VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF MECHANICAL ENGINEERING

B.Tech Production and Industrial Engineering

(B.Tech BPI)

Curriculum

(*2018-2019 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and impactful workforce and students.

Rewarding Co-Creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

To be a leader in imparting world class education in Mechanical Engineering, leading to nurturing of scientists and technologists of highest caliber who would engage in sustainable development of the globe.

MISSION STATEMENT OF THE SCHOOL OF MECHANICAL ENGINEERING

The mission of the school is to create and maintain an environment for Excellence in Instruction, Learning and Applied Research in the area of Mechanical and allied disciplines so as to equip our students with necessary knowledge and skills for higher education / employment and to meet the social demands.

B. Tech Production and Industrial Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry
3. Graduates will function in their profession with social awareness and responsibility.
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.
5. Graduates will be successful in pursuing higher studies in engineering or management.
6. Graduates will pursue career paths in teaching or research.

B. Tech Production and Industrial Engineering

PROGRAMME OUTCOMES (POs)

PO_1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_2: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO_3: 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.

PO_4: 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 for complex problems

PO_5: 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.

PO_6: 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.

PO_7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_9: Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_10: 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.

PO_11: 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.

PO_12: Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

B. Tech Production and Industrial Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech. (Production and Industrial Engineering) programme, graduates will be able to

- PSO1: Model, Design & Analyse Manufacturing Systems taking into account social, economic and environmental implications.
- PSO2: Realize engineering components and products using appropriate materials and machine tools.
- PSO3: Work professionally in Industrial Engineering and related systems.

B. Tech Production and Industrial Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	**70**
Programme core (PC)	**60**
Programme elective (PE)	**38**
University elective (UE)	**12**
Bridge course (BC)	**-**
Total credits	**180**

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

B. Tech Production and Industrial Engineering

DETAILED CURRICULUM

University Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	CHY1002	Environmental Sciences	3	0	0	0	3
2.	CHY1701	Engineering Chemistry	3	0	2	0	4
3.	CSE1001	Problem Solving and Programming	0	0	6	0	3
4.	CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3
5.	ENG1011	English for Engineers	0	0	4	0	2
6.	HUM1021	Ethics and Values	2	0	0	0	2
7.	MAT1011	Calculus for Engineers	3	0	2	0	4
8.	MAT2001	Statistics for Engineers	2	1	2	0	4
9.	MEE3099	Industrial Internship	0	0	0	0	2
10.	MEE3999	Technical Answers for Real World Problems (TARP)	1	0	0	8	3
11.	MEE4098	Comprehensive Examination	0	0	0	0	2
12.	MEE4099	Capstone Project	0	0	0	0	20
13.	MGT1022	Lean Start-up Management	1	0	0	4	2
14.	PHY1701	Engineering Physics	3	0	2	0	4
15.	PHY1999	Introduction to Innovative Projects	1	0	0	4	2
16.	EXC4097	Co-Extra Curricular Basket	0	0	0	0	2
17.	FLC4097	Foreign Language Course Basket	2	0	0	0	2
18.	STS4097	Soft Skills	0	0	0	0	6

Programme Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	EEE1001	Basic Electrical and Electronics Engineering	2	0	2	0	3
2.	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
3.	MAT3003	Complex Variables and Partial Differential Equations	3	2	0	0	4
4.	MAT3005	Applied Numerical Methods	3	2	0	0	4
5.	MEE1001	Engineering Drawing	1	0	4	0	3
6.	MEE1005	Materials Engineering and Technology	3	0	2	0	4
7.	MEE1014	Industrial Engineering and Management	3	0	0	0	3
8.	MEE1024	Operations Research	2	2	0	0	3
9.	MEE1031	Theory of Metal Casting and Joining	3	0	0	4	4
10.	MEE1032	Mechanics of Solids and Fluids	3	0	2	0	4
11.	MEE1033	Thermodynamics and Heat Transfer	2	2	2	0	4
12.	MEE1034	Statistical Quality Control	2	0	0	4	3
13.	MEE2001	Machine Drawing	1	0	4	0	3
14.	MEE2012	Manufacturing Automation	3	0	2	0	4
15.	MEE2031	Theory of Metal Cutting and Forming	3	0	2	0	4
16.	MEE2032	Kinematics and Dynamics of Machinery	2	2	0	0	3
17.	MEE3012	Computer Aided Manufacturing	2	0	2	0	3

Programme Elective

S. No.	Course Code	Course Title	L	T	P	J	C
1.	EEE2007	Electronics and Microcontrollers	2	0	0	4	3
2.	EEE3001	Control Systems	3	0	2	0	4
3.	MEE1015	Total Quality Management and Reliability	3	0	0	0	3
4.	MEE1016	Lean Enterprises and New Manufacturing Technology	3	0	0	0	3
5.	MEE1018	Facilities and Process Planning	3	0	0	0	3
6.	MEE1020	Enterprise Resource Planning	2	0	0	4	3

7.	MEE1027	Instrumentation and Control Engineering	3	0	2	0	4
8.	MEE1030	Robotics	2	0	2	0	3
9.	MEE2008	Product Design for Manufacturing	2	0	0	4	3
10.	MEE2013	Modelling and Simulation of Manufacturing Systems	3	0	0	4	4
11.	MEE2015	Non Destructive Testing	3	0	2	0	4
12.	MEE2016	Rapid Manufacturing Technologies	2	0	0	4	3
13.	MEE2033	Production Planning and Control	3	0	0	0	3
14.	MEE2034	Industrial Economics	3	0	0	0	3
15.	MEE2035	Logistics and Supply Chain Management	3	0	0	0	3
16.	MEE2036	Industrial Corrosion and Tribology	3	0	0	4	4
17.	MEE2037	Agile Manufacturing	3	0	0	0	3
18.	MEE3002	Finite Element Analysis	2	2	2	0	4
19.	MEE3003	Engineering Failure Analysis	3	0	0	4	4
20.	MEE3013	Laser Processing	3	0	0	0	3
21.	MEE3014	Engineering Metrology	2	0	2	0	3
22.	MEE3019	Advanced Manufacturing Management	3	0	0	0	3
23.	MEE4001	Tool Design	3	0	0	4	4
24.	MEE4002	Advanced Machining Processes	2	0	0	4	3
25.	MEE4003	Micro and Nano Machining	3	0	0	0	3
26.	MEE4007	Design of Transmission Systems	2	2	0	4	4

University Elective Baskets

Management courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	MGT1001	Basic Accounting	3	0	0	0	3
2	MGT1002	Principles of Management	2	0	0	4	3
3	MGT1003	Economics for Engineers	2	0	0	4	3
4	MGT1004	Resource Management	2	0	0	4	3
5	MGT1005	Design, Systems and Society	2	0	0	4	3
6	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3

7	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10	MGT1010	Total Quality Management	2	2	0	0	3
11	MGT1014	Supply Chain Management	3	0	0	0	3
12	MGT1015	Business Mathematics	3	0	0	0	3
13	MGT1016	Intellectual Property Rights	3	0	0	0	3
14	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15	MGT1018	Consumer Behaviour	3	0	0	0	3
16	MGT1019	Services Marketing	3	0	0	0	3
17	MGT1020	Marketing Analytics	2	0	2	0	3
18	MGT1021	Digital and Social Media Marketing	3	0	0	0	3
19	MGT1022	Lean Start-up Management	1	0	0	4	2
20	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
21	MGT1024	Organizational Behaviour	3	0	0	4	4
22	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4
23	MGT1026	Information Assurance and Auditing	2	0	0	4	3
24	MGT1028	Accounting and Financial Management	2	2	0	4	4
25	MGT1029	Financial Management	2	1	0	4	4
26	MGT1030	Entrepreneurship Development	3	0	0	4	4
27	MGT1031	International Business	3	0	0	4	4
28	MGT1032	Managing Asian Business	3	0	0	4	4
29	MGT1033	Research Methods in Management	2	1	0	4	4
30	MGT1034	Project Management	3	0	0	4	4
31	MGT1035	Operations Management	3	0	0	0	3
32	MGT1036	Principles of Marketing	3	0	0	4	4
33	MGT1037	Financial Accounting and Analysis	2	1	0	4	4
34	MGT1038	Financial Econometrics	2	0	0	4	3
35	MGT1039	Financial Markets and Institutions	2	0	0	4	3
36	MGT1040	Personal Financial Planning	2	0	0	4	3

37	MGT1041	Financial Derivatives	2	1	0	4	4
38	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
39	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
40	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
41	MGT1045	Industrial Marketing	3	0	0	4	4
42	MGT1046	Sales and Distribution Management	3	0	0	4	4
43	MGT1047	Social Marketing	3	0	0	4	4
44	MGT1048	Political Economy of Globalization	3	0	0	4	4
45	MGT1049	Sustainable Business Models	3	0	0	4	4
46	MGT1050	Software Engineering Management	2	0	0	4	3
47	MGT1051	Business Analytics for Engineers	2	2	0	0	3
48	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3
49	MGT1053	Entrepreneurship Development, Business Communication and IPR	1	0	2	0	2
50	MGT1054	Product Planning and Strategy	2	2	0	0	3
51	MGT1055	Design Management	2	2	0	0	3
52	MGT1056	Accounting and Financial Management	3	0	0	4	4
53	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3
6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3

11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2
16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3
19	HUM1034	Macro Economics	3	0	0	0	3
20	HUM1035	Introductory Econometrics	2	0	2	0	2
21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

Course code	Environmental Sciences	L	T	P	J	C
CHY1002		3	0	0	0	3
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		V:1.1				

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implications of life style on the environment.
2. To understand the various causes for environmental degradation.
3. To understand individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome:

Students will be able to

1. Students will recognize the environmental issues in a problem oriented interdisciplinary perspectives
2. Students will understand the key environmental issues, the science behind those problems and potential solutions.
3. Students will demonstrate the significance of biodiversity and its preservation
4. Students will identify various environmental hazards
5. Students will design various methods for the conservation of resources
6. Students will formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects
7. Students will have foundational knowledge enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	Environment and Ecosystem	7 hours	CO: 1, 2

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module:2	Biodiversity	6 hours	CO: 1, 3

Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.

Module:3	Sustaining Natural Resources and Environmental Quality	7 hours	CO: 4, 5

Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.

Module:4	Energy Resources	6 hours	CO: 5, 6

Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar- Hydrogen revolution.			
Module:5	**Environmental Impact Assessment**	**6 hours**	**CO: 6, 7**
Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.			
Module:6	**Human Population Change and Environment**	**6 hours**	**CO: 1, 7**
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.			
Module:7	**Global Climatic Change and Mitigation**	**5 hours**	**CO: 2, 7**
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information technology in environment-Case Studies.			
Module:8	**Contemporary issues**	**2 hours**	**CO: 7**
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	

Text Books

1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.
2. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.

Reference Books

1. David M.Hassenzahl, Mary Catherine Hager, Linda R.Berg (2011), Visualizing Environmental Science, 4thEdition, John Wiley & Sons, USA.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017

Course code	Engineering Chemistry	L	T	P	J	C
CHY1701		3	0	2	0	4
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
		1.1				

Course Objectives:

1. To impart technological aspects of applied chemistry
2. To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcomes (CO):

Students will be able to

1. Recall and analyze the issues related to impurities in water and their removal methods and apply recent methodologies in water treatment for domestic and industrial usage
2. Evaluate the causes of metallic corrosion and apply the methods for corrosion protection of metals
3. Evaluate the electrochemical energy storage systems such as lithium batteries, fuel cells and solar cells, and design for usage in electrical and electronic applications
4. Assess the quality of different fossil fuels and create an awareness to develop the alternative fuels
5. Analyze the properties of different polymers and distinguish the polymers which can be degraded and demonstrate their usefulness
6. Apply the theoretical aspects: (a) in assessing the water quality; (b) understanding the construction and working of electrochemical cells; (c) analyzing metals, alloys and soil using instrumental methods; (d) evaluating the viscosity and water absorbing properties of polymeric materials

Student Learning Outcomes involved: 1,2,14

[1] Having an ability to apply mathematics and science in engineering applications
[2] Having a clear understanding of the subject related concepts and of contemporary issues
[14] Having an ability to design and conduct experiments, as well as to analyze and interpret data

Module:1	Water Technology	5 hours	CO1

Characteristics of hard water - hardness, DO, TDS in water and their determination – numerical problems in hardness determination by EDTA; Modern techniques of water analysis for industrial use - Disadvantages of hard water in industries.

Module:2	Water Treatment	8 hours	CO1

Water softening methods: - Lime-soda, Zeolite and ion exchange processes and their applications. Specifications of water for domestic use (ICMR and WHO); Unit processes involved in water treatment for municipal supply - Sedimentation with coagulant- Sand Filtration - chlorination; Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultrafiltration, UV treatment, Ozonolysis, Reverse Osmosis; Electro dialysis.

Module:3	Corrosion	6 hours	CO 2

Dry and wet corrosion - detrimental effects to buildings, machines, devices & decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress corrosion cracking; Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Module:4	Corrosion Control	4 hours	CO 2

Corrosion protection - cathodic protection – sacrificial anodic and impressed current protection methods; Advanced protective coatings: electroplating and electroless plating, PVD and CVD.
Alloying for corrosion protection – Basic concepts of Eutectic composition and Eutectic mixtures - Selected examples – Ferrous and non-ferrous alloys.

Module:5	**Electrochemical Energy Systems**	**6 hours**	**CO 3**

Brief introduction to conventional primary and secondary batteries; High energy electrochemical energy systems: Lithium batteries – Primary and secondary, its Chemistry, advantages and applications.
Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells- working principles, advantages, applications.
Solar cells – Types – Importance of silicon single crystal, polycrystalline and amorphous silicon solar cells, dye sensitized solar cells - working principles, characteristics and applications.

Module:6	**Fuels and Combustion**	**8 hours**	**CO 4**

Calorific value - Definition of LCV, HCV. Measurement of calorific value using bomb calorimeter and Boy's calorimeter including numerical problems.
Controlled combustion of fuels - Air fuel ratio – minimum quantity of air by volume and by weight-Numerical problems-three way catalytic converter- selective catalytic reduction of NO_X; Knocking in IC engines-Octane and Cetane number - Antiknocking agents.

Module:7	**Polymers**	**6 hours**	**CO 5**

Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays, (Compression moulding), Fibre reinforced polymers, Composites (Transfer moulding), PET bottles (blow moulding);

Conducting polymers- Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)

Module:8	**Contemporary issues:**	**2 hours**	
Lecture by Industry Experts			
	Total Lecture hours:	**45 hours**	

Text Book(s)

1. Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015.
2. O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015.
3. B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008
4. "Photovoltaic solar energy : From fundamentals to Applications", AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley publishers, 2017.

Reference Books

1. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.
2. S. S. Dara, A Text book of Engineering Chemistry, S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT

List of Experiments		**CO: 6**
1.	Water Purification: Estimation of water hardness by EDTA method and its removal by ion-exchange resin	1 h 30 min
2.	Water Quality Monitoring: Assessment of total dissolved oxygen in different water samples by	3 h

3.	Winkler's method Estimation of sulphate / chloride in drinking water by conductivity method	
4/5	Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods	**3h**
6.	Analysis of Iron in carbon steel by potentiometry	1 h 30 min
7.	Construction and working of an Zn-Cu electrochemical cell	1 h 30 min
8.	Determination of viscosity-average molecular weight of different natural/ synthetic polymers	1 h 30 min
9.	Arduino microcontroller based sensor for monitoring temperature / conductivity in samples.	1 h 30 min
	Total Laboratory Hours	**17 hours**

Mode of Evaluation: Viva-voce and Lab performance & FAT			
Recommended by Board of Studies	31-05-2019		
Approved by Academic Council	54th ACM	Date	13-06-2019

Course code	PROBLEM SOLVING AND PROGRAMMING	L	T	P	J	C
CSE1001		0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. To develop broad understanding of computers, programming languages and their generations
2. Introduce the essential skills for a logical thinking for problem solving
3. To gain expertise in essential skills in programming for problem solving using computer

Expected Course Outcome:

1.Understand the working principle of a computer and identify the purpose of a computer programming language
2. Learn various problem solving approaches and ability to identify an appropriate approach to solve the problem
3. Differentiate the programming Language constructs appropriately to solve any problem
4. Solve various engineering problems using different data structures
5. Able to modulate the given problem using structural approach of programming
6. Eefficiently handle data using at les to process and store data for the given problem

List of Challenging Experiments (Indicative)

1.	Steps in Problem Solving Drawing Flowchart using yEd tool/Raptor Tool	4 hours
2.	Introduction to Python, Demo on IDE, Keywords, Identifiers, I/O Statements, Simple Program to display Hello world in Python.	4 hours
3.	Operators and Expressions in Python	4 hours
4.	Algorithmic Approach 1: Sequential	2
5.	Algorithmic Approach 2: Selection (if, elif, if.. else, nested if else	2 hours
6.	Algorithmic Approach 3: Iteration (while and for)	4 hours
7.	Strings and its Operations	2 hours
8.	Regular Expressions	2 hours
9.	List and its operations.	2 hours
10.	Dictionaries: operations	2 hours
11.	Tuples and its operations	2 hours
12.	Set and its operations	2 hours
13.	Functions, Recursions	2 hours
14.	Sorting Techniques (Bubble/Selection/Insertion)	4 hours
15.	Searching Techniques : Sequential Search and Binary Search	3 hours
16.	Files and its Operations	4 hours
	Total Laboratory hours	**45 hours**

Text Book(s)

1.	John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.

Reference Books

1.	Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.
2	Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.Mode of Evaluation: PAT / CAT/ FAT

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies								
Approved by Academic Council								
Course code	**Problem Solving And Object Oriented Programming**			**L**	**T**	**P**	**J**	**C**
CSE1002				**0**	**0**	**6**	**0**	**3**
Pre-requisite	**NIL**			**Syllabus version**				
				v1.0				

Course Objectives:

4. To emphasize the benefits of object oriented concepts.
5. To enable students to solve the real time applications using object oriented programming features
6. To improve the skills of a logical thinking and to solve the problems using any processing elements

Expected Course Outcome:

Upon Successful Completion of this course, student will be able to

1. Demonstrate the basics of procedural programming and to represent the real world entities as programming constructs.
2. Enumerate object oriented concepts and translate real-world applications into graphical representations.
3. Demonstrate the usage of classes and objects of the real world entities in applications.
4. Discriminate the reusability and multiple interfaces with same functionality based features to solve complex computing problems.
5. Illustrate possible error-handling constructs for unanticipated states/inputs and to use generic programming constructs to accommodate different datatypes.
6. Validate the program against le inputs towards solving the problem.

Module:1	**Structured Programming**	**12 hours**

Structured Programming conditional and looping statements - arrays - functions - pointers - dynamic memory allocation - structure

Module:2	**Introduction to object oriented approach**	**10 hours**

Introduction to object oriented approach: Why object oriented programming? - Characteristics of object oriented language: classes and objects - encapsulation - data abstraction - inheritance - polymorphism - Merits and Demerits of object oriented programming. UML - class diagram of OOP - Inline function default argument function - Exception handling (Standard) - reference: independent reference function returning reference pass by reference.

Module:3	**Classes and objects**	**14 hours**

Classes and objects: Denition of classes access specier class versus structure constructor destructor copy constructor and its importance array of objects dynamic objects - friend function-friend class

Module:4	**Polymorphism and Inheritance**	**26 hours**

Polymorphism and Inheritance: Polymorphism - compile time polymorphism function over-loading operator overloading. Inheritance - types of inheritance - constructors and destructors in inheritance constraints of multiple inheritance - virtual base class - run time polymorphism - function overriding.

Module:5	**Exception handling and Templates**	**18 hours**
Exception handling and Templates Exception handling(user-dened exception) - Function template , Class template Template with inheritance , STL Container, Algorithm, Iterator - vector, list, stack, map.		
Module:6	**IO Streams and Files**	**18 hours**
IOstreams and Files IOstreams, Manipulators - overloading Inserters() and Extractors(), Sequential and Random les writing and reading objects into/from les		
	Total Lecture hours:	**98 hours**

Text Book(s)	
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, C++ primer, Fifth edition, Addison-Wesley, 2012.
2	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999.
3	Brian W. Kernighan, Dennis M. Ritchie , The C programming Language, 2nd edition, Prentice Hall Inc., 1988.
Reference Books	
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013.
2	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010.
3	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

	Postman Problem A postman needs to walk down every street in his area in order to deliver the mail. Assume that the distances between the streets along the roads are given. The postman starts at the post once and returns back to the post o_ce after delivering all the mails. Implement an algorithm to help the post man to walk minimum distance for the purpose.	10 hrs
	Budget Allocation for Marketing Campaign A mobile manufacturing company has got several marketing options such as Radio advertisement campaign, TV non peak hours campaign, City top paper network, Viral marketing campaign, Web advertising. From their previous experience, they have got a statistics about paybacks for each marketing option. Given the marketing budget (rupees in crores) for the current year and details of paybacks for each option, implement an algorithm to determine the amount that shall spent on each marketing option so that the company attains the maximum pro_t.	15 hrs.
	Missionaries and Cannibals Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Implement an algorithm to find a way to get everyone to the other side of the river, without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.	10 hrs.

Recommended by Board of Studies			
Approved by Academic Council			

Course code	**English for Engineers**		**L**	**T**	**P**	**J**	**C**
ENG1011			**0**	**0**	**4**	**0**	**2**
Pre-requisite	Cleared EPT / Effective English		**Syllabus version**				
			v. 2.2				

Course Objectives:

1. To facilitate effective language skills for academic purposes and real-life situations.
2. To enhance students' language and communication with focus on placement skills development.
3. To aid students apply language and communication skills in professional reading and reporting.

Expected Course Outcome:

1. Apply language skills with ease in academic and real-life situations.
2. Build up a job winning digital foot print and learn to face interviews confidently.
3. Develop good interpreting and reporting skills to aid them in research.
4. Comprehend language and communication skills in academic and social contexts.
5. Acquire vocabulary and learn strategies for error-free communication.

Module:1	**Listening**	**4 hours**
Casual and Academic		
Module:2	**Speaking**	**4 hours**
Socializing Skills - Introducing Oneself- His / Her Goals & SWOT		
Module:3	**Reading**	**2 hours**
Skimming and Scanning		
Module:4	**Writing**	**2 hours**
Error-free sentences, Paragraphs		
Module:5	**Listening**	**4 hours**
News (Authentic Material): Analyzing General and Domain Specific Information		
Module:6	**Speaking**	**4 hours**
Group Discussion on factual, controversial and abstract issues		
Module:7	**Reading:**	**2 hours**
Extensive Reading		
Module:8	**Writing**	**2 hours**
Email Etiquette with focus on Content and Audience		
Module:9	**Listening**	**4 hours**
Speeches : General and Domain Specific Information		
Module:10	**Speaking**	**4 hours**
Developing Persuasive Skills - Turncoat and Debate		

Module:11	**Reading**	**2 hours**
Intensive Reading		
Module:12	**Writing**	**2 hours**
Data Transcoding		
Module:13	**Cross Cultural Communication**	**4 hours**
Understanding Inter and Cross-Cultural Communication Nuances		
Module:14	**Speaking**	**4 hours**
Public Speaking/Extempore /Monologues		
Module:15	**Reading for research**	**2 hours**
Reading Scientific/Technical Articles		
Module:16	**Writing**	**2 hours**
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)		
Module:17	**Speaking:**	**4 hours**
Mock Job/Placement Interviews		
Module:18	**Writing**	**2 hours**
Report Writing		
Module:19	**Speaking**	**4 hours**
Presentation using Digital Tools		
Module:20	**Vocabulary**	**2 hours**
Crossword Puzzles/Word games		
	Total Lecture hours:	**60 hours**

Text Book(s)

1.	Clive Oxenden and Christina Latham-Koenig, New English File: Advanced: Teacher's Book with Test and Assessment CD-ROM: Six-level general English course for adults Paperback –Feb 2013, Oxford University Press, UK
2.	Clive Oxenden and Christina Latham-Koenig,New English File: Advance Students
3.	Book Paperback – Feb 2012, Oxford University Press, UK Michael Vince, Language Practice for Advanced - Students Book, Feb. 2014, 4th Edition, Macmillan Education, Oxford, United Kingdom

Reference Books

1.	Steven Brown, Dorolyn Smith, Active Listening 3, 2011, 3rd Edition, Cambridge University Press,UK
2.	Tony Lynch, Study Listening, 2013, 2nd Edition, Cambridge University Press, UK
3.	Liz Hamp-Lyons, Ben Heasley, Study Writing, 2010, 2nd Edition, Cambridge University Press, UK
4.	Kenneth Anderson, Joan Maclean, Tony Lynch, Study Speaking, 2013, 2nd Edition,

	Cambridge, University Press, UK
5.	Eric H. Glendinning, Beverly Holmstrom, Study Reading, 2012, 2nd Edition Cambridge University Press, UK
6.	Michael Swan, Practical English Usage (Practical English Usage), Jun 2017, 4th edition, Oxford University Press, UK
7.	Michael McCarthy, Felicity O'Dell, English Vocabulary in Use Advanced (South Asian Edition), May 2015, Cambridge University Press, UK
8.	Michael Swan, Catherine Walter, Oxford English Grammar Course Advanced, Feb 2012, 4th Edition, Oxford University Press, UK
9.	Heather Silyn-Roberts, Writing for Science and Engineering: Papers, Presentations and Reports, Jun 2016, 2nd Edition, Butterworth-Heinemann, UK

Mode of Evaluation: Assignment and FAT- Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

List of Challenging Experiments (Indicative)

1.	Create a Digital or Online Profile or a Digital Footprint	6 hours
2.	Prepare a video resume	8 hours
3.	Analyse a documentary critically	4 hours
4.	Turn Coat- Speaking for and against the topic / Activities through VIT Community Radio	6 hours
5.	Present a topic using 'Prezi'	6 hours
6.	Analyse a case on cross cultural communication critically	6 hours
7.	Create a list of words relating to your domain	4 hours
8.	Listen to a conversation of native speakers of English and answer the following questions	6 hours
9.	Read an article and critically analyse the text in about 150 words	6 hours
10.	Read an autobiography and role play the character in class by taking an excerpt from the book	8 hours
	Total Practical Hours	**60 hours**

Mode of assessment:

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

Course Code	Ethics and Values	L	T	P	J	C
HUM 1021 / HUM1032		2	0	0	0	2
Pre-requisite	Nil	Syllabus Version				
		1.1				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Course Outcomes:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand various social problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime

Module:1	Being Good and Responsible	5 hours	CO: 1

Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society

Module:2	Social Issues 1	4 hours	CO: 2

Harassment – Types - Prevention of harassment, Violence and Terrorism

Module:3	Social Issues 2	4 hours	CO: 2

Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices;
White collar crimes - Tax evasions – Unfair trade practices

Module:4	Addiction and Health	5 hours	CO: 3

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases

Module:5	Drug Abuse	3 hours	CO: 3

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention

Module:6	Personal and Professional Ethics	4 hours	CO: 4

Dishonesty - Stealing - Malpractices in Examinations – Plagiarism

Module:7	Abuse of Technologies	3 hours	CO:3,5

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social

networking websites			
Module:8	**Contemporary Issues:**	**2 hours**	**CO: 1,2,3,4,5**
Guest lectures by Industrial Experts			
	Total Lecture Hours:	**30 hours**	

Reference Books

1.	Dhaliwal, K.K (2016), "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts, Writers Choice, New Delhi, India.
2.	Vittal, N (2012), "Ending Corruption? - How to Clean up India?", Penguin Publishers, UK.
3.	Pagliaro, L.A. and Pagliaro, A.M (2012), "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological , Developmental and Clinical Considerations", Wiley Publishers, U.S.A.
4.	Pandey, P. K (2012), "Sexual Harassment and Law in India", Lambert Publishers, Germany.

