KALASALINGAM
ACADEMY OF RESEARCH AND EDUCATION
(DEEMED TO BE UNIVERSITY)
Under sec. 3 of UGC Act 1956.
Anand Nagar, Krishnankoil - 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | info@kalasalingam.ac.in | www.kalasalingam.ac.in

SCHOOL OF AUTOMOTIVE AND MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

BACHELOR OF TECHNOLOGY
MECHANICAL ENGINEERING
(Integrated with Siemens)

CURRICULUM AND SYLLABUS

(For the Students Admitted from the Academic Year 2019-20 Onwards)

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

VISION

To be a Centre 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):

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 analyse 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 modelling 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 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: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1- PO 13- An ability to utilize the gained knowledge of mathematics and engineering sciences to real time problems involving thermal, design, manufacturing and materials domain.

PSO2- PO 14- An ability to specify, fabricate, test, operate, validate and complete documentation of any basic mechanical systems or processes.

PSO3- PO 15- An ability to apply the acquired software's skills to design and analysis of advanced mechanical systems or processes.

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DEPARTMENT OF MECHANICAL ENGINEERING (R2018)

S. No	Category		Credits
I.	Basic Sciences and Mathematics	25	**31**
	Open Elective (Basic Sciences and Mathematics)	6	
II.	Humanities and Social Science		**3**
	Soft Skills		**3**
	Humanities Elective		**6**
III.	Basic Engineering		**24**
IV.	Program Core		
	a)Core Courses	48	**61**
	b)Community Service Project	3	
	c)Project work	10	
V.	Elective Courses		
	a)Major Elective	18	**30**
	b)Open Elective (Engineering stream)	12	
VI	Internship/Industry Training		**2**
VII	Mandatory courses	--	**---**
	Total Credits		**160**

I. BASIC SCIENCES AND MATHEMATICS

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	PHY18R171	Introduction to Electromagnetic Theory	IC	3	1	2	5
2.	CHY18R171	Chemistry	IC	3	1	2	5
3.	MAT18R101	Calculus and Linear Algebra	TP	3	1	0	4
4.	MAT18R102	Multiple Integration, Ordinary Differential Equations and Complex Variable	TP	3	1	0	4
5.	MAT18R203	Partial differential Equations, Probability and Statistics	TP	3	1	0	4
6.	BIT18R101	Biology for Engineers	T	3	0	0	3
Total							**25**

II. HUMANITIES AND SOCIAL SCIENCE

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	HSS18R151	English for technical communication	TP	3	0	1	3
2.	HSS18R101	Soft skills-I	T	3	0	0	1
3.	HSS18R102	Soft skills-II	T	3	0	0	1
4.	HSS18R201	Soft skills-III	T	3	0	0	1
Total							**6**

III. BASIC ENGINEERING

S. No	Course Code	Course Name	Course Type	L	T	P	C
1	EEE18R172	Basic Electrical Engineering	IC	3	1	2	5
2	MEC18R151	Engineering graphics & Design	TP	2	0	2	3
3	MEC18R211	Engineering Mechanics	T	3	1	0	4
4	CSE18R171	Programming for problem solving	IC	3	1	2	5
5	MEC18R152	Engineering Practice	TP	2	0	2	3
6	MEC18R903	Basics of Robotic Simulation	IC	3	0	2	4
Total							**24**

IV. PROGRAM CORE

A) Core Courses

S. No	Course Code	Course Title	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R203	Thermodynamics	T	-	3	0	0	3
2.	MEC18R208	Materials Science	T	-	3	0	0	3
3.	MEC18R210	Instrumentation and Control	T	-	3	0	0	3
4.	MEC18R271	Strength of Materials	IC	MEC18R211	3	0	2	4
5.	MEC18R272	Fluid Mechanics and Machinery	IC	-	3	0	2	4
6.	MEC18R274	Thermal Engineering	IC	MEC18R203/ MEC18R202	3	0	2	4
7.	MEC18R302	Manufacturing Processes	T	-	3	0	0	3
8.	MEC18R303	Design of Machine Elements	T	MEC18R271	3	0	0	3
9.	MEC18R351	Finite Element Analysis	TP	MEC18R271	2	0	2	3
10.	MEC18R373	Heat and Mass Transfer	IC	-	3	0	2	4
11.	MEC18R374	Kinematics and Theory of Machines	IC	MEC18R211	3	0	2	4
12.	MEC18R352	Metal cutting technology	TP	-	2	0	2	3
13.	MEC18R448	Automation in manufacturing systems	T	-	3	0	0	3
14.	MEC18R902	Synchronous Modelling with NX CAD	IC	-	3	0	2	4
				Total				**48**

B) Community Service Project

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	MEC18R399	Community Service Project	Project	0	0	3	3
			Total				**3**

C) Main Project work

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	MEC18R498	Project Work Phase – I	Project	0	0	6	2
2.	MEC18R499	Project Work Phase - II	Project	0	0	26	8
			Total				**10**

V. MAJOR ELECTIVE

A) Manufacturing Stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R311	Non-Traditional Machining Techniques	T	-	3	0	0	3
2.	MEC18R316	Theory of Metal Cutting	T	MEC18R352	3	1	0	4
3.	MEC18R325	Welding Technology	T	MEC18R208	3	0	0	3
4.	MEC18R335	Recent Trends in Welding Techniques	T	MEC18R208	3	0	0	3
5.	MEC18R336	Mechanical Behaviour of Materials	T	MEC18R208	3	0	0	3
6.	MEC18R337	Manufacturing system and simulation	T	-	3	0	0	3
7.	MEC18R339	Tooling for Production	T	-	3	1	0	4
8.	MEC18R340	Composite Materials	T	MEC18R208	3	1	0	4

9.	MEC18R343	Heat treatment and Surface treating	T	MEC18R208	3	1	0	4
10.	MEC18R421	Non-Destructive Examination	T	MEC18R302	3	1	0	4
11.	MEC18R431	Micro Manufacturing	T	MEC18R352	3	1	0	4

B) Design Stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R306	Computer Aided Design	T	MEC18R151	3	0	0	3
2.	MEC18R309	Design of Jigs, Fixtures And Press Tools	T	MEC18R151	3	0	0	3
3.	MEC18R315	Design for Manufacturing	T	MEC18R302	3	0	0	3
4.	MEC18R326	Advanced Strength of Materials	T	MEC18R271	3	1	0	4
5.	MEC18R341	Principles of Component Design	T	MEC18R151	3	1	0	4
6.	MEC18R434	Design of Material handling equipments	T	MEC18R303	3	1	0	4

C) Thermal Stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R312	Internal Combustion Engines	T	MEC18R274	3	0	0	3
2.	MEC18R313	Turbo Machinery	T	MEC18R203	3	0	0	3
3.	MEC18R329	Gas dynamics and Jet propulsion	T	MEC18R272	3	1	0	4
4.	MEC18R401	Power plant engineering	T	MEC18R203	3	1	0	4
5.	MEC18R402	Automobile Engineering	T	MEC18R203	3	1	0	4

D) Industrial Engineering Stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R304	Mechatronics systems	T	-	3	0	0	3
2.	MEC18R305	Microprocessors in automation	T	-	3	0	0	3
3.	MEC18R319	Process Planning and Cost Estimation	T	-	3	1	0	4
4.	MEC18R324	Plant Layout and Material Handling	T	-	3	0	0	3
5.	MEC18R330	Robotics and Robot Applications	T	MEC18R374	3	0	0	3
6.	MEC18R334	Foundry Mechanization and Management	T	MEC18R302	3	0	0	3
7.	MEC18R404	Principles of Management	T	-	3	0	0	3
8.	MEC18R414	Sensors and transducers	T	EEE18R172	3	1	0	4
9.	MEC18R416	Industrial Safety	T	-	3	0	0	3
10.	MEC18R417	Work Study	T	-	3	0	0	3
11.	MEC18R419	Production Planning And Control	T	MEC18R352	3	1	0	4
12.	MEC18R424	Industrial Automation and Robotics	T	MEC18R374	3	1	0	4
13.	MEC18R430	Integrated Manufacturing Systems	T	MEC18R302	3	1	0	4
14.	MEC18R438	Tero Technology	T	-	3	1	0	4

E) Siemens Integrated Elective Courses (Handled by Siemens experts)

Mechatronics and Automation stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R904	Factory CAD	IC	-	3	0	2	4
2.	MEC18R905	Plant simulation	IC	-	3	0	2	4

Digital Manufacturing and Industry 4.0 stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R904	Factory CAD	IC	-	3	0	2	4
2.	MEC18R906	Additive Manufacturing	IC	-	3	0	2	4

F) Siemens Integrated Elective Courses (Additional)

Mechatronics and Automation stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R353	Fundamentals of Mechatronics System	TP	-	2	0	2	3
2.	MEC18R308	Robotic Mechanism Design	T	-	3	0	0	3
3.	MEC18R314	Robot Collaborative System Design	T	-	3	0	0	3
4.	MEC18R406	Autonomous Robots	T	-	3	0	0	3
5.	MEC18R407	Intelligent Medical Robotics	T	-	3	0	0	3

Digital Manufacturing and Industry 4.0 stream

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R353	Fundamentals of Mechatronics System	TP	-	2	0	2	3
2.	MEC18R327	Industrial IoT	T	-	3	0	0	3
3.	MEC18R328	Smart Manufacturing and Industry 4.0	T	-	3	0	0	3
4.	MEC18R408	Big data analytics for Manufacturing	T	-	3	0	0	3
5.	MEC18R409	Production Drawing and Manufacturing Analysis	T	-	3	0	0	3

IC-Integrated course, TP-Theory with practical, T-Theory

VI. OPEN ELECTIVES (BASIC SCIENCE AND MATHEMATICS)

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	OEE18R009	Laser Technology	T	-	3	0	0	3
2.	OEE18R003	Mathematical Biology	T	-	3	0	0	3
3.	OEE18R005	Combinatorics	T	-	3	0	0	3
4.	OEE18R008	Photonics and Optoelectronic Devices	T	-	3	0	0	3
5.	OEE18R006	Industrial Chemistry for Engineers	T	-	3	0	0	3
6.	OEE18R004	Mathematical Modelling	T	-	3	0	0	3

VII. OPEN ELECTIVES OFFERED FROM THE DEPARTMENT OF MECHANICAL ENGINEERING

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	MEC18R320	Finite Element Method	T	3	0	0	3
2.	MEC18R321	Optimization Techniques	T	3	0	0	3
3.	MEC18R323	Materials Management	T	3	0	0	3
4.	MEC18R344	Nuclear Power generation	T	3	0	0	3
5.	MEC18R345	Surface Engineering	T	3	0	0	3
6.	MEC18R346	Thermodynamics of materials	T	3	0	0	3
7.	MEC18R347	3D Printing	T	3	0	0	3
8.	MEC18R348	Maintenance Engineering	T	3	0	0	3
9.	MEC18R349	Smart Materials	T	3	0	0	3
10.	MEC18R350	Avionics	T	3	0	0	3
11.	MEC18R403	Mechatronics	T	3	0	0	3
12.	MEC18R427	Enterprise Resource Planning	T	3	0	0	3
13.	MEC18R428	Productivity management and reengineering	T	3	0	0	3
14.	MEC18R432	Product life Cycle management	T	3	0	0	3
15.	MEC18R440	Basic Machining	T	3	0	0	3
16.	MEC18R441	Supply chain management	T	3	0	0	3
17.	MEC18R442	Basics in Heat transfer	T	3	0	0	3
18.	MEC18R443	Automatic Guided Vehicle	T	3	0	0	3
19.	MEC18R445	Applied thermodynamics	T	3	0	0	3
20.	MEC18R446	Industrial Psychology	T	3	0	0	3
21.	MEC18R447	Process equipment and design	T	3	0	0	3
22.	MEC18R449	Engineering Design	T	3	0	0	3

VIII. HUMANITIES ELECTIVES

S. No	Course Code	Course Name	Course Type	L	T	P	C
1.	HSS18R001	Management Concepts and Techniques	T	3	0	0	3
2.	HSS18R002	Marketing Management	T	3	0	0	3
3.	HSS18R003	Organizational Psychology	T	3	0	0	3
4.	HSS18R004	Project Management	T	3	0	0	3
5.	HSS18R005	Stress Management and Coping Strategies	T	3	0	0	3
6.	HSS18R006	Economics for Engineers	T	3	0	0	3
7.	HSS18R007	Human Resource Management and Labour Law	T	3	0	0	3
8.	HSS18R008	Entrepreneurship Development	T	3	0	0	3
9.	HSS18R009	Cost Analysis and Control	T	3	0	0	3
10.	HSS18R010	Product Design and Development	T	3	0	0	3
11.	HSS18R011	Business Process Reengineering	T	3	0	0	3
12.	HSS18R012	Political Economy	T	3	0	0	3
13.	HSS18R013	Professional Ethics	T	3	0	0	3
14.	HSS18R014	Operations Research	T	3	0	0	3
15.	HSS18R015	Total Quality Management	T	3	0	0	3
16.	HSS18R016	Advanced Soft skills	T	3	0	0	3

IX. SPECIAL ELECTIVES (HONOURS ELECTIVES)

S. No	Course Code	Course Name	Course Type	Pre-requisite	L	T	P	C
1.	MEC18R307	Design of transmission systems	T	MEC18R271	3	1	0	4
2.	MEC18R310	CNC Machining	T	MEC18R302	3	1	0	4
3.	MEC18R317	Tribology	T	MEC18R211	3	1	0	4
4.	MEC18R318	Refrigeration and Air conditioning	T	MEC18R274	3	1	0	4
5.	MEC18R322	Modern Manufacturing Processes	T	MEC18R302	3	1	0	4
6.	MEC18R331	Vibration Analysis and Noise Monitoring	T	-	3	1	0	4
7.	MEC18R333	Design of Heat Transfer Equipments	T	MEC18R274	3	1	0	4
8.	MEC18R338	Gear manufacturing and inspection	T	MEC18R302	3	1	0	4
9.	MEC18R342	Computational Fluid Dynamics and Heat Transfer	T	MEC18R274	3	1	0	4
10.	MEC18R405	Energy conservation and management	T	MEC18R274	3	1	0	4
11.	MEC18R412	Micro Electro Mechanical Systems	T	EEE18R172	3	1	0	4
12.	MEC18R426	Design and analysis of experiments	T	-	3	1	0	4
13.	MEC18R429	Product Design and Development	T	-	3	1	0	4
14.	MEC18R435	Design for cellular manufacturing systems	T	MEC18R302	3	1	0	4
15.	MEC18R437	Design for ergonomics	T	-	3	1	0	4

X. INDUSTRIAL TRAINING / INTERNSHIP

MEC18R397 - Industry Training

MEC18R398 - Internship

XI. MANDATORY COURSES

1. Environmental Sciences 2. Indian Constitution 3. Essence of Indian Traditional Knowledge

XII. ONE CREDIT COURSE

MEC18R901 - Essentials for NX Designer (Handled by Siemens experts)

SIEMENS INTEGRATED COURSES

S. No	Course Code	Course Name	Course Type	Category	L	T	P	C
1.	MEC18R901	Essentials for NX Designer	P	Professional Elective (One Credit)	0	0	2	1
2.	MEC18R902	Synchronous Modelling with NX CAD	IC	Program Core	3	0	2	4
3.	MEC18R903	Basics of Robotic Simulation	IC	Basic Engineering	3	0	2	4
4.	MEC18R904	Factory CAD	IC	Major Elective	3	0	2	4
5.	MEC18R905	Plant simulation	IC	Major Elective	3	0	2	4
6.	MEC18R906	Additive Manufacturing	IC	Major Elective	3	0	2	4

BASIC SCIENCES AND MATHEMATICS

PHY18R171 : INTRODUCTION TO ELECTROMAGNETIC THEORY	L	T	P	C
	3	1	2	5
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Integrated Course			

Course Objective(s):

To Understand the basic knowledge about the Electrostatics, Magnetostatics, Materials about magnetic and dielectric, Faraday laws and concepts, Maxwell's equation and Electromagnetic waves.

Course Outcome(s):

CO1	*Describe the properties of static charges*
CO2	*Understand the basic concepts of magnetic field effects*
CO3	*Understand the fundamentals of magnetic properties of materials*
CO4	*Explore the basic idea about electromagnetic induction*
CO5	*Apply the knowledge on electromagnetism in solving real world problems*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3	2	1

Course Topics:

Unit-I: ELECTROSTATICS

The Electric Field- Continuous Charge Distributions-Divergence and Curl of electrostatic field: Field lines, Flux and Gauss's law, Divergence of E-Application of Gauss's law-The Curl of E-Electric Potential: Poisson's equation and Laplace equation, The potentials of a Localized Charge Distribution, Boundary Conditions-Work and Energy in electrostatics: Energy of a point charge distribution and energy of continuous charge distribution. Electric field and potential due to electric dipole

Unit-II: MAGNETOSTATICS

The Lorentz Force Law-Biot-Savart's Law- Applications of Biot-Savart's Law- Magnetic field due to current in a straight conductor-Magnetic field due to a circular current loop- Divergence and curl of static magnetic field - Ampere's Circuital law- Integral and differential form of Ampere's law- Applications of Ampere's law: Magnetic field due to solenoid and Magnetic field due to Toroid-Magnetic vector potential

Unit-III: MAGNETIC AND DIELECTRIC MATERIALS

Properties of magnetic materials, Diamagnetism, Paramagnetism and Ferromagnetism- Ferromagnetic Domains- Hysteresis curve- Comparison of Dia, Para, and Ferro magnetism. Dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarization – internal field – Claussius Mosotti equation – dielectric breakdown mechanisms.

Unit-IV: FARADAY'S LAW, DISPLACEMENT CURRENT AND MAXWELL'S EQUATIONS

Faraday's laws of electromagnetic induction-Lenz's law-Inductance- Electromotive force- motional EMF - Self-inductance of single coil-Mutual inductance of two coils-Energy stored in magnetic field - displacement current - physical interpretation - Maxwell's equation in free space, Maxwell's equation in linear isotropic media.

Unit-V: ELECTROMAGNETIC WAVES

Poynting Theorem - Waves in one Dimension (Sinusoidal wave), Polarization-Electromagnetic waves in vacuum-Monochromatic plane waves-Energy and momentum in electromagnetic waves-Electromagnetic waves in matter. Application of electromagnetic waves: Reflection and Refraction at Dielectric interface (Normal Incidence only).

List of Experiments:

1. To compare capacitances using De'Sauty's bridge.
2. To determine the self-inductance of the coil using Anderson's bridge.
3. To determine the specific resistance of the material of two given wires using a meter bridge
4. To determine the internal resistance of a primary cell using a potentiometer
5. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
6. To study the series LCR circuit and determine its (a) Resonant Frequency, (b)Quality Factor
7. To study the parallel LCR circuit and determine its (a) Anti-resonant frequency and(b) Quality factor Q
8. To determine the Low Resistance by Carey Foster's Bridge
9. Determination of Thermo emf- direct method – BG
10. To determine the volume magnetic susceptibility of Manganese sulphate solution at different concentrations.
11. Determination of dielectric constant of liquids.
12. To determine the mutual inductance of the coil using Anderson's bridge.

Text Book(s):

1. J. David Griffiths, "*Introduction to Electrodynamics*", Edition: 4, Pearson India , 2015.
2. Sathya Prakash, "*Electricity and Magnetism*", Edition: 31, Pragati Prakashan India , 2016.

Reference(s):

1. Shobhit Mahajan and S. Rai Choudhary, "*Electricity, Magnetism and Electromagnetic Theory*", Edition: 1, McGraw Hill India , 2012.
2. M. Edward Purcell, "*Electricity and Magnetism*", Edition: 2, McGraw Hill India , 2011.
3. Indu Prakash, Ram Krishna and A.K. Jha, "*A Text Book of Practical Physics (Engineering Students)*", Edition: 11, Kitab Mahal India , 2011.

CHY18R171 : CHEMISTRY	L	T	P	C
	3	1	2	5
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Integrated Course			

Course Objective(s):

Introducing the fundamental concepts and applications of Chemistry to the engineering students to understand, analyse and apply the same to complex technical issues

Course Outcome(s):

CO1	*Demonstrate a knowledge on the significance and role of water quality parameters in the domestic and engineering applications and analysing the same through modern methods*
CO2	*Explain the principles of thermodynamics for solving engineering problems*
CO3	*Explain the basic concepts of electrochemistry, batteries, corrosion and to apply the same for the betterment of society*
CO4	*Explain about synthesis, characteristics and applications of technologically important polymers, composites and nanomaterials*
CO5	*Explain the underlying principles, instrumentation and applications of analytical techniques*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3		

Course Topics:

Unit-I: ATOMIC AND MOLECULAR STRUCTURE

Schrodinger wave equation: Derivation of time independent Schrodinger wave equation, Representation of Schrodinger wave equation in polar coordinates - Radial distribution function graphs of s, p, d and f orbitals. Molecular Orbital Theory: MOT concept, MO diagrams of homo-nuclear diatomic molecules (hydrogen, nitrogen and oxygen) and hetero-nuclear diatomic molecules (carbon monoxide and nitric oxide). Crystal field theory: CFT concept, weak and strong ligands, energy level diagrams of transition metal ions (Fe2+& Fe3+) in octahedral and tetrahedral complexes and their magnetic properties. Intermolecular forces - Ionic, dipolar and van der Waals interactions.

Unit-II: PERIODIC PROPERTIES

Effective nuclear charge - Factors affecting effective nuclear charge: Penetration or shielding of orbitals - Variation of s, p, d and f orbital energies of atoms in the periodic table - Aufbau principle (Building-up principle): Application of Aufbau principle in writing electronic configuration, Deviation from Aufbau principle - Periodicity of properties in a periodic table - Periodic properties: Atomic and ionic sizes, ionization energies, electron affinity and electronegativity - Variation of periodic properties in the periodic table - Hard soft acids and bases: Concept and examples

Unit-III: FREE ENERGY AND CHEMICAL EQUILIBRIA

Thermodynamic functions: Definition and mathematical expression for Work, Energy, Enthalpy, Entropy and Free energy - Nernst equation: Derivation, apply Nernst equation to determine of solubility product, pH (glass electrode). Potentiometric titrations: Acid-Base, Redox and precipitation reaction - Water analysis: Hardness by

EDTA method and chloride ion by Argentomentric method - Corrosion: Definition, types (dry & wet) and mechanism. and control of Dry and Wet corrosion.

Unit-IV: ORGANIC REACTIONS

Nucleophilic substitution reactions: Definition, types and examples of nucleophile, Compare nucleophilicity and basicity of a nuceophile - Types of nucleophilic substitution (case RX and ArX): Mechanism of SN1, SN2, SNi and Benzyne. Electrophilic substitution reactions: Definition, types and examples of electrophile - Electrophilic substitution reactions of hydrocarbons: Halogenation, sulphonation, nitration. Friedel crafts alkylation and acylation reaction. Nucleophilic addition reactions (case aldehydes and ketones): Polarity of C=O bond. General mechanism of nucleophilic addition reactions on aldehydes and ketones: HCN, HOH, ROH and NaHSO3 addition. Electrophilic addition reactions (case alkenes): General mechanism of electrophilic addition reactions on alkene - Addition of HBr [Markownikoff & Anti-Markownikoff (peroxide effect)] - Addition of alkene (polymerization of ethylene). Elimination reactions: Types of elimination reactions (case alkyl halides): Dehydrohalogenation of alkyl halides - E1 and E2 mechanism - Dehydration of alcohols to alkene and ethers. Greener synthesis of drug molecules (Aspirin and Ibuprofen)

Unit-V: STEREOCHEMISTRY AND SPECTROSCOPIC TECHNIQUES

Stereochemistry - Definition with examples: Geometrical isomers (alkene) and stereoisomers, symmetry, chirality, enantiomers, diastereomers, meso and racemic mixture. Representation of 3D structures: Wedge formula, Fischer projections, Newmann and Sawhorse formula (up to 2 carbons) - Conformational analysis: Ethane, butane and cyclohexane - Configurational analysis: Rules of RS nomenclature and application of RS nomenclature to molecules containing one chiral centre. Electronic spectroscopy: Principle, instrumentation, selection rules and medicinal application of fluorescence spectroscopy. Nuclear magnetic resonance spectroscopy (1H-NMR): Principle, instrumentation, chemical shift, coupling constant and application (structural identification of the compound C3H6O from 1H-NMR data). X-ray diffraction: Principle, instrumentation and applications X-ray diffraction.

List of Experiments:

1. Determination of Viscosity by Ostwald Viscometer
2. Determination of surface tension by stalagmometer.
3. Adsorption of acetic acid by charcoal.
4. Determination of chloride content of water.
5. Estimation of hardness of water by EDTA method.
6. Determination of the rate constant of a reaction
7. Thin layer chromatography.
8. Determination of the partition coefficient of a substance between two immiscible liquids
9. Determination of Saponification /acid value of oil.
10. Preparation of Aspirin
11. Potentiometric titration of strong acid vs strong base.
12. Potentiometric titration of weak acid vs strong base.
13. Determination of cell constant and conductance of solutions.

Text Book(s):

1. L. Ernest Eliel, H. Samuel Wilen, N. Lewis Mander, "*Stereochemistry of Organic Compounds*", Edition: 1, Wiley India , 2017.
2. M. Bruce Mahan and J. Rollie Meyers, "*University Chemistry*", Edition: 11, Pearson India , 2017.

Reference(s):

1. Colin Banwell and Elaine McCash, "*Fundamentals of Molecular Spectroscopy*", Edition: 4, McGraw Hill India , 2016.
2. Peter Atkins, Julio de Paula, "*Atkins' Physical Chemistry*", Edition: 10, Oxford University Press India , 2014.
3. R.D. Madan and Satya Prakash, "*Modern Inorganic Chemistry*", Edition: 4, S. Chand Publishing India , 2009.

MAT18R101 : CALCULUS AND LINEAR ALGEBRA	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Theory with Practical			

Course Objective(s):

To enable the students to acquire knowledge and skills in basic components of calculus, to handle the situations involving multivariable calculus, and to diagonalize a symmetric matrix using eigenvalues and eigenvectors.

Course Outcome(s):

CO1	*Know the fundamental theorems such as Rolle's theorem, Mean value theorem, Taylor's theorem and its applications.*
CO2	*Understand the basic concepts of limit, continuity, derivative, partial derivative and total derivative and its applications.*
CO3	*Solve the real world problems using differentiation and integration.*
CO4	*Understand the concepts of sequence, convergent of sequences, series and testing of convergent of series using different methods.*
CO5	*Find the solution of simultaneous linear equations using matrices and to find the eigen values and eigen vectors of a matrix, Cayley-Hamilon theorem and orthogonal transformations.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3		

Course Topics:

Unit-I: CALCULUS

Rolle's Theorem- Mean value theorems - Taylor's and Maclaurin theorems with remainders - indeterminate forms and L'Hospital's rule - Maxima and minima.

Unit-II: MULTIVARIABLE CALCULUS (DIFFERENTIATION)

Limit, continuity and partial derivatives - directional derivatives - total derivative - Maxima, minima and saddle points - Method of Lagrange multipliers.

Unit-III: CALCULUS

Curvature (Cartesian coordinates) - Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Unit-IV: SEQUENCES AND SERIES

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions

Unit-V: MATRICES

System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Cayley-Hamilton Theorem - Diagonalization of matrices - Orthogonal transformation- Reduction of Quadratic form to Canonical form.

Text Book(s):

1. B.S.Grewal, J.S.Grewal, "*Higher Engineering Mathematics*", Edition: 43, Khanna Publishers , 2017.
2. Erwin Kreyszig, "*Advanced Engineering Mathematics*", Edition: 10, Wiley India , 2001.

Reference(s):

1. Bandaru Venkata Ramana, "*Engineering Mathematics*", Edition: 1, McGraw Hill India , 2006.
2. T.Veerarajan, "*Engineering Mathematics*", Edition: 1, McGraw Hill India , 2008.

MAT18R102 : MULTIPLE INTEGRATION, ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLE	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Theory with Practical			

Course Objective(s):

To enable the students to understand the concepts of multiple integrations, their applications, and to handle analytic functions on complex plane and perform complex integration.

Course Outcome(s):

CO1	*Understand the concepts of double and triple integral and its applications.*
CO2	*Know about the applications of double and triple integral in vector calculus.*
CO3	*Know the methods of solving differential equations of first and second orders.*
CO4	*Understand the concepts of analytic functions, conformal mappings and bilinear transformations.*
CO5	*Understand the concepts of singularity, residues and evaluation of certain improper integrals.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3		

Course Topics:

Unit-I: MULTIVARIABLE CALCULUS (INTEGRATION)

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to polar), Applications: areas and volume; Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds

Unit-II: INTEGRAL THEOREMS

Gradient, curl and divergence. Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit-III: ORDINARY DIFFERENTIAL EQUATIONS

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equations.

Unit-IV: COMPLEX VARIABLE – DIFFERENTIATION

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit-V: COMPLEX VARIABLE – INTEGRATION

Contour integrals, Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral

involving sine and cosine, Evaluation of certain improper integrals (Integration around small semicircles and rectangular contours)

Text Book(s):

1. B.S.Grewal, J.S Grewal., "*Higher Engineering Mathematics*", Edition: 43, Khanna Publishers India , 2017.
2. Erwin Kreyszig, "*Advanced Engineering Mathematics*", Edition: 10, Wiley India , 2001.

Reference(s):

1. Bandaru Venkata Ramana, "*Engineering Mathematics*", Edition: 1, McGraw Hill India , 2006.
2. T.Veerarajan, "*Engineering Mathematics*", Edition: 1, Tata McGraw-Hill , 2008.

MAT18R203 : PARTIAL DIFFERENTIAL EQUATIONS, PROBABILITY AND STATISTICS	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Theory with Practical			

Course Objective(s):

To enable the students to solve the partial differential equations and to apply them, to understand the concepts of probability and statistics, and to solve real world problems using statistical methods.

Course Outcome(s):

CO1	*Know the method of solving first and second order partial differential equations.*
CO2	*Classify the second order partial differential equations and to know about solving of initial and boundary value problems.*
CO3	*Understand the concepts of probability, random variable, probability density functions, probability mass function, cumulative distributions and expectation.*
CO4	*Know about standard distributions such as binomial, poisson and normal distributions and their applications.*
CO5	*Evaluate moments, skewness and kurtosis for standard distributions and know about correlation and regressions.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3												3		
CO5	3												3		

Course Topics:

Unit-I: PARTIAL DIFFERENTIAL EQUATIONS

First order partial differential equations, solutions of first order linear and non-linear PDEs. Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method.

Unit-II: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Flows, vibrations and diffusions, second-order linear equations and their classification, Initial and boundary conditions, solution of the wave equation and diffusion equation by the method of separation of variables, The Laplacian in plane, cylindrical and spherical polar coordinates and solutions.

Unit-III: BASIC PROBABILITY AND RANDOM VARIABLES

Axiomatic definition of Probability - Conditional probability – Independent events - Total probability – Bayes theorem - Random variables – Discrete random variable - Probability mass function – Continuous random variable - Probability density functions – Cumulative distribution function- Properties- Expectation.

Unit-IV: STANDARD DISTRIBUTIONS AND BIVARIATE DISTRIBUTIONS

Binomial, Poisson, Uniform, Exponential and Normal distributions and their properties. Two dimensional random variables – Joint probability density function – Cumulative distribution function – Marginal density function

Unit-V: STATISTICS

Moments, skewness and Kurtosis - evaluation of statistical parameters for Binomial, Poisson and Normal distributions, Correlation and regression – Rank correlation- Curve fitting by the method of least squares- fitting of straight lines and second degree parabolas.

Text Book(s):

1. T.Veerarajan, "*Engineering Mathematics*", Edition: 1, Tata McGraw-Hill , 2010.
2. T.Veerarajan, "*Probability,Statistics and Random process*", Edition: 1, McGraw-Hill Education , 2016.

Reference(s):

1. Kreyszig, "*Advanced Engineering Mathematics*", Edition: 10, John Wiley and Sons , 2001.
2. B.S.Grewal, J.S.Grewal, "*Higher Engineering Mathematics*", Edition: 37, Khanna Publish , 2004.

BIT18R101 : BIOLOGY FOR ENGINEERS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Basic Science and Mathematics **Course Type :** Theory			

Course Objective(s):

Any engineer, irrespective of the parent discipline (mechanical, electrical, civil, chemical, metallurgical, etc.,) has a high probability of using the disciplinary skills toward designing/improving biological systems in the future. This course is designed to convey the essentials of cell and molecular biology to provide a frame-work for more specific understanding, and contribution by any engineer.

Course Outcome(s):

CO1	*Describe the fundamentals of cell structure and cell cycle*
CO2	*Understand the classification and functions of biomolecules*
CO3	*Elaborate the basic cellular mechanisms such as replication, transcription and translation*
CO4	*Describe the underlying concepts of infection and immunity*
CO5	*Explain various applications of biology*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2		2		3									
CO2	3	2		3		2									
CO3	3			3		2									
CO4	3	2		3		3									
CO5	3	2		2											

Course Topics:

Unit-I: INTRODUCTION

Fundamental difference between science and engineering- comparison between eye and camera, Bird flying and aircraft; major discoveries in biology- ; Classification based on: Cellularity- Unicellular and Multicellular; Ultra structure - prokaryotes and eukaryotes; three major kingdoms of life; Cell structure, intracellular organelles and their functions, comparison of plant and animal cells- Overview of Cell cycle and cell division

Unit-II: BIOMOLECULES

Chemistry of biomolecules: Carbohydrates, Lipids, Proteins; classification of amino acids; classification of proteins based on structure and functions; Nucleic acids -types, structure and function of DNA and RNA

Unit-III: GENES TO PROTEINS

Gene, Genome and chromosome; Central dogma of molecular biology; Classical experiments of DNA: Griffith and, Avery, McCarty and MacLeod, Meselson and Stahl - DNA replication, Transcription and Translation

Unit-IV: MICROBIOLOGY

Microscopy; Microbes as infectious agents - malaria, tuberculosis, typhoid, polio, dengue, AIDS;; cultivation of bacteria. Immunity - innate and acquired immunity - organs and cells of the immune system - classification of antibodies - types of T cells - transplantation, autoimmunity overview

Unit-V: APPLICATIONS OF BIOLOGY

Healthcare-antibiotics, vaccines, monoclonal antibodies, insulin and interferons; Beneficial bacteria - probiotic bacteria, nitrogen fixing bacteria, fermentation and fermented foods and products Environmental - waste water treatment, bioremediation; Biomaterials and biopolymers for medical and environmental applications; Biosensors

Text Book(s):

1. E.D.P.De Robertis, and E.M.F.De Robertis, "- *Cell and Molecular Biology*", Edition: 8 , Williams & Wilkins- Philadelphia , 2010.
2. D.Voet, G.Voet, "*Biochemistry*", Edition: 3, John Wiley and Sons , 2001.

Reference(s):

1. M.J.Pelczar, ECS Chan and NR Krieg, "*Microbiology*", Edition: 7, Tata McGraw Hill , 2010.
2. D.Friefelder, "*Molecular Biology*", Edition: 5, McGraw-Hill Companies , 2013.

HUMANITIES AND SOCIAL SCIENCES

HSS18R151 ENGLISH FOR TECHNICAL COMMUNICATION	L	T	P	C
	2	0	2	3
Pre-requisite: Basic English Knowledge at School Level	**Course Category:** Humanities and Social Sciences **Course Type:** Theory with Practical			

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):

After completing this course, the student will be able to:
CO1: Speak good English covering their day to day activities
CO2: Analyse the importance of Listening to communicate well
CO3: Make Situational Dialogues on emerging multiple situations
CO4: Read aloud Newspapers and other Texts
CO5: 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		2												3	2
CO2			2											3	1
CO3				1										3	2
CO4	2													3	3
CO5											2			3	3

Course Topics:

1 UNIT I – VOCABULARY BUILDING
1.1 The concept of word formation
1.2 Root words from foreign languages and their use in English
1.3 Prefixes and suffixes; word derivatives using them
1.4 Synonyms, Antonyms and standard Abbreviations

2 UNIT II – BASIC WRITING SKILLS
2.1 Sentence structures
2.2 Use of phrases and clauses in sentences
2.3 Creating Coherence
2.4 Techniques for Writing Precisely

3 UNIT III – IDENTIFYING COMMON ERRORS IN WRITING
3.1 Tenses
3.2 Subject – verb agreement
3.3 Noun –Pronoun Agreement
3.4 Verbs – Transitive, Intransitive
3.5 Misplaced Modifiers
3.6 Articles
3.7 Prepositions
3.8 Redundancies and Clichés
3.9 Direct, Indirect speech
3.10 Infinitives, Gerunds

HSS18R101 SOFT SKILL - I	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Learners would have developed the skills of reading and comprehension by mastering the basic linguistic skills
- Learners would have acquired an understanding of the methods of reading and interpretation

Course Outcomes Mapping:

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

Course Topics:

S.	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			Para jumbles/Jumbled Sentences	2

S.	Course	Module Name	Topics	# hours
25		Reading Comprehension	Cloze Passage; Theme Detection	2
26			Reading Comprehension	2

HSS18R102 SOFT SKILL - II	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Will be able to critically evaluate various real-life situations by resorting to Analysis
- of key issues and factors.
- Will be able to read between the lines and understand various language structures
- Will be able to demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.

Course Outcomes Mapping:

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

Course Topics:

S.	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

HSS18R201 SOFT SKILL - III	L	T	P	C
	1	0	0	1
Course Category: Humanities and Social Sciences	**Course Type:** Theory			

Course Outcomes:

- Learners would have developed the skills of reading and comprehension by mastering the basic linguistic skills
- Learners would have acquired an understanding of the methods of reading and interpretation

Course Outcomes Mapping:

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

Course Topics:

Sl no:	Course	Module	Topics Covered	No: of hrs
1	Business English	Presentations	Structure	2
2			Develop and Edit	2
3			Refine and Deliver	2
4		Writing skills	Essay Writing	2
5		Expositions and Discussions	Organize Content; Emphasize Key Points	2
6			Differing Opinions; Logical Conclusions	2
7	Interview preparation and Orientation	Research and Prepare	Pre Interview Preparation	2
8			Resume Preparation	2
9		Facing Interviews	Resume Based questions; Competency Based questions	2
10			Mock Interviews	2
11		Group discussions	Group discussions	2
12			Mock GD	2
13		Corporate Rehersal	Personal Accountability; Managing self	2
14			Business Ettiquette	2
15			Team Dynamics	2

BASIC ENGINEERING

EEE18R172 : BASIC ELECTRICAL ENGINEERING	**L**	**T**	**P**	**C**
	3	**1**	**2**	**5**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Integrated Course			

Course Objective(s):

To focus the fundamental ideas of the Electrical Engineering by providing wide exposure to the basic concepts of Electrical Engineering such as DC Circuits, AC Circuits, electrical machines, measuring instruments and electrical installations etc.

