P. Boggart, Introductory Combinatorics, Pitman Books Ltd, 1983.

Reference Books:

1. V. Krishnamurthy, Combinatorics Theory and Applications, East – West Press, 1989.

2. V.K. Balakrishnan, Theory and Problems of combinatorics, Schaums outline series – McGraw Hill, 1994.

3. Ian Anderson, Combinatorics of finite sets, Oxford Science Publication, 2011.

BMA332 MATHEMATICAL MODELLING	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Free Electives (Basic Science And Mathematics)				

Course Objective(s)
This paper deals with physics of non-linearity and their applications.
Course Outcome (s)
CO1: At the end of the course, students should be able to:
Get the basic ideas on information in light.
CO2: Get the basic ideas on the electromagnetic phenomena
CO3: Acquire the knowledge on photophysical phenomena
CO4: Find out the applications in non linear optics
CO5: Get the ideas on Fiber optics

Course Topics

UNIT I
Mathematical Modeling through Ordinary Differential Equations of First order: Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models – Dynamic problems – Geometrical problems.

UNIT II
Mathematical Modeling through Systems of Ordinary Differential Equations of First Order: Population Dynamics – Epidemics – Compartment Models –Economics – Medicine, Arms Race, Battles and International Trade – Dynamics.

UNIT III
Mathematical Modeling through Ordinary Differential Equations of Second Order: Planetary Motions – Circular Motion and Motion of Satellites –Mathematical Modeling through Linear Differential Equations of Second Order –Miscellaneous Mathematical Models.

UNIT IV

Mathematical Modeling through Difference Equations: Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Economics and Finance – Population Dynamics and Genetics – Probability Theory.

UNIT V

Mathematical Modeling through Graphs: Solutions that can be Modelled Through Graphs – Mathematical Modeling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

Text Book:

1. Mathematical Modeling, J.N. Kapur, Wiley Eastern Limited, New Delhi, 1988.

Reference:

J.N. Kapur, Mathematical Models in biology and Medicine, EWP, New Delhi,1985.

BCY501	**NANO CHEMISTRY**	L	T	P	C
		3	0	0	3
Objective(s)	Educate them in synthesis and characterization of nano materials				

Course Outcome(s)

CO1	Summarize the basis of nano technology
CO2	Compare the properties of nanomaterials with micro and macro materials
CO3	Sketch the synthesis of nanomaterials
CO4	Illustrate the synthesis techniques of nanomaterials
CO5	Choose best technologies for characterization of nanomaterials

Unit-I: Basics of Nano chemistry

Basics of nanomaterials: Properties of nanomaterials, quantum confinement effect, surface to volume ratio, surface properties of nanoparticles. Classification of the nano materials – zero dimensional, one dimensional, two dimensional and three dimensional nanostructures.

Unit-II: Properties of Nanomaterials

Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra

Unit-III: Synthetic Techniques
Chemical methods: sol-gel synthesis, solvothermal synthesis, thermolysis route. Physical methods: Pulsed laser deposition- Magnetron sputtering

Unit-IV: Applications of Nanomaterials
Catalysis on nanoparticles, semiconductors, sensors, and electronic devices, photochemistry and nanophotonics, applications of CNTs, nanomaterials in biology and medicine.

Unit-V: Characterization Techniques
X-ray diffraction- Electron microscopes – scanning electron microscopes (SEM) – transmission electron microscopes (TEM) – scanning probe microscopy – atomic force microscopy (AFM) – scanning tunneling electron microscope (STEM) – basic principles only.

Reference Books:
1. S.Shanmugam, Nanotechnology, , MJP Publishers, Chennai (2010).
2. Patrick Salomon , A Handbook on Nanochemistry,, Dominant Publishers and Distributers, New Delhi.
3. S. Balaji , Nanobiotechnology, MJP Publishers, Chennai (2010).
4. CNR Rao The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, Springer (2006).
5. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, (2005).
6. G. B. Segreev, Nanochemistry, , Elsevier, Science, New York, (2006).
7. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, “The Chemistry of Nanomaterials:Synthesis, Properties and Applications” WILEY-VCH Verlag GmbH & Co. KGaA, weinheim, 2004
8. C.N.R. Rao, G.U. Kulkarni, P.J. Thomas, Nanocrystals: Synthesis, Properties and Applications” Springer Series in materials science-95, Springer-Verlag Berlin Heidelberg 2007
9. Znong Lin Wang, “Characterization of nanophase materials” WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2000.

BCY504	APPLIED CHEMISTRY	L	T	P	C
		3	0	0	3
Objective(s)	Awareness about recent technologies in applied chemistry				

Course Outcome(s)

CO1	Solve water related problems
CO2	Illustrate electrochemical concepts
CO3	Employ corrosion prevention methodologies
CO4	Develop innovative fuels
CO5	Formulate novel polymers

Unit-I: Water Treatment

Brief introduction regarding sources, impurities in water. Hardness of water, types, determination of hardness using EDTA method. Brief discussion and chemistry involved in the process of sedimentation, coagulation, filtration and sterilization, UV, Ozone, chlorination including break point chlorination. Softening of Water: (i) Lime-soda, process: Principles in hot, cold, lime-soda process. (ii) Zeolite softener, demineralization by synthetic ion exchange resins, Comparison between lime-soda, Zeolite and ion exchange process.

Unit-II: Electrochemistry

Introduction, Arrhenius ionic theory, Debye-Huckel theory of strong electrolytes, Activity and Activity coefficient, Conductivity of electrolytes, Kohlrausch's law of independent migration of ions, Oswald's dilution law, Acids and Bases, Concept of pH and pOH , Buffer solutions, Solubility product, common ion effect, Hydrolysis of salts, Conductometric titrations, transport number. Potentiometric titrations.

Unit-III: Corrosion of Metals and Alloys

Definition and classification of corrosion. Electrochemical corrosion- General revision of concept of electrode potential, galvanic cells, electrochemical and galvanic series, causes of corrosion, mechanism of direct chemical attack, pilling- Bed worth rule, concentration cells. Differential aeration theory of corrosion, types of corrosion, pitting corrosion, intergranular stress, waterline and microbial corrosion. Corrosion prevention : (a) Design and material selection, (b) Anodic and Cathodic inhibitors, (c) Cathodic and Anodic protection, (d) Protective coatings- types of surface, coatings and its application.

Unit-IV: Fuels

Introduction, Classification of fuels, Calorific value, Characteristics of a good fuel, comparison between solid, liquid and gaseous fuels. Bomb calorimeter. Calorific value of a gaseous fuel, Theoretical calculation of calorific value of a fuel, Wood, Coal, Classification of coal, selection of coal , analysis of coal, Types of carbonization of coal. Diesel engine fuel, Petroleum, synthetic petrol. LPG as a fuel. Non petroleum fuels, Natural gas, Coal gas, water gas. Non conventional sources of energy-bio mass, biogas, wind energy, solar.

Unit-V: Polymers

Introduction, Nomenclature and functionality of polymers, Classification of polymers, Types of polymersation. Methods of polymerization, Characteristics of polymers, structure and properties of polymers. Plastics, Inorganic polymers, Silicones, Rubbers, vulcanization of rubbers, synthetic rubber or elastomers, Application of rubber, Conducting polymers and bio polymers.

Reference Books:

1. S.S. Dara, A Text Book of Engineering Chemistry, S.Chand & Co. New Delhi, first Edition, 1985.
2. P.C.Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai & Sons, New Delhi, Fifteenth Edition,2009.
3. Fontana and Green , Corrosion Engineering, Tata McGraw Hill International Book Co. 2nd edition, 2005.
4. V.R.Gowariker, N.V.Viswanathan, Jayadev sreedhar, Polymer Science, New Age International publishers, (1986) Reprint 2010.

BCY505	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3
Objective(s)	Educate them in operating analytical instruments				

Course Outcome(s)

CO1	Summarize chromatographic techniques
CO2	Interpret spectroscopic data
CO3	Compute the spectral results
CO4	Employ gas chromatography in separating mixture of compounds
CO5	Identification of elements using microscopic analysis

Unit-I: Chromatography

Introduction – solvent extraction (basic concepts only) – ion exchange (basic concepts only) – electrophoresis (basic concepts only) – column and thin layer chromatography - Principles, instrumentation, theory and applications of GC and HPLC.

Unit-II: Qualitative Optical Spectroscopy

Introduction-Principles, instrumentation, theory and applications of Infrared spectroscopy, Raman spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy and X-ray diffraction methods.

Unit-III: Quantitative Optical Spectroscopy

Introduction - Principles, instrumentation, theory and applications of Atomic absorption spectroscopy(AAS)–Inductively coupled plasma atomic emission spectroscopy- Inductively coupled plasma mass spectrometry - Atomic fluorescence spectroscopy-
X-ray fluorescence spectroscopy – Ultraviolet (UV)-visible spectroscopy.

Unit-IV: Mass Spectrometry

Introduction-Principles, instrumentation, theory and applications of Gas chromatography mass spectrometry (GCMS) – High performance liquid chromatography electrospray ionization mass spectrometry (LC-ESI-MS) – Laser mass spectrometry (MALDI).

Unit-V: Microscopic and Surface Analysis

Introduction-Principles, instrumentation, theory and applications of Atomic force microscopy (AFM)–Auger electron spectroscopy-X-ray photoelectron spectroscopy (XPS)- Scanning electron microscopy (SEM)–Transmission electron microscopy (TEM).

Reference Books:

1. Frank A.Settle (Editor), Handbook of instrumental techniques for analytical chemistry, Prentice-Hall Inc., New Jersey, 1997.
2. Vogel's Textbook of quantitative chemical analysis, G.H.Jefferey, J Bassett, J Mendham, and R C Denney, Longman scientific and technical publishers, London
3. D.A.Skoog, F.J.Holler, S.R.Crouch, Instrumental Analysis, Cengage Learning, New Delhi, 2007.
4. H.H. Willard, L.L.Merritt, and J.A.Dean, Instrumental Methods of Analysis, 6th Edition (1986),CBS Publishers & Distributors, Shahdara, Delhi.

BCY506	ENVIRONMENTAL CHEMISTRY	L	T	P	C
		3	0	0	3
Objective(s)	Demonstrate the analysis of environmental degradation				

Course Outcome(s)

CO1	Examine various water quality parameters
CO2	Model instrumental methods of water analysis
CO3	Identify gaseous pollutants and its effects
CO4	Point out degradation of atmosphere by electromagnetic radiation
CO5	Categorize various soil pollutants

Course Topics

Unit-I: Environmental Chemistry of Water

The principles and application of aqueous chemistry to the environmental systems. Unique properties of water, Water Quality Parameters: physico-chemical, biological, bacteriological; Water Quality Criteria and Standards; Water quality monitoring and management aspects, Chemical methods involved in treating water and wastewater, Removal of dissolved organics and inorganics, Heavy metal pollution and its abatement.

Unit-II: Water and Wastewater Analysis

Basic concepts and Instrumental methods of analysis; Determination of major parameters of water such as pH, acidity, alkalinity, hardness, BOD, COD, solids, fluoride, nitrogen, iron, manganese, sulphate, phosphate, volatile acids and trace contaminants.

Unit-III: Atmospheric Chemistry

Structure and properties of atmosphere, Classification and chemistry of major air pollutants and their control. Types and sources of air pollution-natural, Combustion and other combustion sources.

Atmospheric Composition & Behaviour: Gaseous & particulate constituents of the atmosphere, Temperature and pressure profile of atmosphere, General circulation of atmosphere.

Unit-IV: Atmospheric Photochemistry

Electromagnetic radiations, Kinetics of thermal and photochemical processes, Reactions in the upper atmosphere, Photo processes in the troposphere, Photochemical smog, Photosynthesis, Ozone chemistry.

Unit-V: Soil Chemistry

The nature and importance of soil; Soil in the natural and man-made environment, Soil properties; Acid-Base and Ion-exchange reactions in soils. Macro and Micronutrients; Fertilisers and other soil amendments.
Waste and pollutants in soil, Heavy metals and radio-nuclides in soil. Colloidal chemistry of inorganic constituents, clays, OM and soil humus; Absorption in soils - forces and isotherms; Soil as cation and anion exchanger; Degradation of natural substances; Remediation of metal contaminated soil.

Reference Books:

1. T.G. Spiro and W.M.Stigliani, Chemistry of the Environment, 2nd ed., Tsinghua University Press, 2003.

2. V.Snoeyink and D.Jenkins, Water Chemistry, J.Wiley and Sons, 1980.

3. Shugui Dai, Environmental Chemistry, (ed.), Higher Education Press, 1997.

4. C.N. Sawyer, P.L. McCarty, G. F. Parkin, Chemistry for Environmental Engineering, McGraw Hill, 4th edition, 2002.

5. L.D. Bene_eld, J. F. Judkins and B. L. Weand, Process Chemistry for Water and Wastewater Treatment, Prentice Hall, 1982.

6. R.A. Bailey, H. M. Clark, J. P. Ferris, S. Krause, R. L. Strong, Chemistry of the Environment, Academic Press Second Edition, 2002.