Mode of Evaluation: Quizzes, CAT, FAT, Digital assignments, poster/collage making and Seminars

Recommended by Board of Studies	26-07-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course Code	Calculus for Engineers	L	T	P	J	C
MAT1011		3	0	2	0	4
Pre-requisite	10+2 Mathematics or MAT1001	Syllabus Version				
		1.0				

Course Objectives (CoB):1,2,3

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Course Outcome (CO): 1,2,3,4,5,6

At the end of this course the students should be able to

1. apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution
3. evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
4. evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
5. understand gradient, directional derivatives, divergence, curl and Greens', Stokes, Gauss theorems
6. demonstrate MATLAB code for challenging problems in engineering

Module:1	Application of Single Variable Calculus	9 hours	CO: 1

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution -

Module:2	Laplace transforms	7 hours	CO: 2

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module:3	Multivariable Calculus	4 hours	CO: 3

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:4	Application of Multivariable Calculus	5 hours	CO: 3

Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.

Module:5	Multiple integrals	8 hours	CO: 4

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- Beta and Gamma functions–interrelation

-evaluation of multiple integrals using gamma and beta functions.			
Module:6	**Vector Differentiation**	**5 hours**	**CO: 5**
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems			
Module:7	**Vector Integration**	**5 hours**	**CO: 5**
line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.			
Module:8	**Contemporary Issues:**	**2 hours**	**CO: 1, 2, 3,4,5**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	

Text Book(s)

[1] Thomas' Calculus, George B.Thomas, D.Weir and J. Hass, 13th edition, Pearson, 2014.
[2] Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015.

Reference Books

1. Higher Engineering Mathematics, B.S. Grewal, 43rd Edition ,Khanna Publishers, 2015
2. Higher Engineering Mathematics, John Bird, 6th Edition, Elsevier Limited, 2017.
3. Calculus: Early Transcendentals, James Stewart, 8th edition, Cengage Learning, 2017.
4. Engineering Mathematics, K.A.Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013)

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		**CO: 6**
1.	Introduction to MATLAB through matrices, and general Syntax	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Green's theorem to real world problems	2 hours
	Total Laboratory Hours	**24 hours**

Mode of Evaluation:

Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	Statistics for Engineers	L	T	P	J	C
MAT2001		3	0	2	0	4
Prerequisites	MAT1011 – Calculus for Engineers	Syllabus Version: 1.0				

Course Objectives (CoB): 1,2,3

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyse distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Course Outcome (CO): 1,2,3,4,5

At the end of the course the student should be able to:

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analysing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.
6. demonstrate R programming for statistical data

[1] Having an ability to apply mathematics and science in engineering applications.
[2] Having a clear understanding of the subject related concepts and of contemporary issues.
[7] Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning).
[9] Having problem solving ability- solving social issues and engineering problems.
[14]Having an ability to design and conduct experiments, as well as to analyse and interpret data.

Module: 1	Introduction to Statistics	6 hours	CO: 1

Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].

Module: 2	Random variables	8 hours	CO: 2

Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.

Module: 3	Correlation and regression	4 hours	CO: 3

Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.

Module: 4	Probability Distributions	7 hours	CO: 2

Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution.

Module: 5	Hypothesis Testing I	4 hours	CO: 4

Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean

and difference of means.			
Module: 6	**Hypothesis Testing II**	9 hours	**CO: 4**
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.			
Module: 7	**Reliability**	5 hours	**CO: 5**
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.			
Module: 8	**Contemporary Issues**	2 hours	**CO: 4, 5**
Industry Expert Lecture			
	Total Lecture hours	**45 hours**	

Text book(s)

1. Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).

Reference books

1. Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
2. Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
3. Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011).
4. Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Experiments (Indicative)		**CO: 6**
1.	Introduction: Understanding Data types; importing/exporting data.	2 hours
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	2 hours
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	2 hours
5.	Fitting the following probability distributions: Binomial distribution	2 hours
6.	Normal distribution, Poisson distribution	2 hours
7.	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours
8.	Testing of hypothesis for Two sample means and proportion from real-time problems	2 hours
9.	Applying the t test for independent and dependent samples	2 hours
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours
	Total laboratory hours	**22 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date:	13-06-2019

MEE3099	**Industrial Internship**	**L**	**T**	**P**	**J**	**C**
		0	**0**	**0**	**0**	**2**
Pre-requisite	Completion of minimum of Two semesters					

Course Objectives:

The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Expected Course Outcome:

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. Communicate effectively
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. Develop the ability to engage in research and to involve in life-long learning
5. Comprehend contemporary issues
6. Engage in establishing his/her digital footprint

Contents	**4**	**Weeks**

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	TECHNICAL ANSWERS FOR REAL WORLD PROBLEMS (TARP)	L	T	P	J	C
MEE3999		1	0	0	8	3
Pre-requisite	PHY1999 and 115 Credits Earned	Syllabus version				
		v. 2.2				

Course Objectives:

1. To help students to identify the need for developing newer technologies for industrial / societal needs
2. To train students to propose and implement relevant technology for the development of the prototypes / products
3. To make the students learn to the use the methodologies available for analysing the developed prototypes / products

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify real life problems related to society
2. Apply appropriate technology (ies) to address the identified problems using engineering principles and arrive at innovative solutions

Module:1		2 hours

1. Identification of real life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed

The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment the project done – Mark weightage of 20:30:50 – project report to be submitted.

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course Code	Comprehensive Examination	L	T	P	J	C
MEE4098		0	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		2.2				

Course Objectives:

1. To evaluate the overall understanding of the students in the core areas of B.Tech Production and Industrial Engineering Programme.

Expected Course Outcome:

1. Define, explain, evaluate, and interpret the fundamental knowledge pertaining to the field of Mechanical Engineering and apply those essential knowledge to the field of Energy Engineering.

Module:1	Materials Engineering and Technology, Theory of Metal Casting and Joining, Theory of Metal Cutting and Forming	

Primary and Secondary bonding in materials, Crystalline and amorphous materials, Space Lattice-Unit cell –Crystal systems – Bravais Lattice- Miller indices – Closed packed structures- planar and Linear density calculations- Polymorphism and allotropy. Solidification mechanism – Cooling curve of pure metal and alloy – Phase Diagram– Gibbs's Phase rule – Hume Rothery rules-Binary Iso-morphous system- Binary Eutectic alloy system (Lead-Tin System) –Binary Peritectic alloy system (Iron-Nickel System) – Invariant reactions – IronIron carbide phase diagram- Slow cooling of Hypo and hyper eutectoid steels – Temperature-Time-Transformation (TTT) and Continuous Cooling Transformation (CCT) Diagrams – Effect of alloying elements in steel – types of stainless steel and cast iron-Heat Treatment – Microstructure observation – Surface Heat treatment processes –Mechanical properties of materials –Stress-strain curves – Fatigue test - mechanism of creep – SEM, XRD. Composites – Magnetic materials – Intermetallic compounds-Polymers. Casting; foundry; furnaces; fluxing, degassing and inoculation. Types of casting, CO2 molding. Concept of solidification, directional solidification, role of chilling, principles of gating and risering systems:. Defects in castings and its remedies. Energy saving and quality control in foundries; Cleaning and inspection of castings; Foundry automations-moulding machines-automation of sand plant, moulding and fettling sections of foundry – Dust and fume control. Classification of welding processes - defects in welds.

single point tool, milling cutters, drills, broachers. Orthogonal & oblique cutting, mechanism of chip formation, shear plane angle, shear stress and strain, principa1 chip types, mechanics of machining, forces in cutting of metals, stress on tool, stress distribution, Dynamometers. Heat in cutting process-Evaluation of machinability, tool life, Taylor‟s equation, tool failure, economics in metal machining. Requirement of tool material, effect of alloying elements. cutting fluids and its types – MQL. ECM, EDM, USM, AJM, EBM, LBM, PAM, etc.,. Micro/nano machining. Theory of Plasticity - stress tensor – hydrostatic & deviator components of stress – flow curve – true stress strain – yielding criteria – yield locus – octahedral shear stress and shear strains – invariants of stress strain – slip line field theory plastic deformations of crystals. Plastic forming & forging-Rolling and Extrusion-.Drawing & Sheet Metal Forming- Shearing and blanking – bending – Forging.

Module:2	Mechanics of Solids and Fluids, Kinematics and Dynamics of Machinery	

Normal stress, shear stress, and normal strain and shear strain, Hook's law – Uniaxial deformation. Biaxial state of stress – Stress at a point and in inclined planes – Principal stresses and strains, Mohr's circle, Theories of failure. Solid Mechanics. Fluid properties. -Types of flows, Euler and

Bernoulli‟s equations– moment of momentum – Momentum and Energy correction factors – Impulse – Momentum equation-Navier-Stokes Equations. Flow through pipes, Turbulent flow. Thermodynamics and Heat Transfer: Thermodynamic Systems. Zeroth, first and second Law of Thermodynamics, Heat and Work, First Law applied to closed and open systems, Steady flow energy equation. Reversible and irreversible processes, Carnot cycle, Carnot theorem, Entropy, vapor power and gas power cycles. Basic modes of heat transfer, General heat conduction Equation in Cartesian cylindrical and spherical coordinates, Initial and boundary conditions. Steady state heat transfer in simple geometries, composites and extended surfaces. Unsteady state heat transfer and boundary layer theory, Convective heat transfer, Newton's law. Forced and Natural convection. Radiation Heat transfer, Radiation heat exchange between bodies of simple geometry - boiling and condensation, Heat Exchangers.

Links - Pairs - Chains - Mobility - Degree of freedom –Gruebler's and Kutzbach criterion – Kinematics inversions- Grashoff‟s Law. Velocity and acceleration determination in simple mechanisms. Inertia force analysis of slider crack mechanism- Klein's construction. Friction in screw and nut – Pivot and collar – Belt and rope drives. Gyroscopic forces, couples. Cam and followers. Spur gear. Simple, compound and epicylic gear trains. Static and Dynamic balancing of rotating masses. Free and damped vibrations of single degree of freedom systems - longitudinal, transverse, torsional and forced vibration.

Module:3	**Engineering Metrology, Advanced Machining Processes, Tool Design, Computer Aided Manufacturing:**	

Limits and fits – tolerance system, hole and shaft basis systems – interchangeability and selective assembly. Indian standard Institution system – British standard system, International Standard system for plain ad screwed work. Linear Measurement - slip gauges – Limit Gauges- Taylor‟s principle – gauges. Optical Measuring Instruments: Tool maker‟s microscope and its uses – collimators, optical projector – optical flats and their uses, interferometer. Flat Surface Measurement: Surface Roughness Measurement: Differences between surface roughness and surface waviness Numerical assessment of surface finish – CLA,R, R.M.S Values –Taly surf, ISI symbols for indication of surface finish. Measurement Through Comparators: Comparators – Screw Thread Measurement:Gear Measurement.

Nontraditional machining processes –- Principle of ECM process, chemistry of the ECM processes, Parameters of the process, determination of the metal removal rate, dynamics of ECM process, polarization, tool design, electrochemical grinding, electrochemical honing, electrochemical deburring, Application of ECM for deep hole drilling - electrostream drilling and shaped tube electrolytic machining. Chemical machining - EDM - Wire EDM –laser beam machining – Electron Beam Machining - Ion Beam Machining - Plasma Arc Machining - Abrasive flow Machining (AFM) - Magnetic abrasive finishing (MAF) - Chemo mechanical polishing.

Metal cutting process - Selection of tool materials - Basic Principles of Location - Types of drill jigs - Design principles -. Press tools - Fundamentals of die-cutting operations - Design of simple progressive and compound die sets - Forging Die – Flow lines, parting lines, open and close die forging; Materials for die block.

Product Development Cycle –Bresenham‟s Algorithm and DDA – Neutral File formats – Surface and Solid –- CSG and B-Rep- World/device coordinate representations, 2D and 3D geometric transformations. NC, CNC, DNC- Manual part Programming – Computer Assisted Part Programming – Adaptive Control –NC part programming – APT language, machining from 3D models – group technology – Flexible manufacturing systems (FMS) – Rapid prototyping, Knowledge Based Engineering. CIM wheel – CIM Database- CIM-OSI Model– Networking

Standards in CIM Environment – Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality, Artificial Intelligence and Expert system in CIM.

Module:4	**Industrial Engineering and Management: Introduction to macro and micro economics**, M**anufacturing Automation, Statistical Quality Control, Operations Research:**	

Demand and supply – Determinants of demand and supply – Elasticity of demand – Demand forecasting techniques (short term & long term) –Elements of cost – Over-head expenses– break even analysis - Productivity. Work study- Method study – Time study – stopwatch time study – Work measurement - performance rating- allowances – Ergonomics. Plant location and Plant layout – CRAFT, ALDEP, CORELAP. Cellular Manufacturing: Group Technology – Cellular layout – MachinePart Cell Formation (MPCF) – Heuristic approaches – Hierarchical clustering for MPCF. Material requirement Planning (MRP)– MRP logic – Manufacturing resource planning – capacity requirement planning (CRP) –Bill of material.

Automation in manufacturing operations Concepts of manufacturing systems and production processes. Product/production relationships- Automated systems – Machine tool drives components, feedback, position control, and active damping of feed drives. PLC –. Human machine and Man-machine interfaces Control of electro-hydraulic and electro-pneumatic systems. Numerical control and robotics. Robot anatomy – Flexible manufacturing systems - Automated systems - Bar coding technology. Sensor assisted machining Intelligent machine module - hardware and software architecture - Adaptive control of forces in machining – control algorithm, generalized predictive control, In-process detection of tool failure. Vibration control-modal testing of machine structures. In-process monitoring systems.

Quality- Control Charts- SPC -process capability analysis. Multi – variable chart, individual measurement charts. Acceptance Sampling– O.C. curves, Average outgoing quality (AOQ), Average sample number (ASN), Average total inspection (ATI), Multiple and sequential sampling, sampling plans – military standards, Dodge – Roming, IS 2500. ISO and Six Sigma. Linear Programming - Graphical method – Simplex method – Duality – Two – Phase Simplex method – Transportation problems – Northwest Corner method – Vogel‟s Approximation method – MODI method – Assignment problems. Sequencing –Problem with N jobs and 2 machines - 3 machines and „M‟ machines. Network models – CPM and PERT - Critical Path Scheduling – Crashing of Network. Inventory models –Queuing models — Game theory.

Module:5	**Total Quality Management, Industrial Economics, Production Planning and Control:**	

TQM - Contributions of Deming, Juran and Crosby. Principles Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – Supplier partnership – Partnering, Supplier selection, Supplier Rating. Tools of quality – Six-sigma – Bench marking – FMEA. Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Cost of Quality – KAIZEN, 5S, JIT, POKAYOKE, Taguchi Principles and Design.

Demand Analysis - The Theory of Demand. The elasticity concept. Demand for the Products of Individual firms in an Industry. Demand forecasting. The cost theory and optimum size of the firm. The theory of cost and production. The efficiency and size of the firm. The Elements of Market Structure - standard forms of Market structure -Market stroctw"e and Innovation.

Measuremerit of innovation activities - The Theory of technological innovation. Diffusion of New Technology. Industrial Finance and Accounting. The ways and means of Government regulation of Industry. Labour productivity –- Risk and Decision Making – Technological Change in Global Economy – Taxes and Decision Making. PPC-Aggregate and Disaggregate Planning – Master Production Schedule (MPS) – Techniques & Hour Glass Principle – Bill of Material (BOM) structuring. Material Requirements Planning (MRP) System – MRP system nervousness – Manufacturing Resources Planning (MRP II) – Resource Planning - Final assembly scheduling. Capacity Planning using overall factors (CPOF) – Capacity Bills – Capacity requirements planning (CRP) – I/O Control - Shop floor control – Priority sequencing rules and Finite Loading – Inventory models. Shop floor control – Just in time (JIT) – Pull & Push Systems – Kanban system – ERP System - Technical aspects of SAP - Supply Chain Management (SCM).			
Mode of Evaluation: Online Exam			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	CAPSTONE PROJECT	L	T	P	J	C
MEE4099		-	-	-	-	20
Pre-requisite	As per the academic regulations	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide a definite context, to apply the leanings from various courses of the program and solve unstructured and ill-defined problems
2. To develop an integrated approach for problem solving
3. To provide an exposure to take up a real life research problem / product development / industrial problem and arrive at meaningful conclusions / product design / solution

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints
2. Perform literature search and / or patent search in the area of interest
3. Develop a suitable solution methodology for the problem
4. Conduct experiments / Design & Analysis / solution iterations and document the results
5. Perform error analysis / benchmarking / costing
6. Synthesise the results and arrive at scientific conclusions / products / solution
7. Document the results in the form of technical report / presentation

Topics

Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, etc. or a combination of these.

Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.

Criteria

1. Can be individual work or a group project, with a maximum of 3 students.
2. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage
5. Plagiarism checking by Turnitin is compulsory part of UG Project Report. Plagiarism level should not exceed more than 13%.

Mode of Evaluation: Mid reviews, Final Viva-Voce, Thesis and Poster Submission

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	LEAN START-UP MANAGEMENT	L	T	P	J	C
MGT1022		1	0	0	4	2
Pre-requisite	Nil	Syllabus version				
		v. 2.2				

Course Objectives:

The objective of the course is to make a student to create and commercialize the product

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
5. Foreseeing and quantifying business and financial risks

Module:1		**2 hours**
Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)		
Module:2		**3 hours**
Minimum Viable Product (Value Proposition, Customer Segments, Build-measure-learn process)		
Module:3		**3 hours**
Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model-templates)		
Module:4		**3 hours**
Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money)		
Module:5		**2 hours**
Legal, Regulatory, CSR, Standards, Taxes		
Module:6	**Contemporary discussion**	**2 hours**
	Total Lecture hours:	**15 hours**

Text Book(s)

1. Steve Blank, K & S Ranch (2012)The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, 1st edition

2.	Steve Blank (2013)The Four Steps to the Epiphany, K&S Ranch; 2nd edition
3.	Eric Ries (2011) The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business
Reference Books	
1.	Steve Blank (2014) Holding a Cat by the Tail, , K&S Ranch Publishing LLC
2.	Karal T Ulrich, Product Design and Development, SDEppinger, McGraw Hill
3.	Peter Thiel, (2014) Zero to One: Notes on Startups, or How to Build the Future, Crown Business;
4.	Lean Analytics: Use Data to Build a Better Startup Faster(Lean Series), Alistair Croll & Benjamin Yoskovitz,O'Reilly Media; 1stEdition
5.	Marty Cagan, (2008) Inspired: How To Create Products Customers Love, SVPG Press; 1stedition

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Course code	Course title	L	T	P	J	C
PHY1701	Engineering Physics	3	0	2	0	4
Pre-requisite	Physics of 12th standard or equivalent	Syllabus version				
		V.2.1				

Course Objectives:

To enable the students to understand the basics of the latest advancements in Physics viz., Quantum Mechanics, Nanotechnology, Lasers, Electro Magnetic Theory and Fiber Optics.

Expected Course Outcome:

1. To understand the dual nature of radiation and matter.
2. To apply Schrodinger's equations to solve finite and infinite potential problems.
3. To apply quantum ideas at the nanoscale.
4. To apply quantum ideas for understanding the operation and working principle of optoelectronic devices.
5. To analyze the Maxwell's equations in differential and integral form.
6. To classify the optical fiber for different Engineering applications.
7. To apply concept of Lorentz Transformation for Engineering applications.
8. To demonstrate the quantum mechanical ideas – LAB

Module:1	Introduction to Modern Physics	6 hours	CO: 1

Planck's concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module:2	Applications of Quantum Physics	5 hours	CO: 2

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative) (AB 205), Scanning Tunneling Microscope (STM).

Module:3	Nanophysics	5 hours	CO: 3

Introduction to Nano-materials, Moore's law, Properties of Nano-materials, Quantum confinement, Quantum well, wire & dot, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module:4	Laser Principles and Engineering Application	6 hours	CO: 4

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO2 and Dye laser and their engineering applications.

Module:5	Electromagnetic Theory and its application	6 hours	CO: 5

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index , Wave guide (Qualitative)

Module:6	Propagation of EM waves in Optical fibers and Optoelectronic Devices	10 hours	CO: 6

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal. Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.

Module:7	**Special Theory of Relativity**	**5 hours**	**CO: 7**

Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.

Module:8	**Contemporary issues:**	**2 hours**	**CO: 1-7**

Lecture by Industry Experts

	Total Lecture hours:	**45 hours**	

Text Book(s)

1. Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2. William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3. D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4. Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson

Reference Books

1. Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2. John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3. Kenneth Krane Modern Physics, 2010, Wiley Indian Edition.
4. Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI Learning Private Ltd.
5. S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
6. R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
7. Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
8. Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments		**CO: 8**
1.	Determination of Planck's constant using electroluminescence process	2 hrs
2.	Electron diffraction	2 hrs
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique	2 hrs
4.	Determination of size of fine particle using laser diffraction	2 hrs
5.	Determination of the track width (periodicity) in a written CD	2 hrs
6.	Optical Fiber communication (source + optical fiber + detector)	2 hrs
7.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction	2 hrs

8.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (can be given as an assignment)	2 hrs
9.	Laser coherence length measurement	2 hrs
10.	Proof for transverse nature of E.M. waves	2 hrs
11.	Quantum confinement and Heisenberg's uncertainty principle	2 hrs
12.	Determination of angle of prism and refractive index for various colour – Spectrometer	2 hrs
13.	Determination of divergence of a laser beam	2 hrs
14.	Determination of crystalline size for nanomaterial (Computer simulation)	2 hrs
15.	Demonstration of phase velocity and group velocity (Computer simulation)	2 hrs
	Total Laboratory Hours	**30 hrs**

Mode of evaluation: CAT / FAT			
Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Course title	L	T	P	J	C
PHY1999	Introduction to Innovative Projects	1	0	0	4	2
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

This course is offered to the students in the 1st Year of B.Tech. in order to orient them towards independent, systemic thinking and be innovative.

1. To make students confident enough to handle the day to day issues.
2. To develop the "Thinking Skill" of the students, especially Creative Thinking Skills
3. To train the students to be innovative in all their activities
4. To prepare a project report on a socially relevant theme as a solution to the existing issues

Expected Course Outcome:

1. To understand the various types of thinking skills.
2. To enhance the innovative and creative ideas.
3. To find out a suitable solution for socially relevant issues- J component

Module:1 A	**Self Confidence**	**1 hour**	**CO1**

Understanding self – Johari Window –SWOT Analysis – Self Esteem – Being a contributor – Case Study

Project : Exploring self, understanding surrounding, thinking about how s(he) can be a contributor for the society, Creating a big picture of being an innovator – writing a 1000 words imaginary autobiography of self – Topic "Mr X – the great innovator of 2015" and upload. **(4 non- contact hours)**

Module:1 B	**Thinking Skill**	**1 hour**	**CO1**

Thinking and Behaviour – Types of thinking– Concrete – Abstract, Convergent, Divergent, Creative, Analytical, Sequential and Holistic thinking – Chunking Triangle – Context Grid – Examples – Case Study.

Project : Meeting at least 50 people belonging to various strata of life and talk to them / make field visits to identify a min of100 society related issues, problems for which they need solutions and categories them and upload along with details of people met and lessons learnt. **(4 non-contact hours)**

Module:1 C	**Lateral Thinking Skill**	**1 hour**	**CO1**

Blooms Taxonomy – HOTS – Outof the box thinking – deBono lateral thinking model – Examples

Project : Last weeks - incomplete portion to be done and uploaded

Module:2 A	**Creativity**	**1 hour**	**CO1**

Creativity Models – Walla – Barrons – Koberg & Begnall – Examples

Project : Selecting 5 out of 100 issues identified for future work. Criteria based approach for prioritisation, use of statistical tools & upload . **(4 non- contact hours)**

Module:2 B	**Brainstorming**	**1 hour**	**CO1**

25 brainstorming techniques and examples

Project : Brainstorm and come out with as many solutions as possible for the top 5 issues identified & upload . **(4 non- contact hours)**

Module:3	**Mind Mapping**	**1 hour**	**CO1**

Mind Mapping techniques and guidelines. Drawing a mind map

Project : Using Mind Maps get another set of solutions forthe next 5 issues (issue 6 – 10) . **(4 non- contact hours)**			
Module:4 A	**Systems thinking**	**1 hour**	**CO1**
Systems Thinking essentials – examples – Counter Intuitive condemns **Project :** Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pick up one solution [explanation should be given why the other possible solutions have been left out]. Go back to the customer and assess the acceptability and upload. . **(4 non- contact hours)**			
Module:4 B	**Design Thinking**	**1 hour**	**CO1**
Design thinking process – Human element of design thinking – case study **Project :** Apply design thinking to the selected solution, apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning out come.			
Module:5 A	**Innovation**	**1 hour**	**CO2**
Difference between Creativity and Innovation – Examples of innovation –Being innovative. **Project:** A literature searches on prototyping of your solution finalized. Prepare a prototype model or process and upload. . **(4 non- contact hours)**			
Module:5 B	**Blocks for Innovation**	**1 hour**	**CO2**
Identify Blocks for creativity and innovation – overcoming obstacles – Case Study **Project :** Project presentation on problem identification, solution, innovations-expected results – Interim review with PPT presentation. . **(4 non- contact hours)**			
Module:5 C	**Innovation Process**	**1 hour**	**CO2**
Steps for Innovation – right climate for innovation **Project:** Refining the project, based on the review report and uploading the text. . **(4 non- contact hours)**			
Module:6 A	**Innovation in India**	**1 hour**	**CO2**
Stories of 10 Indian innovations **Project:** Making the project better with add ons. . **(4 non- contact hours)**			
Module:6 B	**JUGAAD Innovation**	**1 hour**	**CO2**
Frugal and flexible approach to innovation - doing more with less Indian Examples **Project:** Fine tuning the innovation project with JUGAAD principles and uploading (Credit for JUGAAD implementation) . **(4 non- contact hours)**			
Module:7 A	**Innovation Project Proposal Presentation**	**1 hour**	**CO2**
Project proposal contents, economic input, ROI – Template **Project:** Presentation of the innovative project proposal and upload . **(4 non- contact hours)**			
Module:8 A	Contemporary issue in Innovation	**1 hour**	**CO3**
Contemporary issue in Innovation **Project:** Final project Presentation , Viva voce Exam (**4 non- contact hours)**			
	Total Lecture hours:	**15 hours**	

Text Book(s)	
1.	How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007
2.	The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008
Reference Books	
1.	Creating Confidence, Meribeth Bonct, Kogan Page India Ltd, New Delhi, 2000
2.	Lateral Thinking Skills, Paul Sloane, Keogan Page India Ltd, New Delhi, 2008
3.	Indian Innovators, Akhat Agrawal, Jaico Books, Mumbai, 2015

4.	JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Three reviews with weightage of 25 : 25 : 50 along with reports			
Recommended by Board of Studies	15-12-2015		
Approved by Academic Council	No. xx	Date	17-12-2015

Course code	Grundstufe Deutsch	L	T	P	J	C
GER1001		0	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate Proficiency in reading, writing, and speaking in basic German. Learning vocabulary related to profession, education centres, day-to-day activities, food, culture, sports and hobby, family set up, workplace, market and classroom activities are essential.
2. Make the students industry oriented and make them adapt in the German culture.