Course Outcome(s):

CO1	*To Apply basic laws of electricity in DC Circuits*
CO2	*To Apply basic laws of electricity in AC Circuits*
CO3	*To study the working principles of dc Machines and Transformers*
CO4	*To study and working principle of AC Machines*
CO5	*To study the basic components of Low Voltage Electrical Installations*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	3	2	1										3	1	
CO3	3	2											3		
CO4	3	2											3		
CO5	3	2					1					1	3		

Course Topics:

Unit-I: DC CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, Series and Parallel circuits. Kirchhoff current and voltage laws, analysis of simple dc circuits-Mesh and Nodal methods. Superposition, Thevenin and Norton Theorems. Time-domain analysis of I order RL and RC circuits

Unit-II: AC CIRCUITS

Representation of sinusoidal waveforms, RMS and Average values - form and peak factors, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Unit-III: DC MACHINES AND TRANSFORMERS

Construction and working principle of DC Generator and DC Motor and its emf equations- related problems. Transformer – construction, working and types- ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.

Unit-IV: AC MACHINES

Constructional details - Principle of operation - Torque-slip characteristics - Starting torque - Relation between torque and slip - Losses and efficiency. Types of single phase induction motor- construction and working of alternators

Unit-V: ELECTRICAL INSTALLATIONS

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery Backup.

List of Experiments:

1. Verification of Kirchhoff's Laws
2. Verification of AC voltage measurements
3. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C Circuits.
4. Demonstration of DC Motor
5. Demonstration of Transformer
6. Load test on three-phase transformer
7. Open circuit and short circuit tests on single phase transformer
8. Torque Speed Characteristic of separately excited dc motor.
9. Demonstration of Induction Motor
10. Load test on three-phase squirrel cage induction motor.
11. Study basic electrical installation components for LT switchgear

Text Book(s):

1. V.K. Mehta, "*Principles of Electrical Engineering and Electronics*", Edition: 1, S. Chand & Company Ltd , 2012.
2. D.P Kothari and I.J Nagrath, "*Basic Electrical Engineering*", Edition: 1, McGraw Hill , 2009.

Reference(s):

1. T. Thyagarajan, "*Fundamentals of Electrical and Electronics Engineering*", Edition: 3, SciTech Publications India , 2015.
2. K.A Muraleedharan, R. Muthususbramanian and S. Salivahanan , "*Basic Electrical, Electronics and Computer Engineering*", Edition: 1, McGraw Hill India , 2006.
3. G.K Mithal, "*Electronic Devices & Circuits*", Edition: 1, Khanna Publications , 1997.

MEC18R151 : ENGINEERING GRAPHICS AND DESIGN	L	T	P	C
	2	0	2	3
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Theory with practical			

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):

CO1	*Create the projection of points in all quadrants and straight lines*
CO2	*Construct the projections of planes and solid objects with refer to reference planes*
CO3	*Illustrate the true shape of truncated solids and develop the surface of truncated solids in both the manual and computerized manner*
CO4	*Develop surfaces of truncated solids in both the manual and computerized man*
CO5	*Apply orthographic and isometric projections in both the manual and computerized man*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

Course Topics:

Unit-I: PROJECTION OF POINTS AND STRAIGHT LINES

Importance of graphics – use of drafting instruments – BIS conventions and specifications – size, layout and folding of drawing sheets – lettering dimensioning and scales - Projection of points, located in all quadrants - projection of straight lines located in the first quadrant, determination of true lengths and true inclinations

Unit-II: PROJECTION OF PLANES AND SOLIDS

Projection of polygonal surface and circular lamina located in first quadrant inclined to one or both reference planes-Projection of solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method

Unit-III: SECTION OF SOLIDS

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

Unit-IV: DEVELOPMENT OF SURFACES

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

Unit-V: ORTHOGRAPHIC AND ISOMETRIC PROJECTION

Orthographic principles – missing view - free hand sketching in first angle projection from pictorial views. Principles of isometric projection – isometric view and projections of simple solids, truncated prisms, pyramids, cylinders and cones. Introduction to CAD software – menus and tools – drafting platform demonstration

Practical Modules:

1. Construction of conic sections using CAD software
2. Construction of simple planes using exclusive commands like extend, trim etc.,
3. Construction of 3D model – solids and sectional views
4. Generating 2D orthographic blue prints from 3D part models
5. Vectorization of simple building plan and elevation

Text Book(s):

1. Basant Aggarwal and C. Aggarwal, "*Engineering Drawing*", Edition: 2, Tata McGraw-Hill Education , 2013.
2. N.S. Parthasarathy, Vela Murali, "*Engineering Drawing*", Edition: 1, OUP India , 2015.

Reference(s):

1. M.B. Shah and B.C. Rana, "*Engineering Drawing*", Edition: 2, Pearson , 2009.
2. K.V. Natarajan,, "*A Text Book of Engineering Graphics*", Edition: 21, Dhanalakshmi Publishers , 2012.
3. Paul Richard, Jim Fitzgerald, "*Introduction to AutoCAD 2017: A Modern Perspective*", Edition: 1, Pearson Education , 2016.

MEC18R211 : ENGINEERING MECHANICS	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Theory			

Course Objective(s):

The course uses the Laws of Mechanics to predict forces in and motions of machines and structures. The course is the key prerequisite course to sequences of courses dealing with mechanics of machines, stress analysis and design of mechanical systems.

Course Outcome(s):

CO1	*Explain the vectorial and scalar representation of forces and moments of particles and rigid bodies both in two dimensions and in three dimensions.*
CO2	*Apply the knowledge of trusses in frames, beams and machine components.*
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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1									3		
CO2	3	2	2	1									2		
CO3	3	3	2	1									3		
CO4	3	2	2	1									2		
CO5	3	1	1	1									1		

Course Topics:

Unit-I: STATICS OF PARTICLES AND RIGID BODIES

Six Fundamental principles and concepts - vector algebra - Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D - System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant - Equations of Equilibrium of Coplanar Systems and Spatial Systems. Rigid Body equilibrium in 2-D & 3-D - Moment of Forces and its Application - Couples and Resultant of Force System - Equilibrium of System of Forces, Free body diagrams - Equations of Equilibrium of Coplanar Systems and Spatial Systems.

Unit-II: ANALYSIS OF TRUSSES

Basic Structural Analysis- Equilibrium in three dimensions - Method of Sections- Method of Joints- How to determine if a member is in tension or compression- Simple Trusses- Zero force members- Beams & types of beams- Frames & Machines.

Unit-III: FRICTION

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction - Motion of Bodies, simple contact friction, sliding block, wedge friction, screw jack & differential screw jack, rolling resistance.

Unit-IV: PROPERTIES OF SURFACES AND SOLIDS

Centroid of simple figures from first principle, centroid of composite sections - Centre of Gravity and its implications - Area moment of inertia - Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections (T section and I section) - Mass moment inertia of circular plate, Cylinder, Cone, Sphere- Principal moment of inertia.

Unit-V: DYNAMICS

Review of particle dynamics - Displacements, velocity and acceleration, their relationship - Equations of motions - Rectilinear motion- Plane curvilinear motion - Newton's 2nd law- Impulse, momentum, impact - D'Alembert's principle and its applications in plane motion and connected bodies - Work energy principle and its application in plane motion of connected bodies - Virtual Work and Energy Method - Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies.

Text Book(s):

1. F.P.Beer, and E.R.Johnson, "*Vector Mechanics for Engineers – Statics and Dynamics*", Edition: 10, McGraw Hill , 2017.
2. J.L.Merriam, "*Engineering Mechanics*", Edition: 7, Wiley , 2017.

Reference(s):

1. H.Irving, Shames, "*Engineering Mechanics, Statics and Dynamics*", Edition: 4, Prentice Hall of India Ltd , 2017.

CSE18R171 : PROGRAMMING FOR PROBLEM SOLVING	L	T	P	C
	3	1	2	5
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Integrated Course			

Course Objective(s):

To make the students to understand the basic concepts of programming language, rules to be followed while writing a program and how to compile and execute C programs.

Course Outcome(s):

CO1	*Understand the basic programming concepts and syntax of C language*
CO2	*Develop efficient code using pointers, arrays and dynamic memory allocation techniques*
CO3	*Create user defined data types and functions to solve given problems*
CO4	*Design an efficient algorithm for a given problem*
CO5	*Build efficient code to solve the real-world problem*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	3	2	2		1								3	2	
CO3	3	2	2		2								3	2	
CO4	3	2	2		2								3	2	
CO5	3	3	2		2								3	2	
CO6						1	1	1		1		1		1	1

Course Topics:

Unit-I: INTRODUCTION TO PROGRAMMING

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.), Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/ Pseudocode with examples, from algorithms to programs; source code, variables (with data types) variables and memory, locations, Syntax and Logical Errors in compilation, object and executable code, Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops.

Unit-II: ARRAYS AND STRINGS

Introduction - One dimensional and two-dimensional arrays – Declaration of arrays – Initializing and Accessing array elements – Strings: One dimensional character arrays - Declaration and String Initialization - String Manipulation - Multidimensional Arrays - Arrays of Strings

Unit-III: BASIC ALGORITHMS

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit-IV: FUNCTION

Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference, Recursion, Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit-V: STRUCTURE, POINTERS & FILE HANDLING

Structures, defining structures and Array of Structures, Idea of pointers, defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling (only if time is available, otherwise should be done as part of the lab)

List of Experiments:

1. Tutorial 1: Problem solving using computers
2. Lab 1: Familiarization with programming environment
3. Tutorial 2: Variable types and type conversions:
4. Lab 2: Simple computational problems using arithmetic expressions
5. Tutorial 3: Branching and logical expressions:
6. Lab 3: Problems involving if-then-else structures
7. Tutorial 4: Loops, while and for loops:
8. Lab 4: Iterative problems e.g., sum of series
9. Tutorial 5: 1D Arrays: searching, sorting:
10. Lab 5: 1D Array manipulation
11. Tutorial 6: 2D arrays and Strings
12. Lab 6: Matrix problems, String operations
13. Tutorial 7: Functions, call by value:
14. Lab 7: Simple functions
15. Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration):
16. Lab 8 and 9: Programming for solving Numerical methods problems
17. Tutorial 10: Recursion, structure of recursive calls
18. Lab 10: Recursive functions
19. Tutorial 11: Pointers, structures and dynamic memory allocation
20. Lab 11: Pointers and structures
21. Tutorial 12: File handling:
22. Lab 12: File operations

Text Book(s):

1. Byron Gottfried, "*Schaum's Outline of Programming with C*", Edition: 1, McGraw Hill India , 2010.
2. E. Balagurusamy, "*Programming in ANSI C*", Edition: 1, McGraw Hill India , 2012.

Reference(s):

1. W. Brian Kernighan and M. Dennis Ritchie, "*The C Programming Language*", Edition: 1, PHI India , 2009.
2. Stephen Prata , "*C++ Primer Plus*", Edition: 6, Developers Library , 2017.
3. David Vandevoorde, "*C++ Templates*", Edition: 2, McGraw Hill India , 2016.

MEC18R152 : ENGINEERING PRACTICE	L	T	P	C
	2	0	2	3
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Theory with practical			

Course Objective(s):

Apply skills of basic mechanical engineering in diverse contexts including operation, application, classification, assemble, dismantle, maintenance and entrepreneurship, using critical thinking and judgment by theoretical and practice.

Course Outcome(s):

CO1	*Apply coherent and advanced knowledge of Lathe machines and their operations*
CO2	*Summarize the various Air-conditioning methodologies and their maintenance procedure*
CO3	*Compare the working of Two stroke & Four stroke engines and apply professional practice to the operation and maintenance of Lead acid battery*
CO4	*Explain the working principle of Oven and Pumps and identify the working and maintenance procedures*
CO5	*Identify the different types of Plumbing joints and demonstrate various layouts*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1			2			2			1	2		
CO2	2	1	2			2	2		2			2	2	1	
CO3	2		1			2	2		2			2	2		
CO4	2					2	1		2			1	1		
CO5	2					1			2			1	1		

Course Topics:

Unit-I: BASIC MACHINING

Introduction - types of lathe machines - lathe accessories, work holding device and tool holding device - lathe operations - Calculation of MRR for simple turning operation. Introduction to CNC turning machines.

Unit-II: AIR CONDITIONING

Introduction, types of air conditioning system, working of commercial air conditioner, components of AC system, selection of suitable AC based on room size, AC ratings scheduled maintenance, assembling and dismantling of window AC

Unit-III: AUTOMOTIVE SYSTEMS

Introduction – Classification - Purpose, capacity, fuel source, transmission system - working of two stroke and four stroke engines. Introduction – types of batteries - construction – battery rating, scheduled maintenance of four wheeler and two wheeler batteries – assembling and dismantling of lead acid battery - testing of voltage

Unit-IV: ENERGY AND FLOW DEVICES

Types of energy devices (Gas stove, Induction, Micro-oven), working principle of induction and micro oven, commercial food preparing equipment, preventive maintenance check list, assembling and dismantling of gas stove. Introduction – types of pump - centrifugal, jet pump, working of centrifugal and jet pump, assembly and dismantling of pumps.

Unit-V: PLUMBING

Introduction - Plumbing Tools, Pipe – Piping layout symbol - Types of pipe joints - Pipe line diagram for shower, washbasin and overhead tank. Selection of materials for shower, washbasin and overhead tank layouts.

Practical Modules:

1. Plain turning operation in Lathe
2. Filling and evacuating refrigerant gas procedure in refrigerant kit
3. Study on vehicle smoke testing
4. Two wheeler carburetor check-up
5. Charging and draining of a Lead-acid battery
6. Study on diesel pump service
7. Dismantling and assembling of Gas stove.
8. L- Halving (Or) Corner Lap Joint.
9. Study on arc and gas welding practices
10. Plumbing layout for shower and washbasin connections
11. L-Fitting

Text Book(s):

1. S. Suyambazhahan, "*Engineering Practices*", Edition: 2, PHI Learning , 2012.
2. S.K. Hajra Choudhury, A.K .Hajra Choudhury and Nirjhar Roy, "*Elements of Workshop Technology Vol. I & Vol. II*", Edition: 15, Media promoters and publishers private limited , 2010.

Reference(s):

1. P.N.Ananthanarayanan, "*Basic Refrigeration and Air-conditioning*", Edition: 4, Mc Graw Hill , 2013.
2. Eric Kleinert, "*Troubleshooting and Repairing "Major Appliances*", Edition: 3, McGraw-Hill Education , 2012.
3. M. Adithan, S.C. Laroiya, "*Practical Refrigeration & Air-conditioning*", Edition: 5, New age international publishers , 2011.

MEC18R903 : BASICS OF ROBOTIC SIMULATION	**L**	**T**	**P**	**C**
	3	**0**	**2**	**4**
Pre-requisite: Nil	**Course Category:** Basic Engineering **Course Type :** Integrated Course			

Course Objective(s):

To provide an overview of electronic device components to Mechanical engineering students

Course Outcome(s):

CO1	*Understand the principles of simulation and its environment.*
CO2	*Design a replication of actual manufacturing process.*
CO3	*Understand the importance of robotics in production line*
CO4	*Understand the standard engineering manufacturing process in simulation environment.*
CO5	*Learn the application of robotics in multiple domains*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1										1	3		
CO2		3	2				1					2	2	2	2
CO3	1	2											3	3	3
CO4		3										3	2		
CO5		3					2					3	2		

Course Topics:

Unit-I: INTRODUCTION TO SIMULATION ENVIRONMENT

Basic Environment - Study creation - Creating sequences of simulative operations - Collision detection - Section cutting - Video and picture output

Unit-II: KINEMATICS

Defining kinematic devices

Unit-III: ROBOT AUTOMATION

Defining and simulating robotic spot welding - Pneumatic and servo gun definition and usage - pedestrial welding and Gun on robot path development.

Unit-IV: SIMULATION

Defining and simulating robotic continuous applications - Arc welding and grinding path development

Unit-V: APPLICATION

Defining and simulating robotic material handling- Gripper definition and usage- Pick and place path development.

Additional Topics

Multi-robot simulation (i.e. interference zones) - Swept volumes, 7th axis, etc.

Text Book(s):

1. A.David Bell, "*Electronic Devices and Circuits*", Edition: 5, Oxford University Press , 2008.

2. Floyd, "*Electronic Devices*", Edition: 9, Pearson Education , 2016.

Reference(s):

1. R P Jain, "*Modern Digital Electronics*", Edition: 4, McGraw Hill , 2009.
2. Frenzel, "*Communication Electronics: Principles and Applications*", Edition: 3, McGraw Hill , 2002.

PROGRAM CORE COURSES

MEC18R203 : THERMODYNAMICS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

- To learn about work & heat interactions and energy balance in systems
- To learn about application of 1st law of thermodynamics
- To learn about second law of thermodynamics and its limitation
- To learn about the properties of pure substances and related application

Course Outcome(s):

CO1	*Outline the fundamental concepts and first law of thermodynamics*
CO2	*Interpret the idea of second law of thermodynamics*
CO3	*Construct the limitation of thermodynamic laws*
CO4	*Extend the properties of pure substances*
CO5	*Illustrate the basic ideas about the properties and process involved in psychrometry*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1					1				1	3		
CO2	3	2	1					1				1	3		
CO3	3	3	1	2				1				1	3		
CO4	3	2						1				1	3		
CO5	3	2	1					1				1	3		

Course Topics:

Unit-I: FUNDAMENTALS OF THERMODYNAMICS, ZEROTH AND FIRST LAW

Fundamentals - System & Control volume; Property, State & Process; Work – modes of work; Path dependence of displacement work, Temperature, Definition of thermal equilibrium and Zeroth law and Temperature scales, first Law for Cyclic & Non-cyclic processes; Concept of total energy E; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume, Steady state steady flow processes including throttling; Examples of steady flow devices and First law applications for system and control volume.

Unit-II: SECOND LAW OF THERMODYNAMICS

Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.

Unit-III: ANALYSIS OF SECOND LAW OF THERMODYNAMICS

Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property, Illustration of processes in T-s coordinates, Evaluation of S for solids, liquids, ideal gases. Principle of increase of entropy, Definition of Isentropic efficiency for compressors turbines and nozzles, Irreversibility and Availability and Illustration of processes in T-s coordinates

Unit-IV: PURE SUBSTANCES

Definition of Pure substance, Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

Unit-V: PSYCHROMETRY

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.

Text Book(s):

1. P.K.Nag, "*Engineering Thermodynamics*", Edition: 6, Tata McGraw-Hill Co. Ltd. , 2017.
2. Y.A.Cengel, "*Thermodynamics – An Engineering Approach*", Edition: 8, Tata Mc Graw Hill, New delhi , 2017.

Reference(s):

1. E.Radhakrishnan, "*Fundamentals of Engineering thermodynamics*", Edition: 2, Prentice hall , 2005.
2. J.P.Holman, "*Thermodynamics*", Edition: Third Edition, McGraw-Hill , 2008.
3. E.Richard Sonntag Claus Borgnakke, "*fundamentals of thermodynamics*", Edition: 7, Wiley , 2009.

MEC18R208 : MATERIALS SCIENCE	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course Outcome(s):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2									3	1	
CO2	3		2	3									3	3	
CO3	3	2	1	2									3		
CO4	3	2	2	3									3	2	
CO5	3	3	2										3	3	

Course Topics:

Unit-I: 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.

Unit-II: 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.

Unit-III: 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.

Unit-IV: 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.

Unit-V: 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.

Text Book(s):

1. G.Kenneth Budinski and K. Michael Budinski, "*Engineering Materials*", Edition: 4, Prentice-Hall of India , 2002.

Reference(s):

1. D.William Callister Jr, "*Material Science and Engineering*", Edition: 6, John Wiley and Sons , 2005.
2. V.Raghavan, "*Material Science and Engineering*", Edition: 1, Prentice Hall of India , 1999.
3. H. Sydney Avner, "*Introduction to Physical Metallurgy*", Edition: 1, McGraw Hill Book Company , 1994.

MEC18R210 : INSTRUMENTATION AND CONTROL	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

1. To provide a basic knowledge about measurement systems and their components
2. To learn about various sensors used for measurement of mechanical quantities
3. To learn about system stability and control
4. To integrate the measurement systems with the process for process monitoring and Control

Course Outcome(s):

CO1	*Interpret the basic concepts of measurement*
CO2	*Illustrate the response of the signals and their conditioning*
CO3	*Relate the sensor basics and its applications*
CO4	*Make use of sensor for industrial applications*
CO5	*Solve the control system for the instruments*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1									2		
CO2	3	2		1									2		
CO3	3	2		1	2								2		
CO4	3	2		1	2										
CO5	3	2		1											

Course Topics:

Unit-I: MEASUREMENTS

SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q -meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

Unit-II: SIGNAL PROCESSING AND CONDITIONING

Periodic, aperiodic and impulse signals; Laplace, Fourier and z -transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; onvolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

Unit-III: MICRO SENSORS AND ACTUATORS

Micro Sensors: Principles and examples, Force and pressure micro sensors,position and speed micro sensors, acceleration micro sensors, chemical sensors,biosensors, temperature micro sensors and flow micro

sensors.Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles.

Unit-IV: SENSORS AND INDUSTRIAL INSTRUMENTATION

Resistive-, capacitive-, inductive-, piezoelectric-, Hall Effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement.

Unit-V: CONTROL SYSTEMS

Feedback principles, signal flow graphs, transient response, steady -state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead -lag compensators, state -space representation of systems; time- delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on- off, P, P -I, P -I-D, cascade, feed forward, and ratio controllers.

Text Book(s):

1. W. Bolton, "*Instrumentation and control systems*", Edition: 1, Newnes , 2004.
2. G.Thomas. Beckwith, D.Roy Marangoni, H. John, V.Lienhard, "*Mechanical Measurements*", Edition: 6, Pearson Education India , 2007.

Reference(s):

1. K.Gregory McMillan, "*Process/Industrial Instruments and Controls Handbook*", Edition: 5, McGraw-Hill , 1999.

MEC18R271 : STRENGTH OF MATERIALS	L	T	P	C
	3	0	2	4
Pre-requisite: MEC18R211 - Engineering Mechanics	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

To acquire knowledge in the concepts of stress, strain and deformation of solids and two dimensional bodies, beams and supports, beams deflection, torsion in springs and shafts

Course Outcome(s):

CO1	*Analyse the simple stresses in bars, composite bars and thermal stresses*
CO2	*Analyse the stresses in two dimensional bodies and evaluating the deformation in thin cylinder and spherical shells*
CO3	*Demonstrate shear force, bending moment and stress distribution of various types of beams with different support*
CO4	*Analyzing the deflection of the beams through various methods*
CO5	*Illustrate the deflection of all types of shafts due to torsion and deformation various types of springs*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1								3		1
CO2	3	2	3	2	2								3		1
CO3	3	2	3	2	1								3		1
CO4	3	2	3	2	1								3		1
CO5	3	2	3		2								3		1

Course Topics:

Unit-I: STRESS, STRAIN AND DEFORMATION IN SOLIDS

Tension, compression and shear stresses – Hook's law – stress- ultimate stress and working stress – elastic constants and relationships between them – composite bars – thermal stresses.

Unit-II: STRESS AND DEFORMATION IN TWO DIMENSIONAL BODIES

Two dimensional state of stress at a point – normal and shear stresses on any plane, principal planes and principal stresses – graphical method– Mohr's Circle - stresses and deformations in thin cylinders and spherical shells due to internal pressure

Unit-III: BEAMS AND SUPPORTS

Types of beam supports – cantilevers, simply supported, overhanging beams. Types of loadings – shear force – bending moment diagram. Theories of bending – bending stress distribution – load carrying capacity for point and distributed loads.

Unit-IV: DEFLECTION IN BEAMS

Deflection in beams using double integral method – area moment method for computation of slopes and deflection in beams – moment of inertia – Maxwell's reciprocal theorems.

Unit-V: TORSION IN SPRINGS AND SHAFTS

Torsional stresses and deformation in solid shafts, hollow shafts– deflection in solid shafts for fixed ends. Helical springs – leaf springs – stresses in springs – Torsion and deformation – deflections in spring

List of Experiments:

1. Tension test on mild steel rod
2. Compression test
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinell, Rockwell hardness number
6. Deflection test on beams
7. Stiffness test on helical springs.
8. Double shear test on mild steel rod.
9. Pin on disk – exercise on mild steel plate.

Text Book(s):

1. E.P Popov, "*Engineering Mechanics of solids*", Edition: 8, Prentice Hall of India, New Delhi , 2014.
2. S.M.A Kazimi, "*Solid Mechanics*", Edition: 4, Tata McGraw Hill Book Co Ltd , 2017.

Reference(s):

1. R.K Rajput, "*Strength of Materials*", Edition: 8, S. Chand Publications , 2009.
2. R.K Bansal, "*Strength of Materials*", Edition: 4, Laxmi Publications , 2015.
3. P. Stephen Timoshenko, "*History of Strength of Materials*", Edition: 1, McGraw Hill Book Co Ltd , 1953.

MEC18R272 : FLUIDMECHANICS AND MACHINERY	L	T	P	C
	3	0	2	4
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

To covert the basic principles and equation of fluid mechanics and to present numerous and diverse real world engineering examples to give students a feel for how fluid mechanics is applied in engineering practice.

Course Outcome(s):

CO1	*Identity the different properties of fluid and learning the different types of pressure measuring devices for various applications.*
CO2	*Interpret the kinematics and dynamics of fluid flow and analyze the Bernoulli's equation to real time problem*
CO3	*Judging the different types of losses occurs in a pipe when fluid flows*
CO4	*Contrast the working principle of different turbines and analyze the performance Calculation of different turbines*
CO5	*Categorize the working principles of different pumps and focus the performance Calculation of different pumps*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2				2			2	2	2	
CO2	3	2	2	2	2				2			2	2	2	
CO3	3	2	2	2	2				2			2	2	2	
CO4	3	2	2	2	2				2			2	2	2	
CO5	3	3	1	1					2			2	2	2	

Course Topics:

Unit-I: BASIC CONCEPTS AND PROPERTIES

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.

Unit-II: FLUID KINEMATICS AND FLUID DYNAMICS

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 - Venturimeter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's Π theorem and its applications-similarity laws and models

Unit-III: INCOMPRESSIBLE FLUID FLOW

Viscousflow-Navier-Stoke'sequation(Statement only)-shearstress, pressure gradient relationship, Couette flow-laminar flow between parallel plates, Laminar flow through circular tubes (Hagen Poiseulle's) - flow through pipes - Darcy - Weisback's equation, Moody's diagram- friction factor minor losses– flow through pipes in series and in parallel –boundary layer flows, boundary layer thickness, boundary layer separation, measures of boundary layer thickness

Unit-IV: HYDRAULIC TURBINES

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.

Unit-V: HYDRAULIC PUMPS

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.

List of Experiments:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rotameter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of Centrifugal pump / Submergible pump.
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic Kaplan turbine

Text Book(s):

1. V. L Streeter, and E.B Wylie, "*Fluid Mechanics*", Edition: 9, McGraw-Hill , 2010.
2. K.L. Kumar, "*Engineering Fluid Mechanics*", Edition: 8, S.Chand Publication (P) Ltd, New Delhi , 2010.

Reference(s):

1. V.P Vasandani, "*Hydraulic Machines - Theory and Design*", Edition: 11, Khanna Publishers , 2010.
2. R.K Bansal, "*Fluid Mechanics and Hydraulics Machines*", Edition: 9, Laxmi publications (P) Ltd, New Delhi , 2017.
3. F.M White, "*Fluid Mechanics*", Edition: 8, Tata McGraw-Hill , 2015.

MEC18R274 : THERMAL ENGINEERING	L	T	P	C
	3	0	2	4
Pre-requisite: MEC18R203-Thermodynamics	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

This course will make the student to understand the process and applications undergoing with respect to the gas power cycles, nozzles, diffusers and refrigeration system. This would make them to thorough the concepts with elaborate idea and analysis with some practical Knowledge.

Course Outcome(s):

CO1	*Employ the basic concepts behind the gas power cycles with ability to acquire solutions.*
CO2	*Interpret the knowledge gained in the concepts on flow of steam through nozzle, diffuser and turbines*
CO3	*Apply pure substance behavior in vapour power cycles*
CO4	*Analyze and acquire solutions to the problems involved in the air compressors*
CO5	*Solve the basic problems and interpret the concepts behind the refrigeration system*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3							3	2		2	3	2	
CO2	3	2										2	3		
CO3	3	3							3	2		2	3	2	
CO4	3	2										2	3		
CO5	3	2				2						2	3	1	

Course Topics:

Unit-I: GAS POWER CYCLES

Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle –Calculation of mean effective pressure and air standard efficiency, effect of reheat, regeneration and intercooling.

Unit-II: NOZZLES, DIFFUSER AND TURBINES

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.

Unit-III: VAPOUR POWER CYCLES

Basic Rankine cycle, with superheat, reheat and regeneration comparison with Carnot cycle

Unit-IV: AIR COMPRESSOR

Reciprocating compressors, Effect of clearance and volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors

Unit-V: REFRIGERATION

Vapor compression refrigeration system-description, Analysis Refrigerating effect -Power required, Unit of refrigeration, COP - Refrigerants and their desirable properties. Reversed Carnot cycle, Reversed Brayton cycle - Vapor absorption refrigeration system.

List of Experiments:

1. Port timing diagram
2. Valve timing diagram
3. Performance test on four stroke diesel engine
4. Performance test on single stage air compressor
5. Performance test on two stage air compressor
6. Determination of flash point and fire point using open cup apparatus
7. Determination of flash point and fire point using closed cup apparatus
8. Determination of viscosity using Saybolt viscometer.
9. Determination of viscosity using Redwood viscometer.

Text Book(s):

1. R. K. Rajput, "*Thermal Engineering*", Edition: 8, Laxmi Publication , 2010.
2. M. Mahesh Rathore, "*Thermal Engineering*", Edition: 1, Mcgraw Higher ed , 2012.

Reference(s):

1. Frank Krieth, "*The CRC Handbook of Thermal Engineering,*", Edition: 1, Springer-Verlag Berlin Heidelberg , 2000.
2. P.K. Ballaney, "*Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques*", Edition: 5, Khanna Publishers , 2005.
3. R.S. Khurmi, "*A Textbook of Thermal Engineering: Mechanical Technology*", Edition: 1, S, Chand , 2006.

MEC18R302 : MANUFACTURING PROCESSES	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

Course Outcome(s):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3		1		2		1	1	2		3
CO2	3	3	2	2					1						
CO3	3	3	2	3	3			2	2		1	1	2		3
CO4	3	3	3	3				2	1		1	1			
CO5	3	3	3	3			2	1	1		1	2	2		

Course Topics:

Unit-I: METAL CASTING PROCESS

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-II: FABRICATION PROCESS

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-III: BULK DEFORMATION PROCESSES

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-IV: FORMING PROCESS

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-V: MACHINING PROCESS

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. R.K.Jain, "*Production Technology*", Edition: 1 , Khanna Publishersa , 2002.
2. P.Mikell Groover, "*Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*", Edition: 3, Wiley , 2010.

Reference(s):

1. A.Ghosh, and A.K.Malik, "*Manufacturing Science*", Edition: 1, Affiliated East west Press Pvt. Ltd. , 2008.
2. Serope Kalpakjian and R.Steven Schmid, "*Manufacturing Engineering and Technology*", Edition: 7, Pearson Education , 2018.
3. PC. Pandey, H.S.Shan, "*Modern machining processes*", Edition: 1, Tata McGraw-Hill. , 1981.

MEC18R303 : DESIGN OF MACHINE ELEMENTS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R271- Strength of Materials	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

- To introduce students to the design and theory of common machine elements and to give students experience in solving design problems involving machine elements.
- To synergize forces, moments, torques, stress and strength information to develop ability to analyze, design and/or select machine elements – with attention to safety, reliability, and societal and fiscal aspects.
- To require the student to prepare professional quality solutions and presentations to effectively communicate the results of analysis and design

Course Outcome(s):

CO1	*Solve simple stresses in beams, hooks and shafts.*
CO2	*Design shafts, keys and couplings for power transmission.*
CO3	*Estimate load carrying capacity of threads and welds joints.*
CO4	*Select springs and levers for different applications.*
CO5	*Interpret the use of sliding and rolling contact bearings.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2		1				1			3		1
CO2	3	3	3	2		1				2			3		1
CO3	3	2	3	2		1				2			3		1
CO4	3	2	3	2		1				2			3		1
CO5	3	2	2	1		1				2			3		1

Course Topics:

Unit-I: SIMPLE STRESSES

Basics in Engineering Design – preferred numbers, fits and tolerances – Types of simple stresses – static and varying loading – combined loading – theories of failures – allowable stress – factor of safety – stress concentration factor – fluctuating stress- design for combined fatigue loading Soderberg, Goodman and Gerber relations.

Unit-II: DESIGN OF SHAFTS, KEYS AND COUPLINGS

Design principles of shafts – static, fatigue loading – critical speed. Design of keys. Design of couplings.

Unit-III: DESIGN OF TEMPORARY AND PERMANENT JOINTS

Welded joints: Types of welded joints- weld symbols, strength of welds- centrally loaded joints- axially loaded joints-eccentrically loaded joints. Threaded joints: I.S.O. Metric screw threads- treaded joints in tension-fluctuating load- torque requirement for tightening and eccentrically loaded bolted joints.

Unit-IV: DESIGN OF SPRINGS

Helical springs and leaf springs: Stresses and deflection in helical springs - Design of leaf springs- stress and deflection - exercise problems in springs used for automobiles

Unit-V: DESIGN OF BEARINGS

Sliding contact bearings: Theory of lubrication- hydrodynamic bearings-Sommer field number- design of hydrodynamic bearings. Rolling contact bearings: Static and dynamic load capacity- cubic mean load- variable load-probability of survival- selection of deep groove and angular contact ball bearings.

Text Book(s):

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

Reference(s):

1. "*Design Data book*", Edition: 5, PSG College of Technology, Coimbatore , 2016.
2. T.V.Sundararajamoorthy, N.Shanmugam, "*Machine Design*", Edition: 1, Anuradha Publications , 2012.
3. C. Robert Juvinall and M. Kurt Marshek, "*Fundamentals of Machine Design*", Edition: 4, Wiley , 2005.

MEC18R351 : FINITE ELEMENT ANALYSIS	L	T	P	C
	2	0	2	3
Pre-requisite: MEC18R271-Strength of Materials	**Course Category:** Program Core Courses **Course Type :** Theory with practical			

Course Objective(s):

This course enables the students to virtually test and predict the behavior of mechanical structures in addition to solving complex engineering problems

Course Outcome(s):

CO1	*Apply the knowledge of mathematics and finite element concept to solve engineering problems.*
CO2	*Recognize the basic principle of Finite Element Analysis in 1D structural and heat transfer application*
CO3	*Ability to solve 2-D structural and thermal problem using FEA.*
CO4	*Analyze the iso parametic element formulation using FEA*
CO5	*Evaluate the Vibration and Torsion of non-circular shafts.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3				1	1			3		2
CO2	3	3	3	2	2				1	1			3		2
CO3	3	2	2	2	2				1	1			3		2
CO4	3	2	2	2	2				1	1			3		2
CO5	3	2	2	2	2				1	1			3		2

Course Topics:

Unit-I: INTRODUCTION

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.

Unit-II: ONE DIMENSIONAL PROBLEMS

One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer.

Unit-III: TWO DIMENSIONAL PROBLEMS

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.

Unit-IV: ISOPARAMETRIC ELEMENTS FORMULATION

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, and introduction to FE software.

Unit-V: VIBRATION AND TORSION PROBLEMS

Longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies, Torsion of non-circular shafts, quadrilateral and higher order elements

Practical Modules:

1. Stress analysis of a plate with a circular hole
2. Stress analysis of rectangular L – bracket
3. Mode frequency analysis of a 2D component
4. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
5. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)

Text Book(s):

1. J.N Reddy , "*An Introduction to Finite Element Method*", Edition: 3, Tata McGraw Hill , 2006.
2. P. Seshu , "*Text Book of Finite Element Analysis*", Edition: 2, Prentice Hall , 2013.

Reference(s):

1. S.S.Rao, "*The Finite Element Method in Engineering*", Edition: 3, Butterworth Heinemann , 2004..
2. Chandraputla & Belegundu, "*Introduction to Finite Elements in Engineering*", Edition: 4, Prentice Hall , 2011.

MEC18R373 : HEAT AND MASS TRANSFER	L	T	P	C
	3	0	2	4
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

To evaluate various modes of heat transfer and design of heat exchangers and to enable students to do experimentation on heat transfer equipment's and enhance practical knowledge of various systems.

Course Outcome(s):

CO1	*Apply basic principles of heat transfer for solving problems and demonstrate fundamentals principles of heat transfer in practice*
CO2	*Solve free and forced convection problems using correlations and perform experimentation*
CO3	*Analyse the performance of heat exchangers and demonstrate in practice.*
CO4	*Evaluate radiation problems using perform correlations and experimentation*
CO5	*Assess different mass transfer systems*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1				2			2	3		
CO2	3	3	3	2	3				2			1	2	3	2
CO3	3	3	2	1	2				2			2	3	3	
CO4	3	2	2	2	2				2			3	3		
CO5	3	2		1					2			2	2		

Course Topics:

Unit-I: CONDUCTION

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts

Unit-II: CONVECTION

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit-III: CONVECTIVE PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

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-IV: RADIATION

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

Unit-V: MASS TRANSFER

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

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

Text Book(s):

1. R.C Sachdeva, "*Fundamentals of Engineering Heat and Mass Transfer*", Edition: 5, New Age International Publishers , 2017.
2. A. Yunus Cengel and J. Afshin Ghajar, "*Heat and Mass Transfer: Fundamentals and Applications (SIE)*", Edition: 5, Tata Mc Graw Hill publications , 2017.

Reference(s):

1. R. Yadav, "*Heat and Mass Transfer*", Edition: 1, Central Publishing House , 1995.
2. P.K Nag, "*Heat Transfer*", Edition: 3, Tata McGraw-Hill , 2011.
3. J.P Holman, "*Heat and Mass Transfer*", Edition: 10, Tata McGraw-Hill , 2011.

MEC18R374 : KINEMATICS AND THEORY OF MACHINES	**L**	**T**	**P**	**C**
	3	**0**	**2**	**4**
Pre-requisite: MEC18R211- Engineering Mechanics	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

To acquire the knowledge in basic of mechanics, cam profile, vibration and control mechanisms, balancing of machines

Course Outcome(s):

CO1	*Apply the knowledge of simple mechanisms gained in real time applications by fabricating it.*
CO2	*Create and analyze the velocity and acceleration of various mechanisms by applying relative principle.*
CO3	*Design, develop and analyze profile of CAM for any applications*
CO4	*Apply the concept of balancing and use it for reducing the unbalanced forces in rotating masses and reciprocating engines.*
CO5	*Apply different damping methods to minimize vibrations and Calculating gyroscopic couple on various vehicles.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3				2		2	2		1	3	2	
CO2	3	2	3						1	1		1	3	1	1
CO3	3	3	3				2		2	2		1	3	3	
CO4	3	2	2	2	2	1		1				1	3	1	1
CO5	3	3	3	1				1		2		1	3	1	

Course Topics:

Unit-I: BASICS OF MECHANISMS

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms

Unit-II: KINEMATICS

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, kinematic analysis of simple mechanisms- slider crank mechanism dynamics Coincident points- Coriolis component of acceleration- introduction to linkage synthesis three position graphical synthesis for motion and path generation.