<table>
<tr><td rowspan="2">BPY502</td><td rowspan="2">LASER PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Objective(s)</td><td colspan="5">Demonstrate the analysis of environmental degradation</td></tr>
</table>

Course Outcome(s)

CO1	Examine various water quality parameters
CO2	Model instrumental methods of water analysis
CO3	Identify gaseous pollutants and its effects
CO4	Point out degradation of atmosphere by electromagnetic radiation
CO5	Categorize various soil pollutants

Course Topics

Unit 1 - Fundamentals of LASER
Spontaneous emission – stimulated emission – meta stable state – Population inversion – pumping – Laser Characteristics

Unit 2 - Production of LASER
Helium – Neon Laser – Ruby Laser – CO2 Laser – Semiconductor Laser
Unit 3 - Industrial Applications of LASER
Laser cutting – welding – drilling – Hologram – Recording and reconstruction of hologram
Unit 4 - Lasers in Medicine:
Lasers in Surgery – Lasers in ophthalmology – Lasers in cancertreatment
Unit 5 - Lasers in Communication
Optic fibre communication- Total internal reflection – Block diagram of fibre optic communication system – Advantages of fibre optic communication

Text Books

1. Laser fundamentals – William T. Silfvast Cambridge University Press – Published in South Asia by foundation books, 23, Ansari Road, New Delhi , 2008

2. An introduction to LASERS – N. Avadhanulu, S. Chand & Company, 2001.

References

1. LASER Theory and Application – K. Thyagarajan and A.K. Ghatak, Mac millan, India Ltd., 1981.

2. Lasers and non-linear optics, B. B. Laud, New Age International (P) Ltd., IIIrd Edn., 2011

BPY504	**RADIATION PHYSICS**	L	T	P	C
		3	0	0	3
Objective(s)	This paper deals with the detailed theoretical and experimental concepts on radiation physics.				

Course Outcome(s)

CO1	At the end of the course, students should be able to: Gain knowledge on the concepts of radiation
CO2	Get the basic ideas on the x-rays
CO3	Acquire the knowledge on radiation therapy
CO4	Get the knowledge on instrumentation techniques in radiation therapy
CO5	Gain the knowledge on clinical radiation therapy

Course Topics

STRUCTURE OF MATTER, NUCLEAR TRANSFORMATION AND X-RAYS

Elementary particles - Electromagnetic radiation-wave model and quantum model. Nuclear Transformation - Nuclear transformation-radioactivity - Decay constant – Activity - Radioactive series - Radioactive equilibrium -Activation of nuclides.X-Rays-Production of X-rays - X-ray tube - X-ray circuit - voltage rectification - Physics of X-ray production - X-ray energy spectra - Operating characteristics.

Clinical Radiation Generators

Kilo-voltage units- Grenz-ray therapy - Contact therapy - Superficial therapy - Orthovoltage therapy or deep therapy - Super voltage therapy - Resonant transformer units - Megavoltage therapy - Van de graff generator - Linear accelerator - Betatron - Cyclotron - Microtron - Machines using radionuclides-Cobalt-60 unit - Heavy particle beams.

Ionizing Radiation, Quality of X-Ray Beams, Measurement of Absorbed Dose

Ionizing Radiation - Interaction of ionizing radiation-Ionization - Photon beam description - Photon beam attenuation - Attenuation coefficient - Energy transfer - energy absorption coefficient - Interaction of photons with matter - Coherent scattering - The Roentgen - Free air ionization chamber - String electrometer - Ion collection-Saturation and collection efficiency - Measurement of exposure. Quality of X-Ray Beams- Half value layer and its measurement - Peak voltage-Direct indirect measurement - Effective energy. measurement of Absorbed Dose-Radiation absorbed dose - Relation between Kerma - Exposure - Absorbed dose.

Classical Radiation Therapy

Dose distribution and scatter analysis-Phantoms - Depth dose distribution - percentage depth dose-Dependence on beam quality and depth - Tissue air ratio (TAR)-relationship between TAR and percent depth dose- Dose calculation parameters- Collimator Scatter Factor - Phantom Scatter Factor - Tissue-Phantom and Tissue-Maximum Ratios - Scatter-Maximum Ratio-Practical Applications - Accelerator Calculations- SSD Technique - Cobalt 60 Calculations. Treatment planning-Acquisition of Patient Data- Internal Structures- Computed Tomography - Magnetic Resonance Imaging-Ultrasound. Skin Dose. Electron beam therapy - Brachytherapy.

Modern Radiation Therapy, Dosimetry and Radiation Protection

Modern Radiation Therapy-Image-Guided Radiation Therapy - Proton Beam Therapy. Dosimetry-Dosimeter - Film badge dosimeter - Pocket dosimeter. Radiation Protection-Radiation Protection - Dose Equivalent -

Effective Dose Equivalent - Background Radiation - Low-Level Radiation Effects - Effective Dose-Equivalent Limits- Occupational and Public Dose Limits.

Text Books

1. Meredith W.J. and J.B. Massey, *Fundamental Physics of Radiology*, A. John Wright and Sons Ltd.,3rd Edition, 1983.

2. William.R.Hendee, Geoffery.S.Ibbott and Eric.G.Hendee, *Radiation Therapy Physics*, A.John Wiley and Sons.,Inc, 3rd Edition, 2005.

References

1. Smith F.A., *A Primer in Applied Radiation Physics*, World scientific publishing Co., 2000.

2. Podgarsak E.B., *Radiation Physics for Medical Physicists*, Springer, 2006.

3. Evans R. D., *Atomic Nucleus*, Textbook Publications, 2003.

4. Fiaz.M.Khan, *The Physics of Radiation Therapy*, Lippincott Williams and Wilkins, 4th Edition, 2010.

BPY506	**NUCLEAR PHYSICS**	L	T	P	C
		3	0	0	3
Objective(s)	This paper deals with the detailed theoretical and experimental concepts on radioactivity and elementary particles				

Course Outcome(s)

	At the end of the course, students should be able to:
CO1	Gain knowledge on nucleus and nuclear models.
CO2	Get the basic ideas on the nuclear reactions
CO3	Acquire the knowledge on fundamentals in elementary particles
CO4	Carry out research in nuclear physics
CO5	Acquire the knowledge on Radioactive materials

Course Topics

Nucleus and nuclear models

Introduction to nucleus- classification of nuclei – general properties of nucleus – charge, mass, spin , magnetic moment, quadruple moment – mass defect - binding energy- models of nuclear structure - liquid drop model – shell model.

Radioactivity

Introduction – discovery of radioactivity - natural radioactivity - alpha, beta and gamma rays - properties of the rays - experimental measurement of the range of alpha particles – beta ray spectra – origin of the line and continuous spectrum – the neutrino theory of beta decay.

Nuclear Reactions

Soddy Fajan's displacement law - law of radioactive disintegration - the mean life - measurements of decay constants - units of radioactivity - law of successive disintegration - radioactive dating -nuclear reactions - energy balance in nuclear reactions - threshold energy of an endoergic reaction-applications of radio isotopes.

Particle accelerators, detectors, Cosmic rays

GM Counter - Wilson cloud chamber - bubble chamber – cyclotron – synchrotron –synchrocyclotron - betatron – Cosmic rays: introduction – discovery of cosmic rays –cosmic showers –origin of cosmic radiation.

Elementary particles

Introduction – fundamental interactions - elementary particle quantum numbers – quark model.

Text Book

1. Modern Physics by R. Murugesan and Kiruthiga Sivaprasath, S.Chand & Co., 2005.

References

1. Atomic and Nuclear Physics by Shatendra Sharma, Dorling Kindersley India, 2005.
2. Nuclear Physics by D.C. Tayal, Himalaya Publishing House, reprint 2007.
3. Nuclear Physics, An introduction by S.B.Patel, New Age international(P) Ltd., (reprint 2003)

<table>
<tr><td rowspan="2">BPY507</td><td rowspan="2">SPACE PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Objective(s)</td><td colspan="5">This paper deals with the detailed concepts on space science.</td></tr>
</table>

Course Outcome(s)

	At the end of the course, students should be able to:
CO1	Know about the earth's atmosphere.
CO2	Get the basic ideas on the interplanetary medium
CO3	Acquire the knowledge on planets
CO4	Carry out the research work on space physics
CO5	Acquire the knowledge on sun atmosphere

Course Topics

Unit I - The Earth's Upper Atmosphere

Variations of atmospheric densities and temperature. Formation and structure of Ionosphere. Studies of ionosphere by ground based and space techniques. The radiation belts. Auroras. Lyman glow of the night sky. The geo-corona and airglow studies.

Unit I - Sun

Structure of solar atmosphere. Solar convection and differential rotation. Large scale and small scale magnetic fields. Solar granulation and super granulation. Sunspots. Solar flares.

Unit III - Interplanetary Medium

Xray and g-ray studies of sun. Solar X-ray and radio bursts. Solar wind. Interaction with planetary atmosphere. Structure of bow shocks. Magnetosphere. Ring Current. Radiation belts and interplanetary magnetic field.

Unit - IV Moon

Origin of Moon. Solar and Lunar eclipses. Lunar ranging experiments. Studies of lunar surface from various space missions and their results. Satellites of other planets of the solar system.

Unit - V Planets

Infrared spectroscopy of planetary atmospheres. Principal results of the Mariner, Venera and Viking Space Missions to Mars and Venus. Voyager space mission studies of outer planets and their satellites and rings. Comparative studies of planetary atmospheres. Planetary ionospheres. Extra-solar system planets.

Text Books

1. Sun, Earth and radio: An Introduction to the Ionosphere and Magnetosphere, J.A.Ratcliffe, 1970, Littlehampton Book Services Ltd
2. An Intoduction to Planetary Physics: The Terrestrial Plants, Kaula. W.M, 1969, John Wiley & Sons Inc.
3. Harold Zirin: Astrophysics of the Sun, 1988, Cambridge University Press

References

1. W.N.Hess and G.Mead(Ed): Introduction to Space Science, 1965, Gorden and Breach,
2. V.Bumba and Kleczek, Basic Mechanism of Solar Activity, 1976.
3. W. J. Kaufmann, Exploration of the Solar System, Mac Millan, 1978, New york.

HUMANITIES ELECTIVES

HSS001 TOTAL QUALITY MANAGEMENT	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

This subject provides students with the knowledge to understand the philosophy and core values of Total Quality Management (TQM). It helps to determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization; apply and evaluate best practices for the attainment of total quality. Students who complete this course will be able to critically appraise management techniques, choose appropriate statistical techniques for improving processes and write reports to management describing processes and recommending ways to improve them.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Determine the impact of quality on profitability and to learn the basic principles and practices of TQM.

CO2: Develop an understanding on quality management philosophies and frame work.

CO3: Develop in-depth knowledge in various tools and techniques of quality management

CO4: Effectively communicate quality measurement methods and continuous improvement process.

CO5: Learn how to achieve world –class status in manufacturing and service through TQM and bench marking.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2					2				2					
CO2		2					2	2	2		3	2	2	1	
CO3	2				3		1	2				1			
CO4						1	2	2		3	2	2		2	
CO5						2			2	2	3	1	2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: INTRODUCTION TO QUALITY MANAGEMENT 9 Hours

Definitions – TOM framework, benefits, awareness and obstacles - Quality – vision, mission and policy statements - Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality

Unit 2: PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT 9 Hours

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi, Shingeo and Walter Shewhart - Concepts of Quality circle, Japanese 5S principles and 8D methodology.

Unit 3: STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY 9 Hours

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed - Process capability – meaning, significance and measurement – Six sigma concepts of process capability - Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve - Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

Unit 4: TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT 9 Hours

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation.

Unit 5: TAGUCHI TECHNIQUES 9 Hours

Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio - Seven old (statistical) tools - Seven new management tools - Bench marking and POKA YOKE

Text Book(s)

1. Poornima M.Charantimath., Total quality management, Pearson Education, 2nd Edition, 2011.
2. Dale H.Besterfield et al, Total Quality Management, Perarson Education, Thrid edition, (First Indian Reprints 2004).

Reference(s)

1. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition, 2002.
2. Jams R. Evans, Total Quality: Management, Organisation and strategy, 4th Edition, South- Western College, 2004.
3. Vincent K.Omachonu, Joel E.Ross, Principles of Total Quality, 3rd Edition, CRC Press, 2004.
4. S.Rajaram, M. Sivakumar, Total Quality Management, Wiley Publishers, 1st Edition, 2008

HSS002 ENGINEERING MANAGEMENT	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

On completion of this course the student will have clear idea about the demand and revenue analysis, forms and business and function, human resource, financial development, global environment.

Course Outcome(s)

CO1: At the end of the course the student must be able to know various aspects of demand and revenue analysis.

CO2: Ability to understand different types of business organizations and function.

CO3: Understanding human resources and time management.

CO4: Able to understand the concept of product development and operation Management.

CO5: Understanding the business strategy of global environment.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1				1		2	1					2			
CO2						2		1	1	2		2	1	2	
CO3							2	2	3		3	2		2	
CO4											2	2	1		
CO5						2	2	2	2	2		2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit1: INTRODUCTION

Demand and Revenue Analysis - Demand Forecasting - Production Analysis - Cost and Supply Analysis, Price and output Determination - Investment Analysis - Plant Location - Economic Optimization.

Unit1: 2 FORMS OF BUSINESS AND FUNCTIONS

Types of Business Organisation, Forms - Planning - Organizing - Designing effective organisations – Coordination

Unit1: 3 HUMAN RESOURCE DEVELOPMENT

Motivating individuals and workgroups - Leadership for Managerial Effectiveness - Team working and Creativity - Managerial Communication - Personal Management – Time Management - Stores Management - Career Planning.