Expected Course Outcome:

The students will be able to

1. remember greeting people, introducing oneself and understanding basic expressions in German.
2. understand basic grammar skills to use these in a meaning way.
3. remember beginner's level vocabulary
4. create sentences in German on a variety of topics with significant precision and in detail.
5. apply good comprehension of written discourse in areas of special interests.

Module:1	3 hours

Begrüssung, Landeskunde, Alphabet, Personalpronomen, Verben- heissen, kommen, wohnen, lernen, Zahlen (1-100), W-Fragen, Aussagesätze, Nomen- Singular und Plural, der Artikel - Bestimmter- Unbestimmter Artikel)

Lernziel :

Sich vorstellen, Grundlegendes Verständnis von Deutsch, Deutschland in Europa

Module:2	3 hours

Konjugation der Verben (regelmässig /unregelmässig),das Jahr- Monate, Jahreszeiten und die Woche, Hobbys, Berufe, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit ,,Sie''

Lernziel:

Sätze schreiben, über Hobbys, Berufe erzählen, usw

Module:3	6 hours

Possessivpronomen, Negation, Kasus (Bestimmter- Unbestimmter Artikel) Trennbareverben, Modalverben, Uhrzeit, Präpositionen, Lebensmittel, Getränkeund Essen, Farben, Tiere

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, Adjektiv beim Verb

Module:4	4 hours

Übersetzung: (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Die Übung von Grammatik und Wortschatz

Module:5	5 hours

Leserverständnis. Mindmap machen, Korrespondenz- Briefe und Email

Lernziel: Übung der Sprache, Wortschatzbildung			
Module:6			**5 hours**
Aufsätze : Die Familie, Bundesländer in Deutschland, Ein Fest in Deutschland, **Lernziel :** Aktiver, selbständiger Gebrauch der Sprache			
Module:7			**4 hours**
Dialoge: a) Gespräche mit einem/einer Freund /Freundin. b) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; c) in einem Hotel - an der Rezeption ; ein Termin beim Arzt. d) Ein Telefongespräch ; Einladung–Abendessen			
Module:8			**2 hours**
Guest Lectures/ Native Speakers (Einleitung in die deustche Kultur und Politik			
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, Klett-Langenscheidt Verlag, München : 2013
Reference Books	
1.	Lagune, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
2	Deutsche Sprachlehre für Ausländer, Heinz Griesbach, Dora Schulz, 2013
3	Studio d A1, Hermann Funk, Christina Kuhn, CorneslenVerlag, Berlin :2010
4	Tangram Aktuell-I, Maria-Rosa, SchoenherrTil, Max Hueber Verlag, Muenchen :2012
	www.goethe.de wirtschaftsdeutsch.de hueber.de klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies			
Approved by Academic Council	No.	Date	

Course code	Français quotidien	L	T	P	J	C
FRE1001		0	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. learn the basics of French language and to communicate effectively in French in their day to day life.
2. Achieve functional proficiency in listening, speaking, reading and writing
3. Recognize culture-specific perspectives and values embedded in French language.

Expected Course Outcome:

The students will be able to :

1. identify in French language the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations and interrogations.
2. communicate effectively in French language via regular / irregular verbs.
3. demonstrate comprehension of the spoken / written language in translating simple sentences.
4. understand and demonstrate the comprehension of some particular new range of unseen written materials
5. demonstrate a clear understanding of the French culture through the language studied

Module:1	Expressions simples	3 hours

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Savoir-faire pour:

Saluer, Se présenter, Présenter quelqu'un, Etablir des contacts

Module:2	La conjugaison des verbes réguliers	3 hours

La conjugaison des verbes réguliers, La conjugaison des verbes pronominaux, La Négation, L'interrogation avec 'Est-ce que ou sans Est-ce que'.

Savoir-faire pour:

Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.

Module:3	La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions	6 hours

La Nationalité du Pays, L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, L'adjectif (La Couleur, L'adjectif possessif, L'adjectif démonstratif/ L'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.

Savoir-faire pour:

Poser des questions, Dire la date et les heures en français,

Module:4	La traduction simple	4 hours

La traduction simple :(français-anglais / anglais –français),

Savoir-faire pour :

Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.

Module:5	**L'article Partitif, Mettez les phrases aux pluriels**	**5 hours**
L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Trouvez les questions. Savoir-faire pour : Répondez aux questions générales en français, Exprimez les phrases données au Masculin ou au Féminin, Associez les phrases.		
Module:6	**Décrivez :**	**3 hours**
Décrivez : La Famille / La Maison / L'université /Les Loisirs/ La Vie quotidienne etc.		
Module:7	Dialogue	**4 hours**
Dialogue : 1. Décrire une personne. 2. Des conversations à la cafeteria. 3. Des conversations avec les membres de la famille 4. Des dialogues entre les amis.		
Module:8	**Guest lecures**	**2 hours**
Guest lecures/ Natives speakers		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Fréquence jeunes-1, Méthode de français, G. Capelle et N.Gidon, Hachette, Paris, 2010.
2.	Fréquence jeunes-1, Cahier d'exercices, G. Capelle et N.Gidon, Hachette, Paris, 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2010.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2010
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries, Hachette livre Paris 2011
4	ALTER EGO 1, Le cahier d'activités, Annie Berthet, Catherine Hugo, Béatrix Sampsonis, Monique Waendendries , Hachette livre, Paris 2011

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies			
Approved by Academic Council	No.	Date	

EEE1001	Basic Electrical and Electronics Engineering	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	Nil	Syllabus version				
Anti-requisite		v. 1.0				

Course Objectives:

[1] To understand the various laws and theorems applied to solve electric circuits and networks
[2] To provide the students with an overview of the most important concepts in Electrical and Electronics Engineering which is the basic need for every engineer

Expected Course Outcome:

On the completion of this course the student will be able to:

[1] Solve basic electrical circuit problems using various laws and theorems.
[2] Analyze AC power circuits and networks, its measurement and safety concerns
[3] Classify and compare various types of electrical machines
[4] Design and implement various digital circuits
[5] Analyze the characteristics of semiconductor devices and comprehend the various modulation techniques in communication engineering
[6] Design and conduct experiments to analyze and interpret data

Module:1	DC circuits	Hours:5	

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Thevenin's and Maximum power transfer theorem.

Module:2	AC circuits	Hours:6	

Alternating voltages and currents, AC values, Single Phase RL, RC, RLC Series circuits, Power in AC circuits-Power Factor- Three Phase Systems – Star and Delta Connection- Three Phase Power Measurement – Electrical Safety –Fuses and Earthing, Residential wiring

Module:3	Electrical Machines	Hours:7	

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor

Module:4	Digital Systems	Hours:5	

Basic logic circuit concepts, Representation of Numerical Data in Binary Form- Combinational logic circuits, Synthesis of logic circuits.

Module:5	Semiconductor devices and Circuits	Hours:7	

Conduction in Semiconductor materials, PN junction diodes, Zener diodes, BJTs, MOSFETs, Rectifiers, Feedback Amplifiers using transistors. **Communication Engineering:** Modulation and Demodulation - Amplitude and Frequency Modulation

	Total Lecture hours:	30 Hours	

Mode: Flipped Class Room, Use of physical and computer models to lecture, visit to industries. Minimum of 2 lectures by industry experts.

Proposed Laboratory Experiments: (Hardware and Simulation)		

1. Thevenin's and Maximum Power Transfer Theorems – Impedance matching of source and load. 2. Sinusoidal steady state Response of RLC circuits. 3. Three phase power measurement for ac loads. 4. Staircase wiring circuit layout for multi storey building. 5. Fabricate and test a PCB layout for a rectifier circuit. 6. Half and full adder circuits. 7. Full wave Rectifier circuits used in DC power supplies. Study the characteristics of the semiconductor device used. 8. Regulated power supply using zener diode. Study the characteristics of the Zener diode used. 9. Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars. Study the characteristics of the transistor used. 10. Characteristics of MOSFET.

Text Book(s)	
1.	1. John Bird, 'Electrical circuit theory and technology ', Newnes publications, 4 t h Edition, 2010.
Reference Books	
1.	Allan R. Hambley, 'Electrical Engineering -Principles & Applications' Pearson Education, First Impression, 6/e, 2013.
2.	Simon Haykin, 'Communication Systems', John Wiley & Sons, 5 t h Edition, 2009.
3.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits', Tata McGraw Hill, 2012.
4.	Batarseh, 'Power Electronics Circuits', Wiley, 2003.
5.	W. H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', 6/e, Tata McGraw Hill, New Delhi, 2011.
6.	Fitzgerald, Higgabogan, Grabel, 'Basic Electrical Engineering', 5t h edn, McGraw Hill, 2009.
7.	S.L.Uppal, 'Electrical Wiring Estimating and Costing ', Khanna publishers, NewDelhi, 2008.

Recommended by Board of Studies	29/05/2015		
Approved by Academic Council	37th AC	Date	16/06/2015

Course code	Applications of Differential and Difference Equations	L	T	P	J	C
MAT2002		3	0	2	0	4
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus Version				
		1.0				

Course Objectives (CoB): 1,2,3,4

The course is aimed at

[1] Presenting the elementary notions of Fourier series, which is vital in practical harmonic analysis

[2] Imparting the knowledge of eigenvalues and eigen vectors of matrices and the transform techniques to solve linear systems, that arise in sciences and engineering [3] Enriching the skills in solving initial and boundary value problems

[4] Impart the knowledge and application of difference equations and the Z-transform in discrete systems, that are inherent in natural and physical processes

Course Outcome (CO): 1,2,3,4,5

At the end of the course the student should be able to

[1] Employ the tools of Fourier series to find harmonics of periodic functions from the tabulated values

[2] Apply the concepts of eigenvalues, eigen vectors and diagonalisation in linear systems

[3] Know the techniques of solving differential equations

[4] understand the series solution of differential equations and finding eigen values, eigen functions of Strum-Liouville's problem

[5] Know the Z-transform and its application in population dynamics and digital signal processing

[6] demonstrate MATLAB programming for engineering problems

Module:1	Fourier series:	6 hours	CO: 1

Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity – Computation of harmonics

Module:2	Matrices:	6 hours	CO: 2

Eigenvalues and Eigen vectors - Properties of eigenvalues and eigen vectors – Cayley-Hamilton theorem - Similarity of transformation - Orthogonal transformation and nature of quadratic form

Module:3	Solution of ordinary differential equations:	6 hours	CO: 3

Linear second order ordinary differential equation with constant coefficients – Solutions of homogenous and non-homogenous equations - Method of undetermined coefficients – method of variation of parameters – Solutions of Cauchy-Euler and Cauchy-Legendre differential equations

Module:4	Solution of differential equations through Laplace transform and matrix method	8 hours	CO: 3

Solution of ODE's - Nonhomogeneous terms involving Heaviside function, Impulse function - Solving nonhomogeneous system using Laplace transform – Reduction of *n*th order differential equation to first order system - Solving nonhomogeneous system of first

order differential equations $(X' = AX + G)$ and $X'' = AX$			
Module:5	**Strum Liouville's problems and power series Solutions:**	**6 hours**	**CO: 4**
The Strum-Liouville's Problem - Orthogonality of Eigen functions - Series solutions of differential equations about ordinary and regular singular points - Legendre differential equation - Bessel's differential equation			
Module:6	**Z-Transform:**	**6 hours**	**CO: 5**
Z-transform -transforms of standard functions - Inverse Z-transform: by partial fractions and convolution method			
Module:7	**Difference equations:**	**5 hours**	**CO: 5**
Difference equation - First and second order difference equations with constant coefficients - Fibonacci sequence - Solution of difference equations - Complementary function - Particular integral by the method of undetermined coefficients - Solution of simple difference equations using Z-transform			
Module:8	**Contemporary Issues**	**2 hours**	**CO: 2, 3, 5**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	

Text Book(s)

1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley India, 2015

Reference Books

1.	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition, Khanna Publishers, India, 2015
2.	Advanced Engineering Mathematics by Michael D. Greenberg, 2nd Edition, Pearson Education, Indian edition, 2006

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test		**CO:6**
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy, Legendre equations	2 hours
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors	2 hours
6.	Solving system of differential equations arising in engineering applications	2 hours
7.	Applying the Power series method to solve differential equations arising in engineering applications	2 hours

8.	Applying the Frobenius method to solve differential equations arising in engineering applications	2 hours
9.	Visualising Bessel and Legendre polynomials	2 hours
10.	Evaluating Fourier series-Harmonic series	2 hours
11.	Applying Z-Transforms to functions encountered in engineering	2 hours
12.	Solving Difference equations arising in engineering applications	2 hours
	Total Laboratory Hours	**24 hours**

Mode of Evaluation: Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Complex Variables and Partial Differential Equation	L	T	P	J	C
MAT3003		3	2	0	0	4
Pre-requisite	MAT2002 Applications of Differential and Difference Equations	Syllabus version				
		1.0				

Course Objectives (CoB):

The aim of this course is to present a comprehensive, compact and integrated treatment of two most important branches of applied mathematics for engineers and scientists namely the functions of complex variable and Partial differential equations in finite and infinite domains

Course Outcome (CO):1,2,3

At the end of the course the student should be able to

[1] construct analytic functions and find complex potential of fluid flow and electric fields
[2] find the image of straight lines by elementary transformations and
[3] able to express analytic functions in power series
[4] evaluate real integrals using techniques of contour integration
[5] analyze partial differential equations, and its applications, design the boundary value problems (one dimensional heat and wave equations) and find Fourier series, Fourier transform techniques in their respective engineering problems.

Module:1	Analytic Functions	6 hours	CO: 1

Complex variable-Analytic functions and Cauchy – Riemann equations - Laplace equation and Harmonic functions - Construction of Harmonic conjugate and analytic functions - Applications of analytic functions to fluid-flow and Field problems.

Module:2	Conformal and Bilinear transformations	5 hours	CO: 2

Conformal mapping - Elementary transformations-translation, magnification, rotation, inversion. Exponential and Square transformations ($w = e^z$, z^2) - Bilinear transformation - Cross-ratio-Images of the regions bounded by straight lines under the above transformations.

Module:3	Power series	4 hours	CO: 3

Functions given by Power Series - Taylor and Laurent series -singularities - poles – Residues.

Module:4	Complex Integration	5 hours	CO: 4

Integration of a complex function along a contour - Cauchy-Goursat theorem- Cauchy's integral formula -Cauchy's residue theorem - Evaluation of real integrals - Indented contour integral.

Module:5	Partial Differential equations of first order	6 hours	CO: 5

Formation and solution of partial differential equation - General, Particular, Complete and Singular integrals - Partial Differential equations of first order of the forms: F(p,q)=0, F(z,p,q)=0, F(x,p)=G(y,q) and Clairaut's form - Lagrange's equation: Pp+Qq = R.

Module:6	Applications of Partial Differential Equations	10 hours	CO: 5

Linear partial differential equations of higher order with constant coefficients. Solution of a

partial differential equation by separation of variables - Boundary Value Problems-one dimensional wave and heat equations- Fourier series solution.			
Module:7	**Fourier transforms**	**7 hours**	**CO: 5**
Complex Fourier transform and properties - Relation between Fourier and Laplace transforms - Fourier sine and cosine transforms – Convolution Theorem and Parseval's identity.			
Module:8	**Contemporary issues:**	**2 hours**	**CO: 2, 3**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students inventory Tutorial Class • Another 5 problems per Tutorial Class to be given as home work**.**	**30 hours**	**CO: 1, 2, 3**

Text Book(s)

1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley & Sons (Wiley student Edison) (2015)

Reference Books

1	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition (2019), Khanna Publishers, New Delhi
2	A first course in complex analysis with applications, G.Dennis Zill, Patrick D. Shanahan, 3rd Edition, 2013, Jones and Bartlett Publishers Series in Mathematics:
3	Advanced Engineering Mathematics, Michael, D. Greenberg, 2nd Edition, Pearson Education (2006)
4	Advanced Engineering Mathematics, Peter V. O' Neil, 7th Edition, Cengage Learning (2012)
5	Complex Analysis for Mathematics and Engineers, JH Mathews, R. W. Howell, 5th Edition, Narosa Publishers (2013)

Mode of Evaluation:

Digital Assignments(Solutions by using soft skill),Quiz, Continuous Assessments, Final Assessment Test.

Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	Applied Numerical Methods	L	T	P	J	C
MAT3005		3	2	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives (CoB): 1,2,3,4

The aim of this course

[1] is to cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences.

[2] is to use MATLAB as the primary computer language to obtain solutions to a few problems that arise in their respective engineering courses.

[3] is to impart skills to analyse problems connected with data analysis,

[4] is to solve ordinary and partial differential equations numerically

Course Outcome (CO): 1,2,3,4,5

At the end of the course the student should be able to

[1] Observe the difference between exact solution and approximate solution.

[2] Use the numerical techniques (algorithms) to find the solution (approximate) algebraic equations and system of equations.

[3] Fit the data using interpolation technique and spline methods.

[4] Find the solution of ordinary differential equations , Heat and Wave equation numerically.

[5] Apply calculus of variation techniques to extremize the functional and also find approximate series solution to ordinary differential equations

Module:1	Algebraic and Transcendental Equations	5 hours	CO: 1

General iterative method- rates of convergence- Secant method - Newton – Raphson method- System of non-linear equations by Newton's method.

Module:2	System of Linear Equations and Eigen Value Problems	6 hours	CO: 2

Gauss –Seidel iteration method. Convergence analysis of iterative methods-LU Decomposition -Tri diagonal system of equations-Thomas algorithm- Eigen values of a matrix by Power and Jacobi methods.

Module:3	Interpolation	6 hours	CO: 3

Finite difference operators- Newton's forward-Newton's Backward- Central differences- Stirling's interpolation - Lagrange's interpolation - Inverse Interpolation-Newton's divided difference-Interpolation with cubic splines.

Module:4	Numerical Differentiation and Integration	6 hours	CO: 3

Numerical differentiation with interpolation polynomials-maxima and minima for tabulated values-Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules. –Romberg's method. Two and Three point Gaussian quadrature formula.

Module:5	Numerical Solution of Ordinary Differential Equations	8 hours	CO: 4

First and second order differential equations - Fourth order Runge – Kutta method. Adams-

Bashforth-Moulton predictor-corrector methods. Finite difference solution for the second order ordinary differential equations.			
Module:6	**Numerical Solution of Partial Differential Equations**	**6 hours**	**CO: 4**
Classification of second order linear partial differential equations-Laplace equation –Gauss-Seidal method-One dimensional heat equation- Schmidt explicit method-Crank-Nicolson implicit method.-One dimensional wave equation–Explicit method.			
Module:7	**Variational Methods**	**6 hours**	**CO: 5**
Introduction - functional –variational problems- extremals of functional of a single dependent variable and its first derivative- functional involving higher order derivatives- Isoperimetric problems- Galerkins- Rayleigh Ritz methods.			
Module:8	**Contemporary Issues**	**2 hours**	**CO: 4, 5**
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class. • Another 5 problems per Tutorial Class to be given for practise.	**30 hours**	**CO: 1, 2, 3, 4, 5**

Text Book(s)

1. Numerical Methods for Scientific and Engineering, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Ltd., 6th Edition, 2012.
2. Applied Numerical Analysis, C. F. Gerald and P.V. Wheatley, Addition-Wesley, 7th Edition, 2004.

Reference Books

1. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.
2. Applied Numerical Methods Using MATLAB, W.Y. Yang, W. Cao, T.S. Chung and J. Morris, Wiley India Edn., 2007.
3. Numerical Methods for Engineers with Programming and Software Applications, Steven C. Chapra and Ra P. Canale, 7th Edition, Tata McGraw Hill, 2014.
4. Numerical Analysis, R.L. Burden and J. D. Faires, 4th Edition, Brooks Cole, 2012.
5. Numerical Methods: Principles, Analysis and Algorithms, Srimanta Pal, Oxford University Press India; 978-0195693751, 2009.

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	ENGINEERING DRAWING	L	T	P	J	C
MEE1001		1	0	4	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. Understand and escalate the importance of basic concepts and principles of Engineering Drawing (components, sections, views, and graphical representation).
2. Enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
3. Develop the ability to communicate with others through the language of technical drawing and sketching.
4. Ability to read and interpret engineering drawings created by others.
5. Ability to draw orthographic projections and sections.
6. Develop an understanding for size specification procedures and use of SI and traditional units of linear measure.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply BIS and ISO Standards in Engineering Drafting.
2. Graphically construct mathematical curves in engineering applications.
3. Visualize geometrical solids in 3D space through Orthographic Projections
4. Construct isometric scale, isometric projections and views.
5. Draw sections of solids including cylinders, cones, prisms and pyramids.
6. Draw projections of lines, planes, solids, isometric projections and sections of solids including cylinders, cones, prisms and pyramids using Mini-Dafter and CAD.
7. Construct orthographic projections from pictorial views.

Module:1	Lettering and Dimensioning	1 hours

Introduction, lettering practice, Elements of dimensioning - systems of dimensioning.

Module:2	Geometric Constructions	2 hours

Free hand sketching, Conic sections, Special curves.

Module:3	Projection of Points and Projection of Lines	2 hours

Projection of Points: First and Third Angle Projections; Projection of points.

Projection of Lines: Projection of straight lines (First angle projection only); Projection of lines inclined to one plane and both planes, true length and true inclinations.

Module:4	Projection of Solids and Section of Solids	3 hours

Projection of solids: Classification of solids, Projection of solids in simple position, Projection of solids inclined to one plane.

Sections of Solids: Right regular solids and auxiliary views for the true shape of the sections.		
Module:5	**Development of Surfaces**	**2 hours**
Development of surfaces for various regular solids.		
Module:6	**Isometric Projection and Perspective Projection**	**2 hours**
Isometric Projection: Isometric scales, Isometric projections of simple and combination of solids; **Perspective Projection:** Orthographic representation of a perspective views – Plane figures and simple solids - Visual ray method.		
Module:7	**Orthographic Projection**	**2 hours**
Conversion of pictorial view into orthographic Projection.		
Module:8	**Contemporary issues**	**1 hours**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Venugopal K and Prabhu Raja V, "Engineering Graphics", New AGE International Publishers, 2015.
Reference Books	
1.	N. D. Bhatt, Engineering Drawing, Charotar publishing House, 2012.
2	Natarajan, K. V., A Text book of Engineering Graphics, Dhanalakshmi Publishers, 2012.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Identifying the incorrect dimensioning and correct it as per BIS standards for Engineering Components.	4 hours
2.	Tutorials on free hand sketching of the plan view of stadium, garden, etc.,	4 hours
3.	Tutorials on geometric constructions like conics and special curves for projection of cricket ball, missile projection, etc.,	4 hours
4.	Representation of orthographic projection of points	4 hours
5.	Representation of orthographic projection of lines (First angle projection only) inclined to one plane and projection of lines inclined to both the planes- solving problems like electrical bulbs hanging from the roof, finding the shortest distance between fan to electrical switch board, etc.,	8 hours
6.	Sketching orthographic projection of solids in simple position and projection of solids inclined to one plane for household accessories and objects.	8 hours
7.	Drawing the auxiliary views, orthographic views and true shape of sectioned regular solids for household accessories and objects.	4 hours
8.	Development of lateral surfaces of the regular shapes and sectioned shapes for water cans, refrigerator, cylinder container, funnel, etc.,	4 hours
9.	Conversion of orthographic views to isometric views for engineering	8 hours

	components.	
10.	Tutorial problems on perspective projection of plane figures and simple solids for train with track, landscape, etc.,	4 hours
11.	Conversion of pictorial drawing into orthographic projection for engineering components, architectural structures, etc.,	8 hours
	Total Laboratory Hours	**60 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	MATERIALS ENGINEERING AND TECHNOLOGY	L	T	P	J	C
MEE1005		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To develop the knowledge on structure of materials including crystallography, microstructure, defects and phase diagrams
2. To provide an understanding to students on the correlation between structure, processing, mechanical properties and performance of materials
3. To develop the knowledge on mechanical properties of materials and strengthening mechanism
4. To give insight in to advanced materials such as polymers, ceramics and composite and their applications

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Suggest suitable engineering materials for different application
2. Identify various phases of metals and alloys through appropriate phase diagrams
3. Apply suitable heat treatment process based on material properties
4. Evaluate the effect of alloying elements, properties and application of ferrous and non-ferrous metals
5. Evaluate the mechanical behavior of materials for different applications
6. Apply advanced materials such as polymers, ceramics and composites in product design
7. Correlate the structure-property relationship in metals/alloys in as-received and heat treated conditions

Module:1	Structure of Materials	8 hours

Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials, Unit Cells, Metallic Crystal Structures, Density Computations, Crystal Systems, Crystallographic Points, Crystallographic Directions, Crystallographic Planes, Linear and Planar Densities, Close-Packed Crystal Structures, Crystalline and Non-crystalline Materials, Single Crystals, Polycrystalline Materials, Imperfection in solids – Point, Line, Surface and Volume defects - Polymorphism and Allotropy.

Module:2	Constitution of Alloys	7 hours

Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation- Growth of crystals- Planar growth – dendritic growth – Cooling curves - Diffusion - Construction of Phase diagram -Binary alloy phase diagram – Cu-Ni alloy; Cu-Zn alloy and Pb-Sn alloy; Iron-Iron carbide phase diagram – Invariant reactions – microstructural changes of hypo and hyper-eutectoid steel-TTT and CCT diagram.

Module:3	Heat Treatment and Surface Heat treatment	5 hours
Heat treatment – Overview – Objectives – Annealing and types, normalizing, quenching, austempering and martempering – microstructure changes –Surface hardening processes - Carburizing – nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths.		
Module:4	**Ferrous Metals**	**6 hours**
Steels – Types of Steels - HSLA – TRIP - White, Grey, Malleable and Nodular - Properties and application of cast irons, Effect of alloying elements on structure and properties of steels - Properties and uses of Silicon and Hadfield Manganese steels, High speed steels - Stainless steel and Types.		
Module:5	**Non Ferrous metals**	**6 hours**
Properties and Applications of Aluminum, Magnesium, Copper, Nickel, Titanium and their alloys.		
Module:6	**Mechanical behavior of Materials**	**7 hours**
Strengthening mechanisms – Hardness measurements – Hardenability - Tensile properties of the materials – Fracture of metals – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT) –Fatigue – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; Creep and stress rupture– mechanism of creep – stages of creep and creep test.		
Module:7	**Introduction to Advanced Materials**	**4 hours**
Properties and Applications of Engineering polymers- Ceramics – properties and applications of various ceramics – Composites – and their types; properties and processing of composites – Manufacture of fibers.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	W.D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th ed., Wiley & Sons, 2013.

Reference Books

1.	Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright, The Science and Engineering of Materials 6th Edition, Cenage Publications, 2010.
2.	G. F. Carter, Giles F. Carter and Donald E. Paul, Materials Science and Engineering, Digital Printing Edition, ASM International, 2011.
3.	William D. Callister, Jr., David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition International Student Version, Wiley & Sons, 2016.