Unit-III: CAM PROFILES

Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers

Unit-IV: BALANCING OF MACHINES

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-V: VIBRATION AND CONTROL MECHANISM

Basic features of vibratory systems - Basic elements and lumping of parameters - Degrees of freedom – Single degree of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in aeroplanes and ships

List of Experiments:

1. Determination of Moment of Inertia by Oscillation
2. Determination of Speed and Sensitivity of a Porter Governor
3. Determination of Speed and Sensitivity of a Hardnell Governor.
4. Determination of Speed and Sensitivity of a Proell Governor.
5. Determination of Critical Speed of a Shaft using Whirling Apparatus.
6. Determination of Frequency of Transverse Vibration of a Free-Free Beam.
7. Determination of Natural Frequency of spring mass System Theoretically and Verify Experimentally.
8. Determination of Time Period for Oscillations of a Compound Pendulum.
9. Determination of the Natural frequency of Spring Mass System and Damping Factor its Coefficient (Multi Degree of Freedom).
10. Study of simple, compound and epicyclic gear trains.

Text Book(s):

1. S.S Rattan, "*Theory of Machines*", Edition: 4, Tata McGraw-Hill Publishing Company Ltd , 2017.
2. Thomas Bevan, "*Theory of Machines*", Edition: 3, CBS Publishers & Distributors , 2005.

Reference(s):

1. W.L Cleghorn, "*Mechanisms of Machines*", Edition: 2, Oxford University Press , 2005.
2. L. Robert Norton, "*Kinematics and Dynamics of Machinery*", Edition: 1, Tata McGrawHill , 2009.
3. A. Ghosh and A.K Mallick, "*Theory of Mechanisms and Machines*", Edition: 1, Affiliated East- West Pvt. Ltd , 2008.

MEC18R352 : METAL CUTTING TECHNOLOGY	L	T	P	C
	2	0	2	3
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory with Practical			

Course Objective(s):

To understand the basic concepts of cutting mechanism used in manufacturing Industry and Tools used for production Technology and the measurements of various measuring instruments and methods

Course Outcome(s):

CO1	*Illustrate the nomenclature of single and multipoint cutting tools*
CO2	*Describe the importance of the machinability index and economic machining*
CO3	*Summarize the various types of jigs and fixtures and their usage and application in related machines*
CO4	*Evaluate the performance of linear and angular measuring instruments*
CO5	*Enumerate the assembly practices and various materials handlings Devices used in industries*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		1			1				1	3	3	
CO2	3	2	1	1	1			1				1	3	1	
CO3	3	2	2	1				1				1	3	2	
CO4	3	2		1	2			1				1	3	3	
CO5	3	2	1	2				2				1	3	2	

Course Topics:

Unit-I: INTRODUCTION

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-II: MACHINABILITY

Machinability - variables affecting machinability - machinability index - economics of machining - selection of optimal machining conditions - productivity of machine tools

Unit-III: JIGS AND FIXTURE

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.

Unit-IV: METROLOGY AND MEASUREMENTS

Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and work piece quality.

Unit-V: ASSEMBLY AND MATERIAL HANDLING

Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.

List of Experiments:

1. Taper turning and external thread cutting using lathe
2. Contour milling using vertical milling machine
3. Spur gear cutting in milling machine
4. Surface grinding
5. V-tool/parting tool grinding
6. Cylinder grinding
7. Use of Tool Maker's Microscope
8. Sine bar and comparators
9. Surface finish measurement equipment
10. Bore diameter measurement using micrometer
11. Use of Autocollimator
12. Gear inspection using profile projector

Text Book(s):

1. Kalpakjian and Schmid, "*Manufacturing processes for engineering materials*", Edition: 5, Pearson India , 2014.
2. I.C Gupta, "*Engineering Metrology*", Edition: 1, Dhanpatrai Publications , 2012.

Reference(s):

1. R.K Jain, "*Engineering Metrology*", Edition: 1, Khanna Publishers , 2005.
2. D. Roy Marangoni, H. John Lienhard, G. Thomas Beckwith, "*Mechanical Measurements*", Edition: 5, Pearson Pvt Ltd , 2014.
3. G. Edward Hoffman, "*Jig and Fixture Design*", Edition: 5, Delmar Learning , 2010.

MEC18R448 : AUTOMATION IN MANUFACTURING SYSTEMS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Theory			

Course Objective(s):

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC
3. To understand the basics of product design and the role of manufacturing automation

Course Outcome(s):

CO1	*Explain the concepts of automation in the field of machine tool based manufacturing*
CO2	*Outline the basic fundamentals of CAD software*
CO3	*Apply the knowledge in computer aided manufacturing and CNC technology*
CO4	*Interpret the various strategies in low cost automation.*
CO5	*Contrast the basics of product design towards industrial application.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2						1		3		
CO2	3			2	2						1	2	3		3
CO3				2								2	3		
CO4	3	2		2	2	2					1	2	3		
CO5		2	2		3	2									

Course Topics:

Unit-I: INTRODUCTION TO AUTOMATION

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, Unigraphics, Solid works.

Unit-II: COMPUTER AIDED DESIGN

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods.

Unit-III: COMPUTER AIDED MANUFACTURING

Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC- Adaptive Control, Automated Material handling, Automated Guided Vehicles (AVG), Group Technology (GT), Computer Aided Process Planning (CAPP).

Unit-IV: LOW COST AUTOMATION

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies.

Unit-V: INTRODUCTION TO MODELING AND SIMULATION

Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

Text Book(s):

1. P.Mikell Groover, "*Automation, Production Systems, and Computer-integrated Manufacturing*", Edition: 4, Prentice Hall , 2016.
2. Serope Kalpakjian and R.Steven Schmid, "*Manufacturing – Engineering and Technology*", Edition: 7, Pearson , 2013.

Reference(s):

1. YoramKoren, "*Computer control of manufacturing system*", Edition: 1, McGraw Hill Education , 2017.
2. Ibrahim Zeid, "*CAD/CAM: Theory & Practice*", Edition: 2, McGraw Hill Education , 2009.
3. P.N.Rao, "*CAD/CAM: Principles and applications*", Edition: 3, McGraw Hill Education , 2017.

MEC18R902 : SYNCHRONOUS MODELLING WITH NX CAD	L	T	P	C
	3	0	2	4
Pre-requisite: Nil	**Course Category:** Program Core Courses **Course Type :** Integrated Course			

Course Objective(s):

To enable the students about modelling and assembly of machine components

Course Outcome(s):

CO1	*Demonstrate various drawing conventions, abbreviations and their usage*
CO2	*Apply the knowledge of dimensioning, fits and tolerance in industrial sectors*
CO3	*Draw machine element using NX designer tools*
CO4	*Outline the drawing principles of synchronous modelling*
CO5	*Combine the various drawn parts of the component into assembled view*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3						1	3			2		1
CO2	3	1	3		1				3	3		1	3	1	2
CO3	3	1	3		1				3	3			3		2
CO4	3	1	3		1				3	3			3	1	2
CO5	3	1	3		1				3	3			3	1	3

NX ADVANCED USER

Working with existing parts-Hole features -Expressions -Coordinate systems -Part Navigator -Associative -copies -Face and edge operations -Basic freeform -Creating and modifying assemblies

Assembly Constraints - Assembly Arrangements -Reference Sets -Interpart geometry and references -Component arrays -Reuse Library -Revise and replace components

SYNCHRONOUS MODELLING

Documenting design intent (Feature Groups, Product Interfaces) - Editing parametric models (Replace features, Suppression by Expression, model updates) - Associative curve operations (Project, Join, Intersect, Wrap/Unwrap, Text)

Emboss geometry (Emboss Body, Emboss, Offset Emboss) -Blending techniques (Advanced Edge Blend options, Face blends) - Interpart references (Interpart Expressions, Overriding Expressions) - Capturing part shape variations (Deformable Parts) - Design optimization (Optimization Study, Local and Global algorithms)

Intro to Synchronous modeling (Move, Pull, Replace, Delete Face) - Modifying detail features using Synchronous (Resize Blend, Chamfer, Replace Blend) - Reusing and relating faces using Synchronous (Pattern Face, Copy/Paste Face, Dimensions) - Optional: History-Free Synchronous (Optimize Face, Adaptive)

Reference(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.

MAJOR ELECTIVE - MANUFACTURING STREAM

MEC18R311 : NON-TRADITIONAL MACHINING TECHNIQUES	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

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

Course Outcome(s):

CO1	*Outline the importance and list of advanced machining techniques and suitability of mechanical energy based advanced machining process for the different materials.*
CO2	*Select the appropriate electrochemical machining process for the various materials.*
CO3	*Analyze the electrical energy based process for making complex profile in hard metals*
CO4	*Illustrate the Laser, Electron, Plasma and Ion beam machining processes, based on the accuracy of the end product can choose the best machining process.*
CO5	*Apply the basic knowledge in micro-machining and Nano-machining processes and hybridization of non-conventional machining processes.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2	2				2		2	2	2	1
CO2	2	2	2	1	2	2				2		2	2	2	2
CO3	2	2	2	1	3		1			2		2	2	2	
CO4	2	2			3		2			1		2	2	2	2
CO5	3	2	2		3	2						2	2		2

Course Topics:

Unit-I: MECHANICAL ENERGY BASED MACHINING

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-II: ELECTRO CHEMICAL MACHINING

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-III: ELECTRO THERMAL BASED MACHINING

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-IV: THERMAL PROCESS

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-V: HYBRID MACHINING

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*", Edition: 1, Allied Publishers , 2009.
2. A. Helmi, Youssef, "*Machining of Stainless Steels and Super Alloys: Traditional and Nontraditional Techniques*", Edition: 1, John Wiley & Sons, 2016.

Reference(s):

1. Ghosh Amitabh, Malik Ashok, "*Manufacturing Science*", Edition: 1, East West Press Pvt Ltd , 2010.
2. Hmt, Hmt, H M T, "*Production Technology*", Edition: 1, Tata McGraw-Hill Education, 2001.
3. A. Lindberg Roy, "*Processes and Materials of Manufacture*", Edition: 4, Prentice Hall of India, New Delhi , 2006.

MEC18R316 : THEORY OF METAL CUTTING	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R352- Metal Cutting 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):

CO1	*Describes the basic mechanism of metal cutting and chip formation.*
CO2	*Summarize the different aspects of single point cutting tools and their selection procedure.*
CO3	*Demonstrate the nomenclature and selection of multi point cutting tool.*
CO4	*Illustrate the concepts of micromachining process.*
CO5	*Analyze the concepts acquired to determine the machining time and product cost.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1				1			1			1	1	2	
CO2	3	3	1						1			1	3	3	
CO3	3	3	1						1			1	3	3	
CO4	3	2	2		2			1	1			1	2	2	
CO5	2	1			3				1			1	2	2	

Course Topics:

Unit-I: INTRODUCTION

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-II: SINGLE POINT CUTTING TOOLS

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-III: MULTIPOINT CUTTERS

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-IV: MICROMACHINING AND CHATTER IN MACHINING

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-V: ECONOMICS OF MACHINING

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. M.C. Shaw , "*Metal cutting Principles*", Edition: 2, Oxford clarendon Press , 2004.
2. B. L. Juneja, "*Fundamentals of metal cutting and machine tools*", Edition: 1, New Age International , 2003.

Reference(s):

1. Mikell P. Groover, "*Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*", Edition: 4, John Wiley & Sons , 2010.
2. W.A. Geoffrey Boothroyd and Knight, "*Fundamentals of Machining and Machine tools*", Edition: 2, CRC Press New York , 2008.
3. David A. Stephenson, John S. Agapiou, "*Metal Cutting Theory and Practice*", Edition: 3, CRC Press , 2000.

MEC18R325 : WELDING TECHNOLOGY	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R208 - Material Science	**Course Category:** Major Elective **Course Type :** Theory			

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):

CO1	*Select the appropriate welding processes and equipments to use in metal fabrication*
CO2	*Design a suitable equipment for heat transfer applications in welding*
CO3	*Identify the heat input and temperature distribution across a welded structure based on weld geometry*
CO4	*Evaluate the causes of defects in welding of ferrous metals*
CO5	*Interpret the microstructures of welds, defects and remedies for a wide range in non-ferrous alloys*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2					1						2		
CO2	3	3	2	2			2						3	1	
CO3	3		2					1				1	2	1	
CO4	3		2					1				1	2	1	
CO5	3	2	2									1	2	1	

Course Topics:

Unit-I: WELDING PROCESS AND EQUIPMENT'S

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-II: HEAT FLOW IN WELDING

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-III: WELDING METALLURGY

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-IV: WELDING OF FERROUS MATERIALS

Welding of Stainless steels, and cast irons – Welding procedure qualification, Microstructures of weldments, electrode and filler material selection, defects and remedies, weldment properties, microstructure and defects

Unit-V: WELDING OF NON FERROUS MATERIALS

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 and Scott C. Helzer, "*Modern Welding Technology*", Edition: 6, Pearson Prentice Hall , 2011.
2. J. R. Davis, "*Metals Handbook*", Edition: 2, Taylor & Francis , 1998.

Reference(s):

1. Cynthia L. Jenney, Annette O' Brien, "*Welding Handbook, Vol. 1: Welding Science and Technology*", Edition: 9, Woodhead Publishing Ltd , 2001.
2. J. F. Lancaster, "*Metallurgy of Welding*", Edition: 6, Elsevier, , 1999.

MEC18R335 : RECENT TRENDS IN WELDING TECHNIQUES	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R208- Material 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):

CO1	*Classify the different welding process, its heat sources and shielding methods.*
CO2	*Outline the concepts and applications of various types of pressure welding and resistance welding*
CO3	*Identify the advanced welding technique to use in metal fabrication.*
CO4	*Explain the concepts, various operating procedures and applications of soldering and brazing.*
CO5	*Analyze the solidification behavior and structure of weld zone with the welding parameters*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**2**	**1**										**2**		
CO2	**2**	**1**	**1**										**2**		
CO3	**2**	**1**	**1**										**2**	**2**	
CO4	**2**	**1**	**1**										**2**		
CO5	**2**	**3**	**1**										**1**		

Course Topics:

Unit-I: FUSION WELDING

Classification of welding processes- heat sources and shielding methods –fusion welding processes- oxy - acetylene welding, arc welding processes, electroslag and electrogas welding

Unit-II: PRESSURE WELDING AND RESISTANCE WELDING

Cold and hot pressure welding, friction, Solid state welding - friction stir, ultrasonic, induction pressure, explosive and diffusion welding, Principles of resistance welding, Spot welding and Seam welding- cold metal transfer welding.

Unit-III: NEWER WELDING TECHNIQUES

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-IV: SOLDERING AND BRAZING

Soldering- soldering materials, applications of soldering- brazing, filler materials and fluxes, Visual and Oral inspecting procedures.

Unit-V: WELDING METALLURGY

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

Text Book(s):

1. William A. Bowditch and Kevin E. Bowditch, "*Welding Fundamentals*", Edition: 5, Goodheart-Willcox Company, Incorporated , 2016.
2. J. F. Lancaster, "*Metallurgy of Welding*", Edition: 6, Elsevier , 1999.

Reference(s):

1. Cynthia L. Jenney, Annette O' Brien, "*Welding Handbook, Vol. 1: Welding Science and Technology*", Edition: 9, Woodhead Publishing Ltd , 2001.
2. R W Messler, "*Principles of Welding Processes*", Edition: 1, John Wiley & Sons, , 2008.
3. R S Parmar, "*Welding Engineering and Technology*", Edition: 1, Khanna Publishers , 2004.

MEC18R336 : MECHANICAL BEHAVIOUR OF MATERIALS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R208- Materials Science	**Course Category:** Major Elective **Course Type :** Theory			

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):

CO1	*Illustrate the elastic/plastic deformation and failure criteria*
CO2	*Apply dislocation theories for work hardening and strengthening mechanism*
CO3	*Outline the basic concepts involved in fatigue.*
CO4	*Dissect the behavior of material upon creep testing.*
CO5	*Examine the torsion testing of materials and understand the types of torsion failures.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2								2	3	2	
CO2	3	1	1	1	1							2	2	1	1
CO3	3	2	2	2								2	1	2	
CO4	3	2	1	2								2	2	3	
CO5	3	2	2	2								1	2	2	

Course Topics:

Unit-I: DEFORMATION

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-II: THEORY OF PLASTICITY

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-III: FATIGUE OF STRUCTURES

S.N. curves – Endurance limits – Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams – Notches and stress concentrations – Neuber’s stress concentration factors – Plastic stress concentration factors – Notched S.N. curves – Fatigue of composite materials.

Unit-IV: CREEP

Creep- importance in materials engineering – primary mechanisms of creep deformation – design options to minimize creep deformation – stress rupture & stress relaxation tests, development of creep resistant alloys, prediction of long time properties.

Unit-V: TORSION

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*", Edition: 2, Waveland Press , 2005.
2. G. E. Dieter, "*Mechanical Metallurgy*", Edition: 3, McGraw Hill Publications , 2017.

Reference(s):

1. Suryanarayana, "*Testing of Metallic Materials*", Edition: 2, BS Publications , 2007.
2. R. M. Rose, L. A. Shepard and J. Wulff, "*Structure and Properties of Materials Volume IV* ", Edition: 1, John Wiley Eastern Pvt, Ltd, New Delhi 1968.
3. P.K. Mallicak, "*Fiber-reinforced composites*", Edition: 3, CRC Press , 2007.

MEC18R337 : MANUFACTURING SYSTEM AND SIMULATION	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**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):

CO1	*Demonstrate a range of approaches in computer modelling and simulation.*
CO2	*Make use of different techniques of random number generation for diverse conditions.*
CO3	*Select a suitable technique of random variable generation for a specific problem.*
CO4	*Adapt appropriate distribution and evaluation methodology for simulation models. .*
CO5	*Identify apposite discrete event simulation concepts for a range of mechanical problems.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3		1	3	1		1					2		
CO2	3	3	2	2	1								2	2	
CO3	3	3	2	2	1								3	3	2
CO4	3	3	2	3	1	1		3					3	3	3
CO5	1	3	2	2	3	2		2				2	2	3	2

Course Topics:

Unit-I: COMPUTER MODELING AND SIMULATION SYSTEMS

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-II: RANDOM NUMBER GENERATION

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-III: RANDOM VARIABLE GENERATION

Inverse transform technique-exponential distribution-uniform distribution - Weibull distribution - emprical continuous distribution - generate approximate normal variates - Erlang distribution-basics of SPSS.

Unit-IV: DISTRIBUTION AND EVALUATION OF EXPERIMENTS

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-V: DISCRETE EVENT SIMULATION

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*", Edition: 5, Prentice Hall Inc, New Delhi , 2017.
2. G. Gordon, "*Systems simulation*", Edition: 2, Prentice Hall of India Ltd, New Delhi , 2016.

Reference(s):

1. Narsingdeo, "*Systems simulation with digital computer*", Edition: 1, Prentice Hall of India Ltd, New Delhi , 2009.
2. Francis Neelamkovil, "*Computer Simulation and Modeling*", Edition: 1, John Wiley and Sons , 2015.
3. M. D. Ruth, and M.O. Keefe, "*Simulation and Modeling with Pascal*", Edition: 1, Prentice Hall Inc., New Delhi , 2015.

MEC18R339 : TOOLING FOR PRODUCTION	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To understand the basic concepts of machining mechanism used in manufacturing Industry and Tools used for production Technology

Course Outcome(s):

CO1	*Illustrate the nomenclature of single and multipoint cutting tools.*
CO2	*Examine the factors affecting the machinability and machining economics.*
CO3	*Appraise the suitable tool pertaining to an application based on the tool life and machining parameters.*
CO4	*Make use of the design principles of jigs and fixtures for its usage in specific applications.*
CO5	*Identify the types of presses for a variety of sheet metal operations based on the selection and design factors.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2			2		1							1	
CO2	2	2			3		2	1							
CO3	1	3		1	2					1	2		1	2	
CO4		2	2		2			2					2		
CO5	1	2	2	2	1			1					1	1	

Course Topics:

Unit-I: CUTTING TOOLS

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-II: MACHINABILITY

machinability - variables affecting machinability - machinability index - economics of machining - selection of optimal machining conditions - productivity of machine tools

Unit-III: TOOL LIFE

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-IV: JIGS AND FIXTURES

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-V: PRESS WORKING

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*", Edition: 3, Taylor and Francis , 2005.
2. Sen and Bhattacharya, "*Metal cutting Theory and Practice*", Edition: 2, New central book agency,Calcutta , 2000.

Reference(s):

1. Ranganath, B.J, "*Metal Cutting and Tool Design*", Edition: 2, Vikas Publishing House , 1999.
2. Sharma, P.C, "*A text book of Production Engineering*", Edition: 11, S Chand publishing , 1999.
3. Hmt, Hmt, H M T Bangalore, "*Production Technology*", Edition: 1, Tata McGraw-Hill Education , 2017.

MEC18R340 : COMPOSITE MATERIALS	L	T	P	C
	3	1	0	4
Pre-requisite: MEC18R208-Materials Science	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To understand the basic principle of composite materials with some of the fabrication process ,testing and failure analysis of composite materials applications.

Course Outcome(s):

CO1	*Define the composite materials over conventional materials and its applications.*
CO2	*Interpret the differences in the laminate processes and its corresponding effect on performance of the composite materials.*
CO3	*Make use of major manufacturing processes and to study the quality of the products.*
CO4	*Classify the various mechanical properties and appropriate test methods used incomposites materials.*
CO5	*Examine the failure modes of the composites laminates and with Finite Element Method to analysis the failure.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2			2		2		3	2	3	
CO2	3	3	2	1	2	2	1	2				2	2	3	1
CO3	3		3	2	3	2	2	3		2		3	2	3	2
CO4	2	1	2	1	3	1				2		1	3	2	2
CO5	3	2	2	2	1	2	1	2		1		3	2	1	3

Course Topics:

Unit-I: INTRODUCTION TO COMPOSITE

Definition and applications of composite materials, Fibers- glass, carbon, ceramic and aramid fibers; Matrices- polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices. Lamina- assumptions, macroscopic viewpoint, generalized Hooke's law, reduction of homogeneous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

Unit-II: LAMINATE PROCESSES

Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply laminates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criteria, von Mises Yield criterion for isotropic materials, generalized Hill's criterion for anisotropic materials, TsaiHill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates.

Unit-III: FABRICATION PROCESSES

Fundamentals - bag moulding - compression moulding, pultrusion-filament winding - other manufacturing process - quality inspection and non-destructive testing.

Unit-IV: TESTING OF COMPOSITES

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-V: FAILURE PREDICTIONS

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. R. F. Gibson, "*Principles of Composite Material Mechanics*", Edition: 3, McGraw Hill , 2011.
2. Ronald Gibson, "*Principles of Composite Material Mechanics*", Edition: 4, CRC Press , 2016.

Reference(s):

1. B. D. Agarwal and L. J. Broutman , "*Analysis and Performance of Fiber Composites*", Edition: 4, John Wiley and Sons, New York , 1980.
2. Autar K. Kaw, "*Mechanics of Composite Materials*", Edition: 2, Taylor & Francis-India , 2006.
3. Krishnan K. Chawla *Composite materials science and engineering*", Edition: 2, Springer Publications , 2012.

MEC18R343 : HEAT TREATMENT AND SURFACE TREATING	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R208-Materials Science	**Course Category:** Major Elective **Course Type :** Theory			

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):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												1		
CO2	1	1	1										2	2	
CO3	2	1	1										2	2	
CO4	2	3	2										3	2	
CO5	3	3	2										3	3	

Course Topics:

Unit-I: HEAT TREATMENT ATMOSPHERE AND PRINCIPLES

Furnaces and heat treatment atmosphere, quenching media, fixtures, temperature measurements and controllers. Phase transformations – Austenitic, Pearlitic, bainitic, martensitic transformations.

Unit-II: HEAT TREATMENT OF FERROUS ALLOYS

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-III: HEAT TREATMENT OF NON FERROUS ALLOYS

Heat treating of Aluminium, copper, nickel, titanium and magnesium alloys – processes, heat treatment defects, causes, remedies, inspections and quality control

Unit-IV: SURFACE AND SPECIAL TREATMENT

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-V: HEAT TREATMENT OF ENGINEERED COMPONENTS

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. T. V. Rajan and C. P. Sharma, "*Heat treatment-Principles and Techniques*", Edition: 2, PHI Learning Pvt Ltd , 2011.

2. American Society of Metals, "*Metals hand book, Vol. IV*", Edition: 1, ASM Metal park Ohio, USA , 1991.

Reference(s):

1. Karl Eric Thelning, "*Steel and its Heat treatment*", Edition: 2, Butterworth-Heinemann Publications , 2013.
2. T. S. Sudharsan, "*Surface Engineering*", Edition: 1, Ohio State University , 1992.

MEC18R421 : NON DESTRUCTIVE EXAMINATION	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R302-Manufacturing Processes	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

By the end of this course the participants will be familiar with a wide variety of Non-destructive testing techniques applicable to Design, Manufacturing and Industrial domains. The participants will be able to know how each technique works, how they can apply it, when and where it can be used and each technique's capabilities and limitations.

Course Outcome(s):

CO1	*Connect the usage of Non-Destructive Examination in minimizing the cost over preferring conventional destructive testing*
CO2	*Illustrate the principles of operation of liquid penetrant and magnetic particle tests.*
CO3	*Identify the method of finding internal defects and other properties through radiography techniques.*
CO4	*Examine the application of ultrasonic and acoustic emission techniques in a real time environment.*
CO5	*Illustrate the advancements in nondestructive testing methods and equipment's.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2		1		1					3	2	
CO2	3	2				2	2	3	1			1	3	2	
CO3	3	2	2	1		3	2	3	1			2	3	3	
CO4	3	2	2			2	1	3	1			1	3	2	
CO5	3	3	3	3		2	1	3	1	1		1	3	3	

Course Topics:

Unit-I: INTRODUCTION NON-DESTRUCTIVE TESTING AND LIQUID PENETRANT

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-II: MAGNETIC PARTICLE TESTS

Methods of production of magnetic fields - principles of operation of magnetic particle test - applications - advantages and limitations-Eddy current testing

Unit-III: RADIO GRAPH

Sources of ray - X-ray production - properties of X–rays - film characteristics - exposure charts - contrasts - operational characteristics of X-ray equipment - applications.

Unit-IV: ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES

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-V: ADVANCES IN NDT AND EQUIPMENTS

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 – Thermography-Principles-Phased array UT technique.

Text Book(s):

1. Barry Hull and Vernon John, "*Non Destructive Testing*", Edition: Click or tap here to enter text., MacMillan , 1988.
2. Knud G. Boving *NDE Handbook: Non-Destructive Examination Methods for Condition Monitoring*", Edition: 1, Elsevier , 2014

Reference(s):

1. H. Dos Reis, "*Non-Destructive Testing And Evaluation For Manufacturing And Construction.*", Edition: 1, CRC Press , 1989.
2. Harold Berger, "*Nondestructive Testing Standards: A Review*", Edition: 1, ASTM International , 2017.
3. Paul E. Mix, "*Introduction to Nondestructive Testing: A Training Guide*", Edition: 2, John Wiley & Sons , 2005.

MEC18R431 : MICRO MANUFACTURING	L	T	P	C
	3	1	0	4
Pre-requisite: MEC18R352- Manufacturing Technology	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To understand the micro level machining processes and their applications.

Course Outcome(s):

CO1	*Associate various mechanical energy based micro machining processes*
CO2	*Describe various beam energy based micro machining processes.*
CO3	*Illustrate various Nano level finishing processes and associated practices.*
CO4	*Infer micro level process for welding and forming of materials.*
CO5	*Implement various micro machining process for development and inspection of the mechanical components.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2									3	2	2
CO2	3	2		2									3	2	2
CO3	3	2			2							1	3	2	
CO4	3	1		2								1	2	2	
CO5	3	2	3	2		2	2					1	3	3	3

Course Topics:

Unit-I: MICRO MACHINING I

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Machining – Abrasive Water Jet Micro Machining - Micro turning – Chemical and Electrical Chemical Micro Machining – Electrical discharge micro machining.

Unit-II: MICRO MACHINING II

Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining – Plasma Beam Micro Machining –Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

Unit-III: NANO POLISHING

Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing – Magnetic Float polishing – Elastic Emission Machining – chemo mechanical Polishing.

Unit-IV: MICRO FORMING AND WELDING

Micro extrusion – Micro and Nano structural development by Nano Plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding

Unit-V: RECENT TRENDS AND APPLICATIONS

Metrology for micro machined components – Ductile regime machining – AE based tool wear compensation – Machining of Micro gear, micro nozzle, micro pins – Application.

Text Book(s):

1. V. K. Jain, "*Micro Manufacturing Processes*", Edition: 1, CRC Press, Taylor & Francis , 2017.
2. H. Janocha , "*Actuators – Basics and applications*", Edition: 1, Springer publishers , 2010.

Reference(s):

1. V. K. Jain, "*Introduction to Micro machining*", Edition: 2, Narosa Publishing House , 2018.
2. BharatBhushan, "*Handbook of nanotechnology*", Edition: 4, springer , 2018.
3. V. K. Jain, "*Advanced Machining Processes*", Edition: 1, Allied Publishers, Delhi , 2007.

MAJOR ELECTIVE - DESIGN STREAM

MEC18R306:COMPUTER AIDED DESIGN	L	T	P	C
	3	0	0	3
Pre-requisite:MEC18R151-Engineering graphics & design	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, etc..

Course Outcome(s):

CO1	*Analyze of the fundamental of the computer graphics.*
CO2	*Explain the main curve representations and determine their differential properties.*
CO3	*Construct parametric and feature models of solid models.*
CO4	*Interpret picture data fed into a computer and for creating pictures from difficult multidimensional data sets.*
CO5	*Apply assembly models and fits.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	2					1	1		2	1	2
CO2	3	1	3	2	2					1	1		2	1	2
CO3	3	1	3	2	2					1	1	2	2	1	2
CO4	3	2	3	3	3					1	1	2	2	1	2
CO5	3	2	3	2	3					1	1	2	2	1	2

Course Topics:

Unit-I:INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, Outputs primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotators) windowing – view ports – clipping transformation.

Unit-II:CURVES AND SURFACES MODELLING

Introduction to curves, Geometric Modeling – Analytical curves: line, circle and conics –synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces – Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface – Bezier surface and B-Spline surface- surface manipulations.

Unit-III:NURBS AND SOLID MODELING

Basics-curves, linear, areas, circle and bi linear surface. Regularized Boolean set operations – primitive instancing – sweep representations – boundary representations – constructive solid Geometry – comparison of representations – user interface for solid modeling.

Unit-IV:VISUAL REALISM

Hidden – Line – Surface – solid removal algorithms shading – coloring, computer animation. Introduction to parametric and variation geometry based software's and their principles creation of prismatic and lofted parts using these packages.

Unit-V:ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE

Assembly of parts- assembly modeling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking. Graphics and computing standards- Open GL, Data exchange standards- IGES, STEP, CALS etc., and Communication standards.

Text Book(s):

1. Donald Hearn and M.Pauline Baker, "*Computer Graphics C version*", Edition:2 ,Pearson Education ,2002.
2. Ibrahim Zeid, "*Mastering CAD/CAM*", Edition:2,McGraw Hill Education,2016.

Reference(s):

1. William M Neumann and Robart F.Sproul *"Principles of Computer Graphics*", Edition:1 Mc Graw HillBook Co. Singapore, ,2017.
2. Foley, Wan Dam, Feiner and Hughes, "*Computer graphics principles & practices*", Edition:2,Pearson Education,2013.
3. M. Groover, "*CAD/CAM*", Edition:1,Pearson Education,2003.

MEC18R309:DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R151-Engineering graphics & design	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

- 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	*: Design and develop jigs and also jig-less manufacturing.*
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...*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1									3	3	2	
CO2	3	2	3							2		2	3	2	
CO3	3	2	3									2	3	2	
CO4	3	2	3		2			2		2		1	3	2	
CO5	3	2	3									1	3	2	

Course Topics:

Unit-I: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.

Unit-II: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

Unit-III: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.

Unit-IV:PRESS WORKING

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.

Unit-V: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(s):

1. Edward, G., Hoffman, "*Jigs and Fixture Design*", Edition:5 ,Cengage India,2008.
2. 2. Joshi, P.H, "*Jigs and Fixtures*", Edition:2,Tata McGraw-Hill Education Pvt Ltd,2010.

Reference(s):

1. Cyril Donaldson , George H. Lecain , VC Goold, *"Tool Design*", Edition:4 McGraw Hill Education, ,2012.
2. Franklin D Jones M D, "*Jig and Fixture Design*", Edition:1,Forgotten Books2018.
3. H. Gerling , "*All About Machine Tools*", Edition:1,New Age International Private Limited,2006.

MEC18R315 : DESIGN FOR MANUFACTURING	L	T	P	C
	3	0	0	3
Pre-requisite: MEC18R302 – Manufacturing Processes	**Course Category:** Major Elective **Course Type :** Theory			

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):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2		3	3										3	2	
CO3		3	3										3	2	
CO4		3	3										3	2	
CO5	1	2			3								2	2	

Course Topics:

Unit-I: INTRODUCTION

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-II: FACTORS INFLUENCING FORM DESIGN

Working principle - material, manufacture, design - possible solutions - materials choice- influence of materials on form design of welded members, forgings and castings.

Unit-III: COMPONENT DESIGN –MACHINING CONSIDERATION

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-IV: COMPONENT DESIGN – CASTING CONSIDERATIONS

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores

Unit-V: REDESIGN FOR MANUFACTURE AND CASE STUDIES

Identification of uneconomical design - modifying the design - group technology - computer applications for DFMA.

Text Book(s):

1. Harry Peck, "*Design for Manufacture*", Edition: 1, Pittman Publication , 1983.
2. Robert Matousek, "*Engineering Design - A systematic approach*", Edition: 3, Blackie and sons Ltd , 2007.

Reference(s):

1. James G. Bralla, "*Hand Book of Product Design for Manufacturing*", Edition: 2, McGraw Hill Co , 1998.
2. K.G. Swift, "*Knowledge based design for manufacture*", Edition: 1, Prentice-Hall , 1987.
3. Corrado Poli, "*Design for Manufacturing*", Edition: 1, Elsevier , 2001.

MEC18R326:ADVANCED STRENGTH OF MATERIALS	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite:MEC18R271- Strength of Materials	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Outcome(s):

CO1	*Explain the basic concepts of Stress and Strains*
CO2	*Interpret the idea of stress and strain in mechanical properties*
CO3	*Demonstrate mathematically for mechanical properties of material*
CO4	*Apply mathematical evaluation of real to solid geometries*
CO5	*Comprehend the mechanical properties with energy and plasticity*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3		1							1		3	2	
CO2	3	3									1		3	2	
CO3	3	3											3		
CO4	3	2	3								2	2	3	3	
CO5	2	1											2		

Course Topics:

Unit-I:CONCEPTS OF STRESS AND STRAINS

Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions

Unit-II:MECHANICAL PROPERTIES AND GOVERNING LAWS

Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry Boundary Value Problems: concepts of uniqueness and superposition.

Unit-III:ANALYSIS OF STRESS AND STRAIN IN VARIOUS COORDINATES

Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

Unit-IV:APPLICATIONS OF MECHANICAL BEHAVIOR OF MATERIALS

Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress Concentration problems, thermo-elasticity, 2-d contact problems.

Unit-V:ENERGY AND PLASTICITY

Solutions using potentials. Energy methods. Introduction to plasticity.

Text Book(s):

1. G. T. Mase, R. E. Smelser and G. E. Mase, "*Continuum Mechanics for Engineers*", Edition:3 ,CRC Press ,2004.
2. Y. C. Fung, "*Foundations of Solid Mechanics*", Edition:2, Prentice Hall International,1965.

Reference(s):

1. Lawrence. E. Malvern *"Introduction to Mechanics of a Continuous Medium*", Edition:1, Prentice Hall International,1969.
2. Crandall, S, N. Dahl, and T. Lardner, "*An Intro. to the Mechanics of Solids*", Edition:2, McGraw-Hill,1978.
3. GereJames, "*Mechanics of Materials*", Edition:6, ,Thomson Engineering Publishing,2003.

MEC18R341:PRINCIPLES OF COMPONENT DESIGN	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R151-Engineering graphics & design	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to develop knowledge on the principles of designing a mechanical component.

Course Outcome(s):

CO1	*Understanding various processes pertaining to product design.*
CO2	*Develop basic and advanced designing and prototyping skills.*
CO3	*Apply modeling and simulation skills in product modeling and optimize design.*
CO4	*Select suitable material and process for most economic manufacturing.*
CO5	*Analyze the design based on the quality concept.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2										2		
CO2	1	1	2										1	2	
CO3	2												1		2
CO4	1	1	2										1		1
CO5	2	1									2		1		1

Course Topics:

Unit-I:PRODUCT DESIGN PROCESS

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-II:CONCEPTUAL DESIGN

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-III:MODELLING AND OPTIMIZATION

Mathematical modelling - simulation - geometric modelling - finite element modelling – Data Modelling - optimization - search methods - geometric programming - structural and shape optimization.

Unit-IV:MATERIAL SELECTION AND DESIGN FOR ASSEMBLY

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-V:QUALITY IN DESIGN

Total quality concept - quality assurance – quality tool-QFD-statistics process control - Taguchi methods - robust design - failure model effect analysis- fool proof system-poka yoke analysis.

Text Book(s):

1. Dieter George, "*Product Design and Development*", Edition:5 ,McGraw Hill,2011.
2. Karl T. Ulrich, and Steven D. Eppinger, "*Jigs and Fixtures*", Edition:2,Tata McGraw-Hill Education Pvt Ltd,2010.

Reference(s):

1. Richard G. budynas and Keith J. Nisbett, *"Mechanical Engineering Design*", Edition:10 McGraw Hill ,2014.
2. Franklin D Jones M D, "*Jig and Fixture Design*", Edition:1,Forgotten Books2018.
3. John R. Karsnitz, Stephen O'Brien, John P. Hutchinson., "*Engineering Design-An Introduction*", Edition:1,Delmar Cengage Learning,2013.

MEC18R434:DESIGN OF MATERIAL HANDLING EQUIPMENTS	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite:MEC18R303 – Design of Machine Elements	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic understanding the topics principle management and entrepreneurship development.