Unit1: 4 FINANCIAL MANAGEMENT

Product development - Management techniques in product development - Nature of controlling - Operations Management - Just-in-Time.

Unit1: 5 GLOBAL ENVIRONMENT

Managing World Economic Change - The global environment - Multinational Strategies - Economic Cycles and Director Investment - Change and Organisation Development - Managerial Ethics and Social responsibilities.

REFERENCES

1. Harold Koontz& Heinz Weihrich, Essentials of Management, Tata McGraw Hill publishing company Ltd.
2. Koontz, Weihrich& Aryasri, Principles of Management, Tata McGraw Hill publishing company Ltd.
3. Tripathi& Reddy, Principles of Management, Tata McGraw Hill publishing company Ltd.
4. Hampton, Management, Tata McGraw Hill publishing company Ltd.
5. L.M.Prasad, Principles of Management.

HSS003 INDIAN ECONOMIC DEVELOPMENT	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

- To create awareness on the Economic areas of the management.
- To explore the ideas related to business development.

Course Outcome (s)

CO1: Understanding of Indian economics and its effect on economic development and labour force.

CO2: Ability to understand Indian Economic Planning.

CO3: Analyze the Industrial development during the planning period&Role of Public sector Enterprises.

CO4: Understanding the Role of foreign trade.

CO5: Learn the Issues of Poverty and inequality, Unemployment, Rising prices and Industrial relations.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1								2		2		1			
CO2		1						2	2	2		2			
CO3		2			1	2	2	2	3	2	2				
CO4								2	3	3	2	1			
CO5		2		2	1	2	2	2		3		2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INDIAN ECONOMIC SCENARIO

Indian economy before and after Independence - National income trends and compositions. Sources of capital formation and savings - Sectoral growth. Demographic trends in India and its effect on economic development - Occupational structure of the labour force.

ECONOMIC PLANNING AND POLICY

Indian Economic Planning, fiscal policy, Monetary Policy, Unemployment in India and other economic policies

INDUSTRIAL DEVELOPMENT

Industry: Industrial development during the planning period - Industrial policies Industrial licensing policy – MRTP Act, FERA and FEMA - Growth and problems of small-scale industries - Role of Public sector enterprises in India's industrialization. Impact of economic reforms on Indian industrial sector after 1991.

FOREIGN TRADE

External Sector - Role of foreign trade. Trends in exports and imports - Composition and direction of India's foreign trade - Balance of payments crisis and the New Economic Reforms – Export promotion measures and the new trade policies - Foreign capital – FDI, aid: Multinational corporations in India

ISSUES

Important Areas of Concern **-** Poverty and inequality. Unemployment. Rising prices. Industrial relations. Industrial structure and causes of industrial backwardness.

REFERENCES

1. Agrawal, A.N. Indian Economy Problems of Developmental Planning, Wiley Eastern Ltd., Calcutta, latest edition.
2. Ahluwalia, I.J. and I.M.D. Little (eds.), India's Economic Reforms and Development, Essays in honour of Manmohan Singh, Oxford University Press, New Delhi, 1999.
3. Alam, K., Agricultural Development in North East India: Constraints and Prospects, Deep & Deep Publications, New Delhi, 1993.
4. Choudhuri, Pramit. Aspects of Indian Economic Development, Lord George Allen & Unwin Ltd., London, 1975.
5. Dutt, R.C., The Economic History of India Under Early British Rule, Low Price Publications, Delhi, 1950.
6. Dutt, Ruddar and K.P.M. Sundaram, Indian Economy, S. Chand & Co. Ltd., New Delhi, 2001.

HSS004 INDUSTRIAL PSYCHOLOGY	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

The aim of undergoing this course develop an awareness of the major perspectives underlying the field of Industrial Psychology and understanding for the potential Industrial Psychology has for society and organizations now and in the future.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understanding of key concepts, theoretical perspectives, and trends in industrial psychology.

CO2: Evaluate the problems thorough and systematic competency model

CO3: Analyze the problems present in environment and design a job analysis method.

CO4: Create a better work environment for better performance

CO5: Design a performance appraisal process and form for the human behaviour

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2						2	2			2			
CO2	1		2			2					3				
CO3	1				2	2			2		3	2	1		
CO4	2		2						2	2	2				
CO5	2			2		2	2					2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: Introduction **9 Hours**

The role of the psychologist in industry, the field of occupational Psychology - Study of behaviour in work situation and applications of Psychological principles to problems of selection, Placement, Counseling and training

Unit 2: **Design of Work Environments** **9 Hours**

Human engineering and physical environment techniques of job analysis, Social environment- Group dynamics in Industry Personal psychology - Selection, training, placement, promotion, counseling, job motivations, job satisfaction. Special study of problem of fatigue, boredom and accidents.

Unit 3: Understanding Consumer Behaviour **9 Hours**

Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale - the nature and scope of engineering psychology, its application to industry.

Unit 4: Work Methods **9 Hours**

Efficiency at work, the concept of efficiency, the work curve, its characteristics - The work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction The working environment - noise, illumination, atmospheric conditions - Increasing efficiency at work; improving the work methods, Time and motion study, its contribution and failure resistance to time and motion studies, need for allowances in time and motion study.

Unit 5: Work and Equipment Design **9 Hours**

Criteria in evaluation of job-related factor, job design, human factors, Engineering information, input processes, mediation processes, action processes, methods design, work space and its arrangement, human factors in job design. Accident and Safety - The human and economic costs of accidents, accident record and statistics, the causes of accidents situational and individual factors related to accident reduction.

Reference(s)

1. Tiffin,J and McCormic E.J., Industrial Psychology, Prentice Hall, 6th Edn., 1975.
2. McCormic E.J., Human Factors engineering and design, McGraw Hill, 4th Edn.,1976. Mair, N.R.F., Principles of Human relations
3. Gilmer, Industrial Psychology
4. Ghiselli& Brown, Personnel and Industrial Psychology.
5. Myer, Industrial Psychology.
6. Dunnete, M.D., Handbook of Industrial and Organizational Psychology.
7. Blum & Taylor, Industrial Psychology.

HSS006 PROFESSIONAL ETHICS	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

This subject will provide students with ability to understand and analyse managerial problems in industry so that they can use resources (capitals, materials, staffing, and machines) more effectively.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Interpret the functions and ethical values of manager, employees and customer.

CO2: Examine ethics by means of basic theories, consensus and controversies.

CO3: Integrate the sense of corporate social responsibilities, loyalty and safety associated with professionals and employees.

CO4: Develop moral imagination and approaches to management to enlighten the responsibility and decision making of a professional.

CO5: Investigate global issues and develop scrupulous concern to engineers and managers with sample code of conducts.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						2		3	2		2	2			
CO2		2				2		3	1		2	2		1	
CO3		2				2		2			2	1	2		
CO4						2		3	2		2				2
CO5						2		3	2			1			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: ENGINEERING ETHICS 9 Hours

Functions of Being a Manager – Stock holder and stakeholder management – Ethical treatment of employees - ethical treatment of customers- supply chain management and other issues

Unit 2: ENGINEERING AS SOCIAL EXPERIMENTATION 9 Hours

Senses of Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

Unit 3: ENGINEER RESPONSIBILITY FOR SAFETY 9 Hours

Corporate social responsibility - Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

Unit 4: RESPONSIBILITY AND RIGHTS 9 Hours

Moral imagination, stake holder theory and systems thinking - One approach to management decision – making Leadership.

Unit 5: GLOBAL ISSUES 9 Hours

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct

Text Book(s)

1. Mike Martin and Roland Schinzinger, Introduction to Engineering Ethics, 2nd Edition, McGraw Hill, 2010.
2. Charles D Fledderman, Engineering Ethics, Pearson, 2011.

Reference(s)

1. R.S.Nagarajan, Text book on Professional Ethics and Human Values, New Age International, 2007.
2. Gail Baura, Engineering Ethics- An Industrial Perspective, 1st Edition, Academic Press, 2006.
3. Charles e. Harris, Michael s. Pritchard and Michael J. Rabins Texas, Engineering Ethics- Conecpts and Cases, 4th Edition, Cengage Learning, 2009.
4. Charles Byms Fleddermann, Engineering Ethics, Pearson, 2008.
5. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2013.
6. Dr.V.Jeyakumar, Professional Ethics in Engineering, Lakshmi Publication, Chennai, 2014

<table>
<tr><td rowspan="3">HSS008 BASICS OF ECONOMICS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective – Theory</td></tr>
</table>

Course Objective(s)

- To learn, understand and apply economic theories of International Trade, political economy of International Trade and central issues in International Macro Economics**.**

Course Outcome (s)

CO1: Understand the scope and microeconomics in relation.
CO2: Understand the law of demand.
CO3: Evaluate strategy of market demand and supply schedule.
CO4: Explain the effectiveness of macro-economic policy.
CO5: Analyze the balance of payments.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1											2	1	1		
CO2											2	1	1		
CO3		2			2					2	2	2	1		
CO4							1				2	2	1		
CO5		2			1							2	1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit1: DEFINITION AND SCOPE OF ECONOMICS

Definitions by A. Smith, A. Marshal and L. Robbins, P.Samuelson and their critical examination - Nature and scope of Economics - Micro-economics in relation to other branches of Economics.

Unit2: LAW OF DEMAND

Elasticity of demand - price, income and cross, concepts and measurement - Marshallian theory of consumers' behaviour and its critical examination - Indifference curve analysis - Price, income and substitution effects - Giffen goods- Engel curve.

Unit3:MARKET STRUCTURE

Definition of market. Concepts of product and factor markets. Different types of market: perfect competition, monopoly, imperfect competition, monopolistic, competition and oligopoly. Demand and Supply schedules. Price determination under perfect competition in long and short run. Price determination under monopoly. Discriminating monopoly.

Unit4: MACRO-ECONOMICS

Meaning, Macro-economic Policy and Its Objectives and Instruments - National Income and Social Accounting - Concepts, components, and measurement - Basic circular flow of income model, Unemployment, trade cycle, Inflation - causes, types, effects and control.

Unit5: COMMERCIAL AND CENTRAL BANKS

Credit creation, monetary policy and tools - Balance of payments - Items in the balance of payments account, equilibrium in the balance of payments.

REFERENCES

1. Ackley, G., Macroeconomics: Theory and Policy, Macmillan Publishing Company, New York, 1978.
2. Gupta, S.B., Monetary Economics, S. Chand & Co., New Delhi, 1994.
3. Ruddar Datt and K.P.M.Sundharam, Indian Economy, S.Chand & Company Ltd., New Delhi, 2003.
4. Kindleberger, C.P., R.D. Irwin, International Economics, Home Wood, 1973.
5. Lewis, M.K. and P.D. Mizan, Monetary Economics, Oxford University Press, New Delhi, 2000.
6. Ahuja H.L., Economic Environment of Business, Macroeconomic analysis, S.Chand & Company Ltd., New Delhi, 2005.
7. Gupta, G.S. Macroeconomics, Theory and Applications, Tata McGraw-Hill publishing company Ltd., New Delhi, 2001.
8. D.N.Dewedi, Macro economic – Theory and policy, Tata McGraw-Hill publishing company Ltd., New Delhi, 2001.

<table>
<tr><td rowspan="3">HSS010 INTERNATIONAL TRADE AND FINANCE</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective – Theory</td></tr>
</table>

Course Objective(s)

- The Objective of the course is to teach the basic International Trade and Finance how an organization manages its people effectively**.**

Course Outcome(s)

CO1: Evaluate the International Trade and Economic Growth

CO2: Understanding the export and import policies.
CO3: Understand the Exchange rates and functions.
CO4: The student able to understand various documentation and standards for international trade.
CO5: Understand the export schemes of the government.

Mapping of Course Outcome(s)

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2		2				3	1		
CO2						2		2				3	1		
CO3		2				2		2		1	2	2			
CO4								2		3		3		1	
CO5						2		2		2		3	1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INTERNATIONAL TRADE

International Trade – Meaning and Benefits – Basis of International Trade – Foreign Trade and Economic Growth – Balance of Trade – Balance of Payment – Current Trends in India – Barriers to International Trade – WTO – Indian EXIM Policy.

EXPORT AND IMPORT FINANCE

Special need for Finance in International Trade – INCO Terms (FOB, CIF, etc.,) – Payment Terms – Letters of Credit – Pre Shipment and Post Shipment Finance – Forfeiting – Deferred Payment Terms – EXIM Bank – ECGC and its schemes – Import Licensing – Financing methods for import of Capital goods.

FOREX MANAGEMENT

Foreign Exchange Markets – Spot Prices and Forward Prices – Factors influencing Exchange rates – The effects of Exchange rates in Foreign Trade – Tools for hedging against Exchange rate variations – Forward, Futures and Currency options – FEMA – Determination of Foreign Exchange rate and Forecasting.