4.	W Bolton, Materials for Engineering, 2nd Edition, Routledge Publishers, USA, 2011.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Overview of Materials Characterization – Optical Microscopy, Scanning Electron Microscopy, X-Ray Diffraction and Energy Dispersive X-ray analysis.	2 hours
2.	Perform the metallographic studies and identify the given ferrous/non-ferrous samples.	7 hours
3.	Use metallographic analysis software to establish the phases and average grain size of the given samples.	2 hours
4.	Design the heat treatments that result in the following microstructures (a) Coarse pearlite (b) Medium/Fine pearlite (c) 100% Martensite (d) Martensite and retained austenite.	2 hours
5.	Compare the microstructures of the given steel sample before and after heat treatment. Also measure the hardness of the samples.	3 hours
6.	Perform the hardness examination on the given samples using Rockwell Hardness Tester and find out the equivalent Vickers hardness in HV.	2 hours
7.	Perform the phase analysis using XRD.	2 hours
8.	Conduct the tensile studies on the given sample and infer whether the given sample is ductile or brittle. Evaluate the elastic and plastic properties of the given sample.	2 hours
9.	A fractured sample is given for assessment to interpret the reasons for fracture. What are the various metallurgical tests to be carried out to infer the same?	2 hours
10.	Conduct the corrosion studies on the given sample using electrochemical cell. What is the inference drawn from the polarization curves?	3 hours
11.	Perform high temperature corrosion studies on the given sample at 500°C in air oxidation and analyze the microstructure before and after corrosion.	3 hours
	Total laboratory hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	INDUSTRIAL ENGINEERING AND MANAGEMENT	L	T	P	J	C
MEE1014		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To analyze different planning activities needed during the operations stage of a manufacturing or a service industry.
2. To apply productivity techniques for achieving continuous improvement.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Analyze the way price of a product affects the demand for a product for consequent actions and predict demand for a product by making use of different demand forecasting techniques.
2. Explain Break even analysis to determine safe production levels and costing of industrial products.
3. Apply productivity techniques for continuous improvement in different functionalities of an industry.
4. Analyze the existing operations that happen in factories for establishing time standards for different activities.
5. Demonstrate the knowledge of selection of location for the new plant & optimizing the layout within the plant for smooth production.
6. Apply cellular manufacturing concepts in industry.
7. Compute material requirement needed to satisfy the Master Production Schedule of a factory by having thorough understanding of MRP logic.

Module:1	Introduction to macro and micro economics	6 hours

Macro-economic measures – micro economics – Demand and supply – Determinants of demand and supply – Elasticity of demand – Demand forecasting techniques (short term & long term) – Problems.

Module:2	Elements of cost	6 hours

Determination of Material cost - Labour cost – Expenses - Types of cost – Cost of production – Over-head expenses–break even analysis - Problems.

Module:3	Productivity	6 hours

Definition – Factors affecting- Increasing productivity of resources - Kinds of productivity measures - Case study.

Module:4	Introduction to work study	6 hours

Method study – Time study – stopwatch time study – Work measurement - performance rating-allowances – Ergonomics.

Module:5	**Plant location and Plant layout**	**7 hours**
Plant location –need - Factors – comparison – quantitative methods for evaluation Plant layout: objectives-principles – factors influencing – tools and techniques including computer based layout design – CRAFT, ALDEP, CORELAP.		
Module:6	**Cellular Manufacturing**	**6 hours**
Group Technology – Cellular layout – Machine-Part Cell Formation (MPCF) – Heuristic approaches – Hierarchical clustering for MPCF.		
Module:7	**Material requirement Planning (MRP)**	**6 hours**
Objectives – functions – MRP system – MRP logic – Management information from MRP – lot sizing consideration – Manufacturing resource planning – capacity requirement planning (CRP) – Bill of material.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	R Dan Reid, and Nada R. Sanders, Operations Management, John wiley& Sons, 5th Edition, 2012.

Reference Books

1.	William J Stevenson, Operations Management, McGrawHill, 12th Edition, India, 2017.
2.	R Panneerselavam, Production and Operations Management, PHI publications 3rd Edition, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	OPERATIONS RESEARCH	L	T	P	J	C
MEE1024		2	2	0	0	3
Pre-requisite	MAT2001	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide students the knowledge of optimization techniques and approaches.
2. To enable the students apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
3. To teach students about networking, inventory, queuing, decision and replacement models.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply operations research techniques like L.P.P, scheduling and sequencing in industrial optimization problems.
2. Evaluate transportation problems using various OR techniques.
3. Explain various OR models like Inventory, Queuing, Replacement, Simulation, Decision etc. and apply them for optimization.
4. Use OR tools in a wide range of applications in industries.
5. Identify current topics and advanced techniques of Operations Research for industrial solutions.
6. Identify best techniques to solve a specific problem.
7. Analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problems with intellectual independence.

Module:1	Linear Programming Problem	4 hours

Introduction to Operations Research – Linear Programming - Mathematical Formulation – Graphical method – Simplex method – Penalty methods: M-method, Two Phase method- Duality.

Module:2	Transportation Problem	4 hours

Introduction - Formulation - Solution of the transportation problem (Min and Max): Northwest Corner rule, row minima method, column minima method, Least cost method, Vogel's approximation method – Optimality test: MODI method.

Module:3	Assignment and Sequencing Models:	3 hours

Assignment problems – Applications - Minimization and Maximization; Sequencing - Problem with N jobs and 2 machines – n jobs and 3 machines problem - n jobs and m machines problem.

Module:4	Project Management	4 hours

Introduction - Phases of project management-Construction of Network diagrams- Critical path method (CPM) and Project evaluation and review technique (PERT) - Crashing of project network.

Module:5	**Inventory Control**	**4 hours**
Necessity for maintaining inventory - Inventory costs -Inventory models with deterministic demand - inventory models with probabilistic demand - Inventory models with price breaks - Buffer stock.		
Module:6	**Queuing Models**	**4 hours**
Poisson arrivals and Exponential service times – Single channel models and Multi-channel models - Simulation: Basic concepts, Advantages and disadvantages - Random number generation - Monte Carlo Simulation applied to queuing problems.		
Module:7	**Game theory and Replacement Models**	**5 hours**
Game theory: Competitive games - Useful terminology - Rules for game theory - Two person zero sum game – Property of dominance - Graphic solution – Algebraic method. **Replacement models:** Replacement of items that deteriorate with time: No changes in the value of money, changes in the value of money - Items that fail completely: Individual replacement and group replacement policies.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Hamdy A Taha, Operations Research: An Introduction, 9th edition, Pearson Education, Inc., 2014.
Reference Books	
1.	Hira D S and Gupta P K, Operations Research, S. Chand & Sons, 2014.
2.	Kanti Swarup, Gupta P.K., and Man Mohan, Operations Research, 18th edition, S. Chand &Sons, 2015.
3.	Manohar Mahajan, Operations Research, Dhanpat Rai & Co, 2013.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	THEORY OF METAL CASTING AND JOINING	L	T	P	J	C
MEE1031		3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
		v. 2.2				

Course Objectives:

1. Develop the understanding of process variability and quality monitoring.
2. Present a problem oriented in depth knowledge, underlying concepts, methods and application of control charts.
3. Demonstrate the ability to design and implement acceptance sampling plans.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Demonstrate different foundry practices and special casting processes
2. Design appropriate gating systems for castings
3. Analyze casting defects
4. Compute energy densities for various welding arc heat sources Suggest suitable techniques that can be employed during melt treatment, pouring and solidification to control the cast structure of metal
5. Demonstrate the application of traditional and advanced welding processes
6. Evaluate the weldability and material response of various engineering materials
7. Perform a metal casting or welding and asses its quality

Module:1	Introduction to casting and foundry industry	6 hours

Molding practices -basic principles of casting processes; sequence in foundry operations; patterns; molding practice; ingredients of molding sand and core sand, sand testing; different molding processes.

Melting furnaces: Types of furnaces used in foundry; furnaces for melting; melting practice for steel, cast iron, aluminum alloys, copper alloys and magnesium alloys; safety considerations; fluxing, degassing and inoculation

Module:2	Design of Casting Systems	6 hours

Gating and Riser design: Concept of solidification, directional solidification, role of chilling, principles of gating and riser systems: types and design calculations.

Special Casting techniques: Investment casting, Shell molding ,die casting, centrifugal casting, plaster mould casting, magnetic casting, squeeze casting, full mould process, strip casting, CO_2 molding.

Module:3	Foundry Defects and Automation:	6 hours

Defects in castings and its remedies. Energy saving and quality control in foundries; Cleaning and inspection of castings; Foundry automations -moulding machines-automation of sand plant, moulding and fettling sections of foundry – Dust and fume control.

Module:4	**Power sources in welding**	**6 hours**
Classification of welding processes - heat sources, power sources, arc characteristics, V-I relationship, different types of electrodes, ingredients and function of electrode coverings, types of weld joints.		
Module:5	**Fusion welding and Solid State Welding processes**	**7 hours**
Fusion welding processes : Shielded metal arc welding, gas welding, TIG welding, MIG welding, Submerged arc welding processes **Solid state welding processes:** Resistance, friction, friction stir, ultrasonic, induction pressure, diffusion welding processes, explosive welding		
Module:6	**Special welding processes**	**4 hours**
Electron beam, laser beam welding, plasma arc processes; advantages, limitations, Introduction to Robotic welding, underwater welding.		
Module:7	**Welding metallurgy**	**8 hours**
Weld thermal cycles and their effects, effects of pre and post weld heat treatments, concept of HAZ, concept of weldability and its assessment. Welding of different materials, defects in welds, their causes and remedies.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	John K.C (2015) Metal casting and Joining, PHI

Reference Books

1.	S.Kalpakjian and S.R.Schmid, (2012), Manufacturing Processes for Engineering Materials, 5th Edition, Pearson Education Ltd.
2.	P. N. Rao (2013), Manufacturing Technology, Volume 1, Tata McGraw-Hill Education
3.	Helmi A. Hassan A. El-Hofy, Mahmoud H. Ahmed Youssef (2011) Manufacturing Technology: Materials, Processes, and Equipment, CRC Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Project

• Generally a team project [Maximum 4 members] • Report in digital format which includes introduction part discussing about various control charts and scope of the study, literature review, research methodology, data presentation and analysis, appropriate software used and summary of conclusions.	**60 hours**

• Assessment on a continuous basis with a minimum of 3 reviews.				
Sample Projects				
1.	Casting of Aluminium metal by stir casting method			
2.	Making of a core for a pattern			
3.	Simple design of a pattern			
4.	Weldability of DSS			
5.	Problems in welding Inconel-718			
6.	Sensitization in Austenitic Stainless Steel			
7.	Cracks in HAZ & cracks in FZ			
Mode of assessment:				
Recommended by Board of Studies		17-08-2017		
Approved by Academic Council		47	Date	05-10-2017

Course code	MECHANICS OF SOLIDS AND FLUIDS	L	T	P	J	C
MEE1032		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To enable students to understand the concept of stress and strain of deformable bodies of different material properties.
2. To enable the students to understand what are principal stresses and strains to follow various failure theories.
3. To prepare the students to understand fluid properties in order to solve problems of liquids under static and flowing conditions.
4. To demonstrate about flow measurement devices and procedures for various flow network design and multi reservoir problems.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Compute either stress calculation or load calculation with or without accounting temperature effect of axially loaded members.
2. Compute stress planes in other than the cross section for different loading conditions
3. Analyse the members subjected to bending, torsion, combined bending and torsion and able to solve problems of thin shell vessels.
4. Explain application of manometry for flow measurements.
5. Compute the hydrostatic forces on inclined and curved surfaces and able to find centre of buoyancy and metacentre.
6. Apply the fundamental equations to predict fluid flow and solve problems of fluid kinematics and fluid dynamics.
7. Compute major and minor losses for flow through pipes and able to solve multi reservoir problems.
8. Predict experimentally the mechanical properties of materials and important hydraulic coefficients.

Module:1	Introduction	6 hours

Introduction - Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Uniaxial deformation.

Module:2	Fundamentals of Elasticity and Theories of Failure	6 hours

Stress - Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure - Fundamentals of theory of elasticity – Yield criteria and plasticity

Module:3	**Thin Shells**	**6 hours**
Solid Mechanics applications – Thin shells, torsion, bending, buckling		
Module:4	**Fluid Pressure**	**5 hours**
Pressure, Pressure head, Pressure Measurement- Simple Manometers, Differential Manometers		
Module:5	**Hydrostatic Forces**	**6 hours**
Fluid properties – Hydrostatic forces on plane – inclined and curved surfaces – buoyancy – centre of buoyancy – metacentre.		
Module:6	**Fluid Kinematics**	**7 hours**
Types of fluid flows - Streamline and Velocity potential lines- Euler and Bernoulli's equations and their applications – moment of momentum – Momentum and Energy correction factors – Impulse – Momentum equation-Navier-Stokes Equations-Applications.		
Module:7	**Flow through Pipes**	**7 hours**
Flow through pipes – Open Channels and Measurement pipe flow: Darcy's law – Minor losses – Multi reservoir problems – pipe network design – Moodys diagram – Hagen Poiseuille equation – Turbulent flow.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

List of Challenging Experiments		
1.	Evaluation of Engineering Stress / Strain Diagram on Steel rod, Thin and Twisted Bars under tension.	3 hours
2.	Compression test on Bricks, Concrete blocks.	3 hours
3.	Deflection test – Verification of Maxwell theorem.	3 hours
4.	Comparison of hardness values of Steel, Copper and Aluminium using Brinell and Rockwell hardness measuring machines.	3 hours
5.	Estimation of Spring Constant under Tension and Compression.	3 hours
6.	Flow through Orifice	3 hours
7.	Flow through Mouth Piece	3 hours
8.	Flow through Triangular Notch	3 hours
9.	Flow through Venturimeter	3 hours
10.	Flow through Pipe	3 hours
	Total Laboratory Hours	**30 hours**

Text Book(s)

1.	P.N.Modi and S.M.Seth, (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House		
Reference Books			
1.	Timoshenko, S.P. and Young, D.H., (2011), Strength of Materials, East West Press Ltd.		
2.	R.K. Bansal, (2017), Strength of Materials, Laxmi Publications		
3.	D.S. Kumar, (2013) Fluid Mechanics and Fluid Power Engineering, Katson Publishing House, Delhi		
4.	Rowland Richards, (2000) Principles of Solid Mechanics, CRC Press		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	THERMODYNAMICS AND HEAT TRANSFER	L	T	P	J	C
MEE1033		2	2	2	0	4
Pre-requisite	Nil	Syllabus version				
		v. 2.2				

Course Objectives:

1. To impart the students different thermodynamic laws and various modes of heat transfer.
2. To familiarise the students with the different thermodynamic laws and their applications, heat transfer problem formulation for any system.
3. To enable the students to understand the phenomena of boundary layers, condensation and boiling, design and operation of heat exchangers, fins etc.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply the concept of First Law of Thermodynamics to solve engineering problems
2. Apply the concept of Second Law of Thermodynamics and demonstrate the knowledge of entropy
3. Determine the performance of various cycles and compare them based on different performance parameters
4. Apply the basic laws of heat transfer to solve problems of steady and unsteady state heat conduction for simple geometries
5. Analyse natural and forced convective heat transfer process
6. Design the heat exchangers by LMTD and NTU methods and solve radiation heat transfer problems
7. Conduct experiments, interpret the data and analyse the heat transfer problems

Module:1	Basics of Thermodynamics	4 hours

Thermodynamic Systems, Properties, State, Processes and Cycles. Zeroth Law of Thermodynamics, First Law of Thermodynamics, Concept of Heat and Work, First Law applied to closed and open systems, Steady flow energy equation.

Module:2	Second Law of Thermodynamics	4 hours

Second law of thermodynamics, Different Statements and their equivalence, Reversible and irreversible processes, Carnot cycle, Carnot theorem and their corollaries, Entropy, T ds Equations.

Module:3	Vapor and Gas Power Cycles	4 hours

Introduction to vapor power and gas power cycles.

Module:4	Heat Transfer	4 hours

Basic modes of heat transfer, General heat conduction Equation in Cartesian cylindrical and spherical coordinates, Initial and boundary conditions.

Module:5	**Steady and Unsteady heat Transfer**	**4 hours**
Steady state heat transfer in simple geometries with and without heat generation, heat transfer in composites and extended surfaces. Introduction to unsteady state heat transfer.		
Module:6	**Boundary Layer Theory**	**4 hours**
Introduction to boundary layer theory, Convective heat transfer, Newton's law. Forced convection on external and internal surfaces. Natural convection from vertical plates, Empirical relations in convective heat transfer.		
Module:7	**Radiation**	**4 hours**
Radiation Heat transfer, Fundamental laws of radiation, Radiation heat exchange between bodies of simple geometry - Introduction to boiling and condensation, Heat Exchangers.		
Module:8	**Contemporary issues:**	**2 hours**
Lectures from an Industry experts.		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	P.K. Nag, Engineering Thermodynamics, 2013, 5th edition, Tata McGraw Hill, New Delhi
2.	Yunus A Cengel and Afshin J Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 2015, 5th edition, McGraw-Hill, New Delhi.

Reference Books

1.	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, (2011) Fundamentals of Heat and Mass Transfer, , 7th edition, Wiley, New York.
2.	Sonntag, R.E., Borgnakke, C., Van Wylen, G.J. and Van Wyk, S., (2013) Fundamentals of thermodynamics, 8th edition, Wiley, New York.
3.	C. P. Kothandaraman and S. Subramanyan, (2012) Heat and Mass Transfer Data Book, , 5th edition, New Age International Publishers, New Delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Measurement of thermal conductivities of i) a metal, ii) an insulating powder and iii) a composite wall	4 hours
2.	Heat transfer in natural convection	4 hours
3.	Heat transfer in forced convection	4 hours
4.	Heat transfer from a pin	4 hours
5.	Study of unsteady state heat transfer	4 hours
6.	Determination of Stefan-Boltzmann constant	4 hours
7.	Determination of emissivity	3 hours
8.	Heat transfer in a parallel/counter flow heat exchanger	3 hours

		Total Laboratory Hours	**30 hours**
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	**STATISTICAL QUALITY CONTROL**	**L**	**T**	**P**	**J**	**C**
MEE1034		**2**	**0**	**0**	**4**	**3**
Pre-requisite	**MAT2001**	**Syllabus version**				
		v. 2.2				

Course Objectives:

1. Develop the understanding of process variability and quality monitoring.
2. Present a problem oriented in depth knowledge, underlying concepts, methods and application of control charts.
3. Demonstrate the ability to design and implement acceptance sampling plans.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Implement the philosophy of Taguchi's Loss Function to analyse the process variability.
2. Demonstrate the ability to design, use, and interpret control charts for variables.
3. Demonstrate the ability to design, use, and interpret control charts for attributes.
4. Determine the capability indices and non-conformance rate to describe a process.
5. Design a sampling plan to construct OC curve and evaluate its effectiveness for a given process.
6. Describe the DMAIC process (define, measure, analyze, improve, and control).
7. Apply the statistical quality control tools to solve real time industry problem.

Module:1	**Introduction to Statistical Quality Control**	**4 hours**

The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Quality costs and Quality loss

Module:2	**Control Charts For Variables**	**4 hours**

Control Charts for Variables, (all sections): Control Charts for $\bar{X}$ and R (statistical basis, development and use, estimating process capability; interpretation, the effect of non- normality on the chart, the OC function, average run length); Control Charts for $\bar{X}$ and S; Control Chart for Individual Measurements; Applications of Variables Control Charts

Module:3	**Control Charts for Attributes**	**5 hours**

Control Chart for Fraction-Nonconforming (OC curve of the control chart, variable sample size, nonmanufacturing application, the OC function and ARL calculation); Control Charts for Nonconformities or Defects; Choices Between Attribute and Variable Control Charts, Guideline for Implementing Control charts.

Module:4	**Process and Measurement system Capability Analysis**	**4 hours**
PCA analysis using a histogram or a probability plot, process capability ratios, confidence interval for process-capability ratio, PCA using a control chart, estimating natural tolerance limits of a process.		
Module:5	**CUSUM and EWMA Control Charts**	**5 hours**
Cumulative-Sum (CUSUM) & Exponentially Weighted Moving Average(EWMA) Control Charts - CUSUM Control Chart (basic principles of the chart for monitoring the process mean, tabular or algorithmic CUSUM, recommendation for CUSUM design, the standardized CUSUM, rational subgroups, improving the responsiveness of the CUSUM for large shifts, designing a V-Mask, designing CUSUM based on ARL, one sided CUSUM); EWMA control chart (EWMA control chart for monitoring process mean, design of an EWMA control chart, rational subgroups); The moving Average Control Chart.		
Module:6	**Acceptance Criteria for Attributes**	**3 hours**
Lot-By-Lot Acceptance Sampling For Attributes - The accepting sampling problem, single sampling plan for attributes, Double, Multiple, and sequential sampling, Military Standard 105E, the Dodge-Roming sampling plans (AOQL and LTPD plans).		
Module:7	**Six Sigma**	**3 hours**
Six sigma - Concept of six sigma, methods of six sigma, DMAIC methodology, DFSS methodology, six sigma control chart, case studies.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Douglus C. Montgomery, (2012) Introduction to Statistical Quality Control, John Wiley & Sons, 7th Edition.
Reference Books	
1.	Eugene L. Grant and Richard S. Leaven Worth (2017), Statistical Quality Control, TMH, Seventh Edition
2.	Dale H. Besterfield (2008), Quality Control. Pearson Education Asia, 8th Edition

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Project	
• Generally a team project [Maximum 4 members] • Tools and techniques studied in Statistical Quality Control are to be applied.	**60** hours

• Focus on implementing the tools and techniques of SQC in manufacturing, business and service organizations. • Report in digital format which includes introduction part discussing about various control charts and scope of the study, literature review, research methodology, data presentation and analysis, appropriate software used and summary of conclusions. • Assessment on a continuous basis with a minimum of 3 reviews.				
Sample Project				
1.	Statistical Quality Control of Premier Soap in Soap Manufacturing Industry			
2.	A Quality Control Analysis of Cements in a Cement Industry			
3.	A Statistical Quality Control Analysis in a Baker Industry			
4.	The Application of Statistical Quality Control in Plastic Producing industry			
5.	The Application of Statistical Quality Control Techniques to Address Field Concerns in an Automotive Industry			
6.	A Statistical Quality Control Analysis of a Production Line in an Automobile Manufacturing Industry			
7.	A Quality Control Analysis of the Thickness of Part and Corrugated Asbestos Roofing Sheets			
Mode of assessment:				
Recommended by Board of Studies	17-08-2017			
Approved by Academic Council	47	Date	05-10-2017	

Course code	MACHINE DRAWING	L	T	P	J	C
MEE2001		1	0	4	0	3
Pre-requisite	MEE1001	Syllabus version				
		v. 2.2				

Course Objectives:

1. To understand and apply national and international standards while drawing machine component.
2. To understand the concept of various tolerances and fits used for component design
3. To familiarize in drawing assembly, orthographic and sectional views of various machine components.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply the national and international standards in machine drawing.
2. Apply limits and tolerances to assemblies and choose appropriate fits.
3. Prepare production drawings with geometrical dimensioning and tolerances
4. Assign machining and surface finish symbols.
5. Prepare production drawings with geometrical dimensioning and tolerances
6. Illustrate various machine components through drawings.

Module:1	Basics of Machine Drawing	4 hours

Introduction – Projections - Classifications of machine drawing- BIS specifications - Sectioning – Dimensioning methods: Counter Sink, Counter Bores, Spot Faces, Chamfers, Screw Threads, Tapered Features, Title block of Industrial drawing and Bill of Materials.

Module:2	Limits and Fits	2 hours

Classifications and of Fits, Selection of Fits, Representation on Drawings, Tolerance Grade, Computations of Tolerance, Positions of Tolerance, Fundamental of Deviations, Shaft and Hole Terminology, Method of placing limit dimensions.

Module:3	Geometrical Tolerances	2 hours

Need of Geometrical Tolerance, Geometrical Characteristics of Symbols, Indication of MMC, LMC, Interpretation and Indication of Geometrical Tolerance and Dimensioning.

Module:4	Conventional Representations	2 hours

Materials - Interrupted views and Braking of Shaft, Pipe, Bar - Surface finishing & Machining Symbols.

Module:5	Screwed Fastenings and Joints	3 hours

Screwed Fastenings - Screw Thread Nomenclature and types, Joints: Bolts and Nuts, Key, Cotter, Riveted, Pin, Welded joints. Pulleys and Couplings.

Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Bhatt, N.D., Machine Drawing, 50th edition, Charotar Publishing House Pvt. Ltd., India, 2014.
Reference Books	
1.	Ajeet Singh, Machine drawing, 2nd edition, Tata McGraw Hill, India, 2012.
2.	K.L. Narayana, Machine Drawing, 4th edition, New Age International publisher, India, 2014.
3.	K.C. John, Text book on Machine Drawing, 2nd edition, PHI Learning Pvt, Ltd, India, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Introduction to CAD Packages and demonstration of part modeling, assembly and detailed with simple examples to familiarize CAD Packages. Sketcher constraints, basic 3D commands to be used for drawing machine components.	4 hours
2.	Visualization of machine components and its assemblies.	2 hours
3.	CAD modeling of shaft, bearings, fasteners, couplings, gears, keys, rivets, springs and pulleys –user defined, customization using catalogues.	4 hours
4.	Part modeling, assembling and detailed drawing of Shaft joints: Cotter joint and Knuckle joint.	8 hours
5.	Part modeling, assembling and detailed drawing of Keys and Shaft coupling: Flanged and Universal coupling.	8 hours
6.	Part modeling, assembling and detailed drawing of Shaft Bearing: Plummer block and Footstep bearing.	8 hours
7.	Part modeling, assembling and detailed drawing of Pulleys: Belt pulley, V belt pulley, Fast and loose pulley and Speed cone pulley.	8 hours
8.	Part modeling, assembling and detailing of machine components: Tailstock and Bench Vice.	8 hours
9.	Part modeling, assembling and detailing of I.C engine connecting rods.	6 hours
10.	Part modeling, assembling and detailing of Real time machine components.	4 hours
	Total Laboratory Hours	**60 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	47	47

Course code	MANUFACTURING AUTOMATION	L	T	P	J	C
MEE2012		3	0	2	0	4
Pre-requisite	MEE2031/MEE1007	Syllabus version				
		v. 2.2				

Course Objectives:

1. To help students gain essential and basic knowledge of automated systems.
2. To familiarize the students with the design of hydraulic and pneumatic circuits for various automated applications.
3. To make students understand the Programmable Logic Controller to control the systems at industrial premises
4. To enable the students to apply the knowledge of information technology in the field of automation for better enhancement.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply automation principles and strategies and model manufacturing systems
2. Design automated storage and retrieval systems and employ robots in material handling
3. Implement concepts of automation in inspection and testing
4. Apply PLC timers and counters for the control of industrial processes
5. Design of Hydraulic Circuit and pneumatic circuit for manufacturing application
6. Monitor production using smart sensors based on Industry 4.0 techniques
7. Implement artificial intelligence based systems and IOT in manufacturing

Module:1	Automation	5 hours

Introduction, automation principles and strategies, basic elements of advanced functions, levels modeling of manufacturing systems, Introduction to CNC programming.