Course Outcome(s):

CO1	*Enumerate various material handling equipment's and their applications in industries.*
CO2	*Design a wide range of hoist systems and its safety elements.*
CO3	*Compare different drives for hoisting gears and conveyers for engineering applications.*
CO4	*Enumerate the systems involved in automated guided vehicles.*
CO5	*Interpret a variety of systems of elevators and its design.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1												2		
CO2	1	1	3										2		
CO3	1		3										2		
CO4	2	1												1	
CO5	2		3											1	

Course Topics:

Unit-I:INTRODUCTION TO MATERIALS HANDLING EQUIPMENTS

Types, selection and applications of material handling systems, principal groups of material handling equipments and classifications, scope of material handling, criteria for selection of material handling equipments, various material handling problems

Unit-II:DESIGN OF HOISTS

Design of hoisting elements; Welded and roller chains - Hemp and ropes – Design of ropes, pulleys, pulleys systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs – lifting magnets – Grabbing attachments – Design of arresting gear – Brakes: shoe, band and cone types.

Unit-III:DRIVES OF HOISTING GEAR AND CONVEYERS

Hand and power drives - Traveling gear - Rail traveling mechanism – cantilever and monorail cranes – slewing, jib and luffing gear – cogwheel drive – selecting the motor ratings – Types – description – design and applications of Belt conveyers, apron conveyors and escalators pneumatic conveyors, screw conveyors and vibratory conveyers.

Unit-IV:AUTOMATED GUIDED VEHICLE SYSTEM

Types of vehicles and AGVs applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system. Deadlocks in Automated manufacturing systems - Petrinet models – Applications in dead lock avoidance- Hurwicz criterion-Expected Monetary Value criterion-Expected Value of Perfect Information (E.V.P. I.)

Unit-V:ELEVATORS

Bucket elevators: design – loading and bucket arrangements – Cage elevators – shaft way, guides, counter weights, hoisting machine, safety devices – Design of fork lift trucks.

Text Book(s):

1. Rudenko.N, "*Materials handling equipment*", Edition:2 ,Central Books Ltd,1970.
2. Spivakovsy.A.O and Dyachkov.V.K, "*Conveying Machines,*", Edition:2, MIR publishers,1985.

Reference(s):

1. Günter Ullrich and Paul A. Kachur*Automated Guided Vehicle Systems: A Primer with Practical Applications*", Edition:1,Springer,2015.
2. Ronald G. Askin , Charles R. Standridge, "*Modeling and Analysis of Manufacturing Systems*", Edition:1,John Wiley & Sons,1993.
3. Alxandrov.M, "*Materials Handling Equipments*", Edition:1,MIR Publishers,,1981.

MAJOR ELECTIVE - THERMAL STREAM

MEC18R312:INTERNAL COMBUSTION ENGINES	L	T	P	C
	3	0	0	3
Pre-requisite:MEC18R274 - Thermal Engineering	**Course Category:**Major Elective **Course Type :**Theory			

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):

CO1	*Distinguish various components of IC engines and analyze 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 for advancement in IC Engines*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	2	3								2	3	2	
CO2	1	3	3	3								2	3	2	
CO3	3	1										2	3	2	
CO4	1	2				1						1	2	1	
CO5	3	1				1						2	3	2	

Course Topics:

Unit-I:SPARK IGNITION ENGINE

Air Fuel cycles, Ideal Cycles, Spark ignition engine mixture requirements, feedback control, carburetors, fuel injection systems – mono point 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-II:COMPRESSION IGNITION ENGINE

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–recent trends in injection system- Port fuel injection, Direct injection and Common rail injection. Cooling & Lubrication System for IC Engines

Unit-III:POLLUTANTS

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

Unit-IV:EMISSION CONTROL

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

Unit-V:ALTERNATE FUELS

Duel fuel, natural fuel and wankel 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*", Edition:1,McGraw Hill,2017.
2. R.P.Mathur and M.L.Sharma, "*Internal Combustion Engines*", Edition:2,Dhanpatrai Publishers,2014.

Reference(s):

1. V.Ganesan, "*Internal Combustion Engines*", Edition:4,McGraw-Hill Education,2012.
2. Rowland S Benson and Whitehouse, "*Internal combustion Engines, Volume I and II*", Edition:1,Pergamon Press,1983.
3. Duffy Smith and Howard Smith, "*Auto fuel Systems*", Edition:1,Good heart-Wilcox Publisher,1987.

MEC18R313:TURBO MACHINERY	L	T	P	C
	3	0	0	3
Pre-requisite:MEC18R203 - Thermodynamics	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

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

Course Outcome(s):

CO1	*Explain the fundamentals of turbo machines.*
CO2	*Design of fans and blowers.*
CO3	*Examine the Performance of centrifugal compressors.*
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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2									3		
CO2	3	3	3	3								2	3	2	
CO3	3	2	2										3	2	
CO4	3	3	2										3	2	
CO5	3	3	2									2	3	2	

Course Topics:

Unit-I:INTRODUCTION

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-II:FAN AND BLOWERS

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-III:CENTRIFUGAL FLOW COMPRESSORS

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-IV:AXIAL FLOW COMPRESSORS

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-V:AXIAL AND RADIAL FLOW TURBINES

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. S. M. Yahya, "*Turbines*", Edition:4,Tata McGraw-Hill Publishing,2017.
2. S. L. Dixon, "*Fluid Mechanics and Thermodynamics of Turbomachinery*", Edition:7,Elsevier,2014.

Reference(s):

1. V.Kadambi, "*An Introduction to energy conversion*", Edition:2,New Age International,2011.
2. A. Korpela, "*Principles of Turbomachinery*", Edition:1,John Wiley & Sons,2011.
3. Erik Dick, "*Fundamentals of Turbo machines*", Edition:1,Springer,2015.

MEC18R329:GAS DYNAMICS AND JET PROPULSION	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R272 - Fluid Mechanics and Machinery	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

To understand the features of compressible isentropic flows and irreversibilities like shocks.
To provide a basic knowledge of jet and rocket propulsion technologies

Course Outcome(s):

CO1	*Understand the basic concepts of compressible flow*
CO2	*Analyze the isentropic flow*
CO3	*Analyze compressible flows with friction and heat transfer and examine shock waves*
CO4	*Explain the concept of jet propulsion*
CO5	*Evaluate the performance of rocket propulsion systems*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2	2		
CO2	3	2			2							2	3		
CO3	3	2			2							2	3		
CO4	3		3				2			1		2	3	3	
CO5	3	2	3				2			1		2	2	3	

Course Topics:

Unit-I:FUNDAMENTALS OF COMPRESSIBLE FLOW

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow.

Unit-II:ISENTROPIC FLOW

Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow, variable area ducts, choked flow, Area Mach number relations for isentropic flow

Unit-III:FANNO FLOW, RAYLEIGH FLOW AND NORMAL SHOCKS

Flow through constant area ducts - Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables

Unit-IV:JET PROPULSION

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

Unit-V:ROCKET PROPULSION

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

Text Book(s):

1. S. M. Yahya , "*Fundamental of compressible flow*", Edition:5,New Age International (P) Ltd., New Delhi,2016.
2. H. Patrich , "*Introduction to Compressible fluid flow*", Edition:2,CRC Press,2013.

Reference(s):

1. F. Ahmed. , "*Aircraft Prpoulsion and Gas Turbine Engines*", Edition:1,CRC Press,2008.
2. H.S. Mukunda, "*Understanding Aerospace Chemical Propulsion*", Edition:1,Interline Publishing,2004.
3. P. Hill, "*Mechanics & Thermodynamics of Propulsion*", Edition:2,Addison Wesley,1992.

MEC18R401:POWER PLANT ENGINEERING	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R203 - Thermodynamics	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

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

Course Outcome(s):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1					1					2	3		
CO2	3	1					1					2	3		
CO3	3	2					2					1	3		
CO4	3	1					2					2	3		
CO5	3	2			1							1	3		

Course Topics:

Unit-I:THERMAL POWER PLANT

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, Coal disposal for Thermal power plant binary cycles and cogeneration systems

Unit-II:NUCLEAR AND HYDEL POWER PLANT

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants,Waste disposal for nuclear power plant Hydroelectric power plants, classification, typical layout and components

Unit-III:GAS TURBINE AND DIESEL POWER PLANT

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems- Diesel engine power plant – components and lay-out, selection of engine type, environmental hazards.

Unit-IV:UNCONVENTIONAL POWER PLANTS

Unconventional power plants – Solar PV and Solar Thermal, wind, ocean thermal energy conversion, tidal and geothermal power plants, MHD concepts of energy conversion, Fuel Cell power systems, Biogas.

Unit-V:PLANT ECONOMICS

Load curve – definition – fixed and operating costs, comparison of economics of different types of power plants, tariff types, pollution control technologies for different power plants

Text Book(s):

1. R. K.Rajput, , "*Power Plant Engineering*", Edition:5,Laxmi Publications,2016.
2. Domkundwar and Arora Domkundwar, "*Power Plant Engineering*", Edition:6,Dhanpat Rai & Co,2016.

Reference(s):

1. EI- Wakil, "*Power Plant Engineering*", Edition:1,McGraw-Hill,2010.
2. P.K. Nag, "*Power plant Engineering*", Edition:4,,Tata McGraw-Hill,2014.
3. K. K. Ramalingam, "*Power Plant Engineering*", Edition:1,Scitech Publications,2010.

MEC18R402:AUTOMOBILE ENGINEERING	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R203 - Thermodynamics	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

To understand the construction and working principle of various parts of an automobile

Course Outcome(s):

CO1	*Outline the general classifications and functions of automobiles engines*
CO2	*Interpret and analyze the working principles of steering system, brakes and suspension system.*
CO3	*Examine the working principle of automobile transmission systems*
CO4	*Distinguish the various engine auxiliary system and automotive electrical and electronic system*
CO5	*Analyze the importance of alternate fuels and its properties to the environment*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2			2						1	2	1	
CO2	2	2	2										2	1	
CO3	2	2	2										2	1	
CO4	2	2	2				2						2	1	
CO5	2	2	2				1						2	1	

Course Topics:

Unit-I:VEHICLE STRUCTURE AND ENGINES

Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT).

Unit-II:STEERING, BRAKES AND SUSPENSION SYSTEMS

Steering geometry and Steering linkages, types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

Unit-III:TRANSMISSION SYSTEMS

Clutch types & construction, gear boxes- manual and automatic gear shift mechanisms, over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive.

Unit-IV:ENGINE AUXILIARY SYSTEMS

Electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

Unit-V:ALTERNATE ENERGY SOURCES

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cell.

Text Book(s):

1. Kirpal Singh, "*Automobile Engineering*", Edition:13,Standard Publishers,2014.
2. K. K Jain, "*Automobile Engineering*", Edition:5,,Tata McGraw Hill Publishers,2012.

Reference(s):

1. V. Ganesan, "*Internal Combustion Engines*", Edition:4,Tata McGraw Hill Publishers,2012.
2. R. K. Rajput, "*A Text Book of Automobile Engineering*", Edition:1,,Laxmi Publications,2015.
3. J. Heitner, ", " *Automotive Mechanics*", Edition:2,East-West Press,1999.

MAJOR ELECTIVE - INDUSTRIAL ENGINEERING STREAM

MEC18R304:MECHATRONICS SYSTEMS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Major Elective **Course Type :**Theory			

Course Objective(s):

- To understand the structure of microprocessors and their applications in mechanical devices
- To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
- To understand the use of micro-sensors and their applications in various fields learn about work and heat interactions, and balance of energy between system and its surroundings.

Course Outcome(s):

CO1	*Explain the basic concepts systems integration and modeling.*
CO2	*Interpret the idea interfacing sensor and system.*
CO3	*Interpret the idea of interfacing actuating drives with system.*
CO4	*Demonstrate the real time advanced sensors and materials in mechatronics system.*
CO5	*Analyze various integration of mechatronics system and automation.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1			1			1	2	2	1	
CO2	2	2	2	1			1		2			2	2	2	
CO3	2	2	2	1			1		2			2	2		
CO4	2	2	2				2	1			1		2		2
CO5	3									2	1		1	1	2

Course Topics:

Unit-I:INTRODUCTION TO MECHATRONICS SYSTEMS

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface

Unit-II:MECHANICAL PROPERTIES AND SENSORS AND TRANSDUCERS

Classification, Development in Transducer technology, Opto-electronics-Shaft encoders, CD Sensors, Vision System, etc.

Unit-III:DRIVES AND ACTUATORS

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems

Unit-IV:SMART MATERIALS

Shape Memory Alloy, Piezoelectric and Magneto strictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

Unit-V:MICROMECHATRONICS SYSTEMS

Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

Text Book(s):

1. Devdas Shetty & Richard A. Kolk, "*Mechatronics System Design*", Edition:2 ,Cengage ,2012.
2. William Bolton, "*Mechatronics: A Multidisciplinary Approach*", Edition:4, Pearson Education,2014.

Reference(s):

1. R.K.Rajput, S. Chand*A Textbook of Mechatronics*", Edition:1,S Chand & Company,2007.
2. William Bolton, Prentice Hall, "*Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*", Edition:5,Pearson,2011.
3. Nitaigour Mahalik, "*Mechatronics : Principles, Concepts and Applications*", Edition:1,McGraw Hill Education,2017.

MEC18R305 : MICROPROCESSORS IN AUTOMATION	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To understand the basic concepts of Digital circuits, Microprocessor system and digital Controller and Interfacing

Course Outcome(s):

CO1	*Explain the basic concepts of microprocessor number system*
CO2	*Interpret the basics of instructions set in microprocessor 8085*
CO3	*Analyze the usage of peripheral devices of 8085 for advanced interfacing*
CO4	*Apply the real time interfacing of 8085*
CO5	*Analyze the usage of signal processing for real time measurements*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1										2	1	1
CO2		2											1		
CO3			3				2	1			3	3		3	2
CO4			3	2			2							2	
CO5	3												1		2

Course Topics:

Unit-I: NUMBERS SYSTEMS AND DIGITAL USAGE

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals.

Unit-II: MACHINE INSTRUCTIONS

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing.

Unit-III: MICROPROCESSOR AND PERIPHERAL DEVICES

Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, and Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripheral. Programmable peripheral interface (8255)

Unit-IV: MICRO PROCESSOR 8085 AND INTERFACING

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features

Unit-V: INTRODUCTION TO SIGNAL PROCESSING

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm.

Text Book(s):

1. W. H. Gothman, "*Digital Electronics: An Introduction to Theory and Practice*", Edition: 2, Prentice Hall , 1982.
2. Albert Paul Malvino, "*Digital Computer Electronics: An Introduction to Microcomputers*", Edition: 2, McGraw-Hill, , 1983.

Reference(s):

1. Ramesh Gaonkar, "*Microprocessor Architecture, Programming, and Applications with the 8085*", Edition: 6, PENRAM International Publishers , 2013.
2. B.C. Kuo, "*Digital Control Systems*", Edition: 2, Oxford University Press , 2007.
3. L. A. Leventhal, "*Microcomputer Experimentation with the Intel SDK-85*", Edition: 1, Prentice Hall , 1980.

MEC18R319 : PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**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 the various process planning stages with its design and selections.*
CO2	*Demonstration of various functions of Estimation and Costing with references to productions and control*
CO3	*Analyse the various elements associated with cost estimation.*
CO4	*Measure of machining time of various manufacturing operations.*
CO5	*Analyse and estimate the product cost for various manufacturing processes*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				2	2	2				3	1			
CO2	2	3		3	2						2	2			
CO3			3		3						2			1	
CO4		2	2							2	2				
CO5	2	2						2		3	1				

Course Topics:

Unit-I: PROCESS PLANNING

Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection

Unit-II: ESTIMATING AND COSTING

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.-Process planning activities- documents for process planning, economics of process planning, case studies

Unit-III: COST ESTIMATION

Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost.

Unit-IV: ESTIMATION OF MACHINING TIME

Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planing and Grinding

Unit-V: PRODUCT COST ESTIMATION

Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost

Text Book(s):

1. Peter Scalon, "*Process Planning, Design/ Manufacture Interface*", Edition: 1, Butterworth-Heinemann , 2003.
2. P. F. Ostwaal and J. Munez , "*Manufacturing Processes and Systems*", Edition: 9, John Wiley , 1998.

Reference(s):

1. A. K. Chitale and R. C. Gupta, "*Product Design and Manufacturing*", Edition: 6, Prentice Hall of India Pvt. Ltd. , 2014.
2. Nauna Singh, "*System approach to Computer Integrated Design and Manufacturing*", Edition: 1, Wiley , 1996.
3. J. G. Monks, "*Operations Management, Theory and Problems*", Edition: 3, McGraw Hill Book Company , 1987.

MEC18R324 : PLANT LAYOUT AND MATERIAL HANDLING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

The aim of this course is to develop basic understanding of plant layout and material handling.

Course Outcome(s):

CO1	*Define the various plant layout methods and facilities required for process planning.*
CO2	*Identify the service requirements and selection of sites pertaining to plant location.*
CO3	*Classify various space requirements and layout techniques for various production plants.*
CO4	*Analyze various production flow problems related to industrial scenario.*
CO5	*Outline various machines and material handling equipment.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2			2	2				1			2	
CO2	3	3	3		2	2	1						2	3	
CO3		3	2		3						1	1		2	
CO4	2	2	3	3	1						3				
CO5	1	3		1			2				1			2	

Course Topics:

Unit-I: INTRODUCTION TO FACILITY DESIGN

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-II: PLANT LAYOUT- WORKSTATION DESIGN

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-III: SPACE REQUIREMENTS

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-IV: PRODUCTION FLOW DESIGN

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-V: MACHINES AND MATERIAL HANDLING

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. F. E. Meyers and M. P. Stephens , "Manufacturing Facilities Design and Material Handling", Edition: 4, Prentice-Hall, Inc. , 2014.
2. M. James Apple, "Plant layout and Material Handling", Edition: 3, John Wiley & Sons Inc. , 1977.

Reference(s):

1. J. A. Tompkins and J. A. White , "Facilities and Planning", Edition: 4, John Wiley , 2010.
2. L. Richard Francis and J. A. White, "Facilities Layout and Location - an Analytical Approach", Edition: 2, Prentice Hall Inc. , 2004.
3. S. C. Sharma, "Plant layout and Material Handling", Edition: 3, Khanna Publishers , 2000.

MEC18R330 : ROBOTICS AND ROBOT APPLICATIONS	L	T	P	C
	3	0	0	3
Pre-requisite: MEC18R374 - Kinematics and Theory of Machines	**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):

CO1	*Classify the different types of robots and its anatomy.*
CO2	*Construct the robot kinematic and its design.*
CO3	*Develop programming principles and languages for a robot control system.*
CO4	*Discuss various applications of industrial robot systems.*
CO5	*Compare the different robot configuration and its application in various industries.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1										2		
CO2	2	1	2		1							1	2		
CO3	2	1	3		1			1				1	2	2	2
CO4	2	2	3										2		
CO5	2	3	3										2	2	

Course Topics:

Unit-I: INTRODUCTION

Fundamentals of Robotics- robot anatomy, robot classification.

Unit-II: ROBOT KINEMATICS

General characteristics - classification - special purpose tools - assembly fixtures – Typical designs, compliance in wrists - end effectors multiple end effectors systems.

Unit-III: ROBOT PROGRAMMING

Robot programming and languages - robot language development, language classification.

Unit-IV: ROBOT INDUSTRIAL APPLICATIONS

Robot applications - robot applications in manufacturing: material transfer and machine loading / unloading - processing operations like welding and painting - assembly operations – inspection, Safety considerations.

Unit-V: ROBOT DEVELOPMENTS

Recent developments in advanced robotics - special applications of robotics - nuclear industry, surgery, food manufacturing - miniature and micro robotics: technologies and applications.

Text Book(s):

1. Harry Colestock, "*Industrial Robotics*", Edition: 1, McGraw Hill Book Co, New Delhi , 2005.
2. M.P. Groover, "*Industrial Robotics: Technology, Programming, and Applications*", Edition: 2, Mcgraw Hill Education , 2012.

Reference(s):

1. S.R. Deb, "*Robotics Technology and Flexible Automation*", Edition: 2, McGraw Hill India , 2010.
2. C.S.G. Lee, K.S. Fu and Ralph Gonzalez, "*Robotics Control Sensing Vision and Intelligence*", Edition: 1, , McGraw Hill India , 2008.
3. Rex Miller, Mark R. Miller, "*Robots and Robotics: Principles, Systems, and Industrial Applications*", Edition: 1, McGraw Hill Professional , 2017.

MEC18R334 : FOUNDRY MECHANIZATION AND MANAGEMENT	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: MEC18R302 – Manufacturing Processes	**Course Category:** Major Elective **Course Type :** Theory			

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):

CO1	*Define the basic principles of casting and foundry processes with its modern techniques*
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	*Examine the casting process with its boundary conditions*
CO5	*Identify and apply the mechanism behind the solidification of metals and check for the soundness of the components*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2		3												3	
CO3				3											
CO4		3			3										3
CO5	2				1										1

Course Topics:

Unit-I: INTRODUCTION

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-II: FURNACES

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-III: SPECIAL CASTING TECHNIQUE

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-IV: CASTING PROCESS

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-V: SOLIDIFICATION

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. United States Navy Department, "*Foundry Manual*", Edition: 1, Fredonia Books , 2006.
2. R. W. Heine, C. R. Loper and P. C. Rosenthal, "*Principles of Metal Casting*", Edition: 2, Tata McGraw Hill Publishers , 2001.

Reference(s):

1. J. Wulff, H. F. Taylor and M. C. Fleming, "*Foundry Engineering*", Edition: 1, Chapman and Hall London , 1959.
2. P. L. Jain, "*Principles of Foundry Technology*", Edition: 5, Tata McGraw Hill , 2017.
3. N. K. Srinivasan, "*Foundry Engineering*", Edition: 3, Khanna Publications , 2001.

MEC18R404 : PRINCIPLES OF MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To make the student understand about how the planning, decision making activities on utilizing human resources effectively, how to motivate and lead a team and how to control and report a problem occurred in organization

Course Outcome(s):

CO1	*Elaborate the basic concepts of management and types of organizations.*
CO2	*Identify the process of planning tools and explain the decision making processes.*
CO3	*Demonstrate the HRM process for making effective organization*
CO4	*Explain the leadership qualities and motivation theories.*
CO5	*Demonstrate the controlling process related to computers*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3										3	2		
CO2	2	2				2							1		
CO3		1						2	2	2		2	1		
CO4		1						2		2	2				
CO5				3						2		3			

Course Topics:

Unit-I: INTRODUCTION

Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment

Unit-II: CURRENT TRENDS AND ISSUES IN MANAGEMENT

Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

Unit-III: ORGANIZING AND HRM

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Unit-IV: MOTIVATION AND LEADERSHIP

Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Unit-V: CONTROLLING AND REPORTING

Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Book(s):

1. S. P. Robins and M. Couiter, "*Management*", Edition: 10, Prentice Hall India , 2009.
2. J.A.F. Stoner, R. E. Freeman and D. R. Gilbert, "*Management*", Edition: 6, Pearson Education , 2004.

Reference(s):

1. P. C. Tripathy and P. N. Reddy, "*Principles of Management*", Edition: 5, Tata McGraw Hill , 2012.
2. T. Ramaswamy, "*Principles of Management*", Edition: 1, Himalaya Publishing house , 2003.
3. Dipak Bhattacharya, "*Principles of Management : Text and Cases*", Edition: 1, Pearson Education India , 2011.

MEC18R414:SENSORS AND TRANSDUCERS	L	T	P	C
	3	1	0	4
Pre-requisite:EEE18R172- Basic Electrical Engineering	**Course Category:**Major Elective **Course Type :**Theory			

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):

CO1	*Applications of various sensors used in robotics and CNC machines.*
CO2	*Examine the Transducers suitability for various types of Mechanical applications.*
CO3	*Make use of the potentiometer and Thermocouple device for the real time applications.*
CO4	*Inspect the Piezoelectric crystal and Capacitance Transducers used for Measurement systems.*
CO5	*Applications of various sensors used in robotics and CNC machines.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1											2		
CO2		1		1									2		
CO3	2	2	1											2	
CO4	2	2	1											2	
CO5	2	2			3										2

Course Topics:

Unit-I:INTRODUCTION & BASICS OF INSTRUMENTS

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-II:TRANSDUCERS

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-III:POTENTIOMETER AND THERMOCOUPLE

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-IV:CAPACITANCE AND PIEZOELECTRIC CRYSTALS

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-V:CNC TECHNOLOGY & ROBOT SENSORS

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*", Edition:1,Dhanpat Rai and Co., (Pvt) Ltd,2005.
2. Renganathan, S, "*Transducer Engineering*", Edition:2,, Allied publishers Limited,2003.

Reference(s):

1. Ernest O Doeblin *"Measurement Systems – Application and Design*", Edition:2 McGraw-Hill Education ,1990.
2. Woolvert, G.A, "*Transducer in Digital Systems*", Edition:1,Peter Peregrinus Ltd1979.
3. Patranabis, D, "*Principles of Industrial Instrumentation*", Edition:3,Tata McGraw – Hill Publishing Company Limited, New Delhi,,2018.

MEC18R416 : INDUSTRIAL SAFETY	L	T	P	C
	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):

CO1	*Illustrate the representation of various Safety theories and Principles followed in Real Time Industries.*
CO2	*Identify the various safety tools that can be used to solve the industrial problems.*
CO3	*Apply the fire prevention methods for various types of fire.*
CO4	*Categorizing the various types of hazards in workplace, effects and its control measures.*
CO5	*Utilize the various safety standards that can be applicable in industries.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	2			2	3	2		2					1		3
CO3	3			2					2	2			2		
CO4		1	2			2		1				2			
CO5	2					2		2	2	2					

Course Topics:

Unit-I: ACCIDENT PREVENTION

Definitions - history of safety movement - ILO – NSC – BSC – LPA Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapour, cloud and mist explosion.

Unit-II: SAFETY MANAGEMENT

Safety systems - safety information system – safety control system - hazard and risk analysis – 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

Unit-III: FIRE PREVENTION AND PROTECTION

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

Unit-IV: 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

Unit-V: SAFETY REGULATION

History of legislations related to safety - Environmental protection Act

Text Book(s):

1. D. L. Goetsch, "*Occupational Safety and Health, for Technologists, Engineering, and Managers*", Edition: 5, Prentice Hall , 2005.
2. C. Ray Asfahl, "*Industrial Safety and Health Management*", Edition: 5 , Pearson Prentice Hall , 2003.

Reference(s):

1. F. P. Lees, "*Loss Prevention in Process Industries*", Edition: 2, Butterworth - Heinemann , 1996.
2. Willie Hammer and Dennis Price, "*Occupational Safety Management and Engineering*", Edition: 5, Prentice Hall , 2001.
3. E. J. McCornick and M. S. Sanders, "*Human Factors in Engineering and Design*", Edition: 7, McGraw-Hill Education , 1992.

MEC18R417 : WORK STUDY	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

This course will focus on mathematical modelling. A strong emphasis will be given to model formulation.

Course Outcome(s):

CO1	*Contrast the relationship between productivity, work content and time.*
CO2	*Illustrate the operations and ineffective time in shop floor.*
CO3	*Apply the various process and time study methods.*
CO4	*Analyze the various jobs in order to provide factual information.*
CO5	*Design of physical and psychosocial work systems and workplaces.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2		
CO2	1				2								1	1	
CO3	2				2								2		
CO4		2		2				2				1		2	1
CO5	1	1	3					1	1			2	1	2	3

Course Topics:

Unit-I: INTRODUCTION

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-II: OPERATIONS STUDY

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-III: PROCESS AND TIME STUDY

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-IV: JOB EVALUATION

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-V: ERGONOMICS

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. International Labour Organization, "*Introduction to work study*", Edition: 4, International Labour Organization, Geneva , 2012.
2. B. W. Niebel, "*Motion and Time Study*", Edition: 7, R. D. Irwin , 1982.

Reference(s):

1. R. M. Barnes, "*Motion and Time Study Design and Measurement of Work*", Edition: 7, Wiley , 1980
2. R. S. Bridger, "*Introduction to Ergonomics*", Edition: 3, CRC Press , 2008.
3. Curri and Faraday, "*Work Study*", Edition: 4, ELBS , 2000.

MEC18R419 : PRODUCTION PLANNING AND CONTROL	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R352 - Metal cutting technology	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To introduce the Production Planning concepts and to make Control for various production activities

Course Outcome(s):

CO1	*Outline various Production planning analysis with its design and selections.*
CO2	*Illustrate the concepts of value analysis, process planning and routing.*
CO3	*Examine the product data management and Enterprise application integration*
CO4	*Apply the various inventory control methods.*
CO5	*Identify the scheduling and dispatching methods, progress reporting and expediting.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	3							2	2		
CO2	2	2										2	3	2	
CO3	2			3	1							1	2		2
CO4	2	2	2	2	3							2	3	2	
CO5	2				1						1	1	2	2	1

Course Topics:

Unit-I: 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.

Unit-II: PRODUCT PLANNING

Extending the original product information - value analysis - process planning and routing - steps in process planning

Unit-III: PRODUCT DATA MANAGEMENT

Product data management (PDM) - Enterprise application integration (EAI).

Unit-IV: 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.

Unit-V: 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(s):

1. Samuel Eilon, "*Elements of Production Planning and control*", Edition: 3, Universal Publishing Corp. , 2014.
2. Martand Telsang, "*Industrial Engineering and Production Management*", Edition: 1, S. Chand and Company , 2000.

Reference(s):

1. E. S. Buffa, "*Modern Production/Operations Management*", Edition: 8, John Wiley and Sons , 2007.
2. E. D. Scheele, "*Principles and Design of Production Control Systems*", Edition: 1, Prentice Hall , 2000.
3. K. C. Jain and L. N. Aggarwal, "*Production planning control and Industrial Management*", Edition: 6, Khanna Punlishers , 2002.

MEC18R424 : INDUSTRIAL AUTOMATION AND ROBOTICS	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R374 – 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):

CO1	*Illustrate the production concept and strategies of automation.*
CO2	*Construct the CIM architecture and FMS.*
CO3	*Design of flow lines and the implementation of line balancing methods.*
CO4	*Examine the function of automated material handling and storage systems and apply the inspection methods involved in CMM and machine vision.*
CO5	*Design of industrial robots.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				1			1				1	1	1	
CO2	2				1							2	1	2	
CO3	3	2	3	1	2							2	3	2	2
CO4	2				2							2	2	2	2
CO5	3		2		2							3	2	2	2

Course Topics:

Unit-I: INTRODUCTION TO AUTOMATION

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-II: CIM AND FMS

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-III: AUTOMATED FLOW LINES AND ASSEMBLY SYSTEMS

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-IV: AUTOMATED MATERIALS HANDLING AND STORAGE SYSTEMS

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-V: INDUSTRIAL ROBOTICS

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. M. P. Groover, "*Automation Production Systems, and Computer Integrated Manufacturing*", Edition: 4, Pearson Education , 2016.
2. D. M. Considine and G. D. Considine, "*, Standard Hand Book of Industrial Automation*", Edition: 1, Chapman and Hall Advanced Industrial Technology Series, Springer , 1987.

Reference(s):

1. P. Radhakrishnan and S. Subramaniyan, "*CAD/CAM/CIM*", Edition: 4, New Age International (P) Limited , 2018.
2. S. R. Deb and S. Deb, "*Robotics Technology and Flexible Automation*", Edition: 2, Tata McGraw Hill , 2009.
3. L. T. Ross, "*Industrial Robotics Fundamentals: Theory and Applications*", Edition: 3, Goodheart-Willcox , 2017.

MEC18R430 : INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
	3	1	0	4
Pre-requisite: MEC18R302 - Manufacturing Processes	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

Course Outcome(s):

CO1	*Identify the opportunities in integrated manufacturing systems and the use of various manufacturing strategy.*
CO2	*Apply the group technology and various process planning methods.*
CO3	*Apprehend the production planning and control and its techniques.*
CO4	*Illustrate the use of computers in controlling manufacturing process and in inspection methods and testing*
CO5	*Relate the concepts of flexible manufacturing systems, CIM concepts in rapid prototyping, artificial intelligence and expert systems.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1		1						2		2	1	
CO2	2		1		2						2		2	1	
CO3	2		3		3						2		2	2	1
CO4	2		1		3						2		2	3	3
CO5	2		2		3						3	2	2	2	2

Course Topics:

Unit-I: INTRODUCTION

Objectives of a manufacturing system – identifying business opportunities and problems classification production systems – linking manufacturing strategy and systems analysis of manufacturing operation.

Unit-II: GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Introduction – part families – parts classification and cooling – group technology machine cells benefits of group technology. Process planning function CAPP – computer generated time standards.

Unit-III: COMPUTER AIDED PLANNING AND CONTROL

Production planning and control – cost planning and control – inventory management – material requirement planning (MRP) - shop floor control – factory data collection system – automatic identification system – barcode technology – automatic data collection system.

Unit-IV: COMPUTER MONITORING

Types of production monitoring system – structure model of manufacturing process – process control & strategies – direct digital control – supervisory computer control – computer in QC – contact inspection methods non – contact inspection method – computer – aided testing – integration of CAQC with CAD/CAM

Unit-V: INTEGRATED MANUFACTURING SYSTEM

Definition – application – features – types of manufacturing systems – machine tools – materials handling system – computer control system – DNC systems manufacturing cell. Flexible manufacturing system (FMS) – the FMS concept – transfer systems – head changing FMS – variable mission manufacturing system – CAD/CAM system – human labor in the manufacturing system – computer integrated manufacturing system benefits. Rapid prototyping – artificial intelligence and expert system in CIM

Text Book(s):

1. M. P. Groover, "*Automation Production Systems, and Computer Integrated Manufacturing*", Edition: 4, Pearson , 2016.
2. A. Alavudeen, N Venkateshwaran, "*Computer Integrated Manufacturing*", Edition: 1, PHI Learning , 2008.

Reference(s):

1. David Bedworth, "*Computer Integrated Design and Manufacturing*", Edition: 1, TMH , 1998.
2. J. A. Rehg and H. W. Kraebber, "*Computer Integrated Manufacturing*", Edition: 3, Pearson , 2004.
3. J. B. Waldner, "*Principles of Computer Integrated Manufacturing*", Edition: 1, Wiley , 1992.

MEC18R438 : TERO TECHNOLOGY	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to understand the Maintenance and Reliability Engineering field; it introduces maintenance aspects of planning, control, costs, design, purchasing and installation

Course Outcome(s):

CO1	*Know the basic concepts of Probability distributions*
CO2	*Identify the different type of Reliability techniques and models*
CO3	*Summarize the various maintainability and reliability concepts*
CO4	*Understand the principles of plant replacement policy*
CO5	*Examine the knowledge on condition based maintenance monitoring of vibration parameters*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1								1		
CO2	1	2		1	1								1		
CO3	1	1	1		1						1		1		
CO4	1	2	1	1							2		1		
CO5	1	1	1	1	1								1		

Course Topics:

Unit-I: PROBABILITY CONCEPTS

Probability distributions – density and distribution functions for uniform, exponential, rezeligh, weibull, normal distribution – Non-maintained systems

Unit-II: RELIABILITY

Definition and its important – method of improving reliability redundancy techniques – failure data analysis – Reliability models – Hazard models – constant, linearly increasing and weibull models estimating of reliability, failure density and MTTF for hazard models

Unit-III: MAINTENANCES SYSTEMS AND ECONOMICS OF RELIABILITY

Maintainability and availability concepts, MTBF, MTTR, MTBM & MDT repair hazard rate, maintainability and availability functions and their mathematical expressions

Unit-IV: MAINTENANCE AND SPARES MANAGEMENT

Preventive replacement- individual breakdown replacement policy – individual preventive replacement policy – preventive group replacement

Unit-V: CONDITION BASED MAINTENANCE

Advantages and disadvantages – vibration monitoring –vibration parameters – vibration instruments

Text Book(s):

1. L. S. Srinath, "*Reliability Engineering*", Edition: 1, Affiliated East West Press Pvt.Ltd , 2011.
2. R. Collacoot, "*Mechanical Fault Diagnosis & condition monitoring*", Edition: 1, Springer , 1977.

Reference(s):

1. E. Balagurusamy, "*Reliability Engineering*", Edition: 1, Tata Mcgraw Hill Publishing Company , 2017.
2. Bikas Bhadury and S. K. Basu, "*Terotechnology: Reliability Engineering and Maintenance Management*", Edition: 1, Asian Books Pvt. Ltd. , 2008.
3. T. M. Husband, "*Maintenance management and terotechnology*", Edition: 1, Saxon House , 1976.

MAJOR ELECTIVE (SIEMENS INTEGRATED)

MEC18R904 : FACTORY CAD	**L**	**T**	**P**	**C**
	3	**0**	**2**	**4**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Integrated Course			

Course Objective(s):

The aim of this course is to develop basic understanding of plant layout and material handling.

Course Outcome(s):

CO1	*Outline the basics of factory CAD and their importance.*
CO2	*Develop the modelling of smart objects using the tools*
CO3	*Create the facility to importing the objects developed by the tools*
CO4	*Ability to analyze the various models created and prepare the documents*
CO5	*Outline various machines and material handling processes*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2			2	2				1			2	
CO2	3	3	3		2	2	1						2	3	
CO3		3	2		3						1	1		2	
CO4	2	2	3	3	1						3				
CO5	1	3		1			2				1			2	

Course Topics:

Unit-I: BASICS OF FACTORY CAD

Smart factory objects - Creating an new facility layout - Exporting a layout to a visualization program.

Unit-II: CREATION OF SMART OBJECTS

Layer organization and standards - Creating generic tool objects

Unit-III: CREATION OF LIBRARIES AND IMPORTING OBJETCS

Using the Factory Explorer and Factory libraries - Importing tooling and product geometry

Unit-IV: ANALYSE AND DOCUMENTATION

Analyzing and documenting space use - Animating within Factory CAD - Building custom parametric objects

Unit-V: MACHINES AND MATERIAL HANDLING

Converting 2D outlines to 3D objects - Building systems from custom objects - Querying drawing object.

Text Book(s):

1. F. E. Meyers and M. P. Stephens , "*Manufacturing Facilities Design and Material Handling*", Edition: 4, Prentice-Hall, Inc. , 2014.
2. M. James Apple, "*Plant layout and Material Handling*", Edition: 3, John Wiley & Sons Inc. , 1977.

Reference(s):

1. J. A. Tompkins and J. A. White , "*Facilities and Planning*", Edition: 4, John Wiley , 2010.
2. L. Richard Francis and J. A. White, "*Facilities Layout and Location - an Analytical Approach*", Edition: 2, Prentice Hall Inc. , 2004.
3. S. C. Sharma, "*Plant layout and Material Handling*", Edition: 3, Khanna Publishers , 2000.

MEC18R905 : PLANT SIMULATION	**L**	**T**	**P**	**C**
	3	**0**	**2**	**4**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Integrated Course			

Course Objective(s):

To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

Course Outcome(s):

CO1	*Outline the plant simulation strategies and their importance*
CO2	*Creating the model of the objects by using the drafting tools*
CO3	*Illustrate the material movement process and the units utilized.*
CO4	*Illustrate the use of analysis tools use for plant simulation process*
CO5	*Categorize the data handling and processing methods*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1		1						2		2	1	
CO2	2		1		2						2		2	1	
CO3	2		3		3						2		2	2	1
CO4	2		1		3						2		2	3	3
CO5	2		2		3						3	2	2	2	2

Course Topics:

Unit-I: BASICS OF PLANT SIMULATION

Basic Plant Simulation interface- Object-oriented modeling strategies - Basics of material flow objects - Hierarchy, icons, and inheritance

Unit-II: MODELLING OF OBJECTS

Modeling buffers, assembly lines and roads, Kanban, and failures, Resource objects (i.e. workers and shift calendars), Resource objects (i.e. workers, shift calendars, foot paths, etc.)