DOCUMENTATION IN INTERNATIONAL TRADE

Export Trade Documents - Financial Documents – Bill of Exchange-

Type- Commercial Documents - Performa, Commercial, Consular, Customs, Legalized Invoice, Certification of Origin Certificate Value, Packing List, Weight Certificate, Certificate of Analysis and Quality, Certificate of Inspection, Health certificate. Transport Documents - Bill of Landing, Airway Bill, Postal Receipt, Multimodal Transport Document. Risk Covering Document: Insurance Policy, Insurance Cover Note. Official Document: Export Declaration Forms, GR Form, PP From, COD Form, Softer Forms, Export Certification, Certification of Origin, GSPS – UPCDC Norms

EXPORT PROMOTION SCHEMES

Government Organizations Promoting Exports – Export Incentives : Duty Exemption – IT Concession – Marketing Assistance – EPCG, DEPB – Advance License – Other efforts I Export Promotion – EPZ – EQU – SEZ and Export House.

REFERENCES

1. Apte P.G., International Financial Management, Tata McGraw Hill.
2. Larceny & Bhattacharya, International Marketing, Sultan Chand & Sons.
3. B.M.Wali and AB Kalkumdrikas, Export Management, Sterling Publishers Pvt., Ltd.
4. Websites of WTO, World Bank, IMF, Ministry of Commerce, ECGC and EXIM Bank.

HSS011 INFORMATION SYSTEMS FOR MANAGERIAL DECISION MAKING	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

The Objective of the course is to teach the basics about information systems and how an organization manages its people effectively and decision making.

Course Outcome (s)

CO1: Understanding the framework&information system architecture

CO2: Understanding the Functional areas, Finance, marketing, production
CO3: Understand the system development life cycle &structured methodologies
CO4: Able to implement and control of information system.
CO5: Evaluate the software engineering qualities.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						1			2	2					
CO2							2	2			3		1		
CO3	2				3		2				1	2	1		
CO4	2					3	2		3		2		1		
CO5	2				2				3		1	3			2

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INTRODUCTION

Information system – establishing the framework – business model – information system architecture – evolution of information systems.

INFORMATION SYSTEM

Functional areas, Finance, marketing, production, personnel – levels, Concepts of DSS, EIS, ES – comparison, concepts and knowledge representation – managing international information system.

SYSTEM DEVELOPMENT

Modern information system – system development life cycle – structured methodologies – designing computer based method, procedures control, designing structured programs.

IMPLEMENTATION AND CONTROL

Testing security – coding techniques – detection of error – validation – cost benefits analysis – assessing the value and risk information systems.

SOFTWARE ENGINEERING

Software engineering qualities – design, production, service, software specification, software metrics, and software quality assurance – software life cycle models – verification and validation.

REFERENCES

1. Kenneth C. Laudon and Jane Price Laudon, Management Information systems Managing the digital firm, Pearson Education, Asia.
2. Gordon B.Davis, Management Information system: Conceptual Foundations, Structure and Development, McGraw Hill, 1974.
3. Joyce J. Elam, Case series for Management Information System, Silmon and Schuster, Custom Publishing, 1996.
4. Steven Alter, Information system – A Management Perspective, AddisonWesley, 1999.
5. James AN O' Brein, Management Information Systems, Tata McGraw Hill, New Delhi, 1999.
6. Turban Mc Lean, Wetherbe, Information Technology Management making connection for strategic advantage, John Wiley, 1999.
7. Ralph M.Stair and George W.Reynolds, Principles of Information Systems – A Managerial Approach Learning, 2001.

<table>
<tr><td rowspan="3">HSS013 COST ANALYSIS AND CONTROL</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective – Theory</td></tr>
</table>

Course Objective(s)

This course in meant to exhibit the concepts on costing by describing its elements, types and cost sheet preparation. It also encompasses the analytical framework that can be applied in cost analysis like Marginal costing, CVP analysis, break even analysis, etc. enabling the students to make decisions on cost parameters. Students are enabled to apply techniques like standard costing, activity based costing, etc. to manage and control cost effectively.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Understand the basics of Costing and preparation of Cost sheet.

CO2: Analyse the cost by applying tools like Marginal costing, CVP analysis and other applications.

CO3: Enabled to use Budgets for controlling cost in Manufacturing or Production Centres.

CO4: Defining cost standards and critically examining the application of Standard costing in a Production Centre.
CO5: Understanding the application of various strategic cost alternatives including Activity based costing.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1											3	1	2		
CO2											3	1	2		
CO3	1			1							2		2		
CO4									1		2		2		
CO5											2		2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: BASICS OF COSTING **9 Hours**

Costing, Elements of costing, Types of cost, Preparation of cost sheet

Unit 2: COST ANALYSIS **9 Hours**

Marginal costing, Cost - volume – Profit analysis, Break-Even-Analysis, Break –Even - Chart, Applications.

Unit 3: CONTROL TECHNIQUES **9 Hours**

Budgeting and Budgetary control, Types of Budgets, Preparation of purchase Budget, Flexible budgets, Cash Budget, Sales Budget, Materials Budget, Master Budget, zero based Budgeting

Unit 4:STANDARD COSTING **9 Hours**

Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing –Control through variances.

Unit 5: ACTIVITY BASED COSTING **9 Hours**

Transfer Pricing, Target costing, Life Style Costing, Activity Based Costing (only theory)

Text Book(s)

1. K.Saxena & C.D. Vashist, Advanced Cost Accounting and Cost Systems, 2nd Edition, V.Sultan Chand & Sons Publishers. 2014

2. S.P. Jain & K. L. Narang, Advances Cost Accounting Kalyani Publishers, 1st Edition, 2017

Reference(s)

1. J. Blocher, K. H. Chen, G. Cokins and T. W. Lin., Cost Management: A Strategic Emphasis, Irwin/McGraw-Hill, 3d edition, 2008
2. Don R. Hansen, Maryanne M. Mowen, Cornerstones of Cost Management, 6th Edition, Cengage Learning, 2015
3. Roger Hussey, Audra Ong, Strategic Cost Analysis, Business Expert Press, 2012.

HSS014 MARKETING MANAGEMENT	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective - Theory				

Course Objective(s)

This course develops students understanding of how organizations match the requirements of consumers in competitive environments, and develop strategies to create the competitive edge. It covers areas such as analysis, planning, implementation, and control, as well as the marketing mix, exportation, and the social aspects of marketing.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: To Develop understanding of marketing concepts, philosophies and historical background.

CO2: To Develop understanding of marketing operations and complexities for students to apply in practical business situations.

CO3: To Understand concepts related to Segmentation, Targeting and Positioning, product attributes, and pricing strategies prevalent in domestic and international scenario.

CO4: To Study various tools and techniques of promoting the products in ethical manner.

CO5: To Understand emerging concepts of marketing in the emerging global markets

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2	1					1			
CO2							2	2	1	1					
CO3						1		3							
CO4						3	2	3	1	1			1		
CO5							3					3	1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1:MARKETING 9 Hours

Meaning - concept - functions - marketing Planning and implementation marketing Programmes - Marketing environment – Market Segmentation and consumer behaviour – Influencing factors, Decision process –Marketing mix – Marketing department

Unit 2:PRODUCT 9 Hours

Meaning - Product planning - policies - positioning - New product development Product life cycle – BCG Matrix - branding. Packing, labelling

Unit 3: PRICING 9 Hours

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit 4:DISTRIBUTION 9 Hours

Nature of Marketing channels - Types of Channel flows – Channel functions - Channel co-operation, conflict and competition - Direct Marketing Telemarketing, Internet shopping

Unit 5: PROMOTION 9 Hours

Promotion Mix - Advertisement - Message - copy writing – Advertisement - budgeting - Measuring advertisement effectiveness - Media strategy - sales promotion - Personal selling steps, publicity and direct marketing

Text Book(s)

1. Philip.T. Khotler, Kevin Lane Keller, Marketing Management, 15th Edition, Pearson Education, New Delhi, 2016.
2. Ramaswamy.VS, Namakumari. S, Marketing Management – Global Perspective, Indian Context, McGraw Hill, 2013

Reference(s)

1. Rajan Saxena, Dorector, Jain S.P., Marketing Management, McGraw Hill, 2006.
2. K.S. Chandrasekar, Marketing Management, Text and Cases, McGraw hill 2013.
3. Tapan K. Panda, Marketing Management Text and Cases, 2nd Edition, Excel Books.2008.

HSS015 MANAGEMENT CONCEPTS AND TECHNIQUES	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

This course addresses the definition of management, its characteristics, evolution and importance as well as the functions performed by manages-planning, organizing, directing and controlling. The course also intends to show students the applications of management functions in various enterprises such as marketing, finance, personnel, production, etc.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: To Explain the historical backdrop and fundamentals of Management thoughts vital for understanding the conceptual frame work of Management as a discipline.

CO2: To Discuss about the various concepts of planning, Decision making and controlling to help solving managerial problems

CO3: To Understanding concepts of Ethics, Delegation, Coordination and Team work

CO4: To Study and understand the management concepts and styles in Global context

CO5: To develop an understanding about emerging concepts in management thought and philosophy

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2						1	1		
CO2							2	2	1	1			1		
CO3						1		3	3	2			1		
CO4						3	2			1			1		
CO5							3					3	1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: DEVELOPMENT OF MANAGEMENT THOUGHTS 9 Hours

Scientific Management Movement - Administrative Movement - Human Relations Movement -Decision Movement - Behavioural Science Movement - Systems Movement - Contingency Movement.

Unit 2:ESSENTIALS OF PLANNING 9 Hours

Planning Objectives – Goals - Programmed Decisions and Unprogrammed Decisions; Decision – Making - Creativity in Decision - Making, Forecasting and Strategy to Formulation

Unit 3: EFFECTIVE ORGANISING 9 Hours

Span of Control – Departmentation - Authority; Responsibility - Bureaucracy and Adhocracy; Group Dynamics

Unit 4: STAFFING AND DIRECTING 9 Hours

Staffing: Manpower Planning – Recruitment Sources – Selection Procedure – Training Methods – Performance Evaluation Methods – Executive Development Programs - Directing: Communication Process and Barriers – Motivation Techniques – Financial and Non – Financial Motivation- Leadership Qualities and Styles

Unit 5: CONTROLLING AND RECENT CONCEPTS 9 Hours

Controlling: Meaning and Process - Requisites of Effective Control - Control Techniques. Emerging Issues in Management: Japanese and

American Management – Management by Objectives – Knowledge Management – Technology Management – Business Process Outsourcing- Social Responsibility and Business Ethics

Text Book(s)

1. Harold Koontz, Heinz Weihrich, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill, 2016
2. Stephen P. Robbins, Mary A. Coulter, Management, 13th Edition, Pearson Education Limited, New Delhi, 2016

Reference(s)

1. C.B.Gupta, Management Theory and Practice, 19^{th} Revised Edition, Sultan Chand and Sons.2017.
2. L.M.Prasad, Principles and Practices of Management, 9^{th} Edition, Sultan Chand and Sons, 2015.
3. K.Aswathappa, Essentials of Business Environment: Text Cases and Exercises 12^{th}, edition, Himalaya Publishing House, Mumbai, 2014.
4. Tripathi, Reddy, Principles of Management, 5^{th} Edition, McGraw Hill, 2012

<table>
<tr><td rowspan="3">HSS016 ORGANISATIONAL PSYCHOLOGY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective - Theory</td></tr>
</table>

Course Objective(s)

This course aims to clarify the principles and basic concepts of organizational psychology. Including organizations and understanding its business design based on efficiency and quality of employee life. It also aims at enhancing the quality of life of employees. When organization's aspects are gauged in terms of psychological assessment, personnel decisions in line with training and development, organizational change and organizational health in specific the intrinsic problems are understood paving way towards standards that are high.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: To learn basic concepts of industrial and organisational psychology
CO2: To illustrate different ways of achieving organisational effectiveness through individual behaviour.
CO3: To learn the concepts relating to individual behaviour to achieve group target and achieve leadership position in organisation.
CO4: To understand the organisational changes and means to evaluate based on nature of organisations.
CO5: To learn implications of changes aligning the interest of individual, group and organisation.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						2		1	2						
CO2						1		1	2	2					
CO3						1		1	2	3			1		
CO4						1	1	1	1	1					
CO5						1	1	1				1			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: FOCUS AND PURPOSE **9 Hours**

Organisational Behaviour - Need and importance, nature and scope, framework

Unit 2: INDIVIDUAL BEHAVIOUR **9 Hours**

Personality – types – factors influencing personality – theories – learning – types of learners – learning theories – organizational Behaviour modification. Attitudes – characteristics –components – formation – measurement. Perceptions – importance – factors influencing perception – interpersonal perception

Unit 3: GROUP BEHAVIOUR **9 Hours**

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit 4:LEADERSHIP **9 Hours**

Leadership styles – theories – Qualities - leaders Vs managers – sources of power – power centres – power and Organisational Politics- Motivation

Unit 5:ORGANISATIONAL DEVELOPMENT 9 Hours

Organizational development - Importance, characteristics, objectives, stability Vs change, proactive vs reaction change, the change process, resistance to change, managing change, team building - Organizational effectiveness, perspective, effectiveness Vs efficiency, approaches, the time dimension, achieving organizational effectiveness

Text Book(s)

1. Stephen Probing and Timothy A. Judge, Organisational Behavior, Peason Education, 17th edition, 2017.
2. Fred Luthans, Organisational Behavior, McGraw Education, 12th Edition, 2010

Reference(s)

1. Aswathappa, Organisational Behavior, Himalaya Publishing House, 12th edition, 2016.
2. P.Subba Rao, Management and Organisational behavior: Text, Cases and Games, Himalaya Publishing House, 1st edition, 2010.
3. Mullins, Organisational Behavior, Pearson Education Limited, 9th edition, 2010.
4. L.M.Prasad, Organisational Behavior, 5th edition, Sultan Chand and Sons, New Delhi, 2014.