Module:2	Automated Handling And Storage system	6 hours

Automated material handling systems , AGV, Transfer mechanism , Buffer storage , Analysis of transfer lines, Robots in material handling, Automated storage and Retrieval Systems (AS/RS) - carousel storage, Automatic data capture, bar code technology, Automated assembly systems

Module:3	Automated Manufacturing system	6 hours

Group Technology, Part family, Sensor technologies, Automated inspection and testing, Coordinate measuring machines, Machine vision, Rapid prototyping.

Module:4	Programmable controllers in Automation	7 hours

PLC Architecture, Modes of operation, Programming methods, Instructions, Instruction addressing, latches, timers and counters.

Module:5	Advanced Control Strategies in Automation	7 hours

SCADA, DCS, Integration of PLC, SCADA and DCS with manufacturing systems, Man-machine interfaces, Introduction to PLM, Case studies.		
Module:6	**Smart Factory and Smart Manufacturing**	**6 hours**
Industry 4.0- Standard, Real-time production monitoring techniques with smart sensors, Configuration of smart shop floor, traceability and call back of defective products		
Module:7	**Intelligent Manufacturing Systems**	**6 hours**
Artificial Intelligence based systems, Virtual Business, e-Commerce Technologies, Global Manufacturing Networks, Digital enterprise technologies, IOT in manufacturing		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 2016, Fourth edision, Pearson Education, New Delhi.
Reference Books	
1.	P. Radhakrishnan, S. Subramanyan, V. Raju, CAD/CAM/CIM, New age International, New Delhi.
2.	Yusuf Altintas, Manufacturing Autmation, 2012, Cambridge University Press, USA.
3.	David Bedworth, Computer Integrated Design and Manufacturing, TMH, New Delhi.
4.	Gupta A. K., Arora S. K., Industrial Automation and robotics, 2013, Third Edision, University Science Press, New delhi.
5.	Rajesh Mehra, Vikrant Vij, PLSc & SCADA Thory and Practice, 2011, First Edision, University Science Press, New delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
	The lab itself provides students with the opportunity to design and construct an automated manufacturing system and alerts them to the types of problems that arise. Specifically, students will: • Design and build an automated manufacturing system • Learn to programme state of the art industrial robots • Manage a project and learn how to work as a team	
1.	Industrial Robot Programming	4 hours
2.	Automation using PLC such as bottle filling, elevator control	6 hours
3.	Online inspection using machine vision system	5 hours
4.	Process automation simulation using SCADA	5 hours
5.	Interfacing HMI with PLC	5 hours
6.	Factory flow simulation	5 hours

		Total Laboratory Hours	**30 hours**
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	THEORY OF METAL CUTTING AND FORMING	L	T	P	J	C
MEE2031		3	0	2	0	4
Pre-requisite	MEE 1005 , MEE1031	Syllabus version				
		v. 2.2				

Course Objectives:

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.
3. To understand the basic principles of Metal Forming Theory
4. To know the various types of forming processes

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Analyse the various machine tools used for metal cutting based on cutting force and power consumption
2. Evaluate the principles of mechanics in metal cutting process including concept of shear deformation of materials and develop analytical relation between input and output process parameters.
3. Evaluate theoretical and experimental techniques for heat flow in metal cutting, tool life and tool wear during metal cutting process
4. Predicting the yield criterion and the workability including friction with lubrication effects
5. Choose the various bulk metal forming processes and sheet metal forming processes for different functional requirements

Module:1	Machine tools and machining operations	7 hours

Generating motions of machine tools, machines using single-point tools, machines using multipoint tools, machines using abrasive wheels, tool nomenclatures.

Module:2	Mechanics of Chip Formation	7 hours

Orthogonal & oblique cutting, shear plane angle, shear stress and strain, principal chip types, theoretical determination of cutting forces, shear angle relation, force system in turning, merchant circle diagram, friction and shear force, shear stress in turning, energy in cutting process, Kronenberg relation and velocity relation, chip deviation and other effects on cutting forces, stress on tool, stress distribution, Dynamometers for measuring forces in turning, milling and drilling, numerical problems.

Module:3	Heat Flow in Metal Cutting and Tool Life	7 hours

Heat in chip formation, heat at tool-work interface, heat at tool-chip interface, heat in absence of flow zone, method of tool temperature measurement, temperature distribution in tool, evaluation of machinability, tool life, Taylor's equation, tool failure, variables affecting the tool life causes of

tool failures, economics in metal machining, cutting tool material and cutting fluid, numerical problems		
Module:4	**Theory of Plasticity**	**6 hours**
Stress and strain, stress tensor, determination of flow stress, yield criteria, yield locus, octahedral shear stress and shear strains, invariants of stress strain, slip line field theory plastic deformations of crystals temperature and strain rate dependence, recrystallization, determination of flow stress - Slab analysis - Upper bound analysis - Slip line field analysis - Deformation zone geometry - Numerical problems		
Module:5	**Metal Forming Lubrication**	**6 hours**
Friction at die-work piece interface, Ring compression test, lubrication mechanisms; boundary lubrication, mixed lubrication, hydrodynamic lubrication		
Module:6	**Analysis of Bulk Metal Forming Processes**	**5 hours**
Forging, Rolling, Extrusion, Drawing of rods, wires, and tubes - numerical problems.		
Module:7	**Analysis of Sheet Metal Forming Processes**	**5 hours**
Sheet metal forming processes, high energy rate forming processes, formability tests, plastic anisotropy - numerical problems.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	K. C. Jain, A. K. Chitale (2014), Textbook of Production Engineering -, PHI Learning Pvt. Ltd.,
2.	B.L.Juneja, (2012), Fundamentals of Metal Forming Processes, New Age International, 2nd Edition.
Reference Books	
1.	Geoffrey Boothroyd and W. A. Knight (2005),Fundamentals of Machining and Machine Tools , CRC Press
2.	Amitabha Battacharyya (2011),Metal Cutting: Theory and Practice by New Central Book Agency
3.	George E. Dieter, McGraw Hill Inc (2002),Mechanical Metallurgy
4.	Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed(2011),Manufacturing Technology: Materials, Processes, and Equipment, CRC Press, Taylor & Francis Group
5.	Heinz Tschaetsch (2005), Metal Forming Practise, Springer Berlin HeidelbergNew York
6.	William F. Hosford and Robert M.Caddell (2011),Metal Forming: Mechanics and Metallurgy by Cambridge University Press

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
List of Challenging Experiments (Indicative)			
1. Gear cutting using milling and gear hobbing machine 2. Micro machining using EDM 3. Deformation Behavior during Rolling and Swaging 4. Recovery, recrystallization and grain growth grain size measurement by Quantitative metallography 5. Determination of the tensile properties and strain hardening exponent of different class of materials 6. Strain aging and yield point phenomenon 7. Effect of work hardening on the tensile properties of metals 8. Conventional FLD study for various sheet metals 9. Incremental forming study 10. Plastic curve of a metal strip in rolling process 11. Beverage can manufacturing through sheet metal operations			30 hours
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course Code	KINEMATICS AND DYNAMICS OF MACHINERY	L	T	P	J	C
MEE2032		2	2	0	0	3
Pre-requisite	MEE1032	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide understanding about the relationships between the geometry and motions of the parts of a mechanism or machine
2. To impart students with the knowledge about motion, masses and forces in machines.
3. To enable students to apply fundamental of mechanics to machines which include mechanisms, machines, engines etc.,
4. To facilitate the students to understand the function of Cams, Gears the concept of balancing of rotating and reciprocating masses.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Develop an understanding of the concepts related to various mechanisms.
2. Analyze the kinematics of follower motion in relation to cams.
3. Solve problems related to gears and gear trains.
4. Analyze the unbalances existing in machines or engines
5. Analyze the problems related to vibrations
6. Calculate the gyroscopic couple effect on various ships, aeroplanes and vehicles

Module:1	Introduction to mechanisms and its terminologies	3 hours

Degree of freedom – Gruebler's and Kutzbach criterion - Kinematic Inversions- Grashof's Law, Transmission Angle, Mechanical Advantage- Introduction to synthesis of mechanism.

Module:2	Dynamic analysis of mechanisms	2 hours

Determination of velocity and acceleration - simple mechanisms – Relative motion method. Inertia force analysis of slider crank mechanism-- Klein's construction. Turning moment diagram- Applications.

Module:3	Cams and Followers	2 hours

Cams and Followers - Types– Displacement, Velocity and Acceleration of different follower motions. Construction of cam profile.

Module:4	Gears and Gear trains -	3 hours

Law of gearing, Spur gear -Interference and under cutting, Comparison of involute and cycloidal tooth profiles. Gear trains- Simple, compound gear trains and epicyclic gear trains, speed and torque.

Module:5	Balancing	3 hours

Static and dynamic balancing - Balancing of rotors- Balancing of reciprocating masses- Balancing of multi-cylinder in-line engines.

Module:6	Vibrations	3 hours

Free, and damped vibrations of single degree of freedom systems, longitudinal, transverse torsional, Forced vibration. Harmonic excitation, Magnification factor, Vibration isolation and

Transmissibility-Base excitations.		
Module:7	**Governers**	**2 hours**
Control system and stability - Functions of Governors – Gravity controlled and Spring controlled governor characteristics. Stability – Hunting and Isochronisms. Effect of friction – Calculation of equilibrium speeds and ranges of speed of governors. Gyroscopic couple – Gyroscopic effects on the movement of air planes and ships – Stability of two wheel drive and four wheel drive.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	S. S. Rattan, "Theory of Machines", Tata McGraw Hill, 2015
Reference Books	
1.	Joseph Edward Shigley and John Jospeh Uicker JR, Theory of Machines and Mechanisms SI Edition, Oxford University Press, 2014.
2.	R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education, 2017
3.	R L Norton, Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, McGraw-Hill Higher Education, 2011

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Tutorial

- A minimum of 3 problems to be worked out by students in every tutorial class.
- 5 problems to be given as homework per tutorial class.
- At least one open ended design problem to be given.

List of Challenging Experiments		
1.	Finding DOF of a planar mechanisms, inversions, synthesis of planar mechanisms.	
2.	Velocity and Acceleration Analysis of planar mechanisms, Problems on dynamic analysis of planar mechanisms.	
3.	CAM Profiles for Different Follower Motions, Problems on gear trains	
4.	Problems on gears and gear trains.	
5.	Static and dynamic balancing of rotating, reciprocating masses and engines.	
6.	Problems on free and forced vibration with and without damping.	
7.	Calculation of equilibrium speed and range of speed of Governors, Gyroscope stabilization	
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	COMPUTER AIDED MANUFACTURING	L	T	P	J	C
MEE3012		2	0	2	0	3
Pre-requisite	MEE2001	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide an understanding on the theory of metal cutting and machinability
2. To provide the theory behind the computer aided manufacturing and tools for Computer Integrated manufacturing
3. Practically realising components using a CAM system

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Explain the evolution of automation in manufacturing
2. Develop NC and CNC codes for simple components
3. Evolve appropriate machining strategy for Computer Aided Manufacturing
4. Use group technology and cellular manufacturing principles
5. Explain the role of other support systems for computer integrated manufacturing
6. Practically realise components using a CAM system

Module:1	**Introduction to Automation**:	4 hours

Basic elements of an automated system, advanced automation functions, levels of automation. Flexible automation, smart automation

Module:2	**Numerical Control**	5 hours

Basic components of an NC system, classification, merits and demerits, applications, the cost of NC/CNC, dimensioning systems, axes designation, NC motion control, interpolation, part programming formats, manual part programming, computer assisted part programming, APT statements, programming, NC part programming using CAD/CAM softwares.

Module:3	**Computer Numerical Control**	3 hours

Computer Numerical Control (CNC) and DNC: Features of CNC, Elements of CNC machines, the machine control unit for CNC, CNC Controllers, and Multitasking CNC machines.

Module:4	**CAM machining strategies**	4 hours

Roughing, finishing tool paths, CL data post processing. Simulation. Verification, program debugging. Program transformation and realization. Code optimization.

Module:5	**Group Technology and Cellular Manufacturing**	4 hours

Introduction to GT, benefits, part families, part classification and coding, product flow analysis, cellular manufacturing, adaptation consideration in GT, quantitative analysis in cellular manufacturing, GT applications for manufacturing processes.

Module:6	**Flexible Manufacturing Systems**	4 hours

Introduction to FMS, components, applications, benefits, FMS layout, FMS planning and implementation issues, quantitative analysis of FMS. Applications of FMS. FMS optimization.

Module:7	Manufacturing Support Systems	4 hours

CAPP, benefits, types, forward and backward planning implementation considerations, process planning systems, CAQC, CMM, JIT principles, the meaning of JIT, MRP–I and MRP-II, ERP, EDM, PDM & PLM.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	P.N. Rao, Tata McGraw (2015), CAD/CAM Principles & Applications, Hill Pub. New Delhi
Reference Books	
1.	P. Radhakrishnan& S. Subramanian (2008),CAD/CAM/CIM Willey Eastern Limited New Delhi
2.	Mikell P. Grover (2010),Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Education, New Delhi
3.	P.N. Rao, N. K. Tewariet el (2010), Computer Aided Manufacturing Tata McGraw Hill Pub. New Delhi

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Features and selection of CNC turning and milling centres. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of canned cycles. Practice in part programming and operating a machining center, tool Joining and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.	3 hours
2.	Manual Part Programming Using Standard G and M Codes and Part programming simulation using CADEM Software.	3 hours
3.	CNC Virtual CAM Machining using CAM software like Master CAM, CATIA	3 hours
4.	Process Sequence Creation, CNC Machine configuration for 2 Axis Turning, 3 Axis Milling	3 hours
5.	Exposure to Various Standard Control Systems-FANUC, SIEMENS	2 hours
6.	Tool Path Simulation and CL Data Generations by Using MASTER CAM Software	2 hours
7.	Post Process Generation for Different Control System in CATIA software	2 hours
8.	Demonstration on Machining of Computer Generated Part Program by Using Machining Center and Turning Center.	2 hours
9.	Machining simple components by Using CNC machines.	2 hours
10.	Demonstration on CMM machine with one auto component part	2 hours
11.	Exercises using MINITAB and ARENA process simulation softwares	2 hours
12.	Plastic curve of a metal strip in rolling process	2 hours
13.	Beverage can manufacturing through sheet metal operations	2 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

EEE2007	Electronics and Microcontroller	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**NIL**	**Syllabus version**				
Anti-requisite	---	v. 1.0				

Course Objectives:

- To understand different methods for design and implementation of Digital circuits
- To apply the knowledge of solid state devices principles to analyze electronic circuits
- To provide essential knowledge on various operating modes of I/O ports Timers/Counters, control registers and various types of interrupts
- To teach various interfacing techniques

Expected Course Outcome:

- To analyze and design combinational logic circuits.
- To analyze and design sequential logic circuits.
- Understand the difference between different microcontrollers.

Module:1	**Number System and Codes**	**3 hours**	

Introduction to Digital Systems-Number representation-Binary, Octal, Decimal, Hexadecimal- Number Base conversion-Complements:1's and 2's-Signed binary numbers - ASCII,BCD,Excess3andGrayCodes -Parity

Module:2	**Digital Electronics**	**4 hours**	

Calorific Value - Gross and Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel and Ash Storage and Handling.

Module:3	**Combinational circuits**	**4 hours**	

Combinational circuits – Analysis and design procedures - Circuits for arithmetic operations - Code conversion. Decoders and encoders - Multiplexers and demultiplexers

Module:4	**Sequential circuits**	**3 hours**	

Origin of petroleum fuels - Production – Composition -Petroleum refining - Various grades of petro-Products - Properties and testing – Alcohol shale oil - Gasification of liquid fuels – Synthetic fuels - Storage and handling of liquid fuels.

Module:5	**Introduction to Microcontroller**	**4 hours**	

Introduction to microprocessor and microcontroller- Internal architecture of PIC18-Comparison of PIC with other CISC & RISC based systems and microprocessor-PIC family-features.

Module:6	**Assembly language programming**	**6 hours**	

Flag Register, stack- addressing modes, loop, jump, call instructions, arithmetic and logic instructions, Programming I/O ports- timers, counters, interrupts, serial communication

Module:7	**Interfacing with PIC**	**4 hours**	

Mechanism of Combustion – Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid - Liquid and Gaseous Fuels Combustion - Flame Temperature - Theoretical - Adiabatic and Actual - Ignition Limits – Limits of Inflammability.

Module:8	**Contemporary Discussion**	**2 hours**	
	Total Lecture hours:	**Hours: 30**	

Text Book(s)	
1.	Donald G. Givone "Digital principles and Design" Tata McGraw Hill 2003.
2.	Mohamed Ali Mazidi, Rolin D.McKinlay, Danny Causey,"Pic Microcontroller And Embedded Systems: Using Assembly And C For Pic 18",Pearson Education,2016.
Reference Books	
1.	M. Morris Mano, "Digital Design", 4th Edition, *Prentice Hall of India Pvt. Ltd.*, 2017.
2.	Charles H. Roth, Jr., "Fundamentals of Logic Design", 6th Edition, Brooks/Cole, 2014
3.	Thomas L. Floyd & R P Jain, "Digital Fundamentals", PHI, 10th Edition, 2016
4.	Barry B. Brey, "Applying PIC18 Microcontrollers", Pearson/Prentice Hall, 2008
5.	Sid Katzen, "The Essential PIC18® Microcontroller", Springer, 2010

Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	**Date**	**18/03/2016**

EEE3001	Control Systems	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE2001, MAT2002/EEE1001**	**Syllabus version**				
		v. 1.0				

Course Objectives:

1. To present a clear exposition of the classical methods of control engineering, physical system modelling, and basic principles of frequency and time domain design techniques.
2. To teach the practical control system design with realistic system specifications.
3. To provide knowledge of state variable models and fundamental notions of state feedback design

Expected Course Outcome:

On the completion of this course the student will be able to:

1. Formulate mathematical model and transfer function of the physical systems
2. Analyze the system performance by applying various input signals
3. Determine the stability of linear systems in time domain
4. Perform frequency domain analysis using bode and polar plot
5. Analyze the stability of linear system in the frequency domain
6. Design compensators and controllers for the given specifications
7. Formulate and design state-space analysis
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Systems and their Representations**	**6 hours**

Basic elements in control systems □ open loop & closed loop □ Transfer functions of mechanical, electrical and analogous systems. Block diagram reduction □ signal flow graphs.

Module:2	**Time Response Analysis**	**6 hours**

Standard test signals, Time response of first and second order system, Time domain specifications, Steady state error, error constants, generalized error coefficient.

Module:3	**Stability Analysis and Root Locus**	**6 hours**

Stability □ concept and definition, Characteristic equation – Location of poles – Routh Hurwitz criterion □ Root locus techniques: construction, properties and applications.

Module:4	**Frequency Response Analysis**	**6 hours**

Bode plot □ Polar plot □ Correlation between frequency domain and time domain specifications

Module:5	**Stability in Frequency Domain**	**6 hours**

Relative stability, Gain margin, Phase margin, stability analysis using frequency response methods, Nyquist stability criterion.

Module:6	**Compensator and Controller**	**7 hours**

Realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation □ Design of lag, lead, lag-lead series compensator (using Bode plot), P, PI and PID controllers in frequency domain.

Module:7	**State Space Analysis**	**6 hours**

Concepts of state variable and state model, Solution of state equation, State space to transfer function conversion, Controllability, Observability, Pole placement control		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Norman S. Nise, "Control System Engineering", John Wiley & Sons, 6th Edition, 2011.
2.	Benjamin C Kuo "Automatic Control System" John Wiley & Sons, 8th Edition, 2007.
Reference Books	
1.	K. Ogata, "Modern Control Engineering", Pearson, 5th Edition, 2010.
2.	R.C. Dorf & R.H. Bishop, "Modern Control Systems", Pearson Education, 11th Edition, 2008.
3.	M. Gopal, "Control Systems□Principles And Design", Tata McGraw Hill –4th Edition, 2012.
4.	Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, " Control System Design", Prentice Hall, 2003'
5.	J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 4th Edition, 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Block Diagram Reduction	2 hours
2.	Determination of Time Domain Specifications	2 hours
3.	Stability analysis of linear systems	2 hours
4.	PID Controller Design using Bode Plot	2 hours
5.	PID Controller Design using Root Locus	2 hours
6.	Compensator Design in Frequency and Time Domains	2 hours
7.	Transfer Function to State Space Conversion with Controllability and Observability Tests	2 hours
8.	Lag compensator design for linear servo motor for speed control application	2 hours
9.	Pole placement controller design for inverted pendulum	2 hours
10.	PD controller design for position control of servo plant	2 hours
11.	Cascade control design for ball and beam system	2 hours
12.	PID controller design for magnetic levitation system	2 hours
13.	Transfer function of Separately excited DC generator	2 hours
14.	Transfer function of Field Controlled DC Motor	2 hours
15.	Study of First and Second order systems	2 hours
	Total Laboratory Hours	**30 hours**

Mode of evaluation: CAM/ FAT

Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

Course code	TOTAL QUALITY MANAGEMENT AND RELIABILITY	L	T	P	J	C
MEE1015		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To impart knowledge about the total quality management principles
2. To demonstrate the importance of statistical process control for process monitoring
3. To familiarize with the concepts of TQM techniques and quality management systems
4. To impart knowledge on system reliability and system maintenance.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Develop action plans for customer centric business on the basis of various quality philosophies.
2. Apply total quality management techniques for design and manufacture of highly reliable products and services.
3. Develop statistical process control charts for monitoring the health of manufacturing systems.
4. Solve various industrial problems using Six Sigma and related techniques.
5. Establish quality management system and environmental management system for product and service industries.
6. Design systems with a focus on enhancing reliability and availability.

Module:1	Quality: Introductory Concepts	6 hours

Definition of Quality, Differing perspectives of quality by Design, Manufacturing, Service, etc. Contributions of Deming, Juran and Crosby. Customer orientation and Customer satisfaction measurement, Quality Control, Quality assurance and Total Quality Management definitions, Employee involvement, Quality Awards.

Module:2	TQM Techniques	6 hours

Principles of TQM, TQM Framework, FMEA, QFD, Bench Marking, 5S, PDCA, Poka Yoke, TPM, 5S, Corrective and Preventive actions with examples.

Module:3	Statistical Process Control	6 hours

7 QC tools, New Management tools, Statistical Process control, Control charts, Process capability, Cp, Cpk analysis.

Module:4	Six Sigma	6 hours

Features of six sigma, Goals of six sigma, DMAIC, Six Sigma implementation. TRIZ, Taguchi Loss function. Case studies and problems.

Module:5	Quality Systems	6 hours

ISO 9000, ISO 9000:2000, ISO 14000, other quality systems.

Module:6	Reliability	6 hours

Introduction to reliability, Failure rate, System reliability- Series, Parallel and mixed configuration, Problems, Weibull distribution and application.

Module:7	**Maintenance**	**7 hours**
Mean time to repair, Mean time between failures, Predictive maintenance, Reliability Centered Maintenance, Reliability improvement – Redundancy – Element – Unit and stand by redundancy – Reliability allocation for a series system – Maintainability and availability – System downtime – Reliability and Maintainability trade off – Simple problems.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Total Quality Management and Operational Excellence: Text with Cases**,** Routledge, 2014.
2.	A Textbook of Reliability and Maintenance Engineering, Charles Ebeling, UBSPD, 2017.
Reference Books	
1.	Dr. Kiran, Total Quality Management, B.S.Publications, 2017.
2.	E. Balagurusamy, Reliability Engineering, UBSPD, 2017.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	LEAN ENTERPRISES AND NEW MANUFACTURING TECHNOLOGY	L	T	P	J	C
MEE1016		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To make the students understand how the philosophy and core methods of lean manufacturing are applied to any business.
2. To make the students understand the value chain and to map the current state of material and information flow through the value chain and to understand where the added value is for the customer.
3. To help the students to identify waste and its root cause in the value stream.
4. To help the students to develop a future state vision of lean systems by using kaizens (improvement events) to eliminate the causes of waste by identifying new ways to achieve continuous flow through manufacturing cells.
5. To make the students to use their leadership skills needed to drive lean initiatives.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify key requirements and concepts in lean manufacturing
2. Apply the tools in lean manufacturing to analyze a manufacturing system and plan for its improvements.
3. Find the common pitfalls encountered during lean implementation and initiate a continuous improvement change program in a manufacturing organization.
4. Map the value chain and predict the value addition
5. Apply lean accounting principles towards financial management of all streamlined operations in a lean manufacturing setup.
6. Apply knowledge of facility planning, cellular manufacturing and group technology in a typical lean manufacturing setup.

Module:1	Introduction to Lean manufacturing	6 hours

Definition and concept of lean manufacturing; Principles of lean manufacturing – Just in time – Types of pull systems - Toyota Production systems – Benefits of lean manufacturing – Theory of constraints – Reduction of wastes.

Module:2	Lean Manufacturing Tools-I	6hours

Basic tools of lean manufacturing: 5S, Total Productive Maintenance, Key Performance Indicator, Overall Equipment Effectiveness, Plan Do Check Act, Root Cause Analysis, Poka Yoke, Work Cell, Bottleneck analysis, continuous flow.

Module:3	Lean Manufacturing tools –II	6 hours

Secondary tools of lean manufacturing: Gemba, Heijunka,HoshinKanri, Jidoka, Load leveling, Mind maps, 5 whys, SMDE, Six Big Losses, Standardized work, Visual factory, Zero quality control.		
Module:4	**Strategic Issues and Lean implementation**	**6 hours**
Strategic issues: - Actions - Issues - Focus - Leadership - Management of teams – Training. Focused factory concept – Availability, Variability, Lean implementation strategies, causes for failures, sustaining lean, and constraint management.		
Module:5	**Process Mapping and Value stream mapping**	**6 hours**
Process mapping – Need for process map- Types- Detailed instructions - common mistakes in mapping - limits – facilitation; Value stream mapping: - Overview - Where to use – When to use- Step by step approach – How to use – Present and future states - VSM symbols.		
Module:6	**Lean accounting**	**6 hours**
Lean accounting definition, Need for lean accounting, benefits of lean accounting, Lean accounting Vs traditional cost accounting, Activity based costing - Product costing - Volume adjusted costing, Target costing.		
Module:7	**Cellular manufacturing and Group technology**	**7 hours**
Work cell – Cell design - Facility planning – Plant layout – Balancing the work in work cells – Takt time – Defining - Benefits - Uses – Limitations; Facilities planning tools; Group technology coding classification; Productivity Improvement Aids.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Pascal Dennis, Lean production Simplified, Productivity press, New York, 2013.
Reference Books	
1.	P. James Womack, Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Simon & Schuster, 2003.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	FACILITIES AND PROCESS PLANNING	L	T	P	J	C
MEE1018		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To introduce various processes involved in facility planning
2. To expose factors involved in creation of new facilities
3. To impart knowledge required on plant layout tools for better solute

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Plan and develop facilities in manufacturing plants
2. Design different product processes involved in various planning activities
3. Identify plant location and select suitable resources
4. Apply tools for developing and analysing plant layout
5. Apply numerical methods in layout planning
6. Analyse material handling systems in manufacturing firms
7. Evaluate cost and corresponding implementation activities in layout

Module:1	Facilities Planning	6 hours

Introduction to facilities Planning, Significance of Facilities Planning, Objectives of Facilities Planning, Facilities Planning Process, Strategic Facilities Planning, Developing Facilities Planning Strategies.