Unit-III: MATERIAL MOVEMNET AND UNITS

Basic conveying systems (length-oriented objects), other objects (i.e. Information objects, User Interface object, mobile units).

Unit-IV: ANALYSIS TOOLS

Sankey, bottleneck analyzer, and experiment manager basics, Customizing object logic (Method creation), Methods for data collection and evaluation

Unit-V: DATA HANDLING

Methods for interfaces (Excel, DDE, basics of other interfaces), Data acquisition from external files and systems

Text Book(s):

1. M. P. Groover, "*Automation Production Systems, and Computer Integrated Manufacturing*", Edition: 4, Pearson , 2016.
2. A. Alavudeen, N Venkateshwaran, "*Computer Integrated Manufacturing*", Edition: 1, PHI Learning , 2008.

Reference(s):

1. David Bedworth, "*Computer Integrated Design and Manufacturing*", Edition: 1, TMH , 1998.
2. J. A. Rehg and H. W. Kraebber, "*Computer Integrated Manufacturing*", Edition: 3, Pearson , 2004.
3. J. B. Waldner, "*Principles of Computer Integrated Manufacturing*", Edition: 1, Wiley , 1992.

MEC18R906 : ADDITIVE MANUFACTURING	**L**	**T**	**P**	**C**
	3	**0**	**2**	**4**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Integrated Course			

Course Objective(s):

To understand the 3D printing principles and methods

Course Outcome(s):

CO1	*Understand the principles of 3D Printing technique*
CO2	*Illustrate the methods of modelling and correction in 3D volumes.*
CO3	*Apprehend the principles of finishing and materials*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1		1						2		2	1	
CO2	2		1		2						2		2	1	
CO3	2		3		3						2		2	2	1

Course Topics:

Unit-I: BASICS

Introduction to 3D printing techniques FDM, SLA, SLS, Generation of .stl format for 3D volume

Unit-II: MODELLING OF OBJECTS

Examination of Errors – holes, faces normal, self-intersections, noise shells, manifold errors, Repairing of Errors according to technique selection, Finishing and thread control

Unit-III: MATERIAL MOVEMNET AND UNITS

Materials and 3D printing- Introduction to white light scanning- Operation of Printer software controls and rectifications of model.

Text Book(s):

1. M. P. Groover, "*Automation Production Systems, and Computer Integrated Manufacturing*", Edition: 4, Pearson , 2016.
2 A. Alavudeen, N Venkateshwaran, "*Computer Integrated Manufacturing*", Edition: 1, PHI Learning , 2008.

Reference(s):

1. David Bedworth, "*Computer Integrated Design and Manufacturing*", Edition: 1, TMH , 1998.
2. J. A. Rehg and H. W. Kraebber, "*Computer Integrated Manufacturing*", Edition: 3, Pearson , 2004.
3. J. B. Waldner, "*Principles of Computer Integrated Manufacturing*", Edition: 1, Wiley , 1992.

MEC18R901 : ESSENTIALS FOR NX DESIGNER	**L**	**T**	**P**	**C**
	0	**0**	**2**	**1**
Pre-requisite: Nil	**Course Category:** One Credit **Course Type :** Practical			

Course Objective(s):

To understand the fundamentals of NX designer tool

Course Outcome(s):

CO1	*Ability to design the components using NX design tool*
CO2	*Analyze the components using NX designer tools*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1		1						2		2	1	
CO2	2		1		2						2		2	1	

Course Topics:

Unit-I: NX Designer Basics

Understand how to effectively use the NX user interface and work space
- Create sketches to capture design intent
- Create reference geometry for model development such as datum planes, axes, and coordinate systems
- Create basic features by sweeping and extruding geometry

Unit-II: Analysis of components

- Analyze feature geometry
- Add detail to features such as blends and drafts
- Produce assemblies of component parts
- Produce annotated 2D drawings of models

MEC18R353 : FUNDAMENTALS OF MECHATRONICS SYSTEM	L	T	P	C
	0	0	2	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory with Practical			

Course Objectives:

Aim of this course is to educate students about an integrated approach for the design of complex engineering systems and to provide knowledge of sensors, actuators

Course Outcomes:

CO1	*Interpret the needs for models of systems in order to predict their behavior*
CO2	*Understand the requirements of signal conditioning and pulse modulation*
CO3	*Analysis the characteristics of various actuation systems*
CO4	*Describe the structure of microcontroller to carry out the tasks*
CO5	*Describe the linear and non-linear relationship models for various system blocks*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1			1			1	2	2	1	
CO2	2	2	2	1			1		2			2	2	2	
CO3	2	2	2	1			1		2			2	2		
CO4	2	2	2				2	1			1		2		2
CO5	3									2	1		1	1	2

Course Topics

UNIT I: BASIC MECHATRONICS

Design process, measurement systems, control systems, programmable logic controller, sensors and transducers – performance terminology, displacement, position, proximity, force, velocity, motion, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of sensors and switches.

UNIT II: SIGNAL CONDITIONING

Signal conditioning, operational amplifier, protection, filtering, Wheatstone bridges, pulse modulation, digital signals, analog and digital signals, digital to analog, analog to digital, multiplexers and data acquisition.

UNIT III: ACTUATION SYSTEMS

Pneumatic and hydraulic actuation system, directional control valves, pressure control valves, cylinders, servo and proportional control valves, process control valves, rotary actuators, mechanical systems-kinematic chain, cams, gears, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection.

UNIT IV: MICROPROCESSOR AND INTERFACING

Microprocessor systems, microcontrollers, application, programming, interfacing of peripheral device, keyboard and display interfacing, ADC, DAC, input and output addressing, interface requirements, peripheral interface requirements, serial communication interface.

UNIT V: SYSTEM MODELS

Mathematical model, mechanical system building blocks, electrical system building blocks, fluid system building blocks, thermal system building blocks, rotational –translational system, Electromechanical system and Hydraulic mechanical systems.

Practical:

1. Sensor/Transducer
2. Implementation of Inverting and Non-inverting Amplifier using Op-Amp
3. Implementation of Instrumentation Amplifier using Op-Amp
4. Study of Analog to Digital Converter
5. Study of Digital to Analog Converter
6. Study of Multiplexer
7. Design and testing of fluid power circuits to control Velocity, direction and force of single and double acting actuators
8. Design of circuits with logic sequence using Electro pneumatic trainer kits.
9. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software
10. Computerized data logging system with control for process variables like pressure flow and temperature.
11. Servo controller for open and closed loop
12. Speed control of DC motor with a Microprocessor or Microcontroller
13. Stepper motor control with a Microprocessor or Microcontroller
14. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW

Text Book(s):

1. W.Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” Pearson Prentice Hall, 6th Edition, 2019

Reference(s):

2. Clarence.W. desilva, “Mechatronics: A Foundation Course”, CRC Press, 1st Edition, 2021
3 K.P. Ramachandran , G.K. Vijayaraghavan , M.S.Balasundaram, “Mechatronics, As per AICTE: Integrated Mechanical Electronic Systems”, Wiley Publishers, January 2019
4 Dr. Rajesh Purohit, Dr. Swadesh Kumar Singh “A Text Book On Industrial Engineering, Mechatronics & Robotics”, Made Easy Publications, First Edition, January 2019
5 Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 2007

MEC18R308 : ROBOTIC MECHANISM DESIGN	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To impart the knowledge about the basics of robotics and their kinetics

Course Outcomes:

CO1	*Understand the basics of robotics and their geometry*
CO2	*Enumerate the concepts of homogeneous transformation*
CO3	*Ability to apply the forward kinematics principles*
CO4	*Understand the inverse kinematics processes*
CO5	*Interpret the robotics motion in angular aspects*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3		1	1							2	2	2	1
CO2	3	1		3	1							3	1	1	
CO3	2	2		1	2							2	2	1	1
CO4	3	2		1	1							2	2	2	
CO5	3	1		2	1							2	2	2	2

Course Topics

UNIT I: INTRODUCTION

Classification of Robots based on Geometry, Workspace, Actuation, Control and Application - Advantages and Disadvantages of Robots - Robot Components: Link, Joint, Manipulator, Wrist, End-effector : Gripper –Types, Actuator and Sensor - Configuration space – Joint Space – Workspace, Robot Specifications: Number of Axes:Internal and External (7-axis robot) - Capacity and Speed, Reach and Stroke, Tool Orientation, Repeatability, Precision and Accuracy, Operating Environment.

UNIT II: HOMOGENEOUS TRANSFORMATIONS

Degrees of Freedom – Matrix Representation: Representation of a point and vector in space, Global and Local Coordinate axes - Homogeneous Transformation Matrices – Transformations: Representation of pure translation, Representation of pure Rotation - Representation of Combined Transformations - Inverse of Transformation Matrices - Euler Angles – Roll, Pitch, Yaw angles - Quaternions–Spinors and Rotations

UNIT III: FORWARD KINEMATICS

Denavit-Hartenberg Notation - Transformation between two Adjacent Coordinate Frames Forward Kinematics of Two, Three, Four, Five and Six axis Robots.

UNIT IV: INVERSE KINEMATICS

Decoupling Technique - Inverse Transformation Technique - Inverse position: GeometricApproach – Inverse Orientation - Inverse Kinematics of Two, Three, Four, Five and Sixaxis Robots.

UNIT V: VELOCITY KINEMATICS

Angular Velocity – Linear Velocity - Jacobian representation of Linear and Angular Velocity Calculation of Jacobian for Two, Three and Four axis Robots - Inverse Jacobian - Singularities: Wrist and Arm Singularities - Manipulability - Induced joint torques and forces.

Practical:

1. Programming on VAL Language
2. Programming on VAL-II Language
3. Programming on RAPID Language
4. Programming on AML Language
5. Programming the robot for pick and place operation using any robot
6. Robot Programming for Colour identification/shape identification/path tracking
7. Industrial visit and its report on industrial applications of robots

Text Book(s):

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", Wiley, 2015.
2. Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 2011.

Reference(s):

1. Robert J. Schilling, "Fundamentals of Robotics, Analysis and Control", PHI Learning, 2009.
2. Reza N Jazar, "Theory of Applied Robotics", Springer, 2010.
3. Saha S K, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd, 2010.
4. Tadej Bajd, Matjaž Mihelj, Marko Munih, "Introduction to Robotics", Springer, 2013.

MEC18R314 : ROBOT COLLABORATIVE SYSTEM DESIGN	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To provide a brief introduction to robot cognition and collaborative system design.

Course Outcomes:

CO1	*Discuss about the basics of robot cognition and perception*
CO2	*Illustrate the different methods of map building and the robot simulation and execution of a program.*
CO3	*Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs used .*
CO4	*Develop knowledge about simultaneous localization and mapping based techniques and paradigms.*
CO5	*Elaborate the various robot programming packages for display, tele-operation and other applications.*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		2	2								2	1	1
CO2	2		3	2						1			2		
CO3	3	2			1								1		
CO4	2		1	3										1	1
CO5	2	2	1	1			2			1			1		

Course Topics

UNIT I: CYBERNETIC VIEW OF ROBOT COGNITION AND PERCEPTION

Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, Soft Computing Tools and Robot Cognition

UNIT II: MAP BUILDING

Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Traverse Boundary, An Illustration of Procedure Map Building, Robot Simulation, Execution of the Map Building Program

UNIT III: RANDOMIZED PATH PLANNING

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

UNIT IV: SIMULTANEOUS LOCALIZATION AND MAPPING (SLAM)

Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, ParticleMethods Relation of Paradigms..

UNIT V: ROBOT PROGRAMMING PACKAGES

Robot Parameter Display, Program for BotSpeak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation, A Complete Program for Autonomous Navigation..

Text Book(s):

1. Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", SpringerVerlag Berlin and Heidelberg, 2017.
2. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, “Principles of Robot Motion-Theory, Algorithms, and Implementation”, MIT Press, Cambridge, 2015

Reference(s):

3. Sebastian Tharun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2015.
4. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2018.
5. Hooman Somani,”Cognitive Robotics”, CRC Press, 2015.

MEC18R406 : AUTONOMOUS ROBOTS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems.

Course Outcomes:

CO1	*Discuss the various types of robot locomotion*
CO2	*Demonstrate the kinetic model of a mobile robot and its dynamic simulation.*
CO3	*Apply the various types of sensors to identify the robot perception.*
CO4	*Identify the localization of robotic systems.*
CO5	*Use the concepts of planning and navigation of mobile robots.*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		2	2								2	1	1
CO2	2		3	2						1			2		
CO3	3	2			1								1		
CO4	2		1	3										1	1
CO5	2	2	1	1			2			1			1		

Course Topics

UNIT I: ROBOT LOCOMOTION

Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability.

UNIT II: MOBILE ROBOT KINEMATICS AND DYNAMICS

Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.

UNIT III: PERCEPTION

Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering.

UNIT IV: LOCALIZATION

Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems...

UNIT V: INTRODUCTION TO PLANNING AND NAVIGATION

Path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP)

Text Book(s):

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2016.

Reference(s):

2. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in MATLAB", Springer Tracts in Advanced Robotics, 2017.
3. Melgar, E. R., Diez, C. C. "Arduino and Kinect Projects: Design, Build, Blow Their Minds", 2018

MEC18R407 : INTELLIGENT MEDICAL ROBOTICS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To provide knowledge on the application of robotics in the field of health care.

Course Outcomes:

CO1	*Describe the types of medical robots and the concepts of navigation and motion replication.*
CO2	*Discuss about the sensors used for localization and tracking*
CO3	*Summarize the applications of surgical robotics*
CO4	*Outline the concepts in Rehabilitation of limbs and brain machine interface*
CO5	*Classify the types of assistive robots.*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	2								3	1	1
CO2	2		2	3						1			2	1	
CO3	3	1			1								2		
CO4	2		1	3						1				1	1
CO5	2	2		3			2		1			1	1		

Course Topics

UNIT I: INTRODUCTION

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.

UNIT II: LOCALIZATION AND TRACKING

Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - Hybrid systems

UNIT III: CONTROL MODES

Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

UNIT IV: REHABILITATION

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies.

UNIT V: ROBOTS IN MEDICAL CARE

Assistive robots –types of assistive robots – case studies. Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security

Text Book(s):

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modeling and Control”, Wiley Publishers, 2016.
2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2019.

Reference(s):

3. Achim Schweikard, Floris Ernst, “Medical Robotics”, Springer, 2018.
4. Daniel Faust, “Medical Robots”, Rosen Publishers, 2016

MEC18R327 : INDUSTRIAL IOT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To impart the principles of internet of things towards various industrial applications

Course Outcomes:

CO1	*Understand the basics and structure of internet of things*
CO2	*Illustrate the characteristics of IoT sensors of first and advanced generations*
CO3	*Outline the various modules of IoT systems*
CO4	*Apply the industrial IoT principles for various applications*
CO5	*Able to apply the concepts of IoT to various projects*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2		1	1							2	2	2	1
CO2	2	2		2	2							2	2	1	
CO3	1	2		1	2							2	1	2	1
CO4	2	1		2	2							1	1	2	1
CO5	2	1		2	1							2	1	2	2

Course Topics

UNIT I: INTRODUCTION

Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Map Device

UNIT II: IOT SENSORS

Industrial sensors – Description & Characteristics–First Generation – Description & Characteristics– Advanced Generation – Description & Characteristics–Integrated IoTSensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors' Swarm – Description & Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap

UNIT III: TECHNOLOGICAL ANALYSIS

Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module

UNIT IV: IOT DEVELOPMENT EXAMPLES

ACOEM Eagle – En Ocean Push Button – NEST Sensor – Ninja Blocks -Focus on Wearable Electronics

UNIT V: IOT PROJECTS

Creating the sensor project - Preparing Raspberry Pi/ ARM Cortex - Clayster libraries - HardwareInteracting with the hardware - Interfacing the hardware- Internal representation of sensor values - Persisting data - External representation of sensor values – Exporting Sensor data - Creating the actuator project- Hardware - Interfacing the hardware -Creating a controller - Representing sensor values - Parsing sensor data – Calculating control states - Creating a camera - Hardware -Accessing the serial port on RaspberryPi/ ARM Cortex - Interfacing the hardware - Creating persistent default settings – Adding configurable properties - Persisting the settings - Working with the current settings -Initializing the camera.

Text Book(s):

1. Giacomo Veneri , Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0 ", Ingram short title, 2018

Reference(s):

2. Sabina Jeschke, Christian Brecher, Houbing Song , Danda B. Rawat, "Industrial Internet of Things: Cybermanufacturing Systems", Springer, 2018.
3. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", Apress, 2019.

MEC18R328 : SMART MANUFACTURING AND INDUSTRY 4.0	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To provide students with the concepts of planning manufacturing systems, computer integrated manufacturing and enterprise integration, group Technology and knowledge based systems

Course Outcomes:

CO1	*Assess the performance of manufacturing systems and CIM systems*
CO2	*Develop a systematic approach for design and implementation of manufacturing systems.*
CO3	*Interpret new procedures to improve the productivity of existing manufacturing systems.*
CO4	*Enumerate the model and algorithm of Group Technology.*
CO5	*Analyze the impact of knowledge based group technology systems in automated manufacturing system.*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3		2	2		1					2	3	1	2
CO2	1	3		3	2							1	2	2	2
CO3	1	1		2			1					3	3	1	
CO4	1	1		3	2		1					3	3	2	
CO5	1	2		2								2	3	2	

Course Topics

UNIT I: COMPUTER INTEGRATED MANUFACTURING

Computer integrated manufacturing systems – structure and functional areas of CIM system - AD, CAPP, CAM, CAQC, ASRS and advantages of CIM Manufacturing communication systems – MAP/TOP OSI model, data redundancy, top-down and bottom-up approach, volume of information. Intelligent manufacturing – system components, system architecture and data flow, system operation

UNIT II: ARTIFICIAL INTELLIGENCE

Components of knowledge-based systems – basic components of knowledge-based systems, knowledge representation, comparison of knowledge representation schemes, interference engine, knowledge acquisition Machine learning – concept of artificial intelligence, conceptual learning, artificial neural networks -biological neuron, artificial neuron, types of neural networks, applications in manufacturing

UNIT III: PROCESS PLANNING

Automated process planning – variant approach, generative approach, expert systems for process planning, feature recognition, phases of process planning Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design, equipment selection problem, modelling the manufacturing equipment selection problem, problem solving approach in KBSES, structure of the KBSES

UNIT IV: GROUP TECHNOLOGY

Group technology: models and algorithms – visual method, coding method, cluster analysis method, matrix formation – similarity coefficient method, sorting-based algorithms, bond energy algorithm, cost-based method, cluster identification method, extended ci method.

UNIT V: KNOWLEDGE BASE SYSTEM

Knowledge based group technology - group technology in automated manufacturing system, structure of knowledge-based system for group technology (KBSGT) – data base, knowledge base, clustering algorithm.

Text Book(s):

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 8th edition, PHI, 2008.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.

Reference(s):

3. Yagna Narayana, "Artificial Neural Networks", PHI, 2009.
4. Andre Kusaic, " Intelligent Manufacturing Systems", PHI,1989
5. Hamid R. Parsaei and Mohammad Jamshidi, "Design and Implementation of Intelligent Manufacturing Systems", PHI, 2009

MEC18R408 : BIG DATA ANALYTICS FOR MANUFACTURING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To understand the competitive advantage of big data analytics and its frameworks.
To Learn Data analysis methods and stream computing.
To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

Course Outcomes:

CO1	*Enumerate the features, evolution and modern tools of Data Analytics.*
CO2	*Analyze the various methods of HADOOP framework.*
CO3	*Illustrate the statistical methods of Data analysis and Data analysis using R.*
CO4	*Analyze data by utilizing various data mining approaches*
CO5	*Understand the various NoSql alternative database models*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				1							1			
CO2	1				3							2			2
CO3	1				2							2			2
CO4	1				3							2			2
CO5	2				3							1			2

Course Topics

UNIT I: INTRODUCTION TO BIG DATA

Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools

UNIT II: SYSTEM ORGANIZATION

Distributed File Systems - Large-Scale File System Organization – HDFS concepts – Map Reduce Execution, Algorithms using Map Reduce, Matrix-Vector Multiplication – Hadoop YARN.

UNIT III: DATA ANALYSIS

Statistical Methods: Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Predictive Analytics – Data analysis using R.

UNIT IV: MINING DATA STREAMS

Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

UNIT V: BIG DATA FRAMEWORKS

Introduction to NoSQL – Aggregate Data Models – H base: Data Model and Implementations – H base Clients – Examples – Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries.

Text Book(s):

1. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, Wiley and SAS Business Series, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.

Reference(s):

1. Learning R – A Step-by-step Function Guide to Data Analysis, Richard Cotton, O‟Reilly Media, 2013.
2. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, Second Edition, 2007.
3. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
4. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012

MEC18R409 : RODUCTION DRAWING AND MANUFACTURING ANALYSIS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Major Elective **Course Type :** Theory			

Course Objectives:

To understand the basic concept of production drawing and analysis of manufacturing systems in industries.

Course Outcomes:

CO1	*Analyze the principle and working model of manufacturing systems*
CO2	*Interpretation of Line balancing algorithm and production flow analysis.*
CO3	*Analysis of FMS and Group Technology systems in manufacturing.*
CO4	*Enumerate the principle of material handling system and AGV in manufacturing industries.*
CO5	*Understand the basic concept of Storage and Retrieval systems.*

Mapping of Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1		2							1	3	3	2	
CO2	2	1		2								2	3		
CO3	3	2		3							2	2	3	2	
CO4	2	1		2							1	3	3		
CO5	3	1		2							1	2	3		

Course Topics

UNIT I: MANUFACTURING SYSTEMS MODEL

Introduction to manufacturing systems models, types and principles of manufacturing systems, manufacturing models, types and uses physical models, mathematical models, model uses, model building, numerical problems/simulation exercises.

UNIT II: ASSEMBLY LINES

Introduction to assembly lines, line balancing algorithms, COMSOL random sequence generation, ranked positional weight, heuristics, optimal solutions, practical issues, mixed models, sequencing unpaced lines, shop scheduling with many products, order release, flow shop sequencing, single and two machine flow shops, job shop scheduling, dispatching rules and schedule generation, numerical problems/simulation exercises

UNIT III: FLEXIBLE MANUFACTURING SYSTEM

Introduction to FMS, components of FMS machines, movement system, work stations, system controller, planning and control hierarchy, system design, system set up, scheduling and control, flexible assembly system Group technology principles, coding schemes, assign machines to groups, production flow analysis, binary ordering algorithm, assigning parts to machines..

UNIT IV: MATERIAL HANDLING SYSTEMS

Introduction, types and principles of material handling systems, equipment selection, conveyor analysis, closed loop conveyor, AGV systems, design and operation of AGVs vehicle, requirements, analysis, pallet sizing and loading, use of petri nets

UNIT V: STORAGE SYSTEMS

Introduction to warehousing and storage and retrieval system, warehouse components, warehouse design, stacking pattern, location in warehouses, dedicated storage, open storage, class base storage, storing complementary items, order picking, forming pick list, pick sequencing.

Text Book(s):

1. Groover M.P. Automation Production Systems and Computer Integrated Manufacturing Prentice-Hall of India Pvt. Ltd, 2016.
2. Kalpakjian Manufacturing Engineering and Technology Addison-Wesley Publishing Co, 2020.

Reference(s):

1. H. K. Shivanand, Flexible Manufacturing System, New Age International Pvt Ltd, Edition 1, 2006.
2. Ronald G. Askin and Charles R. Standridge Modeling and analysis of manufacturing systems John Wiley & Sons Inc, 1993.

OPEN ELECTIVE (BASIC SCIENCE & MATHEMATICS)

OEE18R008	Photonics and Optoelectronic Devices	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, the students will be able to

CO-1: Know the fundamentals of fibre based optical devices

CO-2: Understand the basic of integrated optical devices

CO-3: Learn about the opto-electronic devices

CO-4: Understanding of nanostructured materials

CO-5: Understanding of quantum devices with applications

Unit – I: Optical Fibre based Devices

Introduction to optical Fibre; Fused single mode fibre directional coupler, Polished single mode fibre directional coupler; Fibrepolariser; Wavelength multiplexer and demultiplexer; Optical fibre switches and intensity modulators; Optical fibre phase modulator; Optical fibre frequency modulator; Optical fibre amplifiers

Unit – II: Integrated Optics based Devices

Optical directional coupler: directional coupler wavelength filter, polarisation splitting directional coupler; Polarisers: leaky mode polariser, metal clad polariser; Phase modulator; Optical switch; Acousto-optic devices : mode converter , tunable wavelength filter, Bragg type modulator , Bragg type deflector; Magneto-optic devices : TE-TM mode converter, modulators and switches, Ti / $LiNbO_3$ based optical devices.

Unit – III: Optoelectronic Devices

Semiconductor Lasers: homojunction, heterojunction and surface emitting lasers, quantum well lasers; Modulation of lasers; Photodetectors: PIN, Avalanche photodiodes; Optoelectronic modulation and switching devices; Electro-optic Devices; Optoelectronic Integrated circuits; SiO_2 / Si based optoelectronic devices.

Unit – IV: Nanophotonics

Nanocomposites: Nanocomposite Waveguides, Random Lasers, Nanocomposites for optoelectronics-Basics of nano-photonics-Introduction to MEMS and NEMS-Working principles: as micro sensors-biosensors, chemical sensors and optical sensors. MEMS/NEMS applications: Applications in automotive industry-health care- aerospace-industrial product- consumer products.

Unit – V: Quantum Devices

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots; Density of states in low-dimensional structures; Resonant tunneling phenomena and applications in diodes and transistors; Applications of quantum devices: quantum well and quantum dot lasers, ultra- fast switching devices, high density memories, dc and rf squids, multi-state logic circuits, long wavelength detectors ; Quantum Computing (Qualitative)

Reference Books:

1. Joachim Piprek, Semiconductor optoelectronic devices, Academic press Hardbound, 2003
2. A.K. Ganguly, Optoelectronic devices and circuits, Narosa publication, 2007
3. Shun Lien Chuang, Physics of Optoelectronic Devices, Wiley-Interscience; 1st ed.,1995
4. Goure and I Verrier, Optical Fibre Devices, Taylor& Francis; 1st ed., 2001
5. Ray Tricker,Optoelectronics and Fiber Optic Technology,Newnes, 2002
6. K Krishna Reddy M Balakrishna Rao, Nanostructures & Quantum Devices, Campus Books International, 2007
7. RahmanFaiz, Nanostructures in Electronics and Photonics, Pan Stallion press (Year)
8. Guozhong Cao, Nano structures &nanomaterials: synthesis, properties & applications, Imperial College Press, 2004
9. Todd D. Steiner, Semiconductor nanostructures for optoelectronic application, Artech House, INC., 2004
10. Jia- Ming Liu, Photonic Devices, Cambrige University Press, 2005

OEE18R009	LASER TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, the students will be able to

CO-1: An ability to enhance the modern technological aspects in laser

CO-2: To correlate the basic concept of theoretical principles in laser

CO-3: An ability to improve the knowledge of various types of laser

CO-4: Enormous interest to study the various properties of laser.

CO-5: Knowledge of laser applications in various engineering fields

Unit - I: Absorption and Emission of Radiation

Concept of coherence – spatial and temporal - Conditions for Producing Laser - spontaneous and stimulated emission - Population Inversion-different methods- Einstein coefficients – negative absorption – Gain and Gain saturation - Saturation intensity - shape and width of spectral lines.

Unit - II: Threshold Condition and Resonators

Rate equations – optical excitation in three and four level lasers – standing waves in laser – cavity theory – dichroic filter – modes, diffraction theory of the Fabry – Perot interferometer – Types of resonators – stability diagram

Unit - III: Types of Lasers

Principle, construction, working-Gas lasers:He-Ne laser, , CO_2 laser- Liquid lasers: dye lasers, solid state laser: Ruby laser, Nd-YAG laser-applications.

Unit - IV: Ultrafast Photonics and Laser Q Switching

Introduction to ultrashort pulse lasers and amplifiers – wavelength conversion – time-resolved experiments – applications of ultrashort pulses – Mode locking – second harmonic generation – theory and experiment – materials for optical second harmonic generation

Unit - V: Applications

Measurement of distance, velocity, rotation with lasers – laser in communications and computer technology– holography – industrial applications – cutting, drilling & welding – lasers in medicine – laser in research and development

Text Books:

1. Simon Hooker & Colin Webb “Laser Physics” Oxford Press, 2010.
2. William T. Silfvast “Laser Fundamentals” Cambridge University Press, Second Edition, 2008.
3. William S. C. Chang “Principles of Lasers and Optics” Cambridge University Press, 2007.
4. Yehoshua Y. Kalisky “The Physics and Engineering of Solid State Lasers” SPIE Press, 2006.
5. Mark Csele“ Fundamentals of light sources and lasers” John Wiley and sons, New jersey 2004

OEE18R006	Industrial Chemistry for Engineers	L	T	P	C
		3	0	0	3

Course Outcome(s)

CO1 To apply the knowledge of electrochemistry to understand the working mechanism of batteries and sensors.

CO2 To understand the process involved in refining of petroleum, cracking of crude oil and manufacturing of fuel gases and to analyze the flue gas.

CO3 To understand the process of adsorption and colloidal state of materials.

CO4 To understand the formulation of protective coatings and to know the process of manufacturing and cleansing action of soaps.

CO5 To know the constituents, composition and manufacturing process of cement, glass and ceramics.

Unit - I: Energy Storage Devices and Sensors

Batteries - primary and secondary cells. Primary cell - Dry cell, Mercury cell. Secondary cell - Lead acid battery, Lithium battery. Solar cells & fuel cells (H_2-O_2, PEFC and SOFC) - principle, construction, working and application. Electrochemical sensors - working, application and merits.

Unit - II: Fuels and Combustion

Petroleum: Origin, refining, cracking - thermal and catalytic, reforming – thermal and catalytic, knocking and octane number, synthetic petrol - Fischer-Tropsch and Bergius method.

*Fuel Gases***:** Large scale production, storage, hazards and uses of LPG, coal gas, water gas, producer gas, and oil gas. Combustion (Problems). Mass analysis from volume analysis and vice versa. Analysis of flue gas (Orsat's apparatus).

Unit- III: Applications of Adsorption and Colloidal State

Adsorption: Classification of Adsorption – Adsorption of Gases on Solids – Adsorption from Solutions – Applications of Adsorption.

Colloidal state: Types of colloidal solution –Preparation and purification of colloidal solutions – Characteristics of colloidal solution –Coagulation of sols – Origin of charge on colloids – Stability of colloids – Applications of Colloids – Protective colloids – Emulsions – Gels – Micelles.

Unit - IV: Organic Protective Coatings and Soaps

*Paints & Varnishes***:** Requirements of a good paint. Primary constituents of paints, dispersion medium (solvent), binder, pigments, formulation of paints and varnishes.

Soaps: Classification of soap, manufacture of soaps by hot and cold process, cleansing action of soap and classification of detergents (anionic and cationic).

Unit - V: Siliceous Materials

Cement: Manufacture - Wet Process and Dry process, types, analysis of major constituents, setting of cement, reinforced concrete.

Glass: Composition and manufacture of glass .Types of glasses- optical glass, coloured glasses and lead glass.

Ceramics: Types- raw materials - white wares, manufacture and uses.

Reference Books:

1) Jain and Jain, *Engineering Chemistry*, 15th Edition, .Dhanpat Rai Publishing Company, New Delhi, 2005.
2) B.N. Chakrabarty, *Industrial Chemistry*, Oxford & IBH Publishing Co, New Delhi, 1981.
3) B.K. Sharma, *Industrial Chemistry*, 11th Edition, Goel Publishing House, Meerut, 2000.
4) P.P. Singh, T.M. Joesph, R.G. Dhavale, *College Industrial Chemistry*, 4th Edition, Himalaya Publishing House, Bombay, 1983.

OEE18R005	COMBINATORICS	L	T	P	C
		3	1	0	3

Course Objectives:

To enable the students to understand the concepts of permutation, combination and inclusion and exclusion principle.

Course outcomes:

Upon successful completion of this course, students will be able to

CO1. understand the rules of sum and product of permutations and combinations.

CO2. analyze the concepts of pigeonhole principle and its applications.

CO3. identify solutions by the technique of generating functions

CO4. understand the concepts of Pascal's triangle, the binomial Theorem and unimodality of binomial Coefficients.

CO5. understand the concepts of the principle of inclusion-exclusion and their applications.

Unit I - Permutations and Combinations

Four Basic Counting Principles, Permutations of sets, Combinations (Subsets) of Sets, Permutations of Multi-sets, Combinations of Multi-sets.

Unit II - The Pigeonhole Principle:
Pigeonhole Principle: Simple Form, Pigeonhole Principle: Strong Form, A Theorem of Ramsey.

Unit III - Generating Permutations and Combinations:
Generating Permutations, Inversions in Permutations, Generating Combinations, Generating r-Subsets**.**

Unit IV - The Binomial Coefficients:

Pascal's Triangle, The Binomial Theorem, Unimodality of Binomial Coefficients, The Multinomial Theorem, Newton's Binomial Theorem.

Unit V - The Inclusion-Exclusion Principle and Applications:

The Inclusion-Exclusion Principle, Combinations with Repetition, Derangements, Permutations with Forbidden Positions, Another Forbidden Position Problem.

Text Book :

1. Richard A. Brualdi, Introductory Combinatorics, Pearson Education, Inc, China machine press, Fifth Edition, 2009

References :

1. Miklos Bona, A walk through Combinatorics, (Second Edition), *World Scientific Publ. Co.*, 2008.
2. C. L. Liu, Introduction to Combinatorial Mathematics, *Mc Graw Hill Book Company, New York*, 1968.

OEE18R003	Mathematical Biology	L	T	P	C
		3	1	0	3

Course Objective:

To enable the students to understand the concepts of models for single species, interacting populations and dynamics of marital interaction.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Learn continuous population models for single species

CO2. Learn discrete population models for a single species

CO3. Understand models for interacting populations

CO4. Analyze the various competitive models..

CO5. Model the dynamics of marital interaction.

Unit-I: Continuous Population Models for Single Species

Continuous Growth Models, Insect Outbreak Model: Spruce Budworm, Delay Models. Linear Analysis of Delay Population Models: Periodic Solutions, Real Life Problems related to Growth Model.

Unit-II: Discrete Population Models for a Single Species

Introduction: Simple Models, Cob webbing: A Graphical Procedure of Solution, Discrete Logistic-Type Model: Chaos, Stability, Periodic Solutions. Discrete Delay Models, Tumor Cell Growth.

Unit-III: Models for Interacting Populations

Predator-Prey Models: Lotka-Volterra Systems, Complexity and Stability, Realistic Predator- Prey Models, Analysis of Predator-Prey Model with Limit Cycle, Periodic Behavior: Parameter Domains of Stability.

Unit-IV: Competitive Models

Competition Models: Competitive Exclusion Principle, Mutualism or Symbiosis, General Models and Cautionary Remarks, Threshold Phenomena, Discrete Growth Models for Interacting Populations, Predator- Prey Models : Detailed Analysis.

Unit-V: Modelling the Dynamics of Marital Interaction: Divorce Prediction and Marriage Repair

Psychological Background and Data: Gottman and Levenson Methodology, Maital Typology and Modelling Motivation, Modelling Strategy and the Model Equations, Steady States and Stability.

Text Book:

1. J. D. Murray, Mathematical Biology: I. An Introduction, Third Edition, *Springer-verlag Berlin Heidelberg,* 2002.

REFERENCE BOOKS:

1. R.M. Anderson and R. M. May, editors, Infectious Disease of Humans : Dynamics and Control. *Oxford University Press, Oxford*, 1991..
2. O. Diekmann and J. A. P. Heesterbeek. Mathematical Epidemiology of Infectious Diseases: Model Building, *Analysis and Interpretation. John Weily, New York*, 2000.

OEE18R004	MATHEMATICAL MODELLING	L	T	P	C
		3	1	0	3

Course Objective:

To make the students to be capable of doing simple mathematical modelling using differential equations and difference equations.

Course Outcomes:

Upon successful completion of this course**,** Students will be able to

CO1: Understand the mathematical modelling of ordinary differential equation of first order.

CO2: Know about the concepts of mathematical modelling in difference equations and Linear difference equations.

CO3: Know mathematical modelling through partial differential equation and study about the mass-balance equations.

CO4: Know the first and second methods of obtaining partial differential equation models.

CO5: Study about the mathematical modelling through delay differential and functional equations.

Unit I:

Review of ODE and System of First Order ODE - Mathematical modelling in population dynamics-Epidemics through systems of ODE of first order - Mathematical modelling through systems of ordinary differential equations of the first order.

Unit II:

Difference Equation and its solution - Mathematical modelling through difference equations - The need for mathematical modeling through difference equations some simple models-Basic theory of linear difference equations with constant coefficients.

Unit III:

Review of PDE and solution of simple linear PDEs, Mathematical modelling through Partial differential equation -situation giving rise to Partial differential equation models-Mass-balance equations.

Unit IV:

First method of getting Partial differential equation models-Momentum balance equations the second method of obtaining PDE models.

Unit V:

Integral Equations - Solution of Simple Integral Equations - Mathematical modelling through functional Integral , delay differential and differential difference equations.

Text Book:

1. J.N. Kapur, Mathematical modelling, *New age international publishers,* 2005 (Reprint).

Reference Book:

1. Frank R. Giordano, William P. Fox, Steven B. Horton , A First Course in Mathematical Modelling , *Cengage Learning Publishers, 5th Edition,* 2013.

OPEN ELECTIVE
(ENGINEERING STREAM)

MEC18R320 : FINITE ELEMENT METHODS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

This course will focus on finite element modelling of structural applications

Course Outcome(s):

CO1	*Apply the knowledge of Mathematics and Engineering to solve structural problems*
CO2	*Apply the concept of numerical methods to find the approximate solution for partial differential equation*
CO3	*Evaluate the significance of coordinate measurement system for the one dimensional finite element problems and using FEA software solve structural application problems such as bar, trusses and beam*
CO4	*Perform numerical and software analysis of two dimensional & axisymmetric structures*
CO5	*Analyze the isoparametic element formulation using FEM*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2									3		1
CO2	3	3	3	2									3		1
CO3	3	3	2	2									3		1
CO4	3	3	2	2									3		1
CO5	3	3	2	2									3		1

Course Topics:

Unit-I: INTRODUCTION

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-II: ONE DIMENSIONAL PROBLEMS

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-III: TWO DIMENSIONAL PROBLEMS – SCALAR VARIABLE PROBLEMS

Introduction – finite element modeling – scalar valued problem – CST element-stiffness matrix – force vector – stress calculation – temperature effects – applications to scalar variable problems.