HSS017 INTERNATIONAL ECONOMICS	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

- To learn, understand and apply economic theories of International Trade
- To understand the political economy of International Trade.
- To learn and understand the central issues in International Macro Economics

Course Outcome(s)

CO1: Understand trade laws, and the national and international institutions central to trade

CO2: Evaluate economic integration and conflicts across countries.

CO3: Evaluate strategic trade policies from the perspective of nations and companies.

CO4: Explain how exchange rate is determined in the long run and the short run.

CO5: Analyze interpret a nation's balance of payments and related accounts.

CO6: Explain the effectiveness of national macroeconomic policy in an interdependent

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3		2				3	2		
CO2						2	1	3							
CO3							1				1		1		
CO4								2		1			2		
CO5	1						3				2	3	2		
CO6						2		2		1		3	2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INTRODUCTION

The Traditional Theory of International Trade, The Basic Trade Model, Heckscher-Ohlin-Samuelson Model, Effects of Tariffs & Quotas, Theory of Factor Movements - New Theories of International Trade and Industrial Policies.

EXCHANGE RATE & BALANCE OF PAYMENT

The Balance of Payments and National Accounts, Determinants of Exchange Rates The Exchange-Rate Regime Choice and a Common Currency Area, International Debt and Currency Crises.

INTERNATIONAL REGULATORY AUTHORITY

Political Economy of Trade Disputes, the FTA and the WTO - The role of the IMF and other International Financial Organizations.

Reasons for Protection World Trade, International Movements of Capital - The Balance of Trade and Other Measures of International

Transactions. Export and import policies.

INTERNATIONAL MACROECONOMICS

European Monetary Unification and the Euro - Preferential Trading Arrangements and the NAFTA International Policies for Economic Development, Trade Outsourcing and Off shoring

REFERENCES

1. Bhagwati N., A. Panagariya and T. N. Srinivasan, Lectures on International Trade, MIT Press, 2nd edition, 1998.
2. Obstfeld M., and K. Rogoff, Foundation of International Macroeconomics, McGraw-Hill, 1996.
3. Romer, D., Advanced Macroeconomics, McGraw Hill, 1996.

HSS018 COMMUNICATION SKILLS	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

- The objective of this course is to improve the communication skills.

Course Outcome(s)

CO1: Everyday dilemmas within dimensions (ethical, social, legal, technological, relational, and cultural) central to the student's major focus.

CO2: Demonstrate oral and written communication skills expected of a future professional inthe field**.**

CO3: Demonstrate communication research skills expected of a future professional in the field.

CO4: Demonstrate understanding of ethical values central to the communication discipline.

CO5: Demonstrate the ability to integrate communication and business scholarship for application in work settings.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2				3	2				
CO2										3					
CO3										3		1			
CO4								3	2	3					
CO5							1			3	2				

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

COMMUNICATION IN BUSINESS

Systems approach, forms of business communication, management and communication, factors facilitating communication.

COMMUNICATION PROCESS

Interpersonal perception, selective attention, feedback, variables, listening barriers to listening, persuasion, attending and conducting interviews, participating in discussions, debates and conferences, presentation skills, paralinguistic features, oral fluency development.

BUSINESS CORRESPONDENCE

Business letter. Memos, minutes, agendas, enquiries, orders, sales letters, notice, tenders, letters of application, letter of complaints.

TECHNICAL REPORTS

Format, Choice of vocabulary, coherence and cohesion, paragraph writing, organization.

PROJECT REPORTS

Project proposal, project reports, and appraisal reports.

REFERENCES

1. Sharan J.Genrson and Steven M.Gerson, Technical Writing - Process and Product, Pearson Education, 2000.
2. Raymond V.Lesikar, John D. Pettit and Mary E.Flatley, Lesikass Basic Communication, Tata McGraw Will, 8th Edition, 1999.
3. Stevel. E. Pauley, Daniel G.Riordan, Technical Report Writing Today, AITBS Publishing & Distributors, India 5th edition, 2000.
4. Robert L.Shurter, Effective letters in business, Third Ed., 1983.
5. McGraith, Basic Managerial Skills for all Prentice Hall of India, 6th Edition, 2002.
6. Halliday, M.A.Ky R.Hasan, Cohesion in English, Longman, London, 1976.

HSS019 Operations Research	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective - Theory				

Course Objective(s)

It is essential for professionals in any field to understand the ethical problems and principles in their field. The general principles of professional ethics will be examined, as well as the distinctive problems. This course is presented in three parts: theory; case studies; and research and presentation. Theory includes ethics and philosophy of engineering.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: Identify and develop operational research models from the verbal description of the real System.

CO2: Build and solve Transportation Models and Assignment Models

CO3: Use mathematical software to solve the proposed models.

CO4: Develop a report that describes the model and the solving technique, analyse theresults and propose recommendations in language understandable to the decision-making processes in Management Engineering.

CO5: Design new simple models, like: CPM, MSPT to improve decision – making and develop critical thinking and objective analysis of decision problems

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2			2	2		3			1		2		
CO2		1	3	2	2								2		
CO3	2	3	2		3								3		3
CO4		2	3		3								3	3	3
CO5	2	3	3		3								2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: LINEAR PROGRAMMING BASICS 9 Hours

Introduction to applications of operations research in functional areas of management - Linear Programming - formulation, solution by graphical and simplex methods (Primal - Penalty, Two Phase), Special cases - Dual simplex method

Unit 2: TRANSPORTATION MODELS AND ASSIGNMENT MODELS 9 Hours

Transportation Models (Minimising and Maximising Cases) – Balanced and unbalanced cases – Initial Basic feasible solution by N-W Corner Rule, Least cost and Vogel’s approximation methods - Check for optimality - Solution by MODI / Stepping Stone method - Cases of degeneracy - Transhipment Models - Assignment Models (Minimising and Maximising Cases) – Balanced and Unbalanced Cases - Solution by Hungarian and Branch and Bound Algorithms - Travelling Salesman problem - Crew Assignment Models.

Unit 3: INTEGER LINEAR PROGRAMMING AND GAME THEORY 9 Hours

Solution to pure and mixed integer programming problem by Branch and Bound and cutting plane algorithms - Game Theory - Two Person Zero sum games - Saddle point, Dominance Rule, graphical and LP solutions.

Unit 4: REPLACEMENT MODELS AND DECISION THEORY 9 Hours

Replacement Models-Individuals Replacement Models (With and without time value of money) – Group Replacement Models - Decision making under risk – Decision trees – Decision making under uncertainty-Hurwicz criterion-Expected Monetary Value criterion-Expected Value of Perfect Information(E.V.P. I.)

Unit 5: PROJECT MANAGEMENT METHOD AND SIMULATION
9 Hours

PERT / CPM – Drawing the network, computation of processing time, floats and critical path. Resource levelling techniques - Application of simulation techniques for decision making

Text Book(s)

1. Kalavathy S, Operations Research, Vikas Publishing House, 4TH Edition, 2013.
2. Paneerselvam R., Operations Research, Prentice Hall of India, 2ND Edition, 2006.
3. Tulsian P.C, Vishal Pandey, Quantitative Techniques (Theory and Problems), Pearson Education, Asia, First Indian Reprint 2002.

Reference(s)

1. D.S.Hira, Problems in Operations Research, Kindle Edition, S.Chand, 2010.
2. Prem Kumar Gupta and D.S. Hira, Operations Research,S.Chand, 2016.
3. R.C.Mishra,Principles of Operations Research, 1st Edition, New Age International 2011.
4. Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, 15th Edition, Sultan Chand and Sons 2010

HSS020 HUMAN RESOURCE MANAGEMENT	**Credits**			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Course Category: Humanities Elective – Theory				

Course Objective(s)

This course aims at exploring key issues related to the management, performance, and development of human resources in the workplace. It places special emphasis on making decisions and developing plans that will enable managers to make the best possible use of their human resources, and covers areas such as: manpower planning, analysis and evaluation, recruitment and selection, wages and salaries, training and management development, performance appraisal, and industrial relations.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: To provide the basic knowledge on developing the employment relations and knowledge to resolve the issues.

CO2: To design an appropriate and suitable role of HR specialist for implementing Human Resource Management policies.

CO3: To Manage the manpower to motivate and attract them to retain in the organization.

CO4: To Develop the responsibility of employer and legal system to manage the employment relations

CO5: To Provide more insights on the applicability of business law on various functional domains this in turn enhances a strong human relation

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							1	1	2						
CO2									2	2					
CO3									3	3					
CO4						1		1	1						
CO5						1	1	1	3						

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: FUNDAMENTALS OF HRM 9 Hours

Human Resource Development Systems-HR environment in India-Functions and Operations of a Personnel Office - Emerging HR Trends - HR information system

Unit 2: HRM FUNCTIONS 9 Hours

Job analysis and job design - HR planning – Recruitment - selection and induction- Staff Training and Development-Career planning and Development- Job Evaluation-Performance Appraisal and Potential Evaluation-Wage determination; salary structure-Wage policies and Regulations-Employee benefits and services.

Unit 3: MOTIVATING HUMAN RESOURCES 9 Hours

Team and Team work - Collective Bargaining Employee Morale – Participative Management – Quality Circle – Empowerment –counselling and mentoring

Unit 4: MAINTENANCE OF WORKERS 9 Hours

Compensation Management- Reward system – Labour relations – Employee Welfare, Safety and Health – Employee benefits and services – Promotion, Transfers and separation – Ethical issues in HR Management and International Human Resource Management - Legal Aspect of Labour

Unit 5: BUSINESS LAW 9 Hours

Factories Act, 1948 - Industrial Dispute Act, 1947 – Industrial employment – Standing Orders Act, 1946 – Trade Union Act, 1926 - Workmen Compensation Act, 1923, Employees State Insurance Act, 1948, Employees Provident Fund and Miscellaneous Provision Act, 1952, Payment of Gratuity Act, 1972. Payment of Wages Act 1936, Minimum wages Act, 1948– Payment of Bonus Act, 1965.Tamil Nadu Shops and Establishments Act.

Text Book(s)

1. Decenzo and Robbins, Human Resource Management, Wiley, 12th edition, 2015.
2. Prasad L.M., Human Resource Management, Sultan Chand, 2014.

Reference(s)

1. Biswajeet Pattanayak, Human Resource Management, 3rd edition, Eastern Economy Edition, New Delhi, 2010.
2. C.B. Gupta, Human Resource Management, 13th Edition, Sultan Chand
3. V.S.P. Rao, Human Resource Management, 3rd edition, Excel Books.
4. Frank B. Cross and Roger LeRoy Miller, The Legal Environment of Business Text and cases, 9th Edition, Cengage Learning, 2015.

<table>
<tr><td rowspan="3">HSS022 BANKING THEORY AND PRACTICE</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective - Theory</td></tr>
</table>

Course Objective(s)

- To introduce students to theories and research at individual, group and banking levels

- To improve your ability to work with and through other people.

Course Outcome(s)

CO1: Evaluate the Central Banking functions, Reserve Bank control over banks

CO2: Understanding of personnel customer accounts, duties and relationship

CO3: Understand the RBI control over loans and Securities

CO4: Student able to understand banking Agencies services

CO5: Student able to understand the deficiency in banking services.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						3						2	1		
CO2						3						2	1		
CO3						3		3				3	1		
CO4						2						2	2		
CO5						2		1				2	2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: EVOLUTION OF BANKING SYSTEM

Central Banking functions, Reserve Bank control over banks.

Unit 2: BANKER - CUSTOMER RELATIONSHIP

Bank as borrowers, customer accounts, duties of paying and collecting bankers.

Unit 3: LENDING BY BANKS

RBI control over loans and advances, Securities for loans.

Unit 4: AGENCY SERVICES BY BANKS

Banker as bailee, safe deposit vaults, credit cards.

Unit 5: CONSUMERS OF BANKING SERVICES

Protection against deficiency in banking services.

REFERENCES

1. M.L.Tannan, Tannan's Banking Law and Practice in India, India Law House, New Delhi, 1997.
2. S.N.Gupta, The Banking Law in theory and Practice Vol. I & II, Universal Law Publishing Co., 1999.
3. M.S.Parthasarathy, Banking Law-Leading Indian Cases, N.M.Tripathi, 1985.
4. L.C.Goyle, Law of Banking and Bankers, Eastern Law House, 1995.

<table>
<tr><td rowspan="3">HSS023 ENTREPRENEURSHIP DEVELOPMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Course Category: Humanities Elective - Theory</td></tr>
</table>

Course Objective(s)

This course focuses on the entrepreneurial process and the different kinds of entrepreneurial outcomes. Topics covered include opportunity identification through analysis of industry niches, skills needed to turn an opportunity into reality, business plans, launch decisions, and obtaining risk capital. This course deals with the problems and challenges facing the management of businesses in raising funds, marketing products and services, improving effectiveness and flexibility, and achieving growth.

Course Outcome(s)

After completing this course, the student will be able to:

CO1: It provides more insights into the concept of entrepreneurship and which in turn leads to think creatively for new business opportunities to sustain individual as well as social goals.