Module:2	Product process and schedule design, Flow systems, activity relationships and space requirements.	6 hours

Introduction, Product Design, Process Design, Schedule Design, Facilities Design, Flow Systems, Material Flow System, Departmental Planning, Activity Relationships, Space Requirements.

Module:3	Plant Location	6 hours

Basic Factors to be considered – Plant location and site selection – Consideration in facilities planning and Layout capacity – Serviceability and flexibility – Analysis in selection of Equipment – Space requirement – Machine selections, Labour Requirement and selection.

Module:4	Layout Planning	6 hours

Types of Layout – Factors influencing product - Process - Tools and Techniques for developing Layout. Developing and Analysis of plant Layout – Presenting the Layout – Office Layout plot planning. Evaluation and Improvement of Layout.

Module:5	Computer Aided Plant Layout	7 hours

Data requirements – Mathematical programming procedures - Heuristics – CORE LAP -

PLANET - MAT - CRAFT- Probabilistic Approach - Random selection (ALDEP) - Based sampling - Simulation – Graph Theory – Facility design – Layout states – Scale effect. Criticism concerning Computer Aided Plant Layout.		
Module:6	**Material Handling**	**6 hours**
Objectives – Principles – Types – Degree of mechanization – Unit load concept – Material Handling cost – Relationship between Material Handling and Plant Layout – Material Handling system Design - Specification of the Design – Analyzing an existing material Handling system. Basics of material handling selection – AGVS in material Handling – Packing.		
Module:7	**Evaluation and Implementation of layout**	**6 hours**
Evaluating the Layout – Qualitative Evaluation Techniques - Efficiency indices – Cost Evaluation of Layout – Quantitative evaluation Techniques – Evaluation procedures – Making the alteration – Presenting the Layout to management – Displaying the Layout – Follow up – Approval – Reproducing the Layout - Installing the Layout.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	James A Tompkins, John A white ,Yavuz A Bozer,JMA Tanchoco, Facilities Planning, Fourth Edition, Wiley, 2010.
Reference Books	
1.	Francis, Facility Layout and Location: An analytical Approach, Pearson, 2015.
2.	Alberto Garcia-Diaz, J Macgregor smith, Pearson New International, Pearson, 2016.
3.	Sunderesh S. Heragu, Facilities Design, Fourth Edition, CRC Press, 2016.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	ENTERPRISE RESOURCE PLANNING	L	T	P	J	C
MEE1020		2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide a broad exposure to Enterprise Resource Planning (ERP) and Its Evolution over the years
2. To expose the various modules of a typical ERP System
3. To address issues relating to ERP Implementation and Customisation

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Explain the evaluation of ERP and its present form
2. Provide an ERP solution to various types of industries
3. Address the maintenance issues in ERP Implementation
4. Identify the various modules of ERP
5. Customise an ERP solution to various Industrial requirements
6. Provide ERP solution to a simple industrial requirement

Module:1	Introduction	5 hours

ERP: An Overview, Enterprise – An Overview, Benefits of ERP, ERP and Related Technologies, Business Process Reengineering (BPR), Data Warehousing, Data Mining, OLAP, SCM.

Module:2	Evolution of ERP	2 hours

Manufacturing: pre 1960-Manufacturing during 1960's-Manufacturing during 1970's and 1980's – Manufacturing during 1990's-Manufacturing beyond 2000.

Module:3	ERP Implementation	4 hours

ERP Implementation Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring.

Module:4	Post Implementation	4 hours

Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of and ERP Implementation.

Module:5	ERP Functional Modules	4 hours

Functional modules in an ERP Package, Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution.

Module:6	Integration of ERP Modules	4 hours

Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.		
Module:7	**ERP System Packages**	**5 hours**
SAP AG, People soft, BAAN, JD Edwards, QAD, SSA and Oracle – Comparison.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**
Challenging Projects (Indicative)		
Guidelines • Generally a team project [Maximum of 3 members only] • Concepts studied should have been used. • Down to earth application and innovative idea should have been attempted. Assessment on a continuous basis with a minimum of 3 reviews.		**60 hours**
Sample projects: 1. ERP concepts and implementation procedures are to be applied by considering various case studies. 2. Focus on implementing ERP in various functional modules of an organization. 3. Report in digital format which includes problem domain, information collection, ERP software chosen, performance analysis before and after implementing ERP and conclusions.		

Text Book(s)	
1.	Alexis Leon (2014), ERP demystified, 3rd Edition Tata McGraw-Hill.
Reference Books	
1.	Joseph A Brady, Ellen F Monk, Bret Wagner (2012), Concepts in Enterprise Resource Planning, Thompson Course Technology, USA, 4th edition.
2.	Vinod Kumar Garg and Venkitakrishnan N K (2013), Enterprise Resource Planning – Concepts and Practice, PHI, New Delhi, 2nd edition.
3.	Jagan Nathan Vaman (2008), ERP in Practice, Tata McGraw-Hill.
4.	Alexis Leon (2008), Enterprise Resource Planning, second edition, Tata McGraw-Hill

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	INSTRUMENTATION AND CONTROL ENGINEERING	L	T	P	J	C
MEE1027		3	0	2	0	4
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To learn the type of the system, dynamics of physical systems, classification of control system, analysis and design objective
2. To provide good knowledge of Instrumentation systems and their applications
3. To provide knowledge of advanced control theory and its applications to engineering problems

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Describe the basic principle of typical measurement systems and error characteristics
2. Understand transduction, working principles of typical sensors used in industrial applications.
3. Demonstrate the applications and role of signal conditioning circuits, data acquisition in measurement systems.
4. Formulate mathematical model for physical systems and simplify representation of complex systems using reduction techniques.
5. Describe the basic concepts in control system design and the role of feedback.
6. Analyse the stability performance of the control system design.
7. Design and realize simple circuits for instrumentation control.

Module:1	Introduction to Measurement systems	6 hours

Sensors, Transducers, classification, static and dynamics characteristics, errors, transduction principles.

Module:2	Measurement of Motion, Force and Torque	6 hours

Displacement and speed measurement for translational and rotation systems using potentiometers, LVDT and RVDT, Encoders, accelerometers and gyroscopes. Force and Torque measurements using strain gauges and piezoelectric pickups.

Module:3	Measurement of temperature, pressure and flow	6 hours

Temperature measurement using Thermistors, RTD, Thermocouple and semiconductor sensors. Pressure measurement using gage, manometers, bellows, diaphragm, differential pressure transmitter. Flow measurement using Venturi-tubes, Rotameters and anemometers.

Module:4	Signal conditioning and data acquisition	6 hours

Basic signal conditioning – bridges, amplifiers, filters, monitoring and indicating systems and data acquisition systems.

Module:5	**Modelling and representation of systems -**	**6 hours**
Model of a system, Concept of transfer function, block diagram and state space, Modelling of basic physical systems.		
Module:6	**Control concepts**	**6 hours**
Open loop and closed loop systems with examples, controller design, and performance measurements-Design of P, PI, PD and PID controllers.		
Module:7	**Stability analysis**	**7 hours**
Concept of poles and zeros, Stability analysis of system using root locus, Routh Hurwitz criterion and Phase and gain margins.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	W. Bolton, Instrumentation and Control Systems, Newnes-Elsevier publication, 2nd edition**,** 2015.
Reference Books	
1.	Ernest O. Doeblin, Measurement Systems: Application and Design, 5th Edition, Tata McGraw- Hill, 2012.
2.	Katsuhiko Ogata, Modern Control Engineering, 5th Edition, Prentice Hall of India Pvt. Ltd, 2010.
3.	Patranabis D, Instrumentation and Control, PHI Learning Pvt. Ltd, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Study, development and calibration of measuring instruments for displacement, speed, torque, force, temperature, pressure, flow, fluid level etc.	3 hours
2.	Control of DC motor, stepper motor and servomotor.	3 hours
3.	Demonstration of PID control system.	3 hours
4.	Use of MATLAB for control system simulation (Control Systems Toolbox) - Modeling of physical systems using Simulink.	3 hours
5.	Signal Conditioning Circuit for specific application.	3 hours
6.	Determination of Dynamic Performance Characteristics of First Order System.	3 hours
7.	Determination of Dynamic Performance Characteristics of Second Order System.	3 hours
8.	Determination of Dynamic Performance Characteristics of Higher Order Systems.	3 hours

9.	Analog to Digital and Digital to Analog Conversion.			3 hours
10.	Grounding Practices.			3 hours
			Total Laboratory Hours	**30 hours**
Mode of assessment:				
Recommended by Board of Studies	17-08-2017			
Approved by Academic Council	47	Date	05-10-2017	

Course code	ROBOTICS	L	T	P	J	C
MEE1030		2	0	2	0	3
Pre-requisite	NIL	Syllabus Version				
		v. 2.2				

Course Objectives:

1. To outline the basic concepts of Industrial Robots and drive system.
2. To plan and to analyze the design concepts and applications of end effectors.
3. To solve kinematics and trajectory related problems.
4. To identify the appropriate sensors for various robotics applications.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Specify various types of Robots for industrial applications
2. Design appropriate end effectors for various applications.
3. Analyze kinematics of various manipulator configurations
4. Compute required trajectory planning for the given task.
5. Select the suitable sensors for real time working of robotic arm.
6. Prepare Robot program for various industrial applications.

Module:1	Introduction to Industrial robot	4 hours

History of Robotics –Basics components of Robotics system – DOF and types of joints – Work space – Robot precession - Types of robotics configurations – Types of robotics drives – Basic motion of robot manipulator – Harmonics drives – Economics aspects of robotics system in industrial automations.

Module:2	Effectors and Grippers	4 hours

Types of end effector - Mechanical gripper – types of mechanical grippers – magnetic gripper – Vacuum gripper – Adhesive gripper – other special grippers – RCC –Tools – painting gun – welding torch –design of mechanical gripper.

Module:3	Robot control system and Robot kinematics	4 hours

Basic control system concepts – Control system analysis – Robot actuation and feedback - Manipulators - Position analysis and finite rotation and translation – Homogeneous matrices – forward and inverse kinematics – DH representation.

Module:4	Manipulator Trajectory planning	4 hours

Point-to-point and continuous path planning – trajectory planning – Cartesian space – joint space – bending path – problems in trajectory planning.

Module:5	Sensor in robotics	4 hours

Range sensing, Triangulation, structured light approach, Light-of-flight range finder – Proximity sensing: Inductive, Hall-effect, capacitive and ultrasonic sensor –Touch sensing – Force and Torque sensing		
Module:6	**Machine vision system**	**4 hours**
Introduction to Machine vision – functional block diagram of machine vision system - Sensing and Digitizing – Image processing and analysis		
Module:7	**Robot programming**	**4 hours**
Classification of robotics language – instruction set in Vel language - simple robot in palletizing and de- palletizing – simple robot program in robot arc welding.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Mikell P. Groover, Mitchell Weiss, Industrial Robotics Technology – Programming and Applications, 2nd edition, McGraw Hill, 2013.

Reference Books

1.	S. R. Deb, Sankha Deb, Robotics Technology And Flexible Automation, 2nd edition, McGraw Hill Education, 2017.
2.	Niku, Saeed. B, Introduction to Robotics: Analysis, Systems, Applications, Prentice Hall of India Pvt. Ltd , New Delhi, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)

1.	Experiment on Tool Centre Point (TCP).	3 hours
2.	Developing a robot program with point to point control method.	3 hours
3.	Developing a robot program with Continuous path control method.	3 hours
4.	Developing a robot program on given straight line profile.	3 hours
5.	Developing a robot program on given Curved profile.	3 hours
6.	Pick and place with digital signal interpret.	3 hours
7.	Forward kinematics for two link planner using Sim-Mechanics.	3 hours
8.	Inverse kinematics for two link planner using Sim-Mechanics.	3 hours
9.	Trajectory Planning using third order polynomial.	3 hours
10.	Programming two link planner with given profile.	3 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	PRODUCT DESIGN FOR MANUFACTURING	L	T	P	J	C
MEE2008		2	0	0	4	3
Pre-requisite	MEE1007/MEE2031	Syllabus version				
		v. 2.2				

Course Objectives:

1. To apply the role of DFM in product specification and standardization
2. To analyze methods of material, shape and process selections
3. To assess the design rules for manufacturing and assembly processes
4. To use approach towards robust design

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Evaluate constraints of manufacturing processes that limit design possibilities with respect to cycle time, material handling and other factory costs
2. Apply various design rules in manufacturing processes
3. Evaluate the process by design guidelines for optimum design and analyze the design alternatives in the manufacture of components
4. Apply quantitative methods to assess DFA between different designs Contents
5. Utilize CAD, CAM, CIM concepts to assess DFMA.
6. Analyze the new product development.
7. Perform DFMA on an existing design and improve its manufacturing.

Module:1	Product Design	4 hours

Introduction to Product design: Asimow's Model - Product design practice in Industry - Industrial design - Aesthetics in product design. Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design.

Module:2	Material Selection	4 hours

Physical and Mechanical Properties of Engineering Materials, Selection of Materials, Selection of Shapes, Strength consideration in product design, Design for stiffness and rigidity: Material savings in design - Ribs, corrugations, Laminates and Members. Case Studies- I.

Module:3	Manufacturing Process Selection	4 hours

Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Co-selection of Materials and Processes, Case Studies – II.

Module:4	Assembly Process Selection	4 hours

Review of Assembly Processes, Design for Welding, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Plastics, Design for Heat Treatment. Case Studies- IV.

Module:5	Use of Computer Aided Tools	4 hours

Role of computers in Product design and manufacturing: CAD/CAM softwares - product life cycle - design process – CIM - Collaborative manufacturing. Computer aided process planning.

Module:6	Design for Manufacture and Assembly	4 hours

Design for manufacturing and Assembly - principles of DFMA and applications. (Boothroyd/ Dewhurst Method – case studies using DFMA software.)		
Module:7	**New Product Development**	**4 hours**
Supporting techniques for new product development processes such as quality function deployment and quality engineering and Taguchi Method.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	A.K. Chitale, R.C. Gupta, Product Design and Manufacturing, Sixth Edition, Prentice –Hall of India, 2013.
Reference Books	
1.	Boothroyd, G.,Peter Dewhurst, Winston A. Knight, Product Design for Manufacture and Assembly, Third Edition, CRC Press, Taylor & Francis, 2010.
2	Michael Ashby., Materials Selection in Mechanical Design, 5th edition, Butterworth-Heinemann, U.K, 2016.
3	Karl T. Ulrich, Ateven D. Eppinger, Product Design and Development, 6th edition, Tata McGraw-Hill,
4	O. Molloy, S. Tilley and E. A. Warman., Design for Manufacturing and Assembly: Concepts, Architectures and Implementation. Springer. USA, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)	
Guidelines for Project: • The project will be a group project with a maximum of 3 members in a group. The size will reflect the complexity of the project. Students should make sure that the concepts to be studied are reflected in the project. • There will be a minimum of three reviews conducted in a semester and the marks will be awarded and taken for final assessment. The marks distribution for 3 reviews will be 20:30:50. • Minimum pass marks for project is 50%. If the student fails to get 50%, he/she has to re-register and redo in a subsequent semester. • If the student has got >= 50% in project, and fails in Theory, then the same marks can be taken up for grading purposes after he/she completes the Theory FAT. • Evaluation is through continuous assessment with 3 reviews. No separate FAT. Sample Projects: 1. Design of Products by implementing Design for manufacturing and assembly principles. 2. Design of home appliances using DFMA principle. 3. Design of engineering components for concurrent costing. 4. Design of automobile components using DFMA software. 5. DFMA of any new products.	**60** hours

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	MODELING AND SIMULATION OF MANUFACTURING SYSTEMS	L	T	P	J	C
MEE2013		3	0	0	4	4
Pre-requisite	MEE1007/MEE2031	Syllabus version				
		v. 2.2				

Course Objectives:

1. Expose the students to Discrete-Event Simulation as a design and analysis tool, problem solving tool, risk analysis tool, and decision-making tool in manufacturing environment.
2. Know how to conduct a successful project using manufacturing-oriented software such as Arena.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify and formulate advance problems and apply knowledge of mathematics and simulation packages to solve manufacturing problems.
2. Use the techniques, skills, and modern packages, necessary for professional practices.
3. Explain the concept of simulation and how to develop and analyze a simulation model.
4. Analyze the fundamental logic, structure, components and management of simulation modelling.
5. Demonstrate knowledge of how to use Arena.
6. Design a simulation model with detailed basic operations and inputs.
7. Demonstrate statistical analysis of output obtained from simulation model.

Module:1	Introduction to System Simulation	6 hours

Introduction to system simulation – Applications – Discrete and Continuous simulation – Simulation models – Simulation procedure – Simulation Examples – General Principles - Simulation software.

Module:2	Mathematical and Statistical Models	6 hours

Review of basic probability and Statistics – Statistical models in simulation – Selecting input probability distributions.

Module:3	Random-Number Generation	6 hours

Properties of random numbers - Generation of Pseudo-Random numbers - Techniques for generating random numbers -Testing of Random numbers.

Module:4	Random-Variate Generation	6 hours

Inverse Transform techniques - Convolution method – Acceptance - Rejection techniques.

Module:5	Input modelling	6 hours

Data collection – Identifying the distribution with data- Parameter estimation - Goodness of fit

tests – Selecting input models without data - Multi Variate and Time Series Input Models.		
Module:6	**Verification and Validation of Simulation Models**	**6 hours**
Model building, verification, and validation - Verification of simulation models - Calibration and validation of models.		
Module:7	**Applications - Simulation modeling using ARENA**	**7 hours**
A packaging line, Modeling machine failures, Assembly operations Batch processing, production/Inventory system.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Jerry banks, John S Carson, Barry L Nelson and David M Nicol, Discrete Event System, Simulation, 5th Edition, Pearson Education Asia, 2013.
Reference Books	
1.	Averill M. Law, Simulation modeling and analysis, 5th edition, McGraw-Hill Education, 2014.
2.	W. David Kelton, Randall P. Sadowski, Nancy B. Zupick, Simulation with Arena, 6th edition, McGraw-Hill Education, 2014.
3.	Sheldon M. Ross, Simulation, 5th Edition, Academic Press, 2012.
4.	Barry L. Nelson, Mathematics, Stochastic Modeling: Analysis and Simulation, Dover Publications, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Projects (Indicative)	
Project Guidelines ▪ Generally a team project [Maximum 4 members]. ▪ Report in digital format which includes problem & system description, input data collection and analysis, arena model, experimentation & output analysis and conclusions. ▪ Focus on practical real life applications of simulation in manufacturing environment ▪ Assessment on a continuous basis with a minimum of 3 reviews. ▪ Simulation methodologies and techniques studied in Modeling and Simulation of Manufacturing Systems are to be applied. **Sample projects** ▪ Life-cycle of simulation models: requirements and case studies in the automotive industry. ▪ Simulation metamodel development using neural networks for automated	60 [Non-contact hours]

material handling systems in semiconductor wafer fabrication. ▪ Fast simulations of large-scale highly congested systems. ▪ General modeling and simulation for enterprise operational decision-making problem.	

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	NON-DESTRUCTIVE TESTING	L	T	P	J	C
MEE2015		3	0	2	0	4
Pre-requisite	MEE1005	Syllabus version				
		v. 2.2				

Course Objectives:

1. Teach different surface inspection techniques.
2. Impart knowledge on different Non-destructive testing methods
3. Demonstrate various special Non-destructive testing methods.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify appropriate surface inspection techniques for various engineering component.
2. Select suitable radiography testing methods for different applications.
3. Apply eddy current and ultrasonic testing methods suitably for detecting internal defects.
4. Apply acoustic emission techniques for suitable engineering applications
5. Select suitable special non-destructive technique for various applications.
6. Detect the defects using non-destructive testing methods

Module:1	Introduction to NDT	5 hours

Procedure,testing and evaluation, Visual examination.

Module:2	Surface NDT Techniques	7 hours

Liquid penetrant testing - Dye penetrant testing,Basic principle, Types of dye and methods of application, Developer; Magnetic particle testing - Magnetic particle testing,Basic theory of magnetism, Magnetization methods, Field indicators, Particle application, Inspection. Advantages and limitations of techniques.

Module:3	Radiographic Testing	6 hours

Radiography principle, X-ray films, exposure, penetrameter, radiographic imaging, inspection standards and techniques, Radiography applications, limitations and safety.

Module:4	Eddy Current Testing	6 hours

Principle, depth of penetration, eddy current response, eddy current instrumentation, probe configuration, applications and limitations.

Module:5	Ultrasonic Testing	6 hours

Properties of sound beam, ultrasonic transducers, inspection methods, flaw characterization technique, immersion testing.

Module:6	Acoustic emission testing	6 hours

Theory of AE sources and Waves, Equipment, Signal Features, Data display, source location,

Barkhausen noise, Applications.		
Module:7	**Special / Emerging Techniques**	**7 hours**
Leak testing, Holography, Thermography, Magnetic resonance Imaging, Magnetic Barkhausen Effect. In-situ metallography.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Wong B Stephen, Non-Destructive Testing - Theory, Practice and Industrial Applications, 1st edition, LAP Lambert Academic Publishing, USA, 2014.
Reference Books	
1.	Ravi Prakash, Nondestructive Testing Techniques, 1st rev. edition, New Age International Publishers, 2010.
2.	J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, 2nd edition, Tata McGraw-Hill Education, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Inspection of welds/samples using solvent removable visible dye. penetrant.	2 hours
2.	Inspection of welds using solvent removable fluorescent dye. penetrant.	2 hours
3.	Familiarization and calibration of eddy current equipment.	2 hours
4.	Inspection on non magnetic/magnetic materials by eddy current. method.	2 hours
5.	Detection of surface flaws in bore holes using eddy current..testing.	2 hours
6.	Conductivity variation measurement using eddy current testing.	3 hours
7.	Dimensional variations measurement using eddy current testing.	3 hours
8.	Inspection of welds/samples by Magnetic Particle Testing - Drymethod	3 hours
9.	Inspection of welds/samples by Magnetic Particle Testing- Wetmethod	3 hours
10.	Inspection of a welded plate by radiographic single wall single image technique- X rays.	3 hours
11.	Corrosion survey using Ultrasonic testing.	3 hours
12.	Detection of surface flaws using eddy current testing in nonferrous material.	2 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	RAPID MANUFACTURING TECHNOLOGIES	L	T	P	J	C
MEE2016		2	0	0	4	3
Pre-requisite	MEE1031 / MEE1007	Syllabus version				
		v. 2.2				

Course Objectives:

1. To introduce students about the basics of rapid prototyping/manufacturing technologies and its applications in various fields, reverse engineering techniques and its significance in rapid manufacturing.
2. To familiarize students about CAD format and process parameter required for commercial rapid prototyping systems
3. To teach students about mechanical properties, geometric issues and post processing relating to specific rapid prototyping techniques.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Demonstrate the knowledge of Rapid Prototyping/Manufacturing technologies.
2. Get exposed to design rules for commercial Rapid Prototyping systems.
3. Possess the knowledge of the Rapid Prototyping software.
4. Create awareness of rapid manufacturing applications in tooling, biomedical, architecture, etc.,
5. Ability to use techniques, skills and modern engineering tools necessary for engineering practice
6. Create critical thinking and innovative skills

Module:1	Introduction to Rapid Manufacturing	4 hours

Additive Manufacturing evolution, Additive manufacturing processes and their relationship with subtractive manufacturing, Advantages of RM. Generalized rapid manufacturing process chain, Rapid Tooling –Benefits, Applications.

Module:2	Data Processing for Rapid Manufacturing	4 hours

Conceptualization and CAD model preparation, data formats – Conversion to STL file format, Fixing the STL file, Part orientation, Support structure design, Model Slicing, Direct and adaptive slicing,Tool path generation.

Module:3	Rapid Manufacturing Processes, Materials and its application	4 hours

Sintering, Powder Bed Fusion, extrusion, jetting, Photo-polymerization, direct-write, sheet lamination, directed-energy deposition and the latest state of the art. Multiple Materials, Hybrids, Composite Materials, current and future directions.

Module:4	Post-Processing	4 hours

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and

thermal techniques.		
Module:5	**Design for Rapid Manufacturing (DFRM)**	**4 hours**
Core DFAM Concepts and Objectives: Complex Geometry, Customized Geometry, Integrated Assemblies and Elimination of Conventional design for manufacture (DFM) Constraints. RM Unique Capabilities, Exploring Design Freedoms and Design Tools for RM.		
Module:6	**Guidelines for process selection**	**4 hours**
Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control.		
Module:7	**Rapid Tooling**	**4 hours**
Direct tooling & Indirect Tooling methods, Applications of Rapid Tooling in Reaction Injection Molding, Wax Injection Molding, Vaccum Casting, RTV Silicone Rubber Molds, Spin-Casting, Cast Resin Tooling, Hydroforming and Thermoforming.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed., Springer Science & Business Media, 2015.
Reference Books	
1.	DongdongGu, Laser Additive Manufacturing of High-Performance Materials, Springer Publications, 2014.
2.	Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles andApplications in Manufacturing, World Scientific, 2010.
3.	Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)	
Guidelines: # Generally a team project of Five. # # Concepts studied in different Modules, as relevant, should have been used. ### Report in Digital format with all drawings using software package to be submitted.	
Sample Projects: • Projects on CAD data generation for 3D printing using various tools	60 [Non-contact hours]

	including: various scanning and reverse engineering techniques and related software. • Projects on CAD data processing such as STL file corrections, orientation optimization, support and toolpath generation for economically producing the components with desired properties. • Design and fabrication of working models for the conceptual testing applications. • Build complex engineering assemblies in plastic material with less process planning. • Redesign the existing locomotive key-components for weight reduction without effecting the functionality that can be produced only by additive manufacturing.			
Mode of assessment:				
Recommended by Board of Studies	17-08-2017			
Approved by Academic Council	47	Date	05-10-2017	

Course code	PRODUCTION PLANNING AND CONTROL	L	T	P	J	C
MEE2033		3	0	0	0	3
Pre-requisite	MEE1014	Syllabus Version				
		v. 2.2				

Course Objectives:

1. Compare the various production systems like job, batch and continuous and to perform aggregate planning.
2. Acquire knowledge in Master Production Schedule (MPS) and Material Requirement Planning (MRP).
3. Analyse the required capacity with respect to people and process.
4. Compare the push and pull strategies.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply graphical and mathematical model for aggregate planning.
2. Develop Master Production Schedule (MPS).
3. Perform Material Requirement Planning (MRP).
4. Plan for capacity requirement using tools like Resource Requirement Planning (RRP), Capacity Requirement Planning (CRP), Rough Cut Capacity Planning (RCCP).
5. Design lean manufacturing strategies for effective shop floor control
6. Develop Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) solutions.

Module:1	Introduction to Production Planning and Control	6 hours

Introduction to Production Planning and Control - Definition - Objectives of Production Planning and Control – Functions of production planning and control - Elements of production control - Types of production - Organization of production planning and control department – Internal organization of department.

Module:2	Aggregate Planning	7 hours

Aggregate Planning - Introduction-Linear decision rules (LDR) - Graphical approach - Mathematical programming model.