Unit-IV: TWO DIMENSIONAL PROBLEMS – VECTOR VARIABLE PROBLEMS

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-V: ISOPARAMETRIC ELEMENTS FORMULATION

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. T.R. Chandrupatla, and A.D. Belegundu, "*Introduction to Finite Elements in Engineering*", Edition: 4, *Pearson Education* , 2012.
2. P. Seshu, "*Textbook of Finite Element Analysis*", Edition: 14, PHI Publication , 2015.

Reference(s):

1. D.V Hutton, "*Fundamentals of Finite Element Analysis*", Edition: 1, McGraw-Hill Int , 2005.
2. S.S Rao, "*The Finite Element Method in Engineering*", Edition: 2, Elsevier , 2013.
3. J.N. Reddy, "*An Introduction to Finite Element Method*", Edition: 3, McGraw-Hill International Student , 2005.

MEC18R321 : OPTIMIZATION TECHNIQUES	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

This course will focus on mathematical modelling. Strong emphases will begiven to model formulation

Course Outcome(s):

CO1	*Explain the Formulation & Solving of non – linear programming.*
CO2	*Demonstrate the Unconstrained optimization*
CO3	*Ability to apply the Nonlinear Equations*
CO4	*Apply Constrained optimization methods*
CO5	*Contrast the recent techniques in optimization*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2			1					2		
CO2	1	1			1								2		
CO3	2			3	3								2		
CO4		2	3		2								2		
CO5	3		3	1	2								2		

Course Topics:

Unit-I: INTRODUCTION TO OPTIMIZATION

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-II: UNCONSTRAINED OPTIMIZATION

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-III: NONLINEAR EQUATIONS

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-IV: CONSTRAINED OPTIMIZATION

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-V: RECENT TECHNIQUES IN OPTIMIZATION

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. K.P. Edwin, Chong, Stanislaw and H. Zak, "*An Introduction to Optimization* ", Edition: 2, *Wiley Interscience* , 2001.
2. Jorge Nocedal and Stephen Wright, "*Numerical optimization*", Edition: 2, Springer publisher , 2006.

Reference(s):

1. J.E. Dennis and R.B. Schnabel, "*2. Numerical methods for unconstrained optimization and nonlinear equations*", Edition: 1, SIAM publications , 1993.
2. R. Fletcher, "*Practical methods of optimization*", Edition: 2, John Wiley and Sons , 1987.
3. Chander Mohan and Kusum Deep, "*Optimization Techniques*", Edition: 1, New Age Science , 2009.

MEC18R323 : MATERIALS MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

To impart knowledge to provide the participant with various types of managerial activities in different management related functions

Course Outcome(s):

CO1	*Illustrate the various functions of Materials Management.*
CO2	*Comprise the Methods of purchasing and Cost Analysis techniques.*
CO3	*Identify the functions of stores management and Material handling.*
CO4	*Interpret various deterministic and probabilistic models of inventory management systems.*
CO5	*Inspect the material requirement planning in the various systems of value analysis.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1				2			2	2	2		
CO2	2	1	2					1		1	1	2	2		
CO3	2	1	1			1	2	2			1	1	2		
CO4	2				2										
CO5	2				2			2			1	1	1		

Course Topics:

Unit-I: FUNCTIONS OF MATERIALS MANAGEMENT

Introduction - objectives - organizations - functions - administration - integrated approach - relationship with other department-make or buy decision- buying process.

Unit-II: PURCHASING MANAGEMENT

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

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

EOQ - inventory systems - periodic - deterministic and probabilistic models - static inventory model – reorder point – lead time analysis – safety stocks-ABC analysis

Unit-V: VALUE ANALYSIS

Standardization - variety reduction - JIT - MRP I, MRP II - vender evaluation and rating - inventory audit and information systems.

Text Book(s):

1. Lamer Lee and D.W Dobler, "*Purchasing and Materials Management*", Edition: 3, Tata McGraw-Hill , 1996.

2. P. Gopalakrishnan, "*Purchasing and Materials Management*", Edition: 4, Tata McGraw Hill Publishing Co. Ltd , 2001.

Reference(s):

1. P. Gopalakrishnan, Abid haleem, "*Handbook of Materials Management*", Edition: 2, Prentice Hall of India , 2015.
2. Starr and Miller, "*Inventory Control Theory and Practice*", Edition: 2, Prentice Hall of India , 1989.
3. K.K. Ahuja, "*Material Management*", Edition: 1, CBS Publishing , 1992.

MEC18R344 : NUCLEAR POWER GENERATION	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

To learn the nuclear power generation technique and its safety aspects.

Course Outcome(s):

CO1	*Identify the different type of nuclear reactions and its applications.*
CO2	*Compare various nuclear reactors with working principle.*
CO3	*Summarize the various nuclear materials used for power generation.*
CO4	*Interpret the nuclear waste disposal process and its effects on environment.*
CO5	*Discuss the safety aspects to be followed in nuclear power plant.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2	3		
CO2	3	2										2	2	2	
CO3	3	2										1	2	1	
CO4	2	2				2	2					1	2	1	
CO5	2	2				3	3					2	2	1	

Course Topics:

Unit-I: INTRODUCTION TO NUCLEAR ENGINEERING

Introduction, Why Nuclear Power for Developing Countries, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction, Types of Nuclear Reactions, Initiation of Nuclear Reaction, Nuclear Cross Section, Nuclear Fission, The Fission Chain Reaction, Moderation, Fertile Materials and Breeding

Unit-II: NUCLEAR REACTORS

Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurised Water Reactors(PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium) Type Reactors, Gas-Cooled Reactors, Breeder Reactors, Reactor Containment Design, Location of Nuclear Power Plant, Nuclear Power Station in India, India's 3-stage Programme for Nuclear Power Development Comparison Nuclear Plants with Thermal Plants.

Unit-III: NUCLEAR MATERIALS

Introduction, Fuels, Cladding and Materials Coolants, Moderating and Reflecting Materials, Control Rod Materials, Shielding Materials.

Unit-IV: NUCLEAR WASTE & ITS DISPOSAL

Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System.

Unit-V: SAFETY RULES

Personal Monitoring, Radiation Protection (Radiation Workers, Non-Radiation workers, Public at large), Radiation Dose (Early effect, late effect hereditary effect)

Text Book(s):

1. P.K. Nag, "*Power Plant Engineering*", Edition: 4, Tata McGraw Hill , 2017.
2. Arora & Domkundwar, "*Power Plant Engineering*", Edition: 8, Dhanpat Rai & Co , 2016.

Reference(s):

1. S. Glasstone and A. Sesonske, "*Nuclear Reactor Engineering*", Edition: 3, Von Nostrand , 1984.
2. J. Kenneth Shultis, R.E, Faw, "*Fundamentals of Nuclear Science and Engineering*", Edition: 2, CRC Press , 2008.
3. Tatjana Tevremovic, "*Nuclear Principles in Engineering*", Edition: 1, Springer , 2008.

MEC18R345 : SURFACE ENGINEERING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

The aim of this course to understand the surface cleaning and coating technology

Course Outcome(s):

CO1	*Evaluate the aspects of surface engineering over a range of surface cleaning processes.*
CO2	*Identify the different type of resistant coatings deposited by electrochemical process.*
CO3	*Knowing the erosion, resistant coatings deposited by chemical vapour deposition and physical vapour deposition.*
CO4	*Preparing corrosion resistant surfaces by plating and nano composite coatings.*
CO5	*Interpret the measurement of surfaces, wear mechanisms, tribological induced stresses.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											2		
CO2	2	3											1		
CO3	2	2											1		
CO4	2	3											1		
CO5	2	2		2									1		

Course Topics:

Unit-I: METAL CLEANING & PREVIEW ON SURFACE ENGINEERING

Need and relevance of surface engineering – pre-treatment of coating, General cleaning process for ferrous and non-ferrous metals and alloys – selection of cleaning process – alkaline cleaning – emulsion cleaning- ultrasonic cleaning – acid and pickling salt bath descaling – abrasive bath cleaning – polishing and short peening – classification of surface engineering processes.

Unit-II: THERMAL SPRAYING PROCESSES AND ELECTRODEPOSITED COATINGS

Thermal spraying – flame, arc, plasma and HVOF processes – PLV process – design for thermally sprayed coatings – coating production – spray consumables principles of electroplating – Technology and control electroplating systems – properties and Faraday's Law – factors affecting throwing power – Applications of electro deposit – non-aqueous and electro-less deposition.

Unit-III: HOT DIP COATING AND DIFFUSION COATINGS

Principles – surface preparation batch coating and continuous coating process – coating properties and applications, Principles of cementation – cladding – Diffusion coating of C.N. Al, Si, Cr and B – structure, properties and application of diffusion coatings – chemical vapour deposition – physical vapour deposition.

Unit-IV: NON-METALLIC COATING OXIDE &COVENSION COATINGS

Plating coating – rubbers and elastomers – vitreous enamels – anodizing phosphating and chromating – application to aluminium, magnesium, tin, zinc, cadmium copper and silver – phosphating primers.

Unit-V: QUALITY ASSURANCE, TESTING & SELECTION OF COATINGS

The quality plan – design – testing and inspection of thickness adhesion, corrosion, resistance and porosity measurement – selection of coatings – industrial applications of engineering coatings. Basic mechanisms of

wear – abrasive, adhesive wear, contact fatigue – fretting corrosion – testing wear resistance practical diagnosis of wear.

Text Book(s):

1. Peter Martin, "*Introduction to Surface Engineering and Functionally Engineered Materials*", Edition: 1, John Wiley & Sons , 2011.
2. S. Grainger, J. Blunt, "*engineering coatings*", Edition: 2, Woodhead Publishing , 1994.

Reference(s):

1. N.V. Parthasarathy, "*Electroplating Handbooks*", Edition: 2, Prentice Hall , 1992.
2. D.R. Gabe, "*Principles of Metal surface treatment and protection*", Edition: 2, Pergamon , 1990.
3. Niku-Lavi, "*Advances in surface treatments*", Edition: 1, Pergamon , 1990.

MEC18R346 : THERMODYNAMICS OF MATERIALS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

Classical and statistical thermodynamics; entropy and energy functions in liquid and solid solutions and their applications to phase equilibrium

Course Outcome(s):

CO1	*Familiarize the basic concepts of thermodynamics with both classical and statistical approach.*
CO2	*Illustrate the thermal behavior of solid materials, including phase transitions.*
CO3	*Exploit thermodynamics to describe the thermal behavior of solid materials.*
CO4	*Interpret the acquired knowledge in the thermodynamic properties of materials.*
CO5	*Predict the use of thermodynamics in phase change material and interpret simple phase equilibrium*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1		1								2	2		
CO2	2	1										2	2		
CO3	2	1										2	2		
CO4	2	1				1						2	2		
CO5	2	2		1								2	2		

Course Topics:

Unit-I: BASIC CONCEPT & LAWS OF THERMODYNAMICS

Heterogeneous & homogeneous systems, Extensive & intensive properties, Simple equilibrium, First law of thermodynamics, constant volume & constant pressure processes, Spontaneous process, Entropy quantification of irreversibility, Properties of heat engines, Second law of thermodynamics, Criterion for equilibrium, Entropy & disorder, most probable microstate, configurational entropy & thermal entropy, Auxiliary functions

Unit-II: PROPERTIES OF PURE SUBSTANCES

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, and thermodynamic properties of steam

Unit-III: THERMODYNAMIC RELATIONS

Free energy functions and their relationships, Gibbs-Helmholtz relations, Maxwell relations, Clausius- Clapeyron equation, importance of thermodynamics in materials science-illustrations and examples; applications in areas of materials technology, industrial and process metallurgy

Unit-IV: THERMAL PROPERTIES OF MATERIALS

Specific heat - Debye and other models, heat capacity, thermal expansion, thermal conduction, thermal stress and shock, melting point, advanced thermodynamic treatment of inorganic materials, Application of the laws of thermodynamics to the chemical behavior of materials, multi component systems, phase and chemical reactions equilibrium, Thermodynamics of phase transformations

Unit-V: PHASE CHANGE MATERIAL

Sensible –Latent heat energy, Types of Phase Change Material, Encapsulation, Composite PCM, Application of Phase Change Material – Buildings, Air conditioning, Textiles, Solar water heating, Space heating/cooling, Green house heating, Selection of PCM for application, Material testing, Method of Analysis

Text Book(s):

1. Y. V. C. Rao, "*Introduction to Thermodynamics*", Edition: 2, Universities Press (India) Pvt. Ltd , 2004.
2. A. Ghosh, "*Textbook of Materials and Metallurgical Thermodynamics*", Edition: 1, PHI Publishers , 2009.

Reference(s):

1. Cengel, "*Thermodynamics – An Engineering Approach*", Edition: 8, Tata Mc Graw Hill , 2015.
2. R. Gaskell David, "*Introduction to Metallurgical Thermodynamics*", Edition: 3, McGraw Hill , 1981.
3. R.H. 3. Tupkary, "*Introduction to Metallurgical Thermodynamics*", Edition: 1, Tu Publishers , 1995.

MEC18R347:3D PRINTING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of this course is to make the students to understand the basic concepts and nuances of 3D Printing Technology

Course Outcome(s):

CO1	*Outline the concepts behind the design consideration required for 3D printing.*
CO2	*Recognize the basic Knowledge in selecting the 3D Printing materials and their applications.*
CO3	*Summarize the various types Inkjet technology and its working principles.*
CO4	*Contrast the Laser technology and its impact on 3D printing.*
CO5	*Interpret the appropriate method for designing and modeling Industrial applications.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2							2	2	2	2
CO2	2	1										2	2	2	
CO3	2	1	2		2			1				2	2	2	1
CO4	2	2	2		2			1				2	2	2	1
CO5	2	2										2	2	2	

Course Topics:

Unit-I:INTRODUCTION

Introduction; Design considerations – Material, Size, Resolution, Process; Modeling and viewing - 3D; Scanning; Model preparation – Digital; Slicing; Software; File formats

Unit-II:PRINCIPLE

Processes – Extrusion, Wire, Granular, Lamination, Photo polymerisation; Materials - Paper, Plastics, Metals, Ceramics, Glass, Wood, Fiber, Sand, Biological Tissues, Hydrogels, Graphene; Material Selection - Processes, applications, limitations

Unit-III:INKJET TECHNOLOGY

Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand; Material Formulation for jetting; Liquid based fabrication – Continuous jet, Multi jet; Powder based fabrication – Color jet

Unit-IV:LASER TECHNOLOGY

Light Sources – Types, Characteristics; Optics – Deflection, Modulation; Material feeding and flow – Liquid, powder; Printing machines – Types, Working Principle, Build Platform, Print bed Movement, Support structures

Unit-V:INDUSTRIAL APPLICATIONS

Product Models, manufacturing – Printed electronics, Biopolymers, Packaging, Healthcare, Food, Medical, Biotechnology, Displays; Open source; Future trends

Text Book(s):

1. Ian M. Hutchings, Graham D. Martin, "*Inkjet Technology for Digital Fabrication*", Edition:1,John Wiley & Sons,2013.
2. Christopher Barnatt, "*3D Printing*", Edition:3,Create Space Independent Publishing Platform,2016.

Reference(s):

1. Christopher Barnatt, "*3D Printing: The Next Industrial Revolution*", Edition:2,Create Space Independent Publishing Platform,2014.
2. Ibrahim Zeid, "*Mastering CAD CAM*", Edition:1,Tata McGraw-Hill Publishing Co,2007.
3. Joan Horvath, "*Mastering 3D Printing*", Edition:1,A Press,2014.

MEC18R348:MAINTENANCE ENGINEERING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to understanding the basic topics in Maintenance Engineering and its application in industry.

Course Outcome(s):

CO1	*Elucidate the principles, functions and practices adapted in industry for the successful management of maintenance activities.*
CO2	*Explain the concepts of Preventive maintenance and maintenance schedules.*
CO3	*Make use of Condition monitoring process with the simple instruments used in Industry.*
CO4	*Ability to interpret the failures and implement the repair methods for basic machine elements*
CO5	*Examine the failures and implement the repair methods for Material Handling Equipments.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1				2			1		1		1	1	
CO2	2	1		1							2			1	
CO3			1				1							2	
CO4	1	2		2		1		2	1		2		1	1	
CO5								2					1	1	

Course Topics:

Unit-I:PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING

Basic Principles of maintenance planning – Objectives: and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

Unit-II:MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM

Unit-III:CONDITION MONITORING

Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear- debris analysis

Unit-IV:REPAIR METHODS FOR BASIC MACHINE ELEMENTS

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location

Unit-V:REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT

Repair methods for Material handling equipment - Equipment records –Job order systems - Use of computers in maintenance.

Text Book(s):

1. S.K. Srivastava, "*Industrial Maintenance Management*", Edition:5,S. Chand and Co,1981.
2. S. N. Bhattacharya, "*Installation, Servicing and Maintenance*", Edition:3,S. Chand and Co,1995.

Reference(s):

1. P Gopalakrishnan, A. K. Banerji, "*Maintenance and Spare Parts Management*", Edition:1,Prentice Hall Of India,2006.
2. Majumdar, "*Pneumatic systems – Principles and maintenance*", Edition:2,Tata McGraw Hill,2001.
3. M. R. Garg, "*Industrial Maintenance*", Edition:2,S. Chand and Co,2003.

MEC18R349:SMART MATERIALS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic principles and mechanisms of smart materials, devices and provides a spring board for further study.

Course Outcome(s):

CO1	*Demonstrate knowledge and understanding of the physical principles underlying the behaviour of smart materials.*
CO2	*Describe the basic principles and mechanisms of the stimuli-response for the most important smart materials.*
CO3	*Demonstrate knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology.*
CO4	*Propose improvement and establishment of Smart composites on the design, analysis, manufacturing and application issues.*
CO5	*Integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2		2		1					2	1			
CO2	3	2	2									1	2	2	
CO3	2	3		3	3								3	2	1
CO4	2	3		2	2						2		2		
CO5	2	2			3	1						1		2	

Course Topics:

Unit-I:OVERVIEW OF SMART MATERIALS

Introduction to Smart Materials, Principles of Piezoelectricty, Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction,Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, - Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer - Matrix Composite (IPMC)-Shape Memory Alloys-Shape Memory Polymers- Shape Memory Effect-Electroactive polymers (EAP)-Work Volume Generation

Unit-II:HIGH-BAND WIDTH-LOW STRAIN SMART MATERIALS

Piezoelectric materials-constitutive relationship, coupling coefficients, constants, materials, Variation of coupling coefficients in hard and soft piezo-ceramics, polycrystalline vs single crystal piezoelectric materials, polyvinyldene fluoride, piezoelectric composites- Sensors Magnetostrictive materials-constitutive relationship, coupling coefficients, joule effect, villari effect, matteuci effect, wiedemann effect, gaint magnetostriction in terfenol-d, terfenol-D particulate composites, galfenol and metglas materials- Sensors

Unit-III:DESIGN OF SMART ACTUATORS AND SENSORS

Actuator Techniques – Actuator and actuator materials – Piezoelectric and Electrostrictive Material – Magnetostructure Material — Finite Element Modelling- Optimal placement of sensors and actuators-Piezoelectric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of

Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing- design of controller for smart structure- case study for advanced smart materials.

Unit-IV:SMART COMPOSITES

Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, and Finite Element Modelling of Smart Composite Beams.

Unit-V:DESIGN OF SMART SYSTEMS AND APPLICATIONS

Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Artophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design– practical applications - case study

Text Book(s):

1. Mel Schwartz, "*Smart Materials*", Edition:Click or tap here to enter text.,CRC Press,2008.
2. P. Gaudenzi, "*Smart Structures*", Edition:Click or tap here to enter text.,Wiley,2009.

Reference(s):

1. R. Vepa, "*Dynamics of Smart Structures*", Edition:Click or tap here to enter text.,Wiley,2010.
2. A.V. Srinivasan and D. M. McFarland, "*Smart Structures, Analysis and Design*", Edition:Click or tap here to enter text.,Cambridge University Press, New York,2001.
3. Brian Culshaw, "*Smart Structures and Materials*", Edition:Click or tap here to enter text.,Artech House,2000.

MEC18R350:AVIONICS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to impart fundamentals of avionics and the various systems pertaining to avionics.

Course Outcome(s):

CO1	*Illustrate the needs of various avionics systems and sub-systems.*
CO2	*Construct various avionics system architecture.*
CO3	*Demonstrate various technologies of flight decks and cockpits.*
CO4	*Categorize the navigation systems and sensors.*
CO5	*Elucidate the principles of autopilot and analyze various air data systems.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2									2		
CO2	2		3		2									2	3
CO3	3	3		2	2	2		2							3
CO4	2	3	3	2	2									3	2
CO5	3	2		1	2			2					3		2

Course Topics:

Unit-I:INTRODUCTION TO AVIONICS

Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems, design, technologies – Introduction to Digital Computer and memories.

Unit-II:DIGITAL AVIONICS ARCHITECTURE

Avionics system architecture – Data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.

Unit-III:FLIGHT DECKS AND COCKPITS

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

Unit-IV:INTRODUCTION TO NAVIGATION SYSTEMS

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

Unit-V:AIR DATA SYSTEMS AND AUTO PILOT

Air data quantities – Altitude, Air speed, Vertical speed, Mach number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

Text Book(s):

1. Albert Helfrick, "*Principles of Avionics*", Edition:7,Avionics Communications Inc,2012.
2. R. P. G. Collinson, "*Introduction to Avionics*", Edition:2,Chapman and Hall,2013.

Reference(s):

1. Middleton, D. H. Ed, "*Avionics Systems*", Edition:9,Longman Scientific and Technical, Longman Group UK Ltd,1989.
2. C. R. Spitzer, "*Digital Avionics Systems*", Edition:6,Prentice-Hall, Englewood Cliffs,1993.
3. C. R. Spitzer, "*The Avionics Hand Book*", Edition:1,CRC Press,2000.

MEC18R403:MECHATRONICS	L	T	P	C
	3	1	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to educate students about an integrated approach for the design of complex engineering systems and to provide knowledge of sensors, actuators and enabling the students to apply the same in the real time problems.

Course Outcome(s):

CO1	*Recognize the basic elements of Measurement and Control Systems.*
CO2	*Identify the various sensors and transducers for a wide range of mechanical applications*
CO3	*Make use of 8085 microprocessor for a variety of domestic and industrial applications.*
CO4	*Examine the function of Programmable Logic Controllers for Mechanical applications.*
CO5	*Build a Mechatronics system for domestic applications.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		3			2			2						3
CO2	2	2	2				1				3	1	2	2	
CO3			3	2	3									3	2
CO4		2	3		2									3	3
CO5		3	3		3									3	1

Course Topics:

Unit-I:INTRODUCTION TO MECHATRONICS

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

Unit-II:SENSORS AND TRANSDUCERS

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

Unit-III:8085 MICROPROCESSOR

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-IV:PROGRAMMING LOGIC CONTROLLERS

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

Unit-V:DESIGN OF MECHATRONIC SYSTEMS

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. W. Bolton, "*Mechatronics*", Edition:4,Longman,2017.
2. Robert H Bishop, "*Mechatronics: An Introduction*", Edition:1,Taylor and Francis,2006.

Reference(s):

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

MEC18R427:ENTERPRISE RESOURCE PLANNING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to provide an integrated and continuously updated view of core business processes using common databases maintained by a database management system.

Course Outcome(s):

CO1	*Define the concepts of ERP and its framework.*
CO2	*Explain the technologies and its architecture in CRM process*
CO3	*Apply the different types of activities of ERP project management cycle and packages*
CO4	*Analyze the application and various training module ERP packages*
CO5	*Evaluate the ERP Procedurement Issues in Indian companies.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					3						3				3
CO2	3		1		1						2				2
CO3			1												
CO4	3		2												
CO5					3						1				1

Course Topics:

Unit-I:ENTERPRISE RESOURCE PLANNING

Principle – ERP framework – Business Blue Print – Engineering vs Business process Re Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models – Process Models

Unit-II:TECHNOLOGY AND ARCHITECTURE

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

Unit-III:ERP SYSTEM PACKAGES

SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – Before and after Y2k – critical issues – Training on various modulus of IBCS ERP Package – Oracle ERP and MAXIMO, including ERP on the NET

Unit-IV:ARCHITECTURE

Overview – Architecture – AIM – applications – Oracle SCM, SAP: Overview – Architecture – applications – Before and after Y2k _ critical issues – Training on various modules of IBCS ERP Packages –Oracle ERP and MAXIMO, including ERP on the NET

Unit-V:ERP PROCEDUREMENT ISSUES

Market Trends – Outsources ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies

Text Book(s):

1. Rajesh Ray, "*Enterprise Resource Planning*", Edition:1,Text Mcgraw Hill,2011.
2. Sadagopan.S, "*ERP-A Management Perspective*", Edition:4,Tata Mcgraw Hill,1999.

Reference(s):

1. Jose Antonio Fernandez, "*The SAP R/3 Handbook*", Edition:1,Tata Mcgraw Hill,1998.
2. Vinod Kumar Crag and N.K. Venkitakrishnan, "*Enterprise Resource Planning – Concepts and Practice*", Edition:4,Prentice Hall of India,1998.
3. Garge & Venkitakrishnan, "*, ERP Implementation Framework*", Edition:2,Prentice Hall,1999.

MEC18R428:PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to develop basics production operations and management and the concepts and tools of re-engineering in production.

Course Outcome(s):

CO1	*Explain the influencing factors of productivity and its cycle with the tools involved in its measurement.*
CO2	*Summarize the different systematic approaches for productivity measurement.*
CO3	*Apply the concepts of organizational transformation and re-engineering.*
CO4	*Analyze and compare various models for process improvement.*
CO5	*Apply the analytical tools for re-engineering.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2										2	1		
CO2	1					1				2	2				
CO3	1			1						2	1	1	1		
CO4	2	1	1	3						1	1	1	2	1	
CO5	1	2		2						1	1	1	1		

Course Topics:

Unit-I:PRODUCTIVITY

Productivity Concepts – Macro and Micro Factors of Productivity – Dynamics of Productivity – Productivity Cycle Productivity at International, National and Organization Level – Productivity Measurement models

Unit-II:SYSTEM APPROACH TO PRODUCTIVITY MEASUREMENT

Conceptual frame work, Management by Objectives (MBO), Performance Objectives Productivity (POP) – Methodology and application to manufacturing and service sector

Unit-III:ORGANISATIONAL TRANSFORMATION

Element of Organizational Transformation and Re-engineering – Principles of Organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the work force for transformation and reengineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

Unit-IV:RE-ENGINEERING PROCESS IMPROVEMENT MODELS

PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

Unit-V:RE-ENGINEERING TOOLS AND IMPLEMENTATION

Analytical and process tools and techniques – information and communicational technology – implementation of Re engineering project – success factor and common implementation problem – cases.

Text Book(s):

1. David J Sumanth, "*Productivity Engineering and Management*", Edition:3,Tata Mcgraw Hill,1994.
2. Edosomwan, J.A, "*Organizational Transformation and Process Reengineering*", Edition:1,Library Cataloging in Pub. Data,1996.

Reference(s):

1. Rastogi, P.N, "*Re – Engineering and Re- Inventing the Enterprise*", Edition:2,Wheeler Publications,1995.
2. B.S Sashay, Premvrat, Sardana, "*Productivity Management – A Systems Approach*", Edition:1,Narosa Publishing House,1996.
3. David J Sumanth, "*TotaL Productivity Management*", Edition:1,Lucie Press,1997.

MEC18R432:PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite:NIL	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

This course will enhance your knowledge and skills in the life cycle of industrial products and current issues in the product portfolios according to global industry and market shifts.

Course Outcome(s):

CO1	*Identify the import components and strategy of PLM.*
CO2	*Analysis the product life cycle management with various tools and techniques.*
CO3	*Explain the importance and workflow of PDM.*
CO4	*Summarize the various product analysis tools used in PLM.*
CO5	*Interpret the recent advancement in PLM and its applications.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2								1	2		3	1	
CO2	2	2	2			1	2			2	2		3		
CO3	2	2								1	2		2		
CO4	2	2	2				2			2	1		2	2	
CO5	2	2				1	1			1	1		3	2	

Course Topics:

Unit-I:INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT(PLM)

Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Strategy identification and selection, Change Management for PLM.

Unit-II:CONSTRUCTING PRODUCT LIFE CYCLE MANAGEMENT

PLM Life cycle model – Plan, design, build, support & dispose. Threads of PLM- Computer Aided Design(CAD), Engineering Data Management(EDM). Product Data Management(PDM). Computer Integrated Manufacturing(CIM). Weaving the threads in to PLM, Comparison of PLM to Engineering Resource Planning(ERP). PLM characteristics-Singularity, Cohesion, Traceability, Reflectiveness.

Unit-III:PRODUCT DATA MANAGEMENT (PDM) PROCESS AND WORKFLOW

PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Versioning, check-in and checkout, views, Metadata, Lifecycle, and workflow. Applied problems and solution on PDM processes and workflow.

Unit-IV:PRODUCT ANALYSIS TOOLS

Design for manufacturing - machining - casting and metal forming - optimum design - Design for assembly and disassembly - probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments - Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity.

Unit-V:RECENT ADVANCES IN PLM

Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process. Digital manufacturing, benefits manufacturing, manufacturing the first-one, Ramp up, virtual learning curve, manufacturing the rest, production planning.

Text Book(s):

1. Michael Grieves, "*Product Lifecycle Management*", Edition:1,McGraw-Hill,2005.
2. Rodger Burden, "*PDM: Product Data Management*", Edition:1,Resource Pub,2003.

Reference(s):

1. John Stark*Product Life Cycle Management*", Edition:3 Springer ,2016.
2. Antti Saaksvuori , Anselmi Immonen , "*Product Lifecycle Management*", Edition:3,Springer2010.
3. 3. Fabio Guidice, Guido La Rosa, "*Product Design for the environment- A life cycle approach*", Edition:3,Taylor and Francis,2006.

MEC18R440:BASIC MACHINING	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic understanding of the topics in Mechanical Engineering

Course Outcome(s):

CO1	*Summarize the various metal cutting tools and its nomenclature.*
CO2	*Discuss the features, operations of Centre lathe, Capstan and turret lathe and automatic lathe.*
CO3	*Illustrate the various processes involved in milling machines.*
CO4	*Describe the principles of Gear Cutting machines.*
CO5	*Interpret the concepts involved in Abrasive and Broaching Processes.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1	2					1	3		
CO2	3	2	2	2	2	1							3	2	
CO3	3	2	2	2	2	1							3	2	
CO4	3	2	2	2	2	1	2						3	2	2
CO5	3		2	2	3	1	1						3	2	3

Course Topics:

Unit-I:METAL CUTTING THEORY

Mechanics of chip formation, single point and multi point cutting tools, forces in machining, Types of chip, cutting tools – nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and machinability, economics in machining.

Unit-II:TURNING MACHINES

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle: Swiss type, automatic screw type – multi spindle

Unit-III:RECIPROCATING, MILLING MACHINES

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, Tapping, Milling operations-types of milling cutter –attachments machining time calculations.

Unit-IV:GEAR CUTTING MACHINES

Gear cutting – forming and generation principle, gear milling, hobbing and gear shaping – micro finishing methods

Unit-V:ABRASIVE AND BROACHING PROCESSES

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding- micro finishing methods - Typical applications
– concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

Text Book(s):

1. P.N. Rao, "*Manufacturing Technology – Vol 2," Metal Cutting and Machine Tools*", Edition:1,Tata McGrawHill,2013.
2. Hajra Choudhury, "*Elements of Workshop Technology* ", Edition:13,Media Promoters & Publishers,2010.

Reference(s):

1. Richerd R kibbe, John E. Neely, Roland O.Merges and Warren J.White, "*Machine Tool Practices*", Edition:10,Prentice Hall,2014.
2. HMT, "*Production Technology*", Edition:1,Tata Mc Graw Hill,2001.
3. GeofreyBoothroyd, "*Fundamentals of Metal Machining and Machine Tools*", Edition:1,McGraw Hill,1984.

MEC18R441:SUPPLY CHAIN MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:**Open Elective **Course Type :**Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic understanding the topics in the field of management and engineering goods.

Course Outcome(s):

CO1	*Illustrate the various functions of supply chain network and customer strategies.*
CO2	*Recognize the need of decision making in supply chain management and its build-up techniques.*
CO3	*Summarize the concept of supply chain management, uncertainty in supply chain and material handling procurement.*
CO4	*Interpret the role of transportation in supply chain with decision support models and supply management.*
CO5	*Reproduce the concepts in supply chain automation and distribution policies and plans in IT sectors.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1						2			2	1	2		
CO2	2	2						2	2		2	1	2		
CO3	2	2						2	2		1	1	2		
CO4	2							1			1				
CO5	2	1						1			1	2	2	1	

Course Topics:

Unit-I:INTRODUCTION

Building Blocks of a Supply Chain Network - Business Processes In Supply Chains - Types of Supply Chains and Examples – Supply Chain Drivers- Role of Supply Chain Management- Scope and Importance.-Customer Driver Strategies.

Unit-II:SUPPLY CHAIN INVENTORY MANAGEMENT

Strategic, Tactical, and Operational Decisions in Supply Chains - Supply Chain Performance Measures - Supply Chain Inventory Management – Demand Forecasting – Impact of Uncertainty of Supply In Safety Inventory – Managing Safety Inventory In Multi Echelon Supply Chains - Bullwhip Effect Ware house Design-Distribution Policies- Transhipment Information Systems-Planning And Managing Inventories In A Supply Chain

Unit-III:SOURCING DECISION IN SUPPLY CHAIN MANAGEMENT

Role of Sourcing – In-House Sourcing and Outsourcing – Third Party Logistics – Supplier Relation – Procurement Processes – Risk Management In Sourcing-, Inventory-Order Processing- Purchasing Ware housing- Materials Handling- Packaging-Customer Service Management--Impact of Supply Uncertainty Aggregation And Replenishment.

Unit-IV:TRANSPORTATION IN SUPPLY CHAIN MANAGEMENT

Role of Transportation – Modes – Design Option For A Transportation Network – Trade Off In Transportation Design- Logistics and Competitive Strategy; System View, Co-Ordination and Management of Transportation-

International Logistics-Ocean Carrier Management- Import Export Logistic Management- Decision Support Models Of Supply Chain Management.

Unit-V:SUPPLY CHAIN AUTOMATION AND ITS ADVANCEMENT

IT Enabled Supply Chains – Role of IT in Forecasting, Inventory Management, Procurement, Transportation - Customer Relationship Management - ERP and Supply Chains - Supply Chain Automation and Supply Chain Integration-- Marketing and Supply Chain Interface-Finance and Supply Chain Interface-Distribution Policies and Plans-Revenue Management.

Text Book(s):

1. Michael H. Hugos, "*Essentials of Supply Chain Management*", Edition:3,John Wley & Sons,2011.
2. Martin Christopher., "*Logistics & Supply Chain Management*", Edition:5,Pearon UK,2016.

Reference(s):

1. N. Viswanadham and Y. Narahari, "*Performance Modeling of Automated manufacturing Systems*", Edition:1,Prentice Hall of India,1998.
2. R.B. Handfield and E.L. Nochols, Jr, "*Introduction to Supply Chain Management*", Edition:5,Prentice Hall,1999.
3. 5. Charlie Chen, Richard E. Crandall, and William R. Crandall, "*Principles of Supply Chain Management*", Edition:2,CRC Press,2014.

MEC18R442:BASICS OF HEAT TRANSFER	L	T	P	C
	3	0	0	3
Pre-requisite: Click or tap here to enter text.	**Course Category:**Choose an item. **Course Type :**Theory			

Course Objective(s):

Enable the students to understand the basic concepts of heat transfer

Course Outcome(s):

CO1	*Apply knowledge on conduction heat transfer and perform its calculations.*
CO2	*Solve forced convection real time problems*
CO3	*Solve free convection real time problems*
CO4	*Examine the factors influencing radiation heat transfer*
CO5	*Analyze the performance of the heat exchangers*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2									2	1	1	
CO2	2	1		1									1	1	
CO3	2	1		1									1	1	
CO4	2	1		1									1	1	
CO5	1	1	1	1	1								2	1	

Course Topics:

Unit-I:CONDUCTION

Introduction to Heat Transfer, Modes of Heat Transfer, Material properties of importance in heat transfer, Thermal conductivity, Specific heat capacity, One Dimensional:-Steady state conduction through wall, cylinder and sphere. Thermal contact resistance, Heat conduction in bodies with heat sources, Fins. Unsteady state Heat conduction-Lumped System Analysis

Unit-II:FORCED CONVECTION

Basic Concepts – Convective Heat Transfer Coefficients- Types of Convection – Forced Convection - Dimensionless numbers and their physical significance- Thermal and Hydrodynamic boundary layer-External Flow – Flow over Plates, Cylinders and Spheres- Internal flow - Laminar and turbulent flows

Unit-III:FREE CONVECTION

Basic Concepts – Dimensionless numbers and their physical significance- Flow over Vertical Plate, Flow over vertical pipe, Flow over Horizontal Plate, Flow over Horizontal pipe Inclined Plate, Flow over Cylinders and Spheres.

Unit-IV:RADIATION

Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power and emissivity, laws of radiation – Planck, Stefan-Boltzmann, Wein's displacement, Kirchhoff's law,
Lambert's cosine law Radiation heat exchange between black bodies, Radiation Shields, irradiation

Unit-V:HEAT EXCHANGER

Classification, heat exchanger analysis, LMTD for parallel and counter flow exchanger, condenser and evaporator, overall heat transfer coefficient, fouling factor, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, introduction of heat pipe and compact heat exchanger

Text Book(s):

1. R.C. Sachdeva , "*Fundamentals of Engineering Heat and Mass Transfer*", Edition:5,New Age International Publishers,2017.
2. R.Yadav, "*Heat and Mass Transfer*", Edition:4,CentralPublishingHouse,1995.

Reference(s):

1. Frank, P., Incropera and David, P. D, "*Fundamentals of Heat and Mass Transfer*", Edition:7,John Wiley publication,2017.
2. M.N.Ozisik, "*Heat Transfer*", Edition:3,Mc Graw Hill BookCo,1994.
3. C. P. KothandaramaN, "*Fundamentals of Heat and Mass Transfer*", Edition:5,New Age International Publishers,2016.

MEC18R443 : AUTOMATIC GUIDED VEHICLE	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

To understand the application of AGVS in industry in order to optimize the material flows and their variety of uses and the technological standards that are available at present.

Course Outcome(s):

CO1	*Identify the evolving history of AGVS and their use.*
CO2	*Recognize the applications of AGVS in modern day's industries and their advantages in reducing human effort.*
CO3	*Describe the technological standards to meet the customer needs accordingly.*
CO4	*Illustrate the use of AS/RS and learn its designing methods.*
CO5	*Identify the AGVS requirements for sustaining in the future challenges.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1												
CO2	1	2	1										1		
CO3	1	2											1		
CO4	1	2			2										2
CO5	1	1			1							2	1	2	1

Course Topics:

Unit-I: INTRODUCTION

Introduction to AGV – Evolution of AGV – Vehicle guidance technology – Vehicle management and safety - Benefits of AGV's - Important issues for AGVS – Navigation.