CO2: It provides and promotes entrepreneurial spirit and provides a framework of successful business world with relation to agencies to promote employment opportunities.

CO3: It focuses on women entrepreneurship and promotes a successful business models and explains operational implementations for investment details.

CO4: It provides the role of government in promoting the entrepreneurship among the individuals and organizations as a whole

CO5: To Understand emerging concepts of marketing in the emerging global markets and provide more insights into project management and venture promotion

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						3	1	1	2	1		1	2		
CO2						1		1	1				1		
CO3						2		2	2				1		
CO4								1	3	1			1		
CO5							3				1	3	1		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Unit 1: BASICS **9 Hours**

Concepts of entrepreneur, entrepreneurship and entrepreneur - Characteristics and competencies of a successful entrepreneur - General functions of an entrepreneur - Type of entrepreneurs - Role of entrepreneur in economic development - Distinction between an entrepreneur and a manager - Entrepreneur and Intrapreneur

Unit 2: GROWTH OF ENTREPRENEURSHIP **9 Hours**

Emergence of entrepreneurship - Economic and non-economic factors for stimulating entrepreneurship development - Obstacles to entrepreneurship development in India - Growth of entrepreneurship in India.

Unit 3: WOMEN AND ENTREPRENEURSHIP **9 Hours**

Concept of women entrepreneurship - Reasons for growth of woman entrepreneurship - Problems faced by them and remedial measures

Unit 4:ROLE OF THE GOVERNMENT IN ENTREPRENEURSHIP DEVELOPMENT **9 Hours**

Concept and meaning of entrepreneurship development - Need for entrepreneurship development programmes (EDPs) - Objectives of EDPs - Organizations for EDPs in India; NIESBUD, SISI – their roles and activities.

Unit 5: VENTURE PROMOTION AND PROJECT FORMULATION **9 Hours**

Concept of projects classification of projects and project report - Project identification and selection - Constraints in project identification - Techniques of Project Identification, Significance – contents - formulation of project report - Need for Project Formulation - Elements of project Formulation

Text Book(s)

1. Michael H Morris, Corporate Entrepreneurship and Innovation in Corporations, 7th Edition, CENGAGE Learning, Delhi, 2010
2. Jerry Katz, Entrepreneurship Small Business, 5th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007

Reference(s)

1. Khanka S.S., Entrepreneurial Development, 1st edition, S. Chand and Company Limited, New Delhi, 2013.
2. Prasama Chandra, Projects: Planning, Analysis, Selection, Implementation and Reviews, 2nd edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1996.
3. Robert D. Hisrich, Entrepreneurship, 10th edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.

HSS031 ENGLISH ADVANCE LEVEL	Credits			
	L	T	P	Total
	3	0	0	3
Course Category: Humanities Elective - Theory				

Course Objective(s)

- Acquisition of higher order Language skills: Style, Idiom, Nuance. Literature appreciation

Course Outcomes

CO1: Develop skills in writing level
CO2: Develop skills in reading and oral.

Mapping of Course Outcome(s)

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1						1		1		3		2			
CO2						2		1		3		2			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Writing: Essays, Reports,

Reading: Select Literary Texts: Prose, Poetry, Drama, Short Stories, Book Review, Oral Skills : Presentations; Discussions

Reference(s)

1. Cambridge Advanced Learners' Dictionary 2005.
2. Palgrave's Golden Treasury: Ed. Palgrave, Frances Taylor London: Oxford University Press, 1861.
3. 20th Century English Literature, London: Penquin 1992.
4. The Garden of Forking Paths and other stories : Harris, V.C. New Delhi: Oxford University Press, 2002.
5. Discussion Materials: Film / News Clippings, Plays etc.

ONE CREDIT COURSES

<table>
<tr><td colspan="2" rowspan="3">MECX001 NON DESTRUCTIVE TESTING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basic knowledge in mechanical testing, material characterization and defects</td><td colspan="5">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

By the end of this course you should become familiar with a wide variety of Non-destructive testing techniques for use in design, manufacturing and industrial service. You will able to know how each technique works, how you can apply it, when and where it can be used and the technique's capabilities and limitations. You will also be able to take an industrial NDT problem and determine which technique is best suited for the job, how you apply such technique and which information the technique will provide.

Course Outcome(s)

CO1: Ability to classify various NDT techniques and to summarize the radiography method

CO2: Capability to classify the ultra-sonic inspection and to identify its applications in industrial problems

CO3: Ability to demonstrate the magnetic particle test method and to test the surface discontinuity

CO4: Capacity to apply dye penetrant test to inspect surface defects
CO5: Ability to identify suitable NDT method for particular industrial problems.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1		**2**						**2**				
CO2		**3**	**3**		**2**			**3**	**3**		**2**	
CO3	**2**	**2**			**3**		**2**	**2**			**3**	
CO4				**3**						**3**		
CO5			**3**						**3**			

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Introduction and Radiography

Introduction to NDT – need – advantages and limitations Radiography – Sources – IR192, cobalt 60 – X-ray film – processing – testing methods – film interpretation

Ultrasonic testing

A,B,C scan, immersion Testing, Normal and Angle Probe Testing

Magnetic particle Testing

Methods – particles - wet, dry and fluorescent

Dye penetrant testing

Surface preparation –Testing procedure - types of penetrant

Other NDT methods

Thermography, Image processing TOFD and Phased Array - leak testing – Halogen, Helium

REFERENCES

1. Barry Hull and Vernon John, Non Destructive Testing, MacMillan, 1988.
2. Non-Destructive Test and Evaluation of Materials by J Prasad , C. G. Krishnadas Nair, McGraw Hill Education (India) Private Limited; 2 edition Non-Destructive Testing Techniques by Ravi Prakash, New Age International Pvt Ltd Publishers; Revised edition (1 December 2010)

<table>
<tr><td rowspan="3">MECX002 ADVANCED WELDING PROCESSES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basic knowledge in mechanical testing, material characterization and defects</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To understand the concept of advanced welding techniques.
- To know the welding geometry, welding joint and its application.
- To apply the recent welding techniques in various manufacturing engineering area.
- To enable the students, how to rectify the welding defects with latest technology.

Course Outcome(s)

CO1: Demonstrate the welding principle, safety equipments, handling procedures

CO2: Ability to understand the welding geometry, perform the welding joint as per design geometry construction and know the type of weld joints

CO3: Explain the principles and application of advanced fusion welding processes

CO4: Infer the principle and application of advanced solid state welding

CO5: Contrast the welding defects with latest technology and know how to prevent the defects

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2	2									
CO2	2	2				2						
CO3	3	1	2									
CO4	2	2	2	3								
CO5	3	2	1	2		2						

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INTRODUCTION AND SAFETY

Introduction to Welding – importance – recent technologies, Safe handling of machines and gases – tools and equipments

GEOMETRY

Welding Geometry – grooves – types – weld joints

ADVANCED FUSION WELDING PROCESSES

Electron beam welding, laser beam welding, plasma arc welding, Interpulse TIG welding, Cold metal transfer welding

ADVANCED SOLID STATE WELDING PROCESSES Diffusion Bonding, Friction stir welding, friction stir spot welding **DEFECTS** Welding defects – types – causes – remedial action

TEXT BOOKS

1. William A Bowditch, Welding Technology Fundamentals, Good Heart Willcox Publishers, 2006.

REFERENCES

1. Howard B Cary, "Modern Welding technology", Prentice Hall, New Jersy, 2002.
2. William A Bowditch, Welding Technology Fundamentals, Good Heart Willcox Publishers, 2006.
3. AWS Welding Handbook, Vol 1 & Vol 2, AWS New York, 1997.
4. Lancaster J F, " Metallurgy of Welding", George Allen Co, Boston, 1980

MECX003 CNC PROGRAMMING		**Credits**			
		L	**T**	**P**	**Total**
		1	**0**	**0**	**1**
Pre-requisite : Knowledge about the machining parameters	**Course Category:** One credit course **Course Type:** Theory				

Course Objective(s)

- To learn the various types of modern CNC machines and CNC modes of operation
- To understand the fundamentals of part programming in terms of various steps needed to be taken for completing a successful CNC program

- To understand the different preparatory (G codes) and miscellaneous functions (Mcodes) as used in CNC programming.

Course Outcome(s)

CO1: Able to compare and analyze the industrial requirements in CNC programming

CO2: Able to imagine and develop to write program based on the industrial needs

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1			3						2			
CO2					3					2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

CNC MACHINES

Numerical control – definition – components of NC systems, Development of NC, DNC, CNC, and adaptive control systems, Working principle of a CNC system, features and advantages of CNC machine Introduction to CNC systems - fanuc oi, siemens 840D, Heidenhein, current trends in programming, Human Machine Interface software – siemens – fanuc systems

CNC HARDWARE SYSTEM

CNC system elements, Drives, Slide ways, Feedback devices, ATC and Tool Magazines, and Machine Control Units

CNC PART PROGRAMMING

Part program structure, CNC program procedure – coordinate system, Sequence number, preparatory functions and G codes, miscellaneous functions and M codes, NC dimensioning – reference points – machine zero, work zero, tool zero and tool offsets, Types of motion control: point-to-point, paraxial and contouring Part Program – tool information – speed – feed data – interpolations, Macro – subroutines – canned cycles - Mirror images – thread cutting, Sample programs for lathe and milling, Conversational automatic programming, and APT programming-Introduction to Computer assisted part programming – EdgeCAM, Master CAM etc.,

REFERENCES

1. CAD/CAM/CIM, R.Radhakrishnan, S.Subramanian, V.Raju, 2nd, 2003, New Age International Pvt. Ltd.
2. CAD/CAM, Mikell P.Groover, Emory Zimmers Jr. Indian Reprint Oct 1993, Prantice Hall of India Pvt., Ltd.
3. S.K.Sinha, NC Programming, I Edition, 2001, Galgotia Publications Pvt. Ltd.
4. Dr.P.N.Rao, CAD/CAM Principles and Applications, 2002, Tata Mc Graw Hill Publishing Company Ltd.
5. Ibrahim Zeid, Mastering CAD/CAM, Special Indian Edition 2007, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

<table>
<tr><td colspan="2" rowspan="3">MECX004 PLASTIC PROCESSING TECHNOLOGY</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basic knowledge in manufacturing processes.</td><td colspan="5">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To describe the knowledge about the injection, blow, extrusion and compression moulding process.

Course Outcome(s)

CO1: Describe the process and considerations of injection moulding.

CO2: Explain the terminologies of blow moulding process.

CO3: Illustrate the principles and types of extrusion and compression moulding.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	2	1									
CO2	2	2	1									
CO3	2	2	1									

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

INJECTION MOULDING

Terminology – Process description- Theory of injection moulding – Design and consideration -moulding cycle —Trouble shooting operations. Types Injection unit & Elements of plastication process – Classification of screw – Screw design – Process control – Clamping unit.

BLOW MOULDING

Terminology – Basis in blow moulding - Process variables – Injection & stretch blow moulding – Single and multi layer. Extrusion blow moulding – Extrusion heads, moulding process controls for blow moulding – Machine, process and product controls. Thermoforming –Thermoforming machinery – Heating of sheet – Heating cycle - Stretching – Concept – Heat balance – Shrinkage –Trimming operations.

EXTRUSION AND COMPRESSION MOULDING

Principle – Types of Extruders – Single screw and twin-screw extruders – Metering – Screw Design - process control variables – Types of dies –Extrusion of Pipes- Extrusion profiles – Extrusion line for cable industry – Blown films – Flat film- Cast film - sheet film.

Types and procedure machinery and equipment moulding of thermoplastics – moulding of Thermosets - Transfer moulding advantages – Limitations- Rotational moulding – types of machines moulds – materials.

REFERENCES

1. Manas Chanda, Salil.K.Roy, Plastic Technology handbook. – CRC Press, Third edition 1998.
2. V. Rosato Kluwer, Injection moulding handbook. - Academic Publishers Boston 2nd edition 1995.
3. Richard C. Progelhof James. L. Throne, Polymer Engineering Principles, Hanser Publisher Munich 1993.
4. N.P. Charemisinoff & P.N. Chere, Handbook of applied Polymer processing Technology, Marcel Dekker Inc, NY 1996.
5. Herbert Rees, Understanding of Injection moulding Technology, Hanser Publications, Munich 1994
6. Vishu Shah, “Handbook of Plastics testing and Failure Analysis” — 3rd edition. John Wiley, NY, 2007.

<table>
<tr><td rowspan="3">MECX005 REVERSE ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Engineering drawing / and Machine Drawing Practice Laboratory</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- By the end of this course, student familiar with reverse engineering concepts and able to understand the database management of reverse engineering.

Course Outcome(s)

CO1: Explain the concept of reverse engineering and construction of model.

CO2: Develop the database management for reverse engineering

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	2	2								
CO2	3	3	2	2								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software’s and its application – CMM and its feature capturing – surface and solid modeling.

Data Management - Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

Text Books

1. Wego Wang, Reverse Engineering: Technology of Reinvention, CRC Press, 2010.
2. Linda M. Wills, Philip Newcomb, Reverse Engineering, KLuwer

Academic Publications, 1996.

MECX006 ADDITIVE MANUFACTURING	**Credits**			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite : Basic knowledge in manufacturing processes.	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- By the end of this course, student familiar with Sintering and Stereolithography

Course Outcome(s)

CO1: Explain the concept of sintering and three-dimensional technology.
CO2: Demonstrate the Stereolithography and laminated manufacturing.