Module:3	Master Production Schedule (MPS)	5 hours

Master Production Schedule (MPS) - Role of MPS-Inputs Outputs-MPS approach to production strategy-Principles of MPS-MPS performance measures-Case study example.

Module:4	Material Requirements Planning (MRP)	7 hours

Material Requirements Planning (MRP)- Introduction Objectives-Functions-Terminology-MRP System: Inputs, Outputs, Benefits, Technical issues-MRP logic-Lot sizing considerations-Manufacturing resource planning.

Module:5	**Capacity management**	**7 hours**
Capacity management- Introduction, Capacity control, Capacity planning-Resource requirement planning (RRP)-Rough cut capacity planning (RCCP): Benefits, Pitfalls of RCCP-Capacity requirement planning: Inputs and outputs of CRP.		
Module:6	**Shop floor control**	**5 hours**
Shop floor control – Just in time (JIT) – Key elements, techniques – JIT & PPC – Pull & Push Systems – Kanban system – Types, number of Kanban calculations, Design, advantages and disadvantages.		
Module:7	**ERP systems**	**6 hours**
ERP systems – Components, Modules, Implementation, advantages and disadvantages - Technical aspects of SAP. Supply Chain Management (SCM): Introduction-Components, stages, Decision phases – Supply chain macro processes in a firm.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Vollmann, T.E., Berry, W.L., Whybark, D.C., and Jacobs, F.R., (2010), Manufacturing Planning and Control for Supply Chain Management, 6th Edition, Mc Graw-Hill Irwin.

Reference Books

1.	Curran, T. and Keller, G., (2009), SAP R/3 Business Blueprint, Prentice-Hall.
2.	Sipper, D., Bulfin, R.L., (2007), Production Planning, Control, and Integration, Mc Graw Hill.
3.	S.K. Mukhopadhyay (2009), Production planning and control – Text and Cases, PHI Ltd.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	INDUSTRIAL ECONOMICS	L	T	P	J	C
MEE2034		3	0	0	0	3
Pre-requisite	MEE1024	Syllabus version				
		v. 2.2				

Course Objectives:

1. To impart knowledge on the analytical skills required for understanding problems in industrial economics.
2. To explain the various aspects of strategic interaction between firms and the determinants of industrial structure.
3. To demonstrate economic models of firm behaviour to analyse questions in business strategy, competition policy and regulations.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify the factors of production and output-cost relationship.
2. Apply break-even analysis to study the volume-profit relationship.
3. Select the suitable pricing methods for various objectives.
4. Describe the time value of money for different cash flow models.
5. Evaluate the market structure for profit maximization criteria.
6. Analyse the investment alternatives using capital budgeting models.
7. Make use of suitable depreciation methods.

Module:1	Introduction to Economics	6 hours

Definitions, Engineering Costs & Estimating; Scope, Difference between Microeconomics & Macroeconomics. Theory of production; production function, meaning, factors of production (meaning & characteristics of Land, Labour, capital & entrepreneur), Law of variable proportions & law of returns to scale.

Module:2	Cost	6 hours

Meaning, short run & long run cost, marginal cost, opportunity cost. break even analysis – margin of safety – angle of incidence and multi product break even analysis -Effect of changes in volume, selling price, fixed cost and variable cost.

Module:3	Determinants of price	6 hours

Pricing under different objectives – Pricing under differentmarket structures – Price discrimination – Pricing of Joint products – Pricing methods inpractice.

Module:4	Estimating models and cash flow diagram	6 hours

Time value of money, equivalence, compound interest, Uniform series and compound interest factor, Arithmetic & geometric gradient.

Module:5	**Markets**	**6 hours**
Meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly)National Income; meaning, stock and flow concept, NI at current price, NI at constant price, GNP, GDP, NNP,NDP, Personal income, disposal income.		
Module:6	**Current assets and liability decisions**	**6 hours**
Estimation of working capital requirements – Management of accounts receivable – Inventory – Cash – Inventory valuation methods. Significance of capital budgeting – payback period – present value method – Accounting rate of return method.		
Module:7	**Depreciation**	**7 hours**
Introduction, Straight line method of depreciation, declining balance method ofdepreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P. (2012). Engineering Economic Analysis. New York: Oxford University Press.
Reference Books	
1.	V.L.Mote, Samuel Paul and G.S.Gupta (2007), Managerial Economics – concepts and cases, TMH, 40th reprint
2.	R.Panneerselvam (2013), Engineering Economics, 2nd Edition, PHI
3.	Yogesh Maheshwari (2005), Managerial Economics", second edition, PHI
4.	A.RamachandraAryasri and V.V.Ramana Murthy (2004), Engineering Economics and Financial Accounting", TMH, New Delhi

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	LOGISITICS AND SUPPLY CHAIN MANAGEMENT	L	T	P	J	C
MEE2035		3	0	0	0	3
Pre-requisite	MEE1024	Syllabus version				
		v. 2.2				

Course Objectives:

1. To improve the overall organization performance and customer satisfaction by improving product or service delivery to consumer.
2. To fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory and labor.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Demonstrate the needs of LSCM
2. Analyse the total cost of Logistics System.
3. Perform benchmarking for establishing the optimal supply chain.
4. Evaluate different alternatives and select best sourcing and transportation.
5. Apply Information Technology tools for Supply Chain coordination.
6. Provide Logistics and SCM solution for the global market
7. Optimise inventory level in a Supply Chain.

Module:1	Logistics and Competitive strategy	6 hours

Competitive advantage – Gaining Competitive advantage through logistics – The Mission of Logistics Management - Integrated supply chains – Supply Chain and Competitive performance - The changing logistics environment - Models in Logistics Management - Logistics to Supply Chain Management – Focus areas in Supply Chain Management.

Module:2	Measuring logistics costs and performance	6 hours

The concept of Total Cost analysis – Principles of logistics costing – Logistics and the bottom-line – Impact of Logistics on shareholder value - customer profitability analysis –direct product profitability – cost drivers and activity-based costing.

Module:3	Logistics and Supply chain relationships	6 hours

Benchmarking the logistics process and SCM operations –Mapping the supply chain processes – Supplier and distributor benchmarking –setting benchmarking priorities –identifying logistics performance indicators –Channel structure – Economics of distribution –channel relationships – logistics service alliances.

Module:4	Sourcing, Transporting and Pricing Products	6 hours

sourcing decisions in supply chain – transportation in the supply chain – transportation infrastructure – suppliers of transport services – basic transportation economics and pricing – transportation documentation - pricing and revenue management in the supply chain.

Module:5	**Coordination and Technology in Supply Chain**	**6 hours**
Lack of coordination and Bullwhip Effect - Impact of lack of coordination - Role of IT in the supply chain – Customer Relationship Management –Internal supply chain management - Supply chain IT in practice - Information technology and the supply chain.		
Module:6	**Managing global Logistics and global Supply Chains**	**6 hours**
Logistics in a global economy – views of global logistics- global operating levels – interlinked global economy – The global supply chains -Global supply chain business processes –Global strategy –Global purchasing – Global logistics – Channels in Global logistics –Global alliances – Issues and Challenges in Global supply chain Management.		
Module:7	**Planning & Managing Inventories in a Supply Chain**	**7 hours**
The role of cycle inventory in a supply chain –Managing multi echelon cycle inventory – Estimating cycle inventory – related costs in practice – the role of safety inventory in a supply chain – managing safety inventory in a multi echelon supply chain – the role of information technology in inventory management – estimating and managing safety inventory in practice.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Donald J. Bowersox and David J. Closs, (2006), Logistical Management: The Integrated Supply ChainProcess, TMH,

Reference Books

1.	Edward J Bradi, John J Coyle (2010) A Logistics Approch to Supply Chain Management, Cengage learning, New Delhi,
2.	Chopra, S. and Meindl, P., (2014) Supply Chain Management: Strategy, Planning & Operations, 6th edition, Pearson Education (Singapore) Pvt. Ltd.
3.	Simchi-Levi, D. Kaminsky, P. Simchi-Levi, E. and Ravi Shankar (2008) Designing & Managing the Supply Chain: Concepts, Strategies & Case Studies, Third Edition, Tata McGraw-Hill, Third Edition,

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	INDUSTRIAL CORROSION AND TRIBOLOGY	L	T	P	J	C
MEE2036		3	0	0	4	4
Pre-requisite	MEE1005	Syllabus version				
		v. 2.2				

Course Objectives:

1. To provide a broad exposure all industrial corrosion and tribological problems
2. To develop methods to prevent corrosion and wear in real life industrial situations
3. To provide an exposure on various testing techniques in corrosion and wear

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify and model various types of corrosion
2. Analyse friction, wear and lubrication issues in various industrial scenario
3. Analyse the role of surface texture on the tribological behaviour
4. Design a suitable process to control friction and prevent wear
5. Conduct various tests to measure corrosion and wear
6. Apply the concepts to solve actual industrial problems

Module:1	Introduction	6 hours

Importance and economics of corrosion, Principles of corrosion - dry and wet corrosion –low temperature and high temperature corrosion in industries

Module:2	Corrosion rate expressions	5 hours

Introduction, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies

Module:3	Different forms of corrosion	6 hours

Introduction, uniform attack, galvanic, crevice, pitting, intergranular, selective leaching, erosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, cavitation corrosion, dezincification, dealuminization, graphitization, erosion corrosion , examples in each case related to different industry components

Module:4	Friction Wear and Lubrication	7 hours

Friction, Friction theories 5,Friction & vibration interaction ,Effect of adhesion,Theory of wear, Hydrodynamic lubrication, EHL, Mixed lubrication, Hydrodynamic lubrication, EHL, Mixed lubrication with examples in Industries

Module:5	Surface Texture and its application in tribology	7 hours

Texture technique, Friction reduction,Wetting capability control :Micro/nano Tribology :Scale effect, Tribology challenge in Micro system,Tribo-corrosion:Synergitic effect between wear and corrosion, failure due to tribo-corrosion

Module:6	**Prevention of corrosion and wear**	**6 hours**
Introduction, Types of coatings, advanced coating technology with examples used in industry		
Module:7	**Testing wear and corrosion**	**6 hours**
Testing wear and corrosion, Types of testing and standards adopted in industries		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Challenging Projects (Indicative)

- Generally a team project [Maximum of 3 members only]
- Concepts studied should have been used.
- Down to earth application and innovative idea should have been attempted.

Assessment on a continuous basis with a minimum of 3 reviews.

• Design of experiments to study accelerated corrosion • Coatings to prevent wear and corrosion • To perform failure analysis due to corrosion and wear • To develop new techniques to prevent corrosion and wear • To identify problems in industries and provide suggestion based on literature survey	**60** hours

Text Book(s)

1.	Fontana M.G., (2017), Corrosion Engineering, McGraw Hill.
2.	Pradeep l. Menezes (2016),Tribology for scientists and engineers , Springer.

Reference Books

1.	Revie W.R. and Uhlig H.H., (2008), Corrosion and Corrosion Control, 4th Ed., Willey.
2.	ASM Handbook, (2003), Corrosion: Fundamentals, Testing, and Protection, Vol 13A, ASM International
3.	Ed: N.Ranganathan, (2015), Material characterization :Modern methods and applications,CRC press, Taylor and Francis
4.	John A. Williams, (2005) Engineering Tribology, Cambridge University Press

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	**AGILE MANUFACTURING**	**L**	**T**	**P**	**J**	**C**
MEE2037		**3**	**0**	**0**	**0**	**3**
Pre-requisite	**MEE1014**	**Syllabus version**				
		v. 2.2				

Course Objectives:

1. To impart knowledge on the pace of changes in the manufacturing technology.
2. To learn the concepts of Lean, Flexibility, and Agility as applied in automotive manufacturing and supply chain management
3. To acquire the ability to apply tools like Production Line Diagnostics and Value Stream Mapping

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Apply the concept of agile manufacturing
2. Execute various agile practices in manufacturing and service sectors
3. Apply recent technology to improve process agility
4. Apply various methods to compute agility of the organization
5. Create learning factory for future developments
6. Use computer aided tools to improve agility
7. Manage corporate knowledge strategically in agile manufacturing

Module:1	**Introduction**	**6 hours**

Types of Production- The Agile Production Paradigm- History of Agile Manufacturing- Agile Manufacturing Vs Mass Manufacturing, Agile Manufacturing Vs Mass Customization- Agile Manufacturing Research Centres.

Module:2	**Agile Practices**	**6 hours**

Agile practice for product development - Manufacturing agile practices -understanding the value of investing in people, Concept models of Agile ManufacturingInfusingmanagerial principles for enabling agility.

Module:3	**Implementing technology to enhance agility**	**6 hours**

Implementing technology to enhance agility- Implementing new technology – reasons – guidelines preparation for technology implementation - A checklist, technology applications that enhance agility - agile technology make-or-buy decisions.

Module:4	**Performance Measurement and Costing**	**6 hours**

Measurement of agility – methods – Scoring and Fuzzy approaches – Costing for Agile Manufacturing practices – Activity Based Costing.

Module:5	**Creating the learning factory**	**6 hours**

Imperative for success, factory becoming a learning factory, building a road map for becoming a learning factory - core capabilities, guiding vision, leadership that fits, ownership and commitment, pushing the envelope, prototypes, integration, learning challenges for learning manufacturing business.

Module:6	**Computer control of agile manufacturing**	**6 hours**
CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, examples.		
Module:7	**Corporate knowledge management in agile manufacturing**	**7 hours**
Strategies, strategic options in Agile manufacturing, Role of standards.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	S. R. Devadasan, V. Sivakumar, R. Murugesh, P. R. Shalij, (2012), Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", PHI, Delhi.

Reference Books

1.	Gunasekaran A, (2001), Agile Manufacturing, 21st Strategy Competitiveness Strategy", Elsevier Publications.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	FINITE ELEMENT ANALYSIS	L	T	P	J	C
MEE3002		2	2	2	0	4
Pre-requisite	MAT3005, MEE1032 / MEE2002	Syllabus version				
		v. 2.2				

Course Objectives:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics, heat transfer and fluid flow problems.
2. To teach the students the characteristics of various elements and selection of suitable elements for the problems being solved.
3. To make the students derive finite element equations for simple and complex elements.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Distinguish different numerical methods involved in Finite Element Analysis
2. Apply equations in finite element methods for 1D, 2D and 3D problems.
3. Apply shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
4. Formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics.
5. Analyse beams and shafts using finite element analysis.
6. Apply commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems.

Module:1	Introduction to Finite Element Method	3 hours

General description of Finite Element Method – Historical development – Comparison with classical methods – Other numerical methods such as FDM, BEM, etc. - General procedure of FEM – Application software's in FEM.

Module:2	Approximate Solutions to Engineering Problems	4 hours

General field problems - GDE formulation - discrete and continuous models – approximate solution as a polynomial - minimization of residue – Weighted residual methods – collocation method, sub domain method, method of least squares and Galerkin method - Variational formulation Ritz method - numerical problems.

Module:3	Finite Element Formulations to 1-D problems	4 hours

II order problems - Bar Problem – Formulation for the whole domain – Formulation for the sub-domain (finite element) using interpolation polynomial - Nodal approximation using shape function – computing element matrices - Assembly of element matrices – Application of B.Cs – solution – post processing.

Module:4	Beam problems	4 hours

(IV order problems) – B.Cs & loading conditions on to nodes – element matrices - solution and

post processing of results – I Dimension problems such as Heat transfer problems, Vibration problems in bar and beams etc.		
Module:5	**Two Dimensional problems**	**5 hours**
Discretization: Geometrical approximations – Simplification through symmetry – Element shapes and behaviour – Choice of element types – Simplex - Complex and Multiplex elements – Selection of interpolation polynomials (shape functions) - Convergence requirements – Element shape and distortion – Location of nodes – Node and Element numbering.		
Module:6	**Field problems – scalar and vector variables**	**4 hours**
Scalar variable problems such as heat transfer, torsion of non-circular shafts etc – Vector variable problems such as plane stress, plane strain and axi-symmetric problems.		
Module:7	**Natural coordinate systems**	**4 hours**
Derivation of shape functions for various elements – Isoparametric elements – 1D, 2D and 3 D elements - Numerical Integration and its advantages.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours	**30 hours**

Text Book(s)

1.	Tirupathi R. Chandrupatla and Ashok D. Belugundu, Introduction to Finite Elements in Engineering, 4th Edition, Prentice Hall, 2011.

Reference Books

1.	Daryl L. Logan, A First Course in the Finite Element Method, Cengage Learning, 2011.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

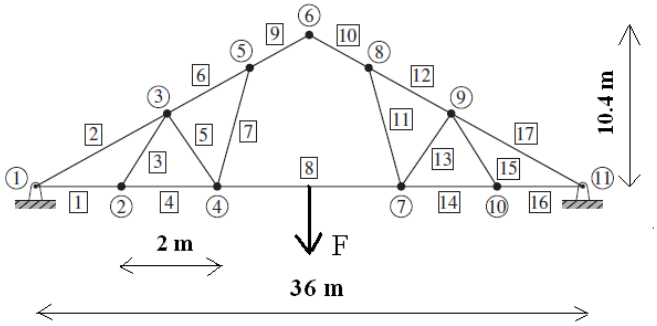
List of Challenging Experiments (Indicative)

Sample Tutorials		Module	Hours
1.	Problems in Weighted residual methods , collocation method, sub domain method, method of least squares and Galerkin method - Variational formulation Ritz method.	2	2
2.	Problems in stress analysis in a bar due to point load and uniformly distributed load; with uniform and non-uniform cross section.	3	4
3.	Problems in 1 D bar element - Heat Transfer Problem; Uniform and non-Uniform bars.	4	4
4.	Problems in 1 D bar element - Vibration Problem.	4	3
5.	Problems in 1 D beam element- Stress analysis of beam with uniform and varying cross section and varying BCs.	4	3
6.	Problems in Beam element- With mass and springs	4	2

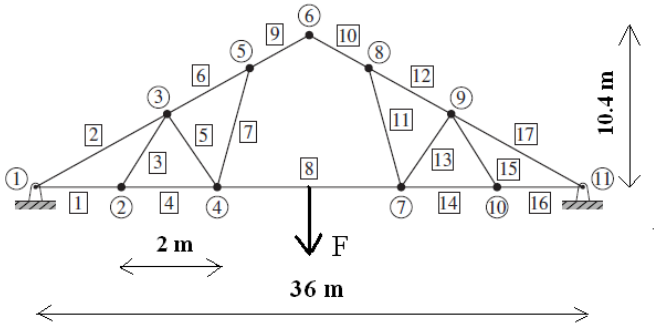
	attached to ends.		
7.	Stress analysis in a plate: Triangular element applicable to axial and bending applications.	5	6
8.	Problems on stress analysis of axisymmetric solids.	6	2
9.	Problems on Plain stress and plain strain examples.	6	2
10.	Problems on Numerical integration and Gauss Quadrature.	7	2
		Total Laboratory Hours	**30 hours**

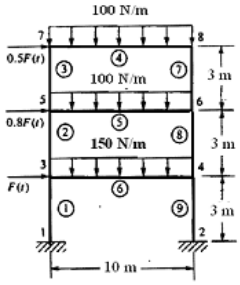
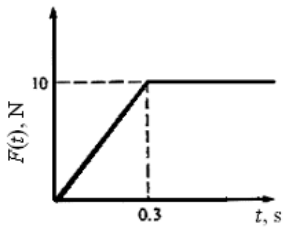
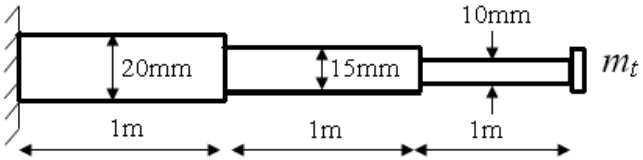
List of Challenging Experiments

1. Evaluate the stress developed at each bar and natural frequencies of the plane truss structure shown in figure which is composed of members having a square 15 mm x 15 mm cross section, modulus of elasticity *E*= 69 GPa and density 1000 kg/m^3. b) Plot the graph between the maximum displacement of the structure and the various excitation frequencies (ω rad/s) when a load of F= 10e$^{i\omega t}$ is applied at the mid-point of the truss #8 as shown in the figure. Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software.



2. Evaluate the stress developed at each bar and natural frequencies of the plane truss structure shown in figure which is composed of members having a square 15 mm x 15 mm cross section, modulus of elasticity *E*= 69 GPa and density 1000 kg/m^3. b) Plot the graph between the maximum displacement of the structure and the various excitation frequencies (ω rad/s) when a load of F= 10e$^{i\omega t}$ is applied at the mid-point of the truss #8 as shown in the figure. Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software.



3.	Determine the maximum stress and displacement of the aluminium frame structure shown in Figure. Consider the following properties: For the elements 1 and 9: A= 8000 mm^2; I =1.6x10^5 mm^4; For the elements 2, 3, 7 and 8: A= 4000 mm^2; I =0.6x10^5 mm^4; For the elements 4, 5 and 6: A= 8500 mm^2; I =4 x10^5 mm^4; Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software.  Frame structure  Loading condition
4.	Determine the first ten natural frequencies for transverse vibration and draw the first five mode shapes of the rectangular beam with varying cross section and tip mass 10N as shown in Figure. The width of the beam is 10mm. The other properties of the beam are as: ρ = 7810 kg/m^3; E = 2.1x10^{11}; ν = 0.3; Also perform the modal analysis of the beam and prove the orthogonality of normal modes. A harmonic force of $100e^{i\omega t}$ is applied at one third of the length from the left support. Determine the maximum displacement of the structure. Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software. 
5.	Consider an isotropic beam with a variable cross section and tip mass as shown in figure . The thickness of the beam is kept constant and the characteristics width of the cross-section is assumed to vary exponentially along the length of the beam according to the following relations: $A(x) = A_0e^{(-x/l)}$, where A_0 is the area at the root. Investigate the free transverse vibration response of the beams (*ie*., determination of natural frequencies and mode shapes). The various parameters to be considered for the analysis are specified in Table 1. Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software.

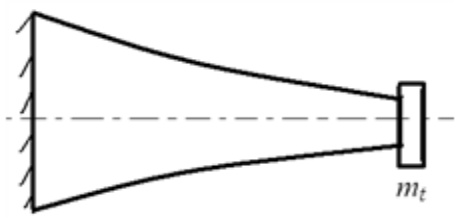
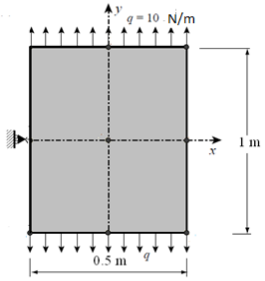


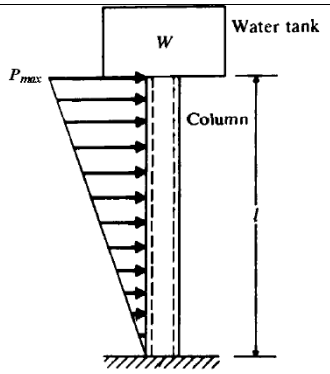
Table 1. Parameters for the free transverse vibration response

Parameter	
Length of the beam	5 m
Young's Modulus of the material of the beam	100 Gpa
Density	1000Kg/m^3
Area of cross section of the beam at the left end	0.2 m^2
Thickness of the beam at the left end	0.02
Tip mass	10 N
Poisson's ratio	0.3

6. Evaluate the maximum stress and displacement of the following structure by assuming the density of each part as 1000 kg/m^3, Young's modulus as 20000 MPa, Poisson's ratio as 0.3. Write MATLAB codes to solve the problem and compare the results evaluated using ANSYS or any commercial FE software and thickness as 2 mm.



7. A water tank of weight 4500 kg is supported by a hollow circular steel column of inner diameter 0.5m, wall thickness 25 cm, and height 10m. The wind pressure acting on the column can be assumed to vary linearly from 0 to 700 kPa, as shown in figure. Find the first ten natural frequencies of the water tank using beam elements. Plot the graph between the maximum displacement of the structure and the various excitation frequencies (ω) when a load of $q= P_{max}e^{i\omega t}$ is applied. Solve the problem using any commercial FE software and compare the answers.

	
Total laboratory hours	**60 hours**
Mode of assessment:	
Recommended by Board of Studies	17-08-2017
Approved by Academic Council	47 Date 05-10-2017

Course code	ENGINEERING FAILURE ANALYSIS	L	T	P	J	C
MEE3003		3	0	0	4	4
Pre-requisite	MEE2002 /MEE1032	Syllabus version				
		v. 2.2				

Course Objectives:

1. Explain the importance of failure study of mechanical components.
2. Discuss about various material characterization tools and analyse the failure.
3. Equip students with knowledge on (i) how to design against failures and (ii) skills required in carrying out failure analysis.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Identify and explain different types of failure of engineering materials and their characteristic features.
2. Differentiate the significance, usage and limitations of various material characterization tools used for failure studies.
3. Apply various theories of failure to the components subjected to multidirectional loading.
4. Determine the life of a mechanical component subjected to variable loading.
5. Apply the principles of fracture mechanics and design for failure against fracture.
6. Design for failure against wear failure and creep loading
7. Develop expertise on the experimental techniques and simulations utilized for failure analysis of various components and interpret the probable reasons for failure.

Module:1	Introduction	7 hours

Material failure modes and their identification; Tools for failure analysis: Optical microscopy, Transmission electron microscopy, Scanning electron microscopy. Systematic approach to failure analysis.

Module:2	Mechanical aspects of Failure	6 hours

Tensile test, Static loading, Combined stress, Principal stresses, Theories of failure, Triaxial stresses and constraint, Plane stress, Plane strain, Stress concentration factors and notch sensitivity. Shock and impact loading.

Module:3	Fatigue	7 hours

Loading under high cycle fatigue conditions, Test methods, S-N-P curves, endurance diagrams, influence factors - Low cycle fatigue, fretting fatigue; Fatigue design for combined stress; cumulative damage and life prediction, statistical interpretation of fatigue test data.

Module:4	Analysis of Fatigue	6 hours

Failures related to corrosion, hot corrosion and stress corrosion cracking; Damages due to hydrogen; Creep of metallic materials, service failures during high temperature service; Failures

related to wear.		
Module:5	**Failure Mechanisms**	**6 hours**
Fracture processes, Meaning of ductile and brittle fracture, Effect of strain rate and temperature.		
Module:6	**Fracture Mechanics**	**6 hours**
Fracture mechanics and Failures, Linear elastic fracture mechanics, fracture mechanics principles in design practice, Elastic Plastic fracture mechanics, Examples of crack-growth Analysis for cyclic loading.		
Module:7	**Failures in joints and fasteners**	**5 hours**
Welded constructions and screw fastenings, Environmental degradation, Embrittlement of metals and alloys.		
Module:8	**Contemporary issues:**	**5 hours**
	Total Lecture hours:	**45 hours**

Challenging Projects

Project — 60 [Non contact hours]

Guidelines for Project:

- The project will be a group project with a maximum of 3 members in a group. The size will reflect the complexity of the project. Students should make sure that the concepts to be studied are reflected in the project.
- Concepts studied should have been used.
- Down to earth application and innovative idea should have been attempted.
- There will be a minimum of three reviews conducted in a semester and the marks will be awarded and taken for final assessment. The marks distribution for 3 reviews will be 20:30:50.
- Minimum pass marks for project is 50%. If the student fails to get 50%, he/she has to re-register and redo in a subsequent semester.
- If the student has got >= 50% in project, and fails in Theory, then the same marks can be taken up for grading purposes after he/she completes the Theory FAT. Evaluation is through continuous assessment with 3 reviews. No separate FAT.