Unit-II: MODERN AREAS OF APPLICATION

Flow Line Organization and the Focus on Series Production -Warehousing and Commissioning – Industry related Aspects and Examples - Paper Manufacturing and Processing- Steel Making Industry.

Unit-III: TECHNOLOGICAL STANDARDS

Navigation and Safety- AGVS Guidance Control - AGV Categories: towing vehicle, unit load carriers, pallet trucks, forklift trucks, light-load transporters, assembly-line vehicles- AGVS Environment.

Unit-IV: AUTOMATED STORAGE AND RETRIEVAL SYSTEM

Definition of AS/RS - Functions of AS/RS - Components and Terminology – Types - Design of AS/RS – AGV Interfacing with other subsystems –Conventional storage methods and equipments.

Unit-V: FUNCTIONAL CHALLENGES FOR THE AGVS OF THE FUTURE

Drive Safe: Integration of Navigation and Safety - Automated Togetherness: Acting Intelligently - Energy Mix: Modern Energy Management - Market Development - Case studies.

Text Book(s):

1. Guntur Ullrich, "*Automated Guided Vehicle Systems - A primer with practical applications*", Edition: 2, Springer publications , 2014.
2. M.P. Groover, "*Automation, Production Systems, and Computer-Integrated Manufacturing*", Edition: 4, Pearson Education , 2015.

Reference(s):

1. T. Muller, "*Automated Guided Vehicle Systems: No. 2: International Conference Proceedings*", Edition: 1, IFS Ltd , 1983.
2. Siddharta Ray, "*'Introduction to Materials Handling*", Edition: 2, New Age International (P) Ltd., Publishers , 2017.
3. Stephen Cameron, Penelope Probert, "*Advanced guided vehicles : aspects of the Oxford AGV Project*", Edition: 1, World Scientific Publishers , 1994.

MEC18R445 : APPLIED THERMODYNAMICS	L	T	P	C
	3	0	0	3
Pre-requisite: MEC18R203/ Thermodynamics	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

To enable the students to understand the basic principles and concepts of classical thermodynamics and apply it to various systems & analyse the performance various cycles

Course Outcome(s):

CO1	*Illuminate the basic concepts of thermodynamics and zeroth and first laws.*
CO2	*Interpret the idea of second law of thermodynamics to elaborate simple systems.*
CO3	*Execute the performance of some gas power cycles.*
CO4	*Comprehend the properties of pure substances.*
CO5	*Analyze the performance of vapour power cycles.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2										2	1	
CO2	2	2	2										2	1	
CO3	2	2											1	1	
CO4	2	1	2										2	1	
CO5	2	2	2										2	1	

Course Topics:

Unit-I: BASIC CONCEPT, FIRST LAW

Classical approach, concept of continuum, thermodynamic systems - closed, open and isolated. First law of thermodynamics for open and closed systems

Unit-II: SECOND LAW OF THERMODYNAMICS

Second law of thermodynamics – Kelvin's and Clausius statements of second law, Reversibility and irreversibility, Carnot theorem, Carnot cycle, reversed carnot cycle, efficiency, COP.

Unit-III: GAS POWER CYCLES

Otto, Diesel, Dual cycle- Calculation of mean effective pressure, and air standard efficiency

Unit-IV: PROPERTIES OF PURE SUBSTANCE

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

Unit-V: VAPOUR POWER CYCLE

Standard Rankine cycle - Performance, comparison between Rankine and Carnot cycle, Reheat and regenerative cycle, combined cycle.

Text Book(s):

1. P.K. Nag, "*Engineering Thermodynamics*", Edition: 6, Tata McGraw-Hill Co. Ltd , 2017.
2. Y.A.Cengel, "*Thermodynamics – An Engineering Approach*", Edition: 8, Tata Mc Graw Hill , 2017.

Reference(s):

1. E. Radhakrishnan, "*Fundamentals of Engineering thermodynamics*", Edition: 2, Prentice hall , 2005.
2. J.P. Holman, "*Thermodynamics*", Edition: 4, McGraw-Hill , 2015.
3. Vanwlen and Sontag, "*Classical Thermodynamics*", Edition: 4, john wiley , 2000.

MEC18R446 : INDUSTRIAL PSYCHOLOGY	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** 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):

CO1	*Outline the key concepts, theoretical perspectives, and trends in industrial psychology.*
CO2	*Identify the problems present in environment and design a job analysis method.*
CO3	*Create a better work environment for better performance.*
CO4	*Explain various work methods and improve efficiency at work.*
CO5	*Examine the factors of job design and discuss about Accidents and safety.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2						2	2			2	1		
CO2	1		2			2					3		1		
CO3	1				2	2			2		3	2	1	2	
CO4	2		2						2	2	2		2	3	
CO5	2			2		2	2					2	2	2	

Course Topics:

Unit-I: INTRODUCTION

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-II: DESIGN OF WORK ENVIRONMENTS

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-III: UNDERSTANDING CONSUMER BEHAVIOUR

Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale - the nature and scope of engineering psychology, its application to industry.

Unit-IV: WORK METHODS

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-V: WORK AND EQUIPMENT DESIGN

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.

Text Book(s):

1. J. Tiffin and E.J. McCormic , "*Industrial Psychology*", Edition: 6, Prentice Hall , 1975.
2. E.J. McCormic , "*Human Factors engineering and design*", Edition: 4, McGraw Hill , 1976.

Reference(s):

1. Gilmer, "*Industrial Psychology*", Edition: 2, McGraw-Hill , 1966.
2. Ghiselli& Brown, "*Personnel and Industrial Psychology*", Edition: 1, McGraw-Hill Book Company , 1955.
3. Myer, "*Industrial Psychology*", Edition: 1, Digitalpublication , 2005.

MEC18R447 : PROCESS EQUIPMENT AND DESIGN	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic knowledge of the topics in Engineering drawing. Knowledge of Heat Transfer, Mass Transfer, Mechanical Operations and Mechanical Equipment Design.

Course Outcome(s):

CO1	*Understand the significance of process design parameters, codes used in industries.*
CO2	*Design cylindrical and spherical vessels as per design standards.*
CO3	*Identify the suitable process for design considering different mechanical aspects.*
CO4	*Understand the fundamental aspects of piping and also design for various applications.*
CO5	*Enumerate various safety measures considered for designing mass transfer column.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		3										1		
CO2	1	2	3										2		
CO3	1	2	3										2		
CO4	1	2	3										2		
CO5	1	3	3										2		

Course Topics:

Unit-I: PROCESS DESIGN PARAMETERS

Introduction to Basic process requirement of plants and projects, Importance of codes and standards and their applications. P&ID, Process Data Sheet, PFD, Introduction to various design codes required in Process Equipment Design such as; ASME, Section VIII; API; ASTM; TEMA and their significance, factor of safety, corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria.

Unit-II: DESIGN OF CYLINDRICAL AND SPHERICAL VESSELS

Types of various welding analysis - Thin and thick walled cylinder analysis, design of end closers, local stresses due to discontinuity, Design of standard and non-standard flanges, design of vessels and pipes under external pressure.

Unit-III: PROCESS OF EQUIPMENT DESIGN

Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipment auxiliary services and safety.

Unit-IV: PROCESS OF PIPING DESIGN

Flow diagrams and pipe work symbols, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports.

Unit-V: DESIGN AND SAFETY MEASURES OF MASS TRANSFER COLUMN

Design of distillation and absorption column - Stresses in column shell - Design and construction features of column internals. Process Hazards, Safety measures, Safety measures in equipment design, Pressure relief devices.

Text Book(s):

1. M.V.Joshi and V.V. Mahajan, "*Process Equipment Design*", Edition: 3, MacMillan India Ltd , 2016.
2. S.D.Dawande, "*Process Design of Equipments*", Edition: 3, Central Techno Publications , 2000.

Reference(s):

1. L. E. Brownell, E. H. Youg, "*Process Equipment Design*", Edition: 1, John Wiley & Sons Publications , 2004.
2. J.M. Coulson and J. Richardson, "*Chemical Engineering*", Edition: 3, Asian Books Printers Ltd , 2002.
3. R.H. Perry, "*Chemical Engineers' Handbook*", Edition: 8, McGraw-Hill , 2008.

MEC18R449 : ENGINEERING DESIGN	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Open Elective **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to give basic knowledge about the engineering design, conceptualization and lateral thinking

Course Outcome(s):

CO1	*Understand the fundamentals of design conceptualization and thinking*
CO2	*Identify the creative thinking techniques for a given problems*
CO3	*Understand the need and analysis of design process.*
CO4	*Apply the design models and innovative thinking for solving design oriented problems*
CO5	*Apply the design principles and techniques to validate the design models.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		3										1		
CO2	1	2	3										2		
CO3	1	2	3										2		
CO4	1	2	3										2		
CO5	1	3	3										2		

Course Topics:

Unit-I: DESIGN FUNDAMENTALS, DESIGN THINKING

Design Conceptualization and Philosophy-Original-Adaptive-Variant and Re-Design- Evolution of Concept-Need for Systematic design, past methods of design. Theories of thinking- types of thinking-convergent and divergent, Inductive and deductive thinking, lateral and vertical thinking..

Unit-II: DESIGN CONCEPTUALIZATION AND CREATIVE THINKING TECHNIQUES

Conceptualization techniques–Idea generation–ideation, brainstorming, Trigger session-Brain writing, Mind maps, SCAMPER, 6 mat thinking techniques, TRIZ, Biomimicry, Shape mimicry, Familiarity Matrix Concepts screening-3D Printing- RPT

Unit-III: DESIGN NEED AND ANALYSIS

Needs and opportunities- Vision and Mission of a concept-Type of needs-Technology S-curve-Need analysis-market analysis and competitive analysis- Kano Diagrams- SWOT analysis.

Unit-IV: DESIGN MODELS AND INNOVATIONS

Product life cycle- Innovation- Types of innovation Organization of design concept and design methods-Engineering Design-Descriptive and prescriptive model- Design decisions and development of design-Free hand sketching- Reengineering.

Unit-V: DESIGN VALIDATION AND CASE STUDIES

Concept testing-exploratory tests, Assessment tests, Validation tests, Comparison tests–Case studies-Intellectual Property Rights (IPR)--Group work and Case study

Text Book(s):

1. Otto K and Wood K, “, *Product Design*”, Edition: 3, Pearson Education , 2011.
2. Pahl G, Beitz W, Feldhusen J and Grote K. H, “*Engineering Design: A Systematic Approach*”, Edition: 3, Springer , 2007.

Reference(s):

1. Ullman D. G, “*The Mechanical Design Process*”, Edition: 6, LLC Publisher , 2017.
2. Bryan Lawson, “*How Designers Think: The Design Process Demystified*”, Edition: 4, Architectural Press , 2005.
3. Edward de Bono, “*Lateral Thinking: A Textbook of Creativity*”, Edition: 3, Penguin UK , 2016.

HUMANITIES ELECTIVE

HSS18R001 : MANAGEMENT CONCEPTS AND TECHNIQUES	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** 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):

CO1	*Explain the historical backdrop and fundamentals of Management thoughts vital for understanding the conceptual frame work of Management as a discipline*
CO2	*Discuss about the various concepts of planning, Decision making and controlling to help solving managerial problems*
CO3	*Understanding concepts of Ethics, Delegation, Coordination and Team work*
CO4	*Study and understand the management concepts and styles in Global context*
CO5	*Develop an understanding about emerging concepts in management thought and philosophy*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2					2						1	2		
CO2	2						2	2	1	1			2		
CO3	1					1		3	3	2			1		
CO4	2					3	2			1			2		
CO5	2						3					3			

Course Topics:

Unit-I: DEVELOPMENT OF MANAGEMENT THOUGHTS

Scientific Management Movement - Administrative Movement - Human Relations Movement -Decision Movement - Behavioural Science Movement - Systems Movement - Contingency Movement.

Unit-II: ESSENTIALS OF PLANNING

Planning Objectives – Goals - Programmed Decisions and Unprogrammed Decisions; Decision – Making - Creativity in Decision - Making, Forecasting and Strategy to Formulation

Unit-III: EFFECTIVE ORGANISING

Span of Control – Departmentation - Authority; Responsibility - Bureaucracy and Adhocracy; Group Dynamics

Unit-IV: STAFFING AND DIRECTING

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-V: CONTROLLING AND RECENT CONCEPTS

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*", Edition: 10, McGraw Hill , 2016.
2. Stephen P. Robbins, Mary A. Coulter, "*Management*", Edition: 13, Pearson Education Limited , New Delhi, 2016.

Reference(s):

1. C.B.Gupta, "*Management Theory and Practice*", Edition: 19, Sultan Chand and Sons , 2017.
2. L.M.Prasad, "*Principles and Practices of Management*", Edition: 9, Sultan Chand and Sons , 2015.
3. K.Aswathappa, "*Essentials of Business Environment: Text Cases and Exercises*", Edition: 12, Himalaya Publishing House , Mumbai, 2014.

HSS18R002 : MARKETING MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** 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):

CO1	*Develop understanding of marketing concepts, philosophies and historical background*
CO2	*Develop understanding of marketing operations and complexities for students to apply in practical business situations*
CO3	*Understand concepts related to Segmentation, Targeting and Positioning, product attributes, and pricing strategies prevalent in domestic and international scenario*
CO4	*Interpret various tools and techniques of promoting the products in ethical manner*
CO5	*Understand emerging concepts of marketing in the emerging global markets*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2					2	1					1	2		
CO2	2						2	2	1	1			2		
CO3	2					1		3					2		
CO4	2					3	2	3	1	1			2		
CO5	2						3					3	2		

Course Topics:

Unit-I: MARKETING

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-II: PRODUCT

Meaning - Product planning - policies - positioning - New product development Product life cycle – BCG Matrix - branding. Packing, labelling

Unit-III: PRICING

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit-IV: DISTRIBUTION

Nature of Marketing channels - Types of Channel flows – Channel functions - Channel co-operation, conflict and competition - Direct Marketing Telemarketing, Internet shopping

Unit-V: PROMOTION

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, "*Marketing Management*", Edition: 15, Pearson Education , New Delhi, 2016.
2. V.S. Ramaswamy, S. Namakumari, "*Marketing Management – Global Perspective*", Edition: 1, Indian Context, McGraw Hill , 2013.

Reference(s):

1. Rajan Saxena, Dorector, S. P. Jain, "*Marketing Management*", Edition: 1, McGraw Hill , 2006.
2. K.S. Chandrasekar, "*Marketing Management*", Edition: 1, Text and Cases, McGraw hill , 2013.

HSS18R003 : ORGANISATIONAL PSYCHOLOGY	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

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):

CO1	*Interpret basic concepts of industrial and organizational psychology*
CO2	*Illustrate different ways of achieving organizational effectiveness through individual behaviour*
CO3	*Understand the concepts relating to individual behaviour to achieve group target and achieve leadership position in organisation*
CO4	*Understand the organisational changes and means to evaluate based on nature of organisations*
CO5	*Inspect the implications of changes aligning the interest of individual, group and organisation*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2		1	2						
CO2	2					1		1	2	2			2		
CO3						1		1	2	3					
CO4	2					1	1	1	1	1			2		
CO5	2					1	1	1				1	2		

Course Topics:

Unit-I: FOCUS AND PURPOSE

Organisational Behaviour - Need and importance, nature and scope, framework

Unit-II: INDIVIDUAL BEHAVIOUR

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-III: GROUP BEHAVIOUR

Pricing objectives – Setting and modifying the price – Different pricing method Product line pricing and new product pricing

Unit-IV: LEADERSHIP

Leadership styles – theories – Qualities - leaders Vs managers – sources of power – power centres – power and Organisational Politics- Motivation

Unit-V: ORGANISATIONAL DEVELOPMENT

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, Timothy A. Judge, "*Organisational Behavior*", Edition: 17, Pearson Education , 2017.
2. Fred Luthans, ", *Organisational Behavior*", Edition: 12, McGraw Education , 2010.

Reference(s):

1. Aswathappa, "*Organisational Behavior*", Edition: 12, Himalaya Publishing House , 2016.
2. P.Subba Rao, " *Management and Organisational behavior: Text, Cases and Games* Edition: 1, Himalaya Publishing House , 2010.
3. Mullins, "*Organisational Behavior*", Edition: 9, Pearson Education Limited , 2010.

HSS18R004 : PROJECT MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course describes concepts relating to project management and enable students to evolve project objectives appropriately with relevance to business proposals. It covers the required dimensions relating to evaluation of project by testing the technical feasibility, financial viability, market acceptability and social desirability of projects. It gives an account on risk and profitability analysis that facilitates the making of the effective project proposal and guides learners in project planning, implementation and control. It also emancipates the scope of project management in undertaking foreign collaboration projects

Course Outcome(s):

CO1	*Familiarizes the concept of project and steps in project management*
CO2	*Understand the basics stages involved in preparing business proposals*
CO3	*Evaluate the technical feasibility, financial viability, market acceptability and social desirability of projects.*
CO4	*Enabled to analyse the Risk and profitability of the project proposals*
CO5	*Act effectively as project managers and as part of project teams*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2						1		1	2	3	1	2		
CO2	2					2		1	3	3	1		2		
CO3	1					3		1	1	1	3				
CO4	2					2	1	1	1	1	3	1	2		
CO5	2					2		1	3	1	1	1	2		

Course Topics:

Unit-I: INTRODUCTION TO PROJECT MANAGEMENT

Projects - Project ideas and preliminary screening. Developments - Project planning to Project completion - Pre-investment phase, Investment phase, operational phase - Governmental Regulatory framework. Capital Budgeting

Unit-II: STAGES OF PROJECT MANAGEMENT

Opportunity studies - prefeasibility studies, functional studies or support studies, feasibility study expansion projects, data for feasibility study. Market and Technical Appraisal: Market and Demand analysis, Market Survey, Demand forecasting. Technical analysis- Materials and inputs, Choice of Technology, Product mix, Plant location, capacity, Machinery and equipment

Unit-III: APPRAISAL PROCESS

Concepts. Time value of money - Present and future value. Appraisal criteria - Urgency, Payback period, Rate of return, Debt service coverage ratio, Net present value, Benefit cost ratio, Internal rate of return, Annual capital charge, Investment appraisal in practice

Unit-IV: RISK AND PROFITABILITY ANALYSIS

Risk analysis- Measures of risk, Sensitivity analysis, and Decision tree analysis. Means of financing, Term Loans, Financial Institutions. Cost of capital. Profitability - Cost of Production, Break-even analysis. Assessing the tax burden and financial projections

Unit-V: PROJECT PLANNING, IMPLEMENTATION AND CONTROL

Forms of Project Organization, Project Planning, Implementation, and Control - Network construction, CPM, PERT, Development of Project schedule, Crashing of Project Network. Introduction to Foreign collaboration projects - Governmental policy framework, Need for foreign technology, Royalty payments, Foreign investments and procedural aspects

Text Book(s):

1. Prasanna Chandra, "*Projects: Planning, Analysis, Selection, Financing, Implementation*", Edition: 8, McGraw Hill , 2014.
2. M.R. Gopalan, "*Project Management Core Textbook*", Edition: 2, Wiley India , 2015.

Reference(s):

1. Harold Kerzne, "*Project Management - Best Practices: Achieving Global Excellence*", Edition: 3, Wiley Publications , 2013.
2. George Ritz, Sidney Levy, "*Project Management in Construction*", Edition: 6, Mc. Graw Hill Education , 2011.
3. Gary Heerkens, ", *Project Management*", Edition: 2, Mc. Graw Hill , 2013.

HSS18R005 : STRESS MANAGEMENT AND COPING STRATEGIES	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

Stress has become an integral part of every professional's life. Approaching the stress in the right manner has become imperative as it has become an unavoidable one. The stress and its effect over performance has also become notable in today's organization. To cope well and to sustain in market, for that the skills are required to understand and to overcome the same. This course helps in understanding the intricacies of stress and overcoming the stress through appropriate approaches

Course Outcome(s):

CO1	*Understand the responsibility of tackling stress*
CO2	*Identify and modify the approaches of stress accordingly while dealing with team in workplace*
CO3	*Illustrate the concepts to face high- pressure working conditions will be able to tackle stress appropriately without ignoring*
CO4	*Interpret to implement a stress -free work environment*
CO5	*Illustrate the behaviour and personality and ensure professional working condition and balanced quality of life*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2						1		1	2		1	2		
CO2	2					1		2	3	3			2		
CO3	2					2		1	1				2		
CO4						1	1	1	1	1		1			
CO5	1					1		1	3	1		1	1		

Course Topics:

Unit-I: UNDERSTANDING STRESS

Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress – Burnout

Unit-II: COMMON STRESS FACTORS TIME

Common Sources of Stress Biological, Personality and Environmental – Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area - Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say 'No'

Unit-III: CRISIS MANAGEMENT

Implications – People issues – Structure issues, environmental issues, psychological fall outs – Learning to keep calm – Preventing interruptions – Controlling crisis – Importance of good communication – Taking advantage of crisis – Pushing new ideas – Empowerment

Unit-IV: WORK PLACE HUMOUR

Developing a sense of Humour – Learning to laugh, role of group cohesion and team spirit, using humour at work, reducing conflicts with humour. Coping Styles Defensive Behaviours and Problem-Solving

Unit-V: SELF DEVELOPMENT

Improving Personality – Leading with Integrity, enhancing creativity – Effective Decision Making – Sensible Communication – The Listening Game – Managing Self - Meditation for Peace – Yoga for Life

Text Book(s):

1. D. Gordano and G. Everly, "*Controlling Stress and Tension*", Edition: 9, Prentice-Hall , 2013.
2. S. Greenberg Jerrold, "*Comprehensive Stress Management*", Edition: 14, McGraw Hill Education , 2017.

Reference(s):

1. Dr. P.K.Dutta, "*Stress Management*", Edition: 1, Himalaya Publishing House , 2010.
2. Schafer, "*Stress Management*", Edition: 4, Cengage Learning , , Delhi, 2008.
3. Wolfgang Linden, "*Stress Management*", Edition: 1, Sage Publication , 2005.

HSS18R006 : ECONOMICS FOR ENGINEERS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course introduces a broad range of economic concepts, theories and analytical techniques. It considers both microeconomics - the analysis of choices made by individual decision-making units (households and firms) - and macroeconomics - the analysis of the economy. Demand and market structure will be analysed at the firm level. Macroeconomic issues regarding National Income, Inflation, labour and money at an aggregate level will be modelled. The role of government policy to address microeconomic market failures and macroeconomic objectives will be examined

Course Outcome(s):

CO1	*Identify and learn economic concepts into market economies*
CO2	*Understand the pricing methods, interpret the market factors to determine the price for products or services and to making decisions based on demand factors.*
CO3	*Understand the major characteristics of different market structures and the implications for the behaviour of the firm.*
CO4	*Measure living standards, inflation, and unemployment for use as economic indicators.*
CO5	*Understand the role of international trade involved in commercial and central banks*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1											3				
CO2						1		1			2				
CO3						1	1		2	1	1				
CO4	3	3									1			2	
CO5	1							1	1					1	

Course Topics:

Unit-I: DEFINITION AND SCOPE OF ECONOMICS

Meaning - Symptoms: Biological and Behavioural - Work Related Stress - Individual Stress – Reducing Stress Definitions by A. Smith, A. Marshal and L. Robbins, P.Samuels on and their critical examination - Nature and scope of Economics - Micro-economics in relation to other branches of Economics

Unit-II: PRICING AND LAW OF DEMAND

Demand, Factors influencing demand, Elasticity of demand - price, income and cross, concepts and measurement - Break Even Analysis – Law of Demand - Price, income and substitution effects - Giffen goods- Pricing Methods

Unit-III: 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

Unit-IV: : 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

Unit-V: 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

Text Book(s):

1. S. B. Gupta, "*Monetary Economics*", Edition: 2, S. Chand & Co , New Delhi, 2009.
2. Ruddar Datt and K.P.M. Sundharam, "*Indian Economy*", Edition: 7, S. Chand & Company Ltd., New Delhi , 2006.

Reference(s):

1. D.N. Dewedi, "*Managerial Economics*", Edition: 8, S. Chand & Company Ltd , New Delhi, 2005.
2. G. S. Gupta, "*Macroeconomics, Theory and Applications*", Edition: 2, Tata McGraw-Hill publishing company Ltd. , ., New Delhi, 2004.
3. William H. Branson, "3. *Macroeconomic –Theory and policy*", Edition: 3, Tata McGraw-Hill publishing company Ltd , New Delhi, 2010..

HSS18R007 : HUMAN RESOURCE MANAGEMENT AND LABOUR LAW	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** 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):

CO1	*Illustrate the basic knowledge on developing the employment relations and knowledge to resolve the issues*
CO2	*Interpret an appropriate and suitable role of HR specialist for implementing Human Resource Management policies*
CO3	*Illustrate the manpower to motivate and attract them to retain in the organization.*
CO4	*Understand the responsibility of employer and legal system to manage the employment relations*
CO5	*Understand the applicability of business law on various functional domains this in turn enhances a strong human relation*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2						1	1	2				2		
CO2	2								2	2			2		
CO3									3	3					
CO4						1		1	1						
CO5	2					1	1	1	3				2		

Course Topics:

Unit-I: FUNDAMENTALS OF HRM

Human Resource Development Systems-HR environment in India-Functions and Operations of a Personnel Office - Emerging HR Trends - HR information system

Unit-II: : HRM FUNCTIONS

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 andservices

Unit-III: MOTIVATING HUMAN RESOURCES

Team and Team work - Collective Bargaining Employee Morale – Participative Management – Quality Circle – Empowerment –counselling and mentoring

Unit-IV: MAINTENANCE OF WORKERS

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-V: BUSINESS LAW

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*", Edition: 12, Wiley , 2015.
2. L.M. Prasad, "*Human Resource Management*", Edition: 3, Sultan Chand , 2018.

Reference(s):

1. Biswajeet Pattanayak, "*Human Resource Management*", Edition: 3, Eastern Economy Edition , New Delhi, 2010.
2. C.B. Gupta, "*Human Resource Management*", Edition: 13, Sultan Chand , 2015.
3. Frank B. Cross and Roger LeRoy Miller, "*The Legal Environment of Business Text and cases*", Edition: 9, Cengage Learning , 2015.

HSS18R008 : ENTREPRENEURSHIP DEVELOPMENT	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

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):

CO1	*Illustrate 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	*Understand and promotes entrepreneurial spirit and provides a framework of successful business world with relation to agencies to promote employment opportunities*
CO3	*Interpret on women entrepreneurship and promotes a successful business models and explains operational implementations for investment details*
CO4	*Understand the role of government in promoting the entrepreneurship among the individuals and organizations*
CO5	*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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1					3	1	1		1		1			
CO2	1					1		1							
CO3						2		2							
CO4	2							1		1			1		
CO5	2						3				1	3	1		

Course Topics:

Unit-I: BASICS

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-II: GROWTH OF ENTREPRENEURSHIP

Emergence of entrepreneurship - Economic and non-economic factors for stimulating entrepreneurship development - Obstacles to entrepreneurship development in India - Growth of entrepreneurship in India.

Unit-III: WOMEN AND ENTREPRENEURSHIP

Concept of women entrepreneurship - Reasons for growth of woman entrepreneurship - Problems faced by them and remedial measures

Unit-IV: ROLE OF THE GOVERNMENT IN ENTREPRENEURSHIP DEVELOPMENT

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-V: VENTURE PROMOTION AND PROJECT FORMULATION

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*", Edition: 7, CENGAGE Learning , Delhi, 2010.
2. Jerry Katz, "*Entrepreneurship Small Business*", Edition: 5, Tata McGraw-Hill Publishing Company Ltd., , 2007.

Reference(s):

1. Khanka S.S, "*Entrepreneurial Development*", Edition: 1, S. Chand and Company Limited , New Delhi, 2013.
2. Prasama Chandra, "*Projects: Planning, Analysis, Selection, Implementation and Reviews*", Edition: 2, Tata McGraw-Hill Publishing Company Limited , New Delhi, 1996.
3. Robert D. Hisrich, "*Entrepreneurship*", Edition: 10, Tata McGraw-Hill Publishing Company Limited , New Delhi, 2017. .

HSS18R009 : COST ANALYSIS AND CONTROL	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

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):

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	*Understand the use of Budgets for controlling cost in Manufacturing or Production Centres*
CO4	*Illustrate the cost standards and critically examining the application of Standard costing in a Production Centre*
CO5	*Understand the application of various strategic cost alternatives including Activity based costing*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1											3	1			
CO2											3	1			
CO3	1			1							2		1		
CO4									1		2				
CO5											2				

Course Topics:

Unit-I: BASICS OF COSTING

Costing, Elements of costing, Types of cost, Preparation of cost sheet

Unit-II: COST ANALYSIS

Marginal costing, Cost - volume – Profit analysis, Break-Even- Analysis, Break –Even - Chart, Applications

Unit-III: CONTROL TECHNIQUES

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-IV: STANDARD COSTING

Types of Standards, Setting up of standards, Advantages and Criticism of Standard Costing –Control through variances

Unit-V: ACTIVITY BASED COSTING

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*", Edition: 2, V.Sultan Chand & Sons Publishers , 2014.
2. S.P. Jain & K. L. Narang, "*Advances Cost Accounting*", Edition: 1, Kalyani Publishers , 2017.

Reference(s):

1. J. Blocher, K. H. Chen, G. Cokins and T. W. Lin, "*Cost Management: A Strategic Emphasis*", Edition: 3, Irwin/McGraw-Hill , 2008.
2. Don R. Hansen, Maryanne M. Mowen, "*Cornerstones of Cost Management*", Edition: 6, Cengage Learning , 2015.
3. Roger Hussey, Audra Ong, "*Strategic Cost Analysis*", Edition: 2, , Business Expert Press , 2012.

HSS18R010 : PRODUCT DESIGN AND DEVELOPMENT	**L**	**T**	**P**	**C**
	text.	text.	text.	text.
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course aims to clarify the principles and basic concepts of Product Design and Development. Including organizations and understanding of its products. It also aims at enhancing the quality of products. Product Design means recognition of a new product need, information gathering and requirements setting up, unambitious-clear and complete specification list, study on the product's mechanical architecture, selection of materials and production processes and engineering the various components necessary to make the product work.

Course Outcome(s):

CO1	*Understand the basic concepts related to design and development of New product*
CO2	*Understand the structured approach towards incorporating quality, safety, and reliability into design*
CO3	*Illustrate the concepts relating to simulating product performance and manufacturing processes*
CO4	*Understand the technologies related to computer aided group technology*
CO5	*Interpret implications of changes related to Economic analysis*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1		1	2					1			
CO2	2	2		1		1	2					1	2	1	
CO3	2	2					2					1	2	1	
CO4	2						1	1				1	2		2
CO5	2			1				2		1	1	1	2		

Course Topics:

Unit-I: NEW PRODUCT IDEA

Definition – Design by Evolution and by Innovation - factors to be considered for product design – Production-Consumption cycle – The morphology of design – Primary design Phases and flowcharting. Role of Allowance, Process Capability, and Tolerance in Detailed Design and Assembly Product strategies, Market research – identifying customer needs – Analysis of product – locating ideas for new products, Selecting the right product, creative thinking, curiosity, imagination and brain storming - product specification

Unit-II: NEW PRODUCT DESIGN

Task - Structured approaches – clarification – search – external and internal – systematic exploration – conception, selection - methodology benefits. The value of appearance - principles and laws of appearance – incorporating quality, safety, and reliability into design. Man-machine considerations – Designing for ease of maintenance.

Unit-III: ROLE OF TECHNOLOGY IN DESIGNING

Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing process – Needs for industrial design-impact – Industrial design process – Technology driven products - user driven products – assessing the quality of the product

Unit-IV: METHODS AND PRINCIPLES OF DESIGNING

Methodologies and tools - Design axioms - Design for assembly and evaluation - Minimum part assessment - Taguchi Method - Robustness assessment - Manufacturing process rules - Designer's tool kit - Computer aided group process rules - Designer's tool kit - Computer aided group technology - Failure Mode Effective Analysis – Design for minimum number of parts – Development of modular design – Minimising part variations – Design of parts to be multifunctional, multi-use, ease of fabrication – Pooka Yoka principles.

Unit-V: FEASIBILITY ANALYSIS

Estimation of manufacturing cost – cost procedures – Value Engineering - reducing the component cost and assembly cost – minimizing the system complexity – Basics and Principals of prototyping – Economic Analysis: Break even analysis. Classes of exclusive rights – Patents – Combination versus aggregation – Novelty and Utility – Design patents – Paten disclosure – Patent application steps - Patent Office prosecution - Sales of patent rights - Trademarks – copy rights.

Text Book(s):

1. Karl. T. Ulrich, D. Steven, "*Product Design and Development*", Edition: 6, McGraw Hill International , 2016.
2. A.K.Chitale, R.C.Gupta, "*Product Design and Manufacturing*", Edition: 3, Prentice Hall of India Private Limited , New Delhi, 2005.

Reference(s):

1. Richard Crowson, "*Product Design and Factory Development*", Edition: 2, CRC Press , 2005.
2. Thomke, Stefan, Ashok Nimgade, "*IDEO Product Development*", Edition: 2, Boston, MA: Harvard Business School Case , 2000.
3. George E.Dieter, Linda C.Schmidt, "*Engineering Design*", Edition: 4, McGraw-Hill Higher Education , 2012.

HSS18R011 : BUSINESS PROCESS REENGINEERING	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course focuses on both quantitative and qualitative analytical skills and models essential to operations process design, management, and improvement in both service and manufacturing oriented companies. The main objective of the course is to prepare the student to play a significant role in the management of a world class company which serves satisfied customers through empowered employees, leading to increased revenues and decreased costs.

Course Outcome(s):

CO1	*Understand the basic concepts related to Business Process Reengineering*
CO2	*Understand the methodologies and tools used for Business Process Reengineering*
CO3	*Illustrate the concepts relating to benefit/cost analysis and its impact on the business organizations*
CO4	*Understand the need for assessment of business re-engineering and the factors contributing to its success*
CO5	*Interpret the best practices used in Business Process Reengineering with illustrations from corporate world*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1	1	2	1						
CO2						1	1	3	1						
CO3						1		1	1	1	2	1			
CO4	1						1	1					1		
CO5							2					3			

Course Topics:

Unit-I: BASIC CONCEPTS

Introduction to BPR Definition; the paradigm shifts in production; the positioning concept; the re-engineering visions; the benefits of business re-engineering

Unit-II: METHODOLOGIES FOR BPR

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process.

Unit-III: MODELLING THE BUSINESS

Methodologies and Tools for BPR, Process management; dynamic business re-engineering change framework; steps to reengineer the process

Unit-IV: :CHANGE MANAGEMENT

Change Management, Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering.

Unit-V: BEST PRACTICES IN BPR

Best Practices in BPR, Case studies: Bell Atlantic, Nissan, Chrysler, Xerox, and Hewlett Packard etc.

Text Book(s):

1. Ali K. Kamrani, Maryam Azimi, "*New Methods in Product Design: New Strategies in Reengineering (Engineering and Management Innovation)*", Edition: 2, CRC Press , 2013.
2. Bassam Hussein, "*PRISM: Process Reengineering Integrated Spiral Model.*", Edition: 2, VDM Verlag Dr. Mueller e.K , 2008.

Reference(s):

1. P. Harmon, "*Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals*", Edition: 2, Elsevier/Morgan Kaufmann Publishers , 2007.
2. R. Anupindi, "*Managing Business Process Flows: Principles of Operations Management*", Edition: 1, Pearson , 2006.
3. R. Srinivasan, "*Business process Reengineering*", Edition: 1, Mcgraw hill Publication , 2017.

HSS18R012 : POLITICAL ECONOMY	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course introduces the political economy of India. It examines the interplay of politics and economics. Some of the key themes to be explored are globalization, economic reform, poverty, redistribution, federalism, political protest, public goods delivery, gender, and ethnic politics. Although this class focuses specifically on India, many the themes discussed in this course are functions of institutions, rights, Party Systems and challenges.

Course Outcome(s):

CO1	*Explain the key concepts of political economy analyse the significant developments in the political ideologies.*
CO2	*Describe the salient features of the constitution of India and its functions and interpret, integrate and critically analyse the fundamental rights duties and responsibilities.*
CO3	*Understand the Political party system their evolution and role in the economy*
CO4	*Understand the various ideological of Indian Political Thoughts*
CO5	*Understand and appreciatiate India's undergoing major economic and social transformation*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		3				1			
CO2						1		2	1	1	1				
CO3											1				
CO4	1						1								
CO5							1					1			

Course Topics:

Unit-I: BASICS OF POLITICAL ECONOMY

Political Economy as a Method, perspectives, Politics as Reproduction of Social Relations, State and Social Opportunity, Politics of Rent Seeking -Evolution of State in India: Historical Roots of planning, Redistribution

Unit-II: INDIAN CONSTITUTION

The Pre-amble- Fundamental rights and duties, Directive Principles- Offices of the President, Prime Minister, Cabinet Government, Chief Election Commissioner, and Governor – Parliamentary system and Procedures -The Judiciary system.

Unit-III: PARTY SYSTEM

National and regional political parties, ideological and social bases of parties; patterns of coalition politics; Pressure groups, trends in electoral behaviour; changing socio- economic profile of Legislators

Unit-IV: INDIAN POLITICAL THOUGHT

Political Ideologies: Liberalism, Socialism, Marxism, Fascism, Gandhism and Feminism - Dharamshastra, Arthashastra and Buddhist traditions; Sir Syed Ahmed Khan, Sri Aurobindo, M.K. Gandhi, B.R. Ambedkar, M.N. Roy

Unit-V: CHALLENGES TO INDIAN DEMOCRACY

Uneven Development of Regions in India – Communalism – Regionalism – Violence – Corruption – environmental degradation- illiteracy –population

Text Book(s):

1. Charles Sackrey, Geoffrey Schneider, Janet Knoedler,, "*Introduction to Political Economy*", Edition: 8, Dollars & Sense , 2016.
2. Robert.S.Dimand, "*Review of Political Economy: An Introductory Text*", Edition: 1, Routledge , 2008.

Reference(s):

1. Barry R. weingast and Donald A.Wittman, "*Handbook of Political Economy*", Edition: 1, Oxford University Press , , New York, 2006.
2. Ed. Sanjay Ruparelia; Sanjay Reddy; John Harriss & Stuart Corbridge, "*Understanding India's New Political Economy: A Great Transformation*", Edition: 1, Routledge , 2011.
3. M.Laxmikanth, "*Indian Polity*", Edition: 4, McGraw Hill Education , New Delhi,2017. .