Mapping of Course Outcome(s)

CO / PO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	3	2								
CO2	3	2	3	2								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Text Books

1. T.S. Srivatsan, T.S. Sudarshan, Additive Manufacturing: Innovations, Advances, and Applications, CRC Press, 2016.
2. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct digital manufacturing, Springer, 2015

MECX007 INTRODUCTION TO BASIC INSTRUMENTATION	**Credits**			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite : Basic knowledge in basic measuring instrument.	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- By the end of this course, student familiar with sensors and transducer and PLC.

Course Outcome(s)

CO1: Demonstrate the measuring concept of sensors and transducer.
CO2: Explain the basics of programmable logic controllers.

Mapping of Course Outcome(s)

CO / PO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	3	2								
CO2	3	2	3	2								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

SENSORS AND TRANSDUCERS

Introduction - Performance Terminology – Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.

PROGRAMMABLE LOGIC CONTROLLERS

Introduction - Basic structure - Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC

Text Books

1. D. Patranabi, Sensors And Tranducers, PHI Learning Pvt. Ltd, 2003.
2. William Bolton, Programmable Logic Controllers, Newnes, 2015.

MECX008 SUPPLY CHAIN MANAGEMENT	Credits			
	L	T	P	Total
	1	0	0	1
Pre-requisite : Basics Materials Management	**Course Category:** One credit course **Course Type:** Theory			

Course objective(s)

To study about the basics and implication of supply chain management.

Course Outcome(s)

CO1: Understanding of Supply chain management
CO2: To explore the various scopes in Inventory management.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3		2		1		1		2	2	1	
CO2	3	3	2	2			1				1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Introduction to supply chain management, Definition, Objectives of SCM. Logistics networks, Inventory management, Introduction, single warehouse, inventory examples, economic lot size model, effect of demand uncertainty. Risk pooling, centralized and decentralized system, managing inventory in the supply chain, forecasting.

Value of information, Bullwhip effect, information and supply chain technology. Supply chain integration- push, pull and push-pull system. Demand driven strategies, impact of internet on SCM, distribution strategies, DSS for supply chain management.

Strategic alliances, Framework for strategic alliance, third party logistics, retailer, supplies partnership, distributor integration, procurement and out servicing strategies.

Text Books

1. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith, "Designing and Managing the Supply Chain", Tata McGraw- Hill, New Delhi, 2003.

REFERENCES

1. Chopra S and Meindl P, "Supply Chain Management: Strategy, Planning, and Operation", Prentice Hall India Pvt. Ltd, New Delhi.
2. Robert B Handfield and Ernest L Nichols, "Introduction to Supply Chain Management", Prentice Hall, Inc. New Delhi, 1999.
3. Sahay B S, "Supply Chain Management", Macmillan Company, 2000.
4. David Brunt and David Taylor, "Manufacturing Operations and Supply Chain Management: The Lean Approach", Vikas Publishing House, New Delhi, 2001.
5. Hartmud Stadler and Christoph Kilger, "Supply Chain Management and Advanced Planning: Concepts, Models, Software", Springer-Verlag, 2000.
6. David F Ross, "Introduction to E-Supply Chain Management", CRC Press, 2003.

<table>
<tr><td rowspan="3" colspan="2">MECX009 TOTAL PREVENTIVE MAINTENANCE</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basics and need for maintenance</td><td colspan="5">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To study various maintenance concepts in industrial cases
- To understand the need and implication of maintenance

Course Outcome(s)

CO1: Understanding of the importance of maintenance.

CO2: Apply various concepts of maintenance.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	2			1	1			2	1	
CO2	3	2		2			1			2	1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Maintenance Concepts, Objectives and functions, Reliability Centered Maintenance, (RCM), Maintenance types, balancing preventive maintenance and breakdown maintenance, preventive maintenance schedules: deviations on target values, preventive maintenance schedules: functional characteristics, replacement models.

TPM Concepts. Importance of TPM, Zero breakdown concepts, Zero Defects and TPM, maximizing equipment effectiveness, autonomous maintenance program, five pillars of TPM, TPM Small group activities.

TPM Planning and Implementation, Organization for TPM, management decision, awareness and training for TPM, establishment of basic policies and goals, formation of master plan, TPM implementation, Ongoing global trends in TPM.

Text Books

1. Introduction to TPM, Seiichi Nakajima, Productivity Press, Chennai.
2. Maintenance and Spare Parts Management,Gopalakrishnan, P, Banerji, A.K., Prentice – Hall of India Pvt. Ltd.

REFERENCES

1. Equipment planning for TPM Maintenance Prevention Design, Goto F, Productivity Press.
2. Total Productive Maintenance for Workshop Leaders, Shirose K., Productivity Press.
3. TPM for Operators,Shirose, K., Productivity Press.
4. New Directions for TPM, Suzuki, T., Productivity Press.
5. Maintenance Planning and Control, Kelly, A, Butterworth, London.

<table>
<tr><td rowspan="3">MECX010 QUALITY, RELIABILITY AND SAFETY ENGINEERING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basics of quality concepts</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To know the importance of quality and its related benefits
- To know the various concepts in reliability and safety engineering

Course Outcome(s)

CO1: Understand the basic concepts of quality and reliability in engineering.

CO2: Analyze the failure mode and effects of the product**.**

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	2		3	2			1				1	
CO2	2	3	2	2			1				1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Principles of TQM – Quality Gurus and their contributions – Old and New Quality Control tools - Quality Function Deployment -Failure Modes and Effect Analysis

Vendor relations –Vendor qualification process – vendor quality surveys – Vendor quality improvement – vendor quality rating and evaluation -ISO 9000 standards – ISO 14000 standards

Quality Costing –Audit – Product and Process audit – Six Sigma –

Benchmarking – TQM in Service Sector–Application case studies on TQM.

REFERENCES

1. Dale H.Besterfield, “Total Quality Management”, Pearson Education Asia, (Indian reprint 2002)
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, PHI 1993.

4. Greg Bounds, Lyle Yorks et al, Beyond Total Quality Management, McGraw Hill,1994.

MECX011 VALUE ENGINEERING	Credits			
	L	T	P	Total
	1	0	0	1
Pre-requisite Basics of planning and costing	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- To understand the basic concepts of value engineering
- To know the importance of value analysis and decision making

Course Outcome(s)

CO1: Understanding of value engineering.
CO2: To understand the need of value analysis in production environment**.**

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	2	2			1				1	
CO2	3	3	2	2			1				1	

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topics

Value Engineering - Definition, Concepts and approaches – evaluation of VE.

Evaluation of function, Problem setting system, problem solving system, setting and solving management-decision – type and services problem, evaluation of value. Results accelerators, Basic steps in using the systems

Value analysis - Understanding the decision environment, Effect of value analysis on other work in the business. Value engineering case studies, Function Analysis System Techniques-FAST diagram.

TEXT BOOK

1. Parker,D.E.,” Value Engineering Theory”, Sundaram publishsers, 1990.

REFERENCES

1. Miles, L.D., "Techniques of Value Engineering and Analysis", McGraw Hill Book Co., 2nd End., 1972
2. Tufty Herald, G."Compendium on Value Engineering", The Indo American Society, 1st Edn., 1983.

<table>
<tr><td rowspan="3">MECX012 ADVANCED MANUFACTURING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Basics of manufacturing concepts</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To know the various aspects of recent manufacturing techniques
- To discuss and apply the modern manufacturing concepts

Course Outcome(s)

CO1: Understanding of shop floor automation process.
CO2: Understanding of CMS, FMS, JIT, Lean Manufacturing System.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	2		3	2			1			2		
CO2	2		3	2			1			2		

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Automation of manufacturing process -– material handling and movement - Industrial robots - Sensor technology - flexible fixtures – Design for assembly, disassembly and service.

Part families Production flow analysis, Components of FMS Planning, scheduling and control of FMS System issues - Types of software - specification and selection – Trends Characteristics of JIT --

work station loads – close supplier ties – flexible work force - line preventive maintenance – Kanban system - strategic implications - implementation issues - Lean manufacture.

TEXT BOOK

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.

REFERENCES

1. S.Kalpakjian and S.R.Schmid, (2004), Manufacturing Engineering and Technology, 4th Edition, Pearson Education (Singapore) Pvt Ltd.
2. Taiichi Ohno, Toyota, “Production System Beyond Large-Scale production ", Productivity Press (India) Pvt.Ltd. 1992.
3. John Nicholas, (2008), Competitive Manufacturing Management, Tata McGraw Hill, New Delhi.
4. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.

<table>
<tr><td rowspan="3">MECX013 ADVANCED INSTRUMENTATION</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Thermodynamics, Thermal engineering and Heat Transfer</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To learn different types of instruments used in heat transfer applications and perform the error analysis

Course Outcome(s)

CO1: Identify the instruments used for temperature measurement and select the suitable one for the application

CO2: Perform error analysis for the experimentation**.**

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3	3	2							3
CO2	3	3	1	1								1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Instruments for temperature measurement

Temperature Measurements in high temperature gases – Calorimetric electrostatic, radiation, cyclic, transient pressure and heat flux probes– Spectroscopic methods – Cooled film sensors – Temperature measurement in cryogenics – Scales of measurement – Thermocouple, resistance and magnetic thermometry.

Error estimation

Error estimates in Temperature measurements – Solids and fluids – Radiation effects – Platinum resistance thermometers – Construction and usage – Calibration – Bridges – Fluid pressure measurement – Capacitive probes – Piezoelectric pressure sensors – Anemometry.

REFERENCES

1. E.R.G. Eckert and R.J Goldstein; Measurements in Heat Transfer, McGraw Hill, 1976.
2. J.P. Holman: Experimental Methods for engineers, McGraw Hill, 1971.
3. E.O. Doebelin: Measurements Systems: Application and Design.
4. T. G. Beekwith and L.M. Buck: Mechanical measurements, Adison-Wesley, 1965.
5. Barney; Intelligent Instrumentation, Printice Hall, 1988.

<table>
<tr><td rowspan="3">MECX014 DESIGN OF HEAT EXCHANGER</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Knowledge in Heat Transfer</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To study the basic principles and design heat exchangers.

Course Outcome(s)

CO1: Explain the basic principles in designing the heat exchangers

CO2: Elaborate the methods used for designing the heat exchanger and design a heat exchanger.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3	3	3							3
CO2	3	3	3	3	3							3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

BASICS PRINCIPLE IN DESIGN

Introduction to Heat Exchangers, Classification of Heat Exchangers, Direct transfer type, Storage type, direct contact type, Tubular, Plate and Extended surface H.Es, Basic Thermal and Hydraulic Relations in Heat Exchangers Design, Basic Principles of Thermal Design.

DESIGN METHODS

The effectiveness-NTU Method, Thermal Hydraulic correlations for H.E Design, Shell side flow correlation, The tube side correlations, Thermal Design of Shell and Tube H.Es, Effects of fouling, Design of Condensers and Evaporators, Types and choice of a condenser/evaporators, Heat Transfer coefficient.

REFERENCES

1. A. P. Fraas and M.N.Ozisik, Heat exchanger Design, Wiley New York. 1989.
2. G. Walker, Industrial Heat Exchangers-A Basic Guide, McGraw-Hill, New York. 1973.
3. J.P.Gupta Fundamentals of heat exchanger and pressure vessel technology, Hemisphere publishing company, Washington. 1986.
4. Tubular exchange manufacturers' Association, TEMA standards, 1982.

<table>
<tr><td rowspan="3">MECX015 DESIGN OF WIND TURBINES</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Knowledge in Renewable Energy Techniques</td><td colspan="4">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To study the concepts of design and installation of wind turbines.

Course Outcome(s)

CO1: Design the various components of wind turbine

CO2: Explain the Procedure in installing a wind turbine**.**

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3	3	3							3
CO2	3	1	1	2	2							3

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Component design

Blades, Pitch Bearings, Rotor Hub, Gearbox, Generator, Mechanical Brake, Yaw Drive, Tower, Foundations.

Wind-turbine Installations

Project Development, Visual and Landscape Assessment, Noise, Electromagnetic Interference, Finance.

REFERENCES

1. T. Burton, N. Jenkins, D. Sharpe, E. Bossanyi, Wind Energy Handbook, Wiley, 2011.
2. J. F. Manwell, J.G. McGowan, A.L. Rogers, Wind Energy Explained, Theory, Design and Application, Wiley, 2012.
3. Tony Burton et al, Wind energy Hand Book, John Wiley & Sons Inc.

MECX016 SAFETY IN POWER PLANT	Credits			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite : Knowledge in Power plant Engineering.	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- To learn the various aspects of safety and measures in power plant

Course Outcome(s)

CO1: Identify the roots and causes of accidents in power plant and analyze.

CO2: Explain the fundamentals of fire and methods of fire fighting in power plant.

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	1			1	3	3					2
CO2	3	1			1	3	3					1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Accidents

Causes & Factors, Cost of Accidents, Accident Prevention, Investigation of Accidents, Reporting and Recording Systems for Accidents First Aid Basics of First Aid, how injuries are caused in lifting, fall.

Fire Fighting

Fundamentals of Fire, Fire Fighting Equipment and Systems, Fire Extinguishing Methods, Demonstration of various Fires Industrial Safety & Hazards Industrial Hazards, Protective Clothing and Equipment, Safe Working Practices in Power Plant, Permit to work system.

MECX017 DESIGN OF GEAR PUMP AND HYDRAULIC CYLINDER	**Credits**			
	L	**T**	**P**	**Total**
	1	**0**	**0**	**1**
Pre-requisite : Fluid power and transmission systems	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- To learn different types of gear pump and hydraulic cylinders with design concept

Course Outcome(s)

CO1: Design gear pumps for required applications..
CO2: Design of hydraulic cylinders and cushioning arrangements..

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3	3								
CO2	3	3	1	1								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Design of Gear pump

Function and application of gear pump, Design Inputs, Gear design, Housing design, Wear plate design, Bearing design, Seal design. Bolted joints

Design of Hydraulic Cylinders

Function & application of Hydraulic cylinders, Design Inputs, Sizing of piston rod & cylinder, Selection of seals, Bolted joints, Force calculation & design of cushioning arrangement.

REFERENCE

1. Andrew Parr, Butterworth and Heinemann, Hydraulics and Pneumatics, Oxford, UK, 1987. Espisito,Fluid Power with Application, Prentice Hall International,1998
2. J.J.Pipenger ,Industrial Hydraulics, McGraw Hill, N.York, 1981.
3. Industrial Hydraulics Manual-Vickers Sperry Rand Corporation, Technical Training Centre.

<table>
<tr><td rowspan="3" colspan="2">MECX018 GEOMETRICAL DIMENSIONING AND TOLERANCING</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite : Engineering Drawing</td><td colspan="5">Course Category: One credit course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- Knowledge on geometric dimensions and tolerances for design

Course Outcome(s)

CO1: Interpret basic tolerances in dimensioning

CO2: Explain basic structures and shapes

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	3	1	1								
CO2	2	3	1	1								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

General tolerancing – tolerances, limits, specified dimension, extreme form variation, clearance fit, allowance, interference fit. Symbols and terms – geometric characteristic symbols, material condition symbols, datum feature, feature control frame, basic dimension, dimensioning symbols.

Datums – datum feature symbol, datum features, high point contact, specific point contact, datum frame, datum axis, partial datums, and datum center plane Material condition symbols – maximum material condition, regardless of feature size, least material condition, applications.

Geometric characteristics – straightness, flatness, circularity, cylindricity, profile, parallelism, perpendicularity, angularity, runout, combination of geometric characteristics.

Position – conventional tolerancing vs. positional tolerancing, floating fasteners, fixed fasteners, positional tolerance at MMC, zero positional tolerance, virtual condition projected tolerance zone, composite positional tolerance, two single-segment feature control frame, concentricity, symmetry.

REFERENCES

1. Neumann, A., "Geometric Dimensioning and Tolerancing Workbook,"
2. Puncochar, D. & Evans, I., "Interpretation of Geometric Dimensioning and Tolerancing", Industrial Press, 2011.
3. Drake, P., "Dimensioning and Tolerancing Handbook," McGraw Hill, 1999.

MECX019 POWERTRAIN INTEGRATION AND SYSTEM DESIGN	Credits			
	L	T	P	Total
	1	0	0	1
Pre-requisite : Design of machine elements, Design of transmission systems and Dynamics of Machineries.	**Course Category:** One credit course **Course Type:** Theory			

Course Objective(s)

- Knowledge on power transmission

Course Outcome(s)

CO1: Design gear transmission and cooling systems.
CO2: Discuss torque distribution

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3	3								
CO2	3	3	1	1								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Rubber mounts design considering multiple degrees of freedom. Engine mounts, Transmission mounts , Axle & final drive mounts Cooling system design and engineering, Prediction of energy dissipation & losses in powershift transmission, PTO gearbox, wet-multiple disc brake/ clutch , Design of oil cooler: shell, plate type , Design of radiator , Design of combi-coolers ,Cooling oil / air / water flow requirements ,Selection of Fan, Air flow calculations & measurement on Equipment Torque converter , Function and selection criteria ,Characteristics of torque converter , Design of Torque converter elements, Cooling requirements ,Engine and torque converter matching and criteria for optimum selection

REFERENCE

1. U. Kiencke and L. Nielsen, Automotive Control Systems: For Engine, Driveline, and Vehicle, 2nd Edition, Springer-Verlag New York, LLC, 2010.
2. Mehrdad Ehsani, Ali Emadi, and Yimin Gao, Modern Electronic, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory and Design, 2nd Edition, CRC Press, 2010.
3. Integrated Powertrain and Driveline Systems 2006 (IPDS 2006), CRC Press, July 2006

ONLINE COURSES

MECO001 MATERIAL SELECTION AND DESIGN	Credits			
	L	**T**	**P**	**Total**
	3	**0**	**0**	**3**
Pre-requisite : Materials science, Design of machine elements	**Course Category:** Online course **Course Type:** Theory			

Course Objective(s)

- To introduce the concept of various steps involved in the Design Process and understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To Learn to use standard practices, standard data, use of catalogues for designing standard machine components

Course Outcome(s)

CO1: Know the materials used for different machine components.
CO2: Relate the effect of material property with processes
CO3: Express the influence of structure of crystal on material property
CO4: Basic knowledge on composite materials.
CO5: Identify the influence of different factors on material selection

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1		1		2	1							
CO2		2	1	3	2							
CO3	1	2	2	2	1							
CO4				1	2		3					
CO5	1		2	3	2							

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Introduction to Mechanical System Design

Materials and Design ,Evolution of Engineering Materials, Evolution of Engineering Materials, Material Resource in Indian Context, Classification of Materials, Case Study: Materials Selection for Vehicle Body,

Mechanical Properties of Materials

Overview of Material Properties, Surface Properties of Materials, Other Functional Properties of Materials,

Basic Structure of Materials

Material Properties; The Role of Crystal Structure, Material Properties; The Role of Crystal Structure, Metals and Metallic Structure, METALLIC ALLOYS, CERAMICS & GLASSES ,Introduction to Polymeric Materials, Phases and microstructure of Polymers, Polymers for Mechanical Design

Overview of Composite Materials

Reinforcement Fibres for Composite Materials, Special type of Composites Metal Matrix Composite, Ceramic Matrix Composite, Design of Laminated Composite

The Design Process

Material Selection using Ashby Method - Case Study, Multiple Constraints in material selection, Multiple Objectives, Role of Materials in Shaping the Product Character, Case Studies, The Role of Shape Factors in Material Selection, Design Case Studies - Guitar String Design

REFERENCES

1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials, Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
2. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, New Delhi, 1994.
3. Agarwal, B.D., and Broutman, L.J., Analysis and Performance of Fiber Composites, John Wiley and Sons, New York, 1980.

<table>
<tr><td rowspan="3">MECO002 MICRO AND SMART SYSTEMS</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : Strength of materials, Mechatronics</td><td colspan="4">Course Category: Online course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To introduce and understand the Concepts & Design of Micro control systems.

Course Outcome(s)

CO1: Know the available micro and smart systems used in daily life.
CO2: Identify the different fabrication processes available for micro systems
CO3: Connect the usage of microsystems in minimizing the construction of large scale mechanical components
CO4: Interpret the possible way of collecting the data of physical forces by converting them into electrical signals

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1			2		3	2	1					
CO2		1	2	1	1							
CO3	2	3	1		1						1	
CO4		1	1		1							

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Introduction

Glimpses of Microsystems; scaling effects, Smart materials and systems: an overview, Microsensors Microactuators, Microsystems: some examples, Examples of smart systems: structural health monitoring and vibration control

Microfabrication processes

Structure of silicon and other materials, Silicon wafer processing; Thin-film deposition, Lithography, wet etching and dry etching, Bulk micromachining and Surface micromachining, Wafer-bonding; LIGA and other moulding techniques, Soft lithography and polymer processing, Thick-film processing; Low temperature co-fired ceramic processing, Smart material processing

Mechanics of Solids

Stresses and deformation: bars and beams, Microdevice suspensions: lumped modelling, Residual stress and stress gradients, Poisson effect; Anticlastic curvature; examples of micromechanical structures, Thermal loading; bimorph effect, Dealing with large displacements; in-plane and 3D elasticity equations, Vibrations of bars and beams, Gyroscopic effect, Frequency response; damping; quality factor, Basic micro-flows for damping calculation,

Finite element method

Types of numerical methods for solving partial differential equations, What is finite element method? Variational principles, Weak form; shape functions, Isoparametric formulation and numerical integration, Implementation of the finite element method, FEM for piezoelectrics,

Electronics and packaging

Semiconductor devices: basics, OpAms and OpAmp circuits, Signal conditioning for microsystems devices, Control and Microsystems, Vibration control of a beam, Integration of microsystems and microelectronics, Packaging of Microsystems: why and how, Flip-chip, ballgrid, etc.; reliability, Case-study 1 (Pressure sensor), Case-study 2 (Accelerometer)

REFERENCES

1. S.D. Senturia, Microsustem Design, Kluwer Academic Publishers, 2001.
2. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, McGraw Hill, 2002.
3. V.K. Varadan, K.J. Vinoy, and S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006.

<table>
<tr><td rowspan="3" colspan="2">MECO003 FINITE ELEMENT ANALYSIS OF SOLIDS AND FLUIDS - I</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : Maths-I, Maths-II, Strength of materials</td><td colspan="5">Course Category: Online course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To equip the students with the Finite Element Analysis fundamentals. and enable the students to formulate the design problems into FEA, to introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays.

Course Outcome(s)

CO1: Identify modern analysis techniques used widely in engineering practice and the sciences.

CO2: Learn how to establish computational models of problems for non-linear and heat transfer problems

CO3: Interpret the use of gauss elimination technique and other mathematical model in finding solutions for problems that cannot be find out by using analytical method

CO4: Develop the finite element formulation for problems in vibration and wave propagation

Mapping of Course Outcome(s)

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	3	3	2	3							2
CO2	3	3	3	2	3							2
CO3	3	3	2	2	3							1
CO4	3	3	2	2	2							1

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

INTRODUCTION

Introduction to finite element analysis process, Analysis of solids/structures and fluids, the principle of virtual work, The finite element formulation, Finite element solution process, Demonstration on using ADINA,

FINITE ELEMENT ANALYSIS ON NON LINEAR AND HEAT TRANSFER PROBLEMS

Nonlinear finite element analysis of solids and structures, Heat transfer analysis, Finite element analysis of heat transfer and incompressible fluid flow,

MATHEMATICAL MODELS IN SOLVING PHYSICAL PROBLEMS

Physical explanation of Gauss elimination, Solution of dynamic equilibrium equations, Demonstration on finite element methods in ADINA,

METHODS USED FOR SOLVING DYNAMIC PROBLEMS

Modeling for dynamic analysis and solution, Wave propagation response, Solution of the generalized eigen value problem, Solution of $K\varphi = \lambda M\varphi$

REFERENCES

1. Bathe, K. J. Finite Element Procedures. Cambridge, MA: Klaus-Jürgen Bathe, 2007. ISBN: 9780979004902.

<table>
<tr><td rowspan="3">MECO004 MECHANICAL ASSEMBLY AND ITS ROLE IN PRODUCT DEVELOPMENT</td><td colspan="4">Credits</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>Total</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite : Manufacturing Technology</td><td colspan="4">Course Category: Online course
Course Type: Theory</td></tr>
</table>

Course Objective(s)

- To know a systematic approach to design and assembly of mechanical assemblies, which should be of interest to engineering professionals

- To learn the mechanical and economic models of assemblies and assembly automation at two levels

Course Outcome(s)

CO1: Know the basis in assembling a product.

CO2: Describe the various mathematical and logical techniques used in assembling the product

CO3: Interpret the various methods available for assembling the products

CO4: Identify the design techniques involved in developing a product

CO5: Manage the problems available in industry through flexible manufacturing system and supply chain management

Mapping of Course Outcome(s)

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2				2	2	3					
CO2		2	1	2	2		1					
CO3		2	3	1								
CO4	2		1	1	2							
CO5	3	3	2	1								

3- Strong Correlation; 2 - Medium Correlation; 1 – Low Correlation

Course Topic(s)

Introduction

Introduction, Logistics, Context, History, Assembly in the Small - Step-by-step Process – Assembly Motions and Forces, Assembly in the Small-Rigid Part Mating Theory and RCC,

Methods used in the construction of an assembly

Mathematical Models of Assemblies, Feature-based Modeling of Assemblies, Constraint in Assembly, Variation Build up in Assemblies, Assembly Sequence Analysis, Algorithms, and Software, The Datum Flow Chain, Assembly in The Large,

Design for Assembly

Design for Assembly - Theory and Examples, AITL System Design Issues: Kinds of Assembly Lines and Equipment, Production Volume, Cycle Times, Assembly in The Large: Workstation Design Issues

Assembly System Design Techniques and Simulation

Assembly System Design Techniques and Simulation, Economic Analysis of Assembly techniques-- Basic Issues, Economics, Step-by-step Process, Product Architecture, Flexibility

Flexible Manufacturing systems and supply chain management

Assembly Systems, Flexible Manufacturing Systems, Outsourcing, and Supply Chain Management , 767 Wing Case Study

REFERENCES

1. Whitney, Daniel E. Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development. New York, NY: Oxford University Press, 2004. ISBN: 9780195157826.