HSS18R013 : PROFESSIONAL ETHICS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** 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):

CO1	*Identify the multiple ethical interests at stake in a real-world situation or practice*
CO2	*Assess their own ethical values and the social context of problems*
CO3	*Develop critical thinking skills and professional judgement and understand practical difficulties of bringing about change*
CO4	*Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work*
CO5	*Manage differing opinions on complex ethical scenarios. It's important for those confronted with ethical challenges to be able to hold multiple conflicting points of view, without necessarily adhering to any of them*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		3	1	1					
CO2						3	1	3	1	1					
CO3				1			2					1			
CO4						2	2		2	2		1			
CO5								2		1					

Course Topics:

Unit-I: ENGINEERING ETHICS

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-II: ENGINEERING AS SOCIAL EXPERIMENTATION

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-III: ENGINEER RESPONSIBILITY FOR SAFETY

Corporate social responsibility - Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

Unit-IV: RESPONSIBILITY AND RIGHTS

Moral imagination, stake holder theory and systems thinking - One approach to management decision – making Leadership.

Unit-V: GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – WeaponsDevelopment – Engineers as Managers – Consulting Engineers – Engineers as ExpertWitnesses and Advisors – Moral Leadership – Sample code of conduct

Text Book(s):

1. Mike Martin and Roland Schinzinger, "*Introduction to Engineering Ethics*", Edition: 2, McGraw Hill , 2010.
2. Charles D Fledderman, "*Engineering Ethics*", Edition: 2, Pearson , 2011.

Reference(s):

1. R.S.Nagarajan, "*Text book on Professional Ethics and Human Values*", Edition: 1, New Age International , 2007.
2. Gail Baura, "*Engineering Ethics- An Industrial Perspective*", Edition: 1, Academic Press , 2006.
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins Texas, "*Engineering Ethics- Conecpts and Cases*", Edition: 4, Cengage Learning , 2009.

HSS18R014 : OPERATIONS RESEARCH	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**
Pre-requisite: Nil	**Course Category:** Humanities and Social Science **Course Type :** 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):

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	*Identify the basic concepts in the linear program theory and game theory*
CO4	*Illustrate the results 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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1					1					2		
CO2	2	1	2									1	2		
CO3	2	1	1							1			2		
CO4	2	1	1							1			2		
CO5	2	1	2				1			1	2	1	2		

Course Topics:

Unit-I: LINEAR PROGRAMMING BASICS

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-II: TRANSPORTATION MODELS AND ASSIGNMENT MODELS

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-III: INTEGER LINEAR PROGRAMMING AND GAME THEORY

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-IV: REPLACEMENT MODELS AND DECISION THEORY

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.

Unit-V: PROJECT MANAGEMENT METHOD AND SIMULATION

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. S. Kalavathy, "*Operations Research*", Edition: 4, Vikas Publishing House , 2013.
2. R. Paneerselvam, "*Operations Research*", Edition: 2, Prentice Hall of India , 2009.

Reference(s):

1. D.S.Hira, "*Problems in Operations Research*", Edition: Kindle, S.Chand , 2010.
2. Prem Kumar Gupta and D.S. Hira, "*Operations Research*", Edition: 2, S.Chand , 2016.
3. R.C.Mishra, "*Principles of Operations Research*", Edition: 1, New Age International , 2011.

HSS18R015 : TOTAL QUALITY MANAGEMENT	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** 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):

CO1	*Understand the role and nature of quality in evolving international economic conditions*
CO2	*Apply the Principles of Quality Management for real time problems.*
CO3	*Interpret the quality encounter process, including supporting facilities and customer requirements/characteristics*
CO4	*Classify quality measurement methods and continuous improvement process*
CO5	*Frame Management strategy methods, including identification, development, implementation and feedback processes*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								1			2				
CO2						2	1					1			
CO3						1				1	1				
CO4										1					
CO5							1			2		2			

Course Topics:

Unit-I: INTRODUCTION TO QUALITY MANAGEMENT

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-II: PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT

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-III: STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY

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-IV: TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT

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-V: TAGUCHI TECHNIQUES

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*", Edition: 2, Pearson Education, , 2011.
2. Dale H.Besterfield, "*Total Quality Management*", Edition: 3, Pearson Education , 2004.

Reference(s):

1. K. Shridhara Bhat, "*Total Quality Management – Text and Cases*", Edition: 1, Himalaya Publishing House , 2002.
2. Jams R. Evans, "*Total Quality: Management, Organisation and strategy*", Edition: 4, South- Western College , 2004.
3. Vincent K.Omachonu, Joel E.Ross, "*Principles of Total Quality*", Edition: 3, CRC Press , 2004.

HSS18R016 : ADVANCED SOFT SKILLS	L	T	P	C
	3	0	0	3
Pre-requisite: Nil	**Course Category:** Humanities Elective **Course Type :** Theory			

Course Objective(s):

This course provides the students with the knowledge in problem solving skills in addition with the logical thinking and reasoning. This would enhance the effective communication and it also enhance the verbal ability and data interpretation techniques which is very much needed to survive and enter in to the industries.

Course Outcome(s):

CO1	*Explain the basic concepts in effective communication with the enhanced knowledge in vocabulary*
CO2	*Identify and solve the problems related to the quantitative ability.*
CO3	*Apply the basic problems involved in the non-verbal reasoning*
CO4	*Illustrate the basic knowledge in verbal questions with proper comprehensive studies*
CO5	*Identify the problems related to data interpretation*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1										2		2			
CO2						2						2			
CO3						2						2			
CO4										2		2			
CO5						1						2			

Course Topics:

Unit-I: EFFECTIVE COMMUNICATION

Comprehending Ability, Business Vocabulary, Speed Reading, Non-Verbal Communication, Cross Cultural Communication, Meeting Management, Technology trend awareness

Unit-II: QUANTITATIVE ABILITY

Time & Work, Time-Speed-Distance, Permutation & Combination Probability, Geometry & Mensuration, Number Properties, Ratio & Proportion, Mixtures & Alligation, Percentages, Profit-Loss-Discount, Averages, Progression, Higher Mathematics

Unit-III: LOGICAL ABILITY

Non-Verbal Reasoning, Deductive & Inductive Reasoning, Binary Logic, Number Series, Clocks, Calendars

Unit-IV: VERBAL ABILITY

Reading Comprehension, Parajumbles, Critical Reasoning, Subject-Verb Agreement, Synonyms & Antonyms, Grammar Reading Comprehension & Logic Miscellaneous Verbal questions

Unit-V: DATA INTERPRETATION

Line Charts, Bar Charts, Pie Charts, Venn diagrams, Caselets, Data tables

Text Book(s):

1. R.S. Agarwal, "*Quantitative Aptitude*", Edition: 3, S Chand Publishing , 2017.
2. R. V. Praveen, "*Quantitative Aptitude and Reasoning* ", Edition: 2, PHI Learning Private Limited , 2013.

Reference(s):

1. Dinesh Khattar, "*Quantitative Aptitude for Competitive Examination*", Edition: 1, Pearson Education , 2008.
2. Sarvesh K Kumar, "*Quantum CAT*", Edition: 1, Arihant Publication , 2016.
3. R. S. Agarwal, "*A modern Approach to Verbal and Non-verbal reasoning*", Edition: 3, S. Chand Publication , 2018.

HONOURS ELECTIVE

MEC18R307:DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R271- Strength of Materials	**Course Category:**Honors **Course Type :**Theory			

Course Objective(s):

To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.

Course Outcome(s):

CO1	*Analyze, understand and design flexible transmission elements such as belt, chain and wire ropes.*
CO2	*Interpret and design spur gear drive for different application and analyze the same for various applications.*
CO3	*Apply design procedure for making helical, bevel and worm gear drives for various applications.*
CO4	*Develop a new set of gear box for different applications.*
CO5	*Demonstrate and select suitable materials for clutches and brakes.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2					2			3		1
CO2	3	1	3	2	3					2			3		1
CO3	3	1	3	2	3					2			3		1
CO4	3	1	3	2	3					2			3		1
CO5	3	1	3	2	3					2			3		1

Course Topics:

Unit-I:DESIGN OF FLEXIBLE ELEMENTS

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-II:DESIGN OF SPUR GEAR

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

Unit-III:DESIGN OF BEVEL, WORM AND HELICAL GEARS

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-IV:DESIGN OF GEAR BOX

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-V:DESIGN OF CLUTCHES AND BRAKES

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*", Edition:8 ,McGraw-Hill International,2008.

2. Bhandari V.B, "*Design of Machine Elements*", Edition:4,McGraw Hill Education India Private Limited,2017.

Reference(s):

1. Maitra, G.M., Prasad, L.V *"Hand book of Mechanical Design*", Edition:2 Tata McGraw-Hill, ,1985.
2. Shigley, J.E., and Mischke, C.R, "*Mechanical Engineering Design*", Edition:2,McGraw-Hill International Editions,1989.
3. Norton, R.L, "*Design of Machinery*", Edition:3,McGraw-Hill Book Co Ltd,2003.

MEC18R310 : CNC MACHINING	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R302 – Manufacturing Processes	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

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

Course Outcome(s):

CO1	*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*
CO3	*Compare the different types of drive systems used in CNC for mechanical engineering field*
CO4	*Identify the effect of different types of co-ordinate system used in CNC machining*
CO5	*Demonstrate the different types of cutting tools and materials*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				2	2	2	2	2	2	2	3	2	2	2
CO2		3			2	2	1	1			1	2		3	
CO3			3		2	1	1	1			1	1	1	2	
CO4	2	3	2	2	2	1	2	1			1	1			3
CO5		3	1			1	1	1			1	1			2

Course Topics:

Unit-I: INTRODUCTION

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-II: CNC MACHINES

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 - maintenance of CNC machines.

Unit-III: DRIVES

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-IV: PART PROGRAMMING

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-V: CUTTING TOOL MATERIALS

Cutting tool materials - carbide inserts classification - qualified, semi qualified and preset tooling, tooling system for machining centre and turning centre work holding devices –ISO tool holders and inserts.

Text Book(s):

1. P.Radhakrishnan, , "*Computer Numerical Control Machines*", Edition: 1, New Age publishers , 2018.
2. A.T.Sadasivan, D. Sarathy , "*Cutting tools for Productive Machining*", Edition: 1 Widia (India) Ltd , 2005.

Reference(s):

1. James Madison, "*CNC Machining Hand book*", Edition: 1, Industrial Press inc , 1996.
2. P.C. Pandey, H.S. Shan, "*Modern machining processes*", Edition: 1, Tata McGraw-Hill , 1980.

MEC18R317:TRIBOLOGY	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R211 – Engineering Mechanics	**Course Category:**Honors **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):

CO1	*Explain the surface friction and types of wear at different conditions*
CO2	*Outline the theories of lubrication, lubrication regimes, theories of hydrodynamic, elasto hydrodynamic etc.*
CO3	*Identify suitable wear testing equipment and standard procedure for different applications.*
CO4	*Apply suitable frictional components to reduce frictional wear.*
CO5	*Evaluate the various tribological instruments with international standards.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2							1			2	1	
CO2	3	2	1	1						1			2	1	
CO3	3	3	2	2	2					1	1	1	2	1	
CO4	3	3	3	2	2					1	1	1	2	1	2
CO5	3	3	2	2	2					1	1	1	2	1	2

Course Topics:

Unit-I:SURFACE FRICTION AND WEAR

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-II:LUBRICATION THEORY

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-III:WEAR TESTING METHOD

An abrasive wear tester-A rolling sliding wear tester- A pin-on-disc wear tester-Three body wear test.

Unit-IV:APPLICATION OF TRIBOLOGY

Introduction-Rolling Contact Bearings- Gears- Journal Bearings – Off shore bearing, wind turbine sliding bearing.

Unit-V:TRIBO MEASUREMENT IN INSTRUMENTATION

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. 1. Sahoo, "*Engineering Tribology*", Edition:1 ,Prentice Hall India Learning Private Limited,2005.

2. 1. Kenneth Holmberg Allan MatthewsBasu, S.K., Senguta, S.N, "*Fundamentals of Tribology*", Edition:1,Prentice Hall India Learning Private Limited,2005.

Reference(s):

1. Krishan Kant Sharma, *"Tribology*", Edition:1 Laxmi Publications ,2016.
2. Stachowiak, "*ENGINEERING TRIBOLOGY*", Edition:1,, Butterworth-Heineman UK2005.
3. 3. Basu, S.K, Sengupta,.Ahuja,B, "*Fundamentals of Tribology*", Edition:1,Prentice –Hall of India Pvt Ltd,2010.

MEC18R318:REFRIGERATION AND AIR CONDITIONING	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R274 - Thermal Engineering	**Course Category:**Honors **Course Type :**Theory			

Course Objective(s):

Enable the students to understand the principles and concepts of refrigeration and air conditioning

Course Outcome(s):

CO1	*Interpret the basic concepts of various refrigeration systems*
CO2	*Predict the types of refrigerants suitable for the applications considering the environmental issues.*
CO3	*Employ the acquired knowledge to provide solution for the psychrometric properties.*
CO4	*Identify the cooling load for a given space and suggest the cooling requirements.*
CO5	*Impart knowledge about the air conditioning equipment and its usage.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1		1								2	2	2	
CO2	3	1		1			1	3				2	2	1	
CO3	3	2										2	2		
CO4	3	2	2	1				1				2	2	1	
CO5	3											1	2		

Course Topics:

Unit-I:INTRODUCTION

Review of thermodynamic principles of refrigeration, concept of aircraft refrigeration system, Advanced vapour compression refrigeration cycle and system, use of P-H charts, multistage and multiple Evaporator systems, cascade system, COP comparison, Advanced vapour absorption refrigeration system & components, ammonia water and lithium bromide water systems, steam jet refrigeration system.

Unit-II:REFRIGERANTS AND APPLICATIONS

Refrigerants - properties - selection of refrigerants, alternate refrigerants, refrigeration plant Controls testing and charging of refrigeration units- applications to refrigeration systems. Ozone depletion and global warming issues

Unit-III:PSYCHROMETRY AND COOLING LOAD CALCULATION (PSYCHROMETRIC AND COMFORT AIR CONDITIONING PROCESS)

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-IV:LOAD

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-V:AIR CONDITIONING EQUIPMENTS

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

Text Book(s):

1. Arora, Domkundwar, "*A course in Refrigeration and Air conditioning*", Edition:1,Dhanpat Rai and CO. (P) Ltd,2018.
2. Manohar Prasad, "*Refrigeration and Air Conditioning*", Edition:3,New Age International,2018.

Reference(s):

1. C. P. Arora, "*Refrigeration and AirConditioning*", Edition:3,TataMcGraw Hill,2014.
2. Roy.J. Dossat, " *Principles of Refrigeration*", Edition:4,Pearson Education,1985.
3. Jordon and Prister, "*Refrigeration and Air Conditioning*", Edition:2,Prentice Hall of India Pvt Ltd,1985.

MEC18R322 : MODERN MANUFACTURING PROCESSES	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R302 - Manufacturing Processes	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to develop the basic Ideas with the Metallurgical Composition, Machining and Robotics.

Course Outcome(s):

CO1	*Recognize the need and importance of Non-traditional process and its selection based on the parameters, shapes*
CO2	*Distinguish the principle, process parameters of abrasive water jet machining and ultrasonic machining process.*
CO3	*Describe the process involved in the electrical discharge machining*
CO4	*Analyze chemical and electro chemical machining process for making complex profile in hard metals.*
CO5	*Outline the appropriate high energy machining process for the various materials*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1									1	3	2	
CO2	2	2	2		2		1			2		2	3	2	1
CO3	2	2	2		2		1			2		2	3	2	1
CO4	3	2	2		2					2		2	3	2	1
CO5	1	2		1	2		1					2	3	2	1

Course Topics:

Unit-I: INTRODUCTION

Need of Non-Traditional Machining Processes – Classification Based on Energy, Mechanism, source of energy, transfer media and process – Process selection Based on Physical Parameters, shapes to be machined, process capability and economics – Overview of all processes.

Unit-II: MECHANICAL PROCESS

Ultrasonic Machining: Principle- Transducer types – Concentrators – Abrasive Slurry – Process Parameters – Tool Feed Mechanism – Advantages and Limitations – Applications. Abrasive Jet Machining: Process- Principle – Process Variables – Material Removal Rate – Advantages and Limitations – Applications. Water Jet Machining: Principle – Process Variables – Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

Unit-III: ELECTRICAL DISCHARGE MACHINING

Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods – Electrode Materials – Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrode Design – Tool wear Characteristics of Spark Eroded Surfaces- Advantages and Limitations – Practical Applications. Electrical Discharge Wire Cut and Grinding: Principle – Wire Feed System
– Advantages and Limitations – Practical applications

Unit-IV: CHEMICAL AND ELECTRO CHEMICAL MACHINING

Chemical Machining: fundamentals, Principle –classification and selection of Etchant -chemical milling, Engraving, Blanking – Advantages and limitations – Applications. Electro Chemical Machining: Electro-chemistry of the process-Electrolytes – Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Design For Electrolyte Flow – Process Variables – Advantages and Limitations – Applications – Electro Chemical Grinding: Honing, cutting off, Deburring and turning.

Unit-V: HIGH ENERGY MACHINING PROCESS

Electron Beam Machining: Principle –Generation and control of electron beam-Advantages and Limitations – Applications. Laser Beam Machining: Principle –Solid and Gas Laser Application – Thermal Features of LBM – Advantages and Limitations – Applications. Ion Beam Machining: Equipment – process characteristics – Advantages and Limitations – Applications. Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters – Advantages and Limitations – Applications. Ion Beam Machining – Principle – MRR – advantages, limitation, applications.

Text Book(s):

1. P.C Pandey And H.S. Shan, "*Modern Machining Process*", Edition: 1, Tata McGraw – Hill Publishing Company Limited, New Delhi , 2017.
2. V.K. Jain, "*Advanced Machining Process*", Edition: 1, Allied Publishers Pvt Limited , 2009.

Reference(s):

1. Amithaba Bhattacharyya, "*New Technology*", Edition: 1, The Institution of Engineers, India , 2009.
2. Hmt, Hmt, H M T Bangalore, "*Production Technology*", Edition: 1, Tata McGraw-Hill Education , 2017.
3. Hassan El – Hofy, "*Advanced machining Processes*", Edition: 1, MC Graw-Hill , 2005.

MEC18R331:VIBRATION ANALYSIS AND NOISE MONITORING	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:**Honors **Course Type :**Theory			

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):

CO1	*Demonstrate vibration and summarize the types of mechanical vibrations.*
CO2	*Explain noise monitoring and apply techniques on noise controlling.*
CO3	*Classify the various sources of automotive noises.*
CO4	*Identify various control techniques of vibrations.*
CO5	*Construct various techniques for noise control.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											2		
CO2	2	3	3	2		2							2		
CO3	1	3		1									2		
CO4	1	3	3	2									2		
CO5	1	3	3	2									2	2	

Course Topics:

Unit-I:FUNDAMENTALS OF VIBRATION

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-II:BASICS OF NOISE

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-III:AUTOMOTIVE NOISE SOURCES

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-IV:CONTROL TECHNIQUES

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-V:SOURCE OF NOISE AND CONTROL

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. Singiresu S.Rao, "*Mechanical Vibrations*", Edition:6 ,Pearson Education,2017.
2. KewalPujara, "*Vibrations and Noise for Engineers*", Edition:2,Dhanpat Rai and Sons Ltd,2018.

Reference(s):

1. Bernard Challen and RodicaBaranescu *"Diesel Engine Reference Book*", Edition:2 SAE International ,1999.
2. Julian Happian-Smith, "*An Introduction to Modern Vehicle Design*", Edition:1,Butterworth - Heinemann2012.
3. John Fenton, "*Handbook of Automotive body Construction and Design Analysis*", Edition:1,Wiley India,2010.

MEC18R333:DESIGN OF HEAT TRANSFER EQUIPMENTS	L	T	P	C
	3	1	0	4
Pre-requisite: MEC18R274 – Thermal Engineering	**Course Category:** Honors **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):

CO1	*Illustrate different types of heat exchangers and identify the varied methods of heat exchanger analysis*
CO2	*Identify the resource parameters which affects the performance of heat exchangers*
CO3	*Manipulate the basic ideas in baffles with its effects and some varied heat exchangers*
CO4	*Employ the acquired knowledge in designing the condenser and evaporator*
CO5	*Interpret the concepts in selection of accessories for heat exchangers*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2	2	1	
CO2	3	2	2	2				2					2	2	
CO3	3	2	2	1									2	2	
CO4	3	2	3	2	2							2	2	2	2
CO5	3											2	2		

Course Topics:

Unit-I:HEAT EXCHANGERS

Types, shell and tube heat exchangers, regenerators and recuperators, industrial applications, temperature distribution and its implications, LMTD, effectiveness

Unit-II:FRICTION FACTOR

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-III:HEAT TRANSFER AND PRESSURE LOSS

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-IV:CONDENSERS

Design of surface and evaporative condensers, design of shell and tube, plate type evaporators

Unit-V:ACCESSORIES

Material selection, packing's, spray design, selection of pumps, fans and pipes, testing and maintenance, experimental methods

Text Book(s):

1. D. Q. Kern, "*Process Heat Transfer*", Edition:1,Tata McGraw Hill, New Delhi,2017.
2. SadikKakac, "*Heat Exchangers: Selection, Rating, and Thermal Design*", Edition:3,CRC Press,2017.

Reference(s):

1. Kuppan Thulukalam, "*Heat Exchanger Design Handbook*", Edition:2,CRC Press,2015.
2. Arthur P Frass, "*Heat Exchanger Design*", Edition:2,John Wiley and Sons, New York,2015.
3. T. Taborek, "*Heat Exchangers, Theory and Practice*", Edition:1,McGraw Hill Book Co,1980.

MEC18R338 : GEAR MANUFACTURING AND INSPECTION	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: MEC18R302-Manufacturing Processes	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

This course provides the candidates 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):

CO1	*Review a range of terminologies and principles of Gear Geometry.*
CO2	*Make use of different gear manufacturing techniques pertaining to the application.*
CO3	*Identify appropriate gear inspection techniques in relevance with the application.*
CO4	*Examine the various stages of materials processing, designing and analyzing of gears.*
CO5	*Build bevel and worm gears according to the design standards for a relevant claim.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2			1							2	3	
CO2	1	3	1			1	2	1				1	2	3	
CO3	3	2	2	3		3	2	3	1				3	2	
CO4	3	3	3	2	3	2		3	1		1	1	3	3	3
CO5	3	2	3	2		2		3				1	3	2	

Course Topics:

Unit-I: GEAR GEOMETRY

Principles of gear tooth action, geometry of spur and helical gears. Gear terminologies

Unit-II: GEAR MANUFACTURING

Gear manufacturing – types – forming gear teeth by milling – gear generation by planning, shaping and hopping process – applications.

Unit-III: GEAR INSPECTION

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-IV: DESIGN AND ANALYSIS

Design considerations, materials treatments and methodology - gear tooth failure mode analysis, stresses and load calculation.

Unit-V: BEVEL AND WORM GEARS

Principles of geometry and design of bevel and worm gearing.

Text Book(s):

1. R.L. Norton, "*Design of Machine Elements*", Edition: 1st, Tata McGraw-Hill Education , 2005.
2. Hmt, Hmt, H M T Bangalore, "*Production Technology*", Edition: 1st, Tata McGraw-Hill Education , 2017.

Reference(s):

1. G. L. Maitra, "*Hand Book of Gear Design*", Edition: 2nd, Tata McGraw-Hill , 2008.
2. R. K. Jain, "*Engineering Metrology*", Edition: 1979, Khanna Publishers, Delhi , 2009.
3. P.S.G. Tech, "*Design Data*", Edition: 3rd, Kalaikathir Publishers , 2012.

MEC18R342:COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite:MEC18R274 - Thermal Engineering	**Course Category:**Honors **Course Type :**Theory			

Course Objective(s):

The course introduces the various methods to solve the complex problems in fluid flow and heat transfer

Course Outcome(s):

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):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2							2	1	2	
CO2	3	2	2	2	2							2	1	2	
CO3	3	2	2	2	2							2	1	2	
CO4	3	2		2								2	2	2	
CO5	1	2	3									2	2	2	

Course Topics:

Unit-I:INTRODUCTION

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-II:FINITE DIFFERENCE METHOD

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-III:FINITE VOLUME METHOD

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-IV:FINITE ELEMENT METHOD

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-V:GRID GENERATION AND POST PROCESSING

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. K. Muralidhar, "*Computational fluid flow and heat transfer*", Edition:2,Narosa publishing house,2014.
2. A. D.Anderson , "*Computational fluid mechanics and heat transfer*", Edition:3,CRC Press,2012.

Reference(s):

1. V. H.Versteeg, "*An Introduction to Computational Fluid Dynamics*", Edition:2,Pearson Education Publishers,2008.
2. Suhas V.Patankar, "*Numerical Heat Transfer and Fluid Flow*", Edition:1,CRC press,2017.
3. Jaluria and Torrance, "*Computational Heat Transfer*", Edition:2,Taylor and Francis Group,2002.

MEC18R405:ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
	3	1	0	4
Pre-requisite:MEC18R274 – Thermal Engineering	**Course Category:**Honors **Course Type :**Theory			

Course Objective(s):

To understand the energy data from industries and carry out energy audit for energy savings

Course Outcome(s):

CO1	*Recognize the demand of Energy and Power*
CO2	*Improve the energy conservation by adopting Energy audit & Energy Economics*
CO3	*Impart the basic principles of Energy Efficiency in Industries.*
CO4	*Apply the Energy conservation methods in thermal power plant*
CO5	*Conserve the energy in electro mechanical equipments*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						3				2	2	3		
CO2	3	3		3			3				2		3		
CO3	3	3		2			3				2		3		
CO4	3	3		2			3				2	3	3		
CO5	3	3		2			3				2	2	3		

Course Topics:

Unit-I:INTRODUCTION

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization

Unit-II:ENERGY AUDIT AND ENERGY ECONOMICS

Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing. Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept

Unit-III:ENERGY EFFICIENCY

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting

Unit-IV:ENERGY CONSERVATION IN THERMAL POWER PLANT

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash stream utilization; Insulation & Refractories.

Unit-V:ENERGY CONSERVATION IN ELECTRO MECHANICAL EQUIPMENTS

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets. Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept

Text Book(s):

1. W. R. Murphy, "*Energy Management*", Edition:1,Butterworths, London,2009.
2. Callaghn, "*Design and Management for Energy Conservation*", Edition:1,Pergamon Press, Oxford,2004.

Reference(s):

1. David Merick and Richard Marshal, "*Energy, present and future options*", Edition:1,John Wiley and Sons,2009.
2. N. A. Chaigier, "*Energy Consumption and Environment*", Edition:1,McGraw-Hill,2007.
3. D. A. Reay, "*Industrial Energy Conservation*", Edition:2,Pergama on Press,2004.

MEC18R412 : MICRO ELECTRO MECHANICAL SYSTEMS	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: EEE17R172- Basic Electrical Engineering	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

The objective of this course is to make students to gain the knowledge in MEMS (Micro electro Mech

Course Outcome(s):

CO1	*Understand the basic concept of MEMS and their technology.*
CO2	*Understand (Ilustrate) the material properties and identify the fabrication process.*
CO3	*Apply the knowledge to design the Micro and Nano devices for various applications.*
CO4	*Apply the knowledge to design the components by analyzing various techniques.*
CO5	*Understand (Interpret) the concept of transducer design and their fabrication techniques*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		3									1	2		
CO2	2	1						1					2	1	
CO3	2		2	1									2		
CO4	2		2	1									2		
CO5	2							1					2		

Course Topics:

Unit-I: FUNDAMENTALS OF MEMS

Introduction, history, development and need of micro-electro - mechanical systems, Components of MEMS- overview of MEMS technology.

Unit-II: MATERIALS AND FABRICATION PROCESSES

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-III: NANO ELECTRO MECHANICAL SYSTEM

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-IV: DESIGN CONSIDERATION

Design consideration – process design-mechanical design –design of silicon die-design of micro fluidic network systems-capillary electrophoresis network system

Unit-V: MEMS AND NEMS

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*", Edition: 1, McGraw Hill Education , 2017.
2. Vijay K Varadan, "*Micro Sensors, MEMS, and Smart Devices*", Edition: 1, John Wiley and sons , 2001.

Reference(s):

1. MarcMadou, "*Fundamentals of micro Fabrication*", Edition: 3, CRC Press , 2011.
2. Vijay K. Varadan, K. J. Vinoy, K. A. Jose, "*RF MEMS and Their Applications*", Edition: 1, John Wiley & Sons , 2003.
3. Stephen Beeby, "*MEMS Mechanical Sensors*", Edition: 1, Artech House , 2004.

MEC18R426:DESIGN AND ANALYSIS OF EXPERIMENTS	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**
Pre-requisite: Nil	**Course Category:**Honors **Course Type :**Theory			

Course Objective(s):

- Obtain the knowledge about various types of experiments that are frequently employed in industries for experimental studies.
- Plan, design and conduct experiments efficiently and effectively.
- Being prepared to analyze and interpret the experimental data obtained through designed experiments.
- Being able to compare classical designs, orthogonal arrays and response surface methods.

Course Outcome(s):

CO1	*Analyze the various types of designs of experiments.*
CO2	*Apply and selection of the proper design of experiments that suits the application.*
CO3	*Classify control factors, their levels, noise factors and objective functions.*
CO4	*Evaluate and learn adjustments and modifications in standard design of experiments.*
CO5	*Apply the regression model for the problem considered.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1											2		
CO2		2		1					1				2		
CO3	2	3	1											2	
CO4	2	1	1								2			1	
CO5	1	2			3										2

Course Topics:

Unit-I:INTRODUCTION TO RESEARCH METHODOLOGY

Introduction to research methodology, The economics of reducing variation, quality characteristics and objective functions, Taguchi quality loss function, DOE process – steps and description, Typical test strategies, Better test strategies- full factorial experiments, fractional factorial experiments, standard orthogonal arrays and linear graphs

Unit-II:ANOVA

Construction of orthogonal arrays and modification of linear graphs. Introduction to analysis of variance (ANOVA) – analogy with Fourier analysis, No way ANOVA, one way ANOVA, two way ANOVA, three way ANOVA, signal to noise (S/N) ratio, sum of squares, degrees of freedom, F-test, p-value, pooling, percent contribution, interpretation, examples on ANOVA.

Unit-III:DESIGN OF EXPERIEMENTS

Control factors and their levels and noise factors. Two level experiments (2K design), blocking and confounding, three level experiments (3K design), mixed level experiments, multiple level experiments, polynomial effects, confirmation experiments, additive models, Latin squares and related designs, case studies.

Unit-IV: ANALYSIS OF EXPERIEMENTS

Response surface methodology (RSM) – First order model, second order model, stationary point, central composite design (CCD), Box-Behnken design, Face centered cubic design (FCCD), surface plots.

Unit-V:MODELLING

Fitting regression models, model building, adequacy checking of models and case studies.

Text Book(s):

1. D. C. Montgomery, "*Design and analysis of experiment*", Edition:9,Wiley,2017.
2. R.Panneerselvam *Design and Analysis of Experiments*", Edition:2,, Prentice Hall India Learning Private Limited,2012.

Reference(s):

1. P.J. Ross, *"Taguchi Techniques for quality engineering*", Edition:2 Tata Mc-Graw Hill ,2005.
2. Douglas C. Montgomery, "*Design and Analysis of Experiments*", Edition:8,Wiley2013.
3. Kishore K. Pochampally , Surendra M. Gupta, "*Six Sigma Case Studies with Minitab*", Edition:3,CRC Press,2014.

MEC18R429 : PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

The aim of undergoing this course is to develop basic understanding the topics in Mechanical Engineering

Course Outcome(s):

CO1	*Analyze the need and importance of product design and development processes in manufacturing industries.*
CO2	*Apply the methodologies for concept generation, selection and testing of product design.*
CO3	*Design product architecture and its role in product development.*
CO4	*Develop the process design using CAD, CAM and CAE tools.*
CO5	*Interpret the benefit analysis through various cost models.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1										1	2		
CO2	2	1	2		1			1				2	2	3	
CO3	2	1	2		2			1				1	3	1	
CO4	2	1	2		3			1				2	3	2	3
CO5	2	1	2					1				1	2		

Course Topics:

Unit-I: INTRODUCTION

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – behaviour analysis. Understanding customer – promoting customer understanding – involving customer in development and managing requirement – Organization process management and improvement

Unit-II: CONCEPT GENERATION, SELECTION AND TESTING

Plan and establish product specifications. Task – Structural approaches – clarification – search – externally and internally – Explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits. Implementation – Product change – variety – component standardization – product performance – manufacturability – Concept Testing Methodologies.

Unit-III: PRODUCT ARCHITECTURE

Product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications – portfolio architecture

Unit-IV: INDUSTRIAL DESIGN

Integrated process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven product s – user – driven products – assessing the quality of industrial design.

Unit-V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT

Definition - Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics - Principles of prototyping – Planning for prototypes – Economic Analysis – Understanding and representing tasks – baselines project planning – accelerating the project – project execution.

Text Book(s):

1. Karl T. Ulrich, Steven D. Eppinger, "*Product design and development*", Edition: 5, McGraw-Hill/Irwin , 2012.
2. George E.Dieter, Linda C.Schmidt, "*Engineering Design*", Edition: 4, McGraw-Hill International , 2009.

Reference(s):

1. Karl Ulrich, Steven Eppinger , "Product Design and Development", Edition: 6, McGraw-Hill Education , 2015.
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "*Product Design and Development*", Edition: 4, Tata McGraw-Hill Education , 2009.
3. Ali Jamnia, "*Introduction to Product Design and Development for Engineers*", Edition: 1, CRC Press , 2018.

MEC18R435 : DESIGN FOR CELLULAR MANUFACTURING SYSTEMS	L	T	P	C
	3	1	0	4
Pre-requisite: MEC18R302 - Manufacturing Processes	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

To provide detailed information about the group technology concept.
To provide depth knowledge on planning, design, implementation and control techniques of cellular manufacturing systems.

Course Outcome(s):

CO1	*Describes the process and characteristics of group technology.*
CO2	*Design of various approaches for cellular manufacturing system.*
CO3	*Demonstrate the implementation process of cellular manufacturing system.*
CO4	*Analyze the performance of group technology and cellular manufacturing process*
CO5	*CO5: Apply and analyze the concepts acquired to determine the economy of cellular manufacturing process*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2										2	1	
CO2	1	3	2	1	1								3		
CO3	1	1	3		1	2							1		
CO4	1	1	2	1	2									2	
CO5	1	2	2		3		2						1	3	

Course Topics:

Unit-I: INTRODUCTION

Introduction to Group Technology (GT), Limitation of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

Unit-II: CMS PLANNING AND DESIGN

Problem in GT/CMS – Design of CMS – Models, Traditional approaches and non-traditional approaches – Genetic Algorithms, Simulated Annealing, Neutral networks.

Unit-III: IMPLEMENTATION OF GT/CMS

Inter and Intra cell layout, cost and non – cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

Unit-IV: PERFORMANCE MEASUREMENT AND CONTROL

Measuring CMS performance – Parametric analysis – PBC in GT/CMS, cell loading, GT and MRP framework.

Unit-V: ECONOMICAL OF GT/CMS

Conventional Vs group use of computer models in GT/CMs, Human aspects of GT/CMS – cases.

Text Book(s):

1. R. G. Askin and A. J. Vakharia, "*Planning and Operation, in The automated factory- Hand Book: Technology and Management*", Edition: 1, Cleland.D.I. and Bidananda,B (Eds), TAB Books , 1991.
2. A. K. Kamarani, H. R. Parsaei and D. H. Lilees, "*Planning, design and analysis of cellular manufacturing systems*", Edition: 1, Elsevier , 2011.

Reference(s):

1. J. L. Burbidge, "*Group Technology in Engineering Industry*", Edition: 1, Mechanical Engineering publications , 1979.
2. S. A. Irani, Sanjay Subramanian and Y. S. Allam, "*Introduction to Cellular Manufacturing Systems*", Edition: 1, Wiley , 2007.
3. Nauna Singh and Divakar Rajamani, "*Cellular Manufacturing Systems: Design, Planning and Control*", Edition: 1, Springer , 1996.

MEC18R437 : DESIGN FOR ERGONOMICS	L	T	P	C
	3	1	0	4
Pre-requisite: Nil	**Course Category:** Honors **Course Type :** Theory			

Course Objective(s):

The aim of this course is to inculcate the knowledge on time management and shop floor control.

Course Outcome(s):

CO1	*Explain the production Improvement studies with work study Concepts.*
CO2	*Demonstrate the Methodology to solve the human factor analysis In Industries.*
CO3	*Illustrate the procedure to develop systematic approach for process control.*
CO4	*Analyze the rate of timing in production and to control on time management.*
CO5	*Compare the effort of human and machine on production processes.*

Mapping of Course Outcome(s):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2								1			1	1
CO2	1	1	3					1			1			1	
CO3	1		2								1		1	1	
CO4	1		2								1			1	
CO5	1		2		2						1		2	1	

Course Topics:

Unit-I: PRODUCTIVITY

Definition, reason for low productivity, methods to improve productivity, work-study and productivity

Unit-II: HUMAN FACTOR IN WORK- STUDY

Relationship of work-study man with management, supervisor & workers, qualities of a work-study man.

Unit-III: METHOD-STUDY

Definition, Objectives, step-by-step procedure, questioning techniques, chart and diagrams for recording data. Like outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart, cycle graph, Chrono-cycle graph, therbligs, micro motion study and film analysis, Simo chart, principles of motion economy. Development and installation of new method.

Unit-IV: WORK-MEASUREMENT

Definition, various techniques of work-measurement work-sampling, stopwatch time study & its procedure, Job selection, Equipment and forms used for study, methods of rating, allowances and their types, standard time, numerical problems, predetermined – time standards and standard data techniques. Incentive –Meaning, objectives of an incentive plan, various types of incentive plans.

Unit-V: ERGONOMICS

Introduction, history of development, man-machine system and its components. Introduction to structure of the body- features of the human body, stress and strain, and metabolism, measure of physiological functions- workload and energy consumption, biomechanics, types of movements of body members, strength and endurance, speed of movements. NIOSH lifting equation, Lifting Index, Maximum acceptable Weights and Forces, Distal upper extremities risk factors, Strain Index, RULA,REBA. Applied anthropometry – types, use, principles in application, design of work surfaces and seat design. Visual displays for static information, visual

displays of dynamic information, auditory, tactual and olfactory displays and controls. Assessments of occupational exposure to noise, heat stress and dust. Effect of vibration/noise, temperature, illumination and dust on human and performance.

Text Book(s):

1. R. M. Barners, "*Motion & Time study: Design and Measurement of work*", Edition: 7, Wiley , 2009.
2. M. E. Mundel and L. David, "*Motion & Time Study: Improving Productivity*", Edition: 7, Pearson Education , 2000.

Reference(s):

1. B. W. Niebel, "*Motion and Time Study*", Edition: 7, Richard D Irwin Inc , 2015.
2. R. S. Bridger, "*Introduction to Ergonomics*", Edition: 3, CRC Press , 2009.
3. N. A. Stanton and Mark Young, "*Guide to Methodology in Ergonomics: Design for Human Use*", Edition: 1, CRC Press , 1999.