Sample Projects:

Failure Analysis Project – Team or Individual. Topic of the project work may be chosen based on Failure analysis and investigation of engineering component like

1. Failure of a large air conditioner fan blade.
2. Cracked automobile suspension lower arm.

3. A cracked vacuum bellows. 4. Failed welded railroads rails. 5. Broken stainless steel hinge for a check valve., etc It is essential to apply the knowledge gained in this course and incorporate them in the project. The project report should consist of Introduction, experimental and/or numerical investigation, results and discussion and conclusion. Final project report has to be submitted at the end of the course.	
Text Book(s)	

1	Arthur J. McEvily, Metal Failures: Mechanisms, Analysis, Prevention, 2nd edition, John Wiley & Sons Inc. USA, 2013.
Reference Books	
1.	Hock-Chye Qua, Applied Engineering Failure Analysis: Theory and Practice, CRC press, Taylor & Francis, U.K, 2017.
2	F.C. Campbell, Fatigue and Fracture: Understanding the basic, 1st edition, ASM International, 2012.
3	Abdel Salam Hamdy Makhlouf, Mahmood Aliofkhazraei, Handbook of Materials Failure Analysis with Case Studies from the Aerospace, BH, Elsevier,U.K, 2016.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	LASER PROCESSING	L	T	P	J	C
MEE3013		3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v. 2.2				

Course Objectives:

1. To understand the fundamental properties of laser beams as advanced materials processing and manufacturing tool.
2. To provide an overview of principles involved in laser-material interactions.
3. Provide solutions through laser based manufacturing processes for various industries.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Explain the concepts and applications of various types of laser sources
2. Analyse the functioning of laser cutting systems
3. Analyse the functioning of laser machining systems
4. Explain the material – laser interactions in different laser surface modification techniques
5. Articulate the process and process mechanisms in laser welding
6. Explain various Laser based additive manufacturing systems

Module:1	Fundamentals of Laser Technology	6 hours

Laser beam properties, focus ability, operation modes, absorption, Power source for CW and pulsed lasers: Energy transfer in solid state laser systems, ion laser systems, molecular lasers, organic dyes and liquid dye lasers.

Module:2	Types of Lasers	6 hours

Semiconductor lasers, Excimer lasers and metal vapor lasers, Optics for lasers, damage in optical components. Types of lasers: He-Ne laser, CO2 laser, Argon laser, Nd:YAG, Excimer laser, Diode laser, Fiber laser.

Module:3	Laser Cutting	6 hours

Forms of Laser Cutting - Fusion Cutting, Sublimation Cutting, Photochemical Ablation; Components of a Laser Cutting System, laser cutting parameters, Quality of Cut Part, Material Considerations, Comparison with Conventional Processes.

Module:4	Laser machining	6 hours

Laser Drilling, Process Parameters: Drilling Characteristics, Process Defects, Analysis of Material Removal during Drilling, 3-D Laser machining and laser assisted machining.

Module:5	Laser surface modification	6 hours

Laser surface heat treatment, Laser surface melting- Glazing, Laser surface alloying, Laser surface cladding and Hard coatings, laser shock peening and laser texturing.

Module:6	**Laser Welding**	**6 hours**
Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections- industrial applications.		
Module:7	**Laser Additive Manufacturing**	**5 hours**
Selective Laser Sintering (SLS), 3D Printing, Ballistic Particle Manufacturing; Solid-Based Systems: Fused Deposition Modelling, Laminated Object Manufacturing; Comparison of Major Systems; Post-Processing; Applications.		
Module:8	**Contemporary Discussion: Industry visit**	**4 hours**
Group discussion with industry persons and presentation from industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	William Steen , JyotirmoyMazumder , Kenneth G. Watkins (2010), Laser Material Processing, Springer; 4th Edition, ISBN-10: 1849960615 ISBN-13: 978-1849960618.

Reference Books

1.	Reinhart Poprawe (2011), Tailored Light 2: Laser Application Technology, RWTH, Springer, ISBN-10: 3642012361 ISBN-13: 978-3642012365.
2.	Narendra B Dahotre, AnoopSamant (2011), Laser Machining of Advanced Materials, CRC Press, ISBN-10: 0415585627, ISBN-13: 978-0415585620.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	ENGINEERING METROLOGY	L	T	P	J	C
MEE3014		2	0	2	0	3
Pre-requisite	MEE2031	Syllabus version				
		v. 2.2				

Course Objectives:

1. Understand the System of limits and fits for engineering parts.
2. Understand the fundamentals of inspection methods and systems
3. Understand the principles and operation of precision measurement tools and equipment used in modern manufacturing

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Explain the basic concept of measurement and characteristics of measuring instruments
2. Measure the linear and angular dimensions using precision measuring instruments
3. Examine the major terminologies for the gear, screw thread and roundness measurement.
4. Measure the surface roughness for the different surface texture.
5. Select the suitable type of instrument used to measure the mechanical parameters.
6. Apply the advanced techniques in metrology to calculate the geometric tolerance.

Module:1	Introduction to metrology	5 hours

Definition and concept of metrology, Need of inspection, Principles of measurement, Measuring Standards, Measuring systems and accuracy of measurement, Precision and accuracy, errors in measurement. Subdivision of standards, Line and End standards, Classification of standards, organizations.

Module:2	Systems of limits and fits	5 hours

Introduction, normal size, tolerance limits, deviations, allowance, fits and their types – unilateral and bilateral tolerance system, hole and shaft basis systems – interchangeability and selective assembly

Module:3	Linear and angular measurements	4 hours

Linear and angular measuring instruments, gauges, types of gauges, Limit gauges: GO and NO GO gauges, Slip gauges, measurement of angles and tapers: Bevel protractor - Sine bar, calibration of dial indicator and micrometer, comparators – use of comparators in mass production

Module:4	Surface Roughness Measurement	4 hours

Different surface texture, elements of surface texture, factors affecting surface finish, methods of measuring surface finish, numerical evaluation of surface roughness – Ra, Rq and Rz, Tomlinson's surface meter, Taylor-Hobson talysurf.

Module:5	Optical Measuring Instruments	3 hours

Tool maker's microscope, collimators, optical projector, principle of interference, optical flats, interference patterns – typical fringe patterns, NPL flatness interferometer		
Module:6	**Screw Thread Measurement**	**4 hours**
Terminology, Classification, Forms of thread, Errors in thread, Measurement of various Elements in threads like major diameter, minor diameter, effective diameter. Measurement of pitch, screw thread gauges, Screw pitch gauge Gear Measurement - Terminology, Gear measuring instruments, Gear tooth profile measurement, sources of error, Measurement of diameter, pitch pressure angle and tooth thickness.		
Module:7	**Advances in metrology**	**3 hours**
Instrument overlapping, metrology integration, Universal measuring machine, Basic concepts of Laser interferometer, CMM, Machine vision system – applications		
Module:8	**Contemporary Discussion**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Jain R. K., (2015), Engineering Metrology, Khanna Publications, Edition: 21st revision
Reference Books	
1.	Bewoor A.K and Kulkarni V.A, (2009), Metrology and measurement, Tata McGraw-Hill, 2009
2.	Alan S. Morris, Reza Langari (2013), Measurement and instrumentation – Theory and application, 2nd edition

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	A set of rectangular blocks (5 Nos.), each having dimensions 20mm x 10mm x 10mm, are to be inspected using (i) a vernier caliper and (ii) micrometer . Record the accuracy, precision and repeatability of the measuring instrument (record at least 10 readings / block). Provide proper inference for the results obtained. If a bilateral tolerance limit of 0.01mm is set, what will be the percentage rejection while inspecting the blocks using (i) a vernier caliper and (ii) micrometer.	2
2.	While performing the measurement operations on a cube of dimension 30mm or on any simple engineering part, record the entire measuring time by clearly demarcating the measurement by instruments for inspection. Set up a dial gauge comparator to inspect the same part for acceptance/rejection and find the percentage reduction in inspection time. Project the time saved for a 365 days, assuming 3 working shifts per day (each shift 8 hr duration); mass inspection challenge.	2

3.	Flat mild steel flats (50mm x 20mm – 5 Nos) have to be surface ground (any one side of each piece) using a surface grinder. It has to be then inspected for determining the surface roughness parameters (Ra, Rq, Rz). Determine the repeatability of the surface roughness tester (perform at least 5 trials /piece).	2
4.	Given the thread produced on a cylindrical workpiece by a single point cutting tool made on lathe. Inspect for the thread parameters by two wire method and decide the thread is within allowed tolerance values	2
5.	Given the thread made by a single point cutting tool on lathe, characterization of thread parameters by a Tool maker's microscope	2
6.	Given the single point cutting tool; Inspect the tool for the tool nomenclature components as per designation by making use of a Profile projector	2
7.	Flatness inspection of a surface on an engineering part/ Correction of flatness of the engineering part if needed	2
8.	Conduct Alignment Tests for the given machine tool-1(cylindrical surface generation machine) and record the reading as per standard testing procedure (eg: Machine Tool Manufacturers Association or similar).	2
9.	Conduct Alignment Tests for the given machine tool-2 (Flat surface generation machine) and record the reading as per standard testing procedure (eg: Machine Tool Manufacturers Association or similar).	2
	Total Laboratory Hours	**30 hours**

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	ADVANCED MANUFACTURING MANAGEMENT	L	T	P	J	C
MEE3019		3	0	0	0	3
Pre-requisite	MEE2012	Syllabus version				
		v. 2.2				

Course Objectives:

1. Identify a list of management techniques for advanced manufacturing practices
2. Demonstrate the application and usefulness of the different approaches in improving the performance the manufacturing environment
3. Apply the various techniques in designing a holistic manufacturing management system and evaluate them

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Analyse various production systems considering the requirements engineering
2. Anaylse manufacturing cells based on machine-component incidence matrix as well as the output with respect to capacity planning
3. Demonstrate the application of various heuristic and meta-heuristic algorithms in the formation of cells of large problem instances
4. Design various sequencing and scheduling rules used in manufacturing cells
5. Explain the concepts of JIT and FMS used in the manufacturing environment
6. Discuss the use of synchronous manufacturing in the identification of bottlenecks as well as in streamlining the operations

Module:1	Operations strategy	2 hours

Introduction to Operations strategy, system concept of production, types of production systems, process planning – make or bye decisions – Requirements of manufacturing – various methods – cellular manufacturing.

Module:2	Cell formation	5 hours

Cell formation – Early methods - PFA, ROC, Similarity based methods

Module:3	Cell formation algorithms	8 hours

Cell formation algorithms - p-median formulation, assignment formulation, ZODIAC algorithm, heuristic approaches, meta-heuristic approaches – MPCF considering sequence – MPCF considering work load – MPCF considering alternative process plans.

Module:4	Cell scheduling and sequencing	5 hours

Cell scheduling and sequencing - Part family sequencing – Dispatching rules

Module:5	Just in Time manufacturing & Flexible Manufacturing Systems	8 hours

Just in Time manufacturing - Concepts and definitions - implementation issues – KANBAN –

CONWIP & KANBAN, Flexible Manufacturing Systems - Concepts – FMS loading problem – FMS scheduling problems		
Module:6	**Synchronous manufacturing**	**7 hours**
Synchronous manufacturing - Concepts of SM – Theory constraints and LP – Drum – Buffer-Rope Scheduling		
Module:7	**Case Studies**	**8 hours**
TOC implementation–Manufacturing industries- Make to Stock to Make to Availabiourslity		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Global Edition, Pearson Education, Limited, 21-Jan-2015
2	Alavudeen, A., Venkateshwaran, N, Computer Integrated Manufacturing, Phi, Eastern Economy Edition, 2010
3	R.B. Khanna, Production And Operations Management, PHI, Eastern Economy Edition, 2015
Reference Books	
1.	EliGoldratt (2014), The GOAL – The process of ongoing improvement, North River Press, 2014

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	PRODUCT DEVELOPMENT AND MANAGEMENT	L	T	P	J	C
MEE3501		2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

The main objectives of the course are to:

1. Impart skills to students for applying Design innovation, Design for quality and Design optimization for designing new products
2. Train students to select materials, manufacturing processes, correct formats for documentation and to work in ways to show respect to stake holders.

Expected Course Outcome:

At the end of the course, the student will be able to:

1. Develop concepts, design modular systems and carry out documentation.
2. Evaluate the safety of new designs using the principles of mechanics of machines
3. Apply Quality function deployment (QFD), Theory of Problem solving (TRIZ), DFX, FMEA, and six sigma to design new products.
4. Use resources efficiently and Treat confidential information correctly.
5. Create documents using documentation tools from the organization's knowledge base.
6. Organize and work with stake holders to integrate their work effectively with them

Module:1	Fundamentals of drafting and presentation	7 hours

Freehand sketches, Layout and Presentation, Graphical Standards, Dimensioning and tolerances, Symbols, Product configurations and Component relationships, Design of Modular System - abstract design, Process of conception and its documentation. Product Attributes, Product configurations and Component relationships (component Matrix).

Module:2	Review of fundamentals of kinematics and dynamics	5 hours

Classifications of mechanisms-components of mechanisms – mobility analysis –D.O.F, kinematic chains, Position Analysis – Vector loop equations for four bar, slider crank and inverted slider crank mechanisms. Introduction to Vibrations-SHM, SDOF, Damping, whirling speed of shaft.

Module:3	Design and Development:	5 hours

Design Conceptualization and Philosophy, Concept generation, selection and testing, Product life cycle, Concurrent Engineering and design optimization. Design Bench Marking, Design Process development (QFD), Theory of Problem solving (TRIZ) – Value Analysis - Design Innovation, DFX, FMEA, Design for quality and six sigma.

Module:4	Material and manufacturing process selection	3 hours

Introduction to metals, nonmetals, composites and ceramics, Bio materials, Nano materials. Fundamentals of material behavior and selection. Selection of manufacturing process- casting, Forging, Metal Forming, Machining, Welding and 3D printing.

Module:5	**Document Creation and Knowledge Sharing**	**2 hours**
Access existing documents, language standards, templates and documentation tools from respective organization's knowledge base. Confirm the content and structure of the documents with appropriate people.		
Module:6	**Self and work Management**	**3 hours**
Establish and agree the work requirements with appropriate people - Keep immediate work area clean and tidy - utilize time effectively - Use resources correctly and efficiently - Treat confidential information correctly.		
Module:7	**Team Work and Communication**	**3 hours**
Leadership and management, Communicate with stake holders clearly, concisely and accurately - Work with stake holders to integrate their work effectively with them - Pass on essential information to stake holders in line with organizational requirements - Work in ways that show respect for stake holders.		
Module:8	**Contemporary issues:**	**2 hours**
Industrial Expert Guest Lecture and Seminars		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1	Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, , McGraw-Hill International Edns. 2011.
2	Radhakrishnan P, Subramanyan S and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2008.
3	Norton L. R., "Machine Design – An Integrated Approach" Pearson Education, 2005.
Reference Book(s)	
1.	Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 2000.
2	Kevin Otto and Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE). 2001
3	Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.

Challenging Lab Exercises (Indicative)	**30 [Non-contact hours]**

1. Brief Introduction of design modelling packages
2. Industrial component drafting – 2 Exercises
3. Industrial component modelling using form features - 2 Exercises
4. Industrial Product Assembly, BOM – 2 Exercises
5. Deploy problem solving methods TRIZ, DFX, FMEA tools – 3 Exercises
6. Industry standards & Documentation – 1 Exercise

Challenging Projects (Indicative)	**60 [Non-contact hours]**

An independent/team project focusing on:

1. Identify a consumer product as needed by the market, develop concept, develop CAD model, simulate in CAE environment, optimize, and develop tooling.
2. Prototyping and testing – cost evaluation –categories of cost – BOM.
3. Make a physical prototype.
4. Prepare a detailed report.

Areas of Focus(not restricted to):

Automation, Robotics, Cyber Physical System, Advanced Mechanisms Design, Automobiles Engineering, Aerospace, energy, Biomechanical and material development etc.

Recommended by Board of Studies	04-02-2020		
Approved by Academic Council	No.	Date	

Course code	DESIGN PROCESS PLANNING & MANAGEMENT	L	T	P	J	C
MEE3502		2	0	2	4	4
Pre-requisite		Syllabus version				
Anti-requisite		v. 1.0				

Course Objectives:

The main objectives of the course are to:

3. Impart students skills to apply CAD/CAM/CAE tools to develop products, manage product data and information
4. Train students to excel in document creation, team work, health, safety, self and work management

Expected Course Outcome:

At the end of the course, the student will be able to:

1. Apply CAD/CAM/CAE tools efficiently to design and develop new products
2. Analyze accuracy of assemblies and execute data exchange as per standards
3. Excel in document creation and work in line with the organization's policies and procedures
4. Evaluate knowledge, skills and competence regularly and take appropriate action
5. Implement organization's health, safety and security policies and procedures
6. Develop e-governance and manage digital data and information.

Module:1	CAD/CAM/CAE	5 hours

Review of : Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics –Introduction to CAM- NC/CNC Machines, Manufacturing Planning, Manufacturing control, Manufacturing methods, Introduction to CAE.

Module:2	Assembly Of Parts And Product Data Exchange	4 hours

Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

Module:3	Document preparation with policies, procedures and guidelines	4 hours

Create documents using standard templates and agreed language standards. Review documents with appropriate people and incorporate their inputs. Treat confidential information correctly - Work in line with organization's policies and procedures Work within the limits of their job role, Publish Documents in agreed format, importance of policies, procedures and guidelines of organization while creating documents.

Module:4	Organization work place procedures and policies	3 hours

Work place show respect for colleagues, commitments to execute the work in time, identify problems in working with colleagues and solve the problems. Adopt organization policy and procedures

Module:5	Managing Health and Safety	4 hours
Safety and security policies, policies and standards. Industry pollution and hazards. Comply with organization's current health, safety and security policies and procedures, Report any identified breaches in health, safety, and Security policies and procedures, Identify, report and correct any hazards, Organization's emergency procedures, Identify and recommend opportunities for improving health, safety, and security. Physical and mental health practices. Psychological counseling process.		
Module:6	**Data and Information Management**	**4 hours**
Fetching the data/information from reliable sources, Checking that the data/information is accurate, complete and up-to-date, Rule-based analysis of the data/information, Insert the data/information into the agreed formats, Reporting unresolved anomalies in the data/information, e-governance, Digital Transformation, Digital data and information management.		
Module:7	**Learning and Self Development**	**4 hours**
Identify accurately the knowledge and skills needed, Current level of knowledge, skills and competence and any learning and development needs, Plan of learning and development activities to address learning needs, Feedback from appropriate people, Review of knowledge, skills and competence regularly and appropriate action taken.		
Module:8	**Contemporary issues:**	**2 hours**
Industrial Expert Guest Lecture and Seminars		
	Total Lecture hours:	**30 hours**

Text Book(s)

1	Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, McGraw-Hill International Edns. 2011.
2	Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2008.

Reference Book(s)

1.	Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 2008
2	Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.
3.	Kevin Otto and Kristin Wood, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE). 2001
4	Norton L. R., "Machine Design – An Integrated Approach" Pearson Education, 2011

Challenging Lab. Exercise's (Indicative)	**30 [Non-contact hours]**
1. Brief Introduction of CAE/CAM tools packages 2. Preparing CAD models for manufacturing– 2 Exercises	

3. Use CAE tools for design validation - 2 Exercises 4. Industrial mechanism simulation – Different types of applications - 3 Exercises 5. NC/CNC based Industrial component modelling - 2 Exercises 6. Preparation manufacturing drawing with tolerances – 1 Exercise	
Challenging Projects (Indicative)	**60 [Non-contact hours]**
An independent/team project focusing on: 5. Identify a consumer product as needed by the market, develop concept, CAD model, simulate in CAE environment, optimize, and develop tooling. 6. Prototyping and testing – cost evaluation –categories of cost – BOM. 7. Make a physical prototype. 8. Prepare detailed documentation with standards. **Areas of Focus(not restricted to):** Automation, Robotics, Cyber Physical System, Advanced Mechanisms Design, CAM, Rapid Prototyping, Automobiles Engineering, Metal Casting, Forging, Tool Design.	

Recommended by Board of Studies	04-02-2020		
Approved by Academic Council	No.	Date	

Course code	TOOL DESIGN	L	T	P	J	C
MEE4001		3	0	0	4	4
Pre-requisite	MEE2031/MEE2006	Syllabus version				
		v. 2.2				

Course Objectives:

1. To teach how to select materials for cutting tools and tool material improvement methods and design of cutting tools
2. To enable the students design of locating devices and clamps
3. To analyze the design of jigs and fixtures
4. Analyze the tools for Bending, Forming and Drawing operations, and design of press tools for automotive and other industrial components

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Select suitable tool material and cutting tool design
2. Analyze the performance of jigs and fixtures
3. Design locators and clamps for jigs and fixtures
4. Design Jigs and Fixtures for Manufacturing, Testing and Assembly applications
5. Design Press Tools and forming dies using various design rules
6. Analyze the design constraints in the given problem
7. Design of cutting tools, Work holding tools and Forming tools for various industrial and automotive applications.

Module:1	Introduction to Tool Design	6 hours

Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials - Ferrous and Nonferrous Tooling Materials- Carbides, Ceramics and Diamond -Nonmetallic tool materials-Designing with relation to heat treatment.

Module:2	Design of Cutting Tools	6 hours

Metal cutting process - Selection of tool materials - Design of single point and multipoint cutting tool - Form tools, Drills, Milling cutters, broaches and chip breakers – Problems on design of single point cutting tools only.

Module:3	Locating and Clamping Methods	6 hours

Basic Principles of location - Locating methods and devices - Principles of clamping - Mechanical, Pneumatic and Hydraulic actuations - Clamping force analysis – Design problems.

Module:4	Design of Jigs	6 hours

Types of drill jigs - General considerations in the design of drill jigs - Drill bushings - Types,

methods of construction - Simple designs of Plate, Channel, Boxes, Post, Angle plate, Turnovers and Pot Jigs.		
Module:5	**Design of Fixtures**	**6 hours**
Principles - Types of fixtures - Fixtures for machine tools: Lathe, Milling, Boring, Broaching and grinding - Assembly fixtures - Inspection and Welding fixtures.		
Module:6	**Design of Press Tool Die**	**6 hours**
Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing.		
Module:7	**Design of Forming Dies**	**6 hours**
Bending dies– Forging dies – Extrusion dies - Drawing dies-Design and drafting		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**
Projects		
• Generally a team project [Maximum of 3 members only]. • Concepts studied should have been used. • Down to earth application and innovative idea should have been attempted. • Assessment on a continuous basis with a minimum of 3 reviews. **Sample projects:** 1. Design a blanking punch and die for a given component. 2. Design a stripper and Die plate. 3. Design a forming die for sheet metal bending. 4. Design an angular milling fixture for machining a component. 5. Design a drill jig for a given component. 6. Design a cold drawing die for the given dimension of pipe. 7. Design the turning fixture. 8. Design the milling fixture. 9. Design a Broaching fixture. **10.** Design a friction welding fixture.		**60**[Non contact hours
Text Book(s)		
1.	Donaldson C., Lecain G.H., Goold V.C., Tool Design, 4th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.	
Reference Books		
1.	E.G.Hoffman, Jig and Fixture Design, Thomson Asia Pvt Ltd, Singapore, 2010.	
2.	John Nee,Fundamentals of Tool Design, Sixth Edition, SME, 2010.	

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	ADVANCED MACHINING PROCESSES	L	T	P	J	C
MEE4002		2	0	0	4	3
Pre-requisite	MEE2031/ MEE2006	Syllabus version				
		v. 2.2				

Course Objectives:

1. To acquaint the basic concepts and applications of micro and nano machining processes
2. To encourage the students for developing the models (experimental/theoretical) of micro and nano machining processes.
3. To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Select the appropriate machining process based on tool-workpiece interaction and source of energy for the end product.
2. Apply the water jet cutting process with relevant process parameters for a product.
3. Recognize the material removal mechanism and process parameters of Ultrasonic machining process
4. Demonstrate the material removal mechanism of various thermal energy based processes.
5. Extend the mechanism of Electrical energy based processes and their process parameters for different applications
6. Make use of Chemical energy based processes.
7. Identify various Hybrid machining processes.
8. Utilize appropriate machining process to produce a product of required geometry and quality.

Module:1	Introduction	3 hours

Need and classification of non-traditional machining processes – Material removal in traditional and non-traditional machining process - considerations in process selection.

Module:2	Advanced cold cutting processes	4 hours

Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM) - Basic principles, process variables, process Mechanism of metal removal, applications and limitations.

Module:3	Ultrasonic machining (UM)	3 hours

Working principle, Mechanism of metal removal, Theory of Shaw and modelling of USM, Estimation of material removal, Effect of process parameters – Application, Limitation and case studies.

Module:4	High Energy Beam Machining	4 hours

Laser Beam Machining (LBM) – Electron Beam Machining (EBM) – Plasma Beam Machining (PBM) - Ion Beam Machining (IBM) – Mechanism of metal removal, Process characteristics, Accuracy and surface quality, Application.		
Module:5	**Electric Discharge Machining (EDM)**	**5 hours**
Theory of EDM, Working principle, Pulse generator circuit – RC and Controlled pulse generator – Analysis of RC circuit - Selection of process parameters, tool electrode, dielectric fluid, Machining characteristics of spark eroded surface – Recent development in EDM process - Wire Electrical discharge machining (WEDM) – working principle, process variables, characteristics, applications.		
Module:6	**Chemical and Electro Chemical Machining Process**	**5 hours**
Chemical machining - Fundamental principle, types of chemical machining, maskants, etchants - Electro Chemical Machining (ECM) – Theory of ECM – Working principle, Mechanism of metal removal, Modelling of ECM, Process characteristics – Advantages, limitations and applications.		
Module:7	**Hybrid Machining Process & Advanced Finishing Process**	**4 hours**
Hybrid Machining Process: Electro Chemical Drilling – Shaped Tube Electrolytic Machining – Electrostream Drilling – Electro Chemical Jet Drilling – Electro Chemical Deburring - Electro Chemical Grinding (ECG) – Electro Chemical Honing (ECH) – Electrochemical super finishing – Electrical Discharge Grinding (EDG) – Electrical Discharge Diamond Grinding (EDDG) - Electro Chemical Discharge Grinding (ECDG) – Process capabilities and applications. **Advanced Finishing Process:** Abrasive Flow Machining (AFM) – Magnetic Abrasive Finishing (MAF) – Magneto-rheological Finishing (MRH) - Chemo Mechanical Polishing (CMP) – Working principle – Mechanism of material removal – Surface quality – Applications.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	P Pandey and H Shan, Modern Machining Processes, McGraw Hill Education, 2017.	
2.	Kapil Gupta, N.K.Jain and R.F.Laubscher, Hybrid Machining Process: Perspectives on machining and finishing, Springer International Publishing, 2016.	
Reference Books		
1.	H. El-Hofy, Fundamentals of Machining Processes: conventional and non-conventional, 2nd edition, CRC press, Taylor & Francis group, 2014.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
Challenging Projects (Indicative)		
	Guidelines:	

	# Generally a team project of Five. # Concepts studied in Modules 2, 4, 6 should have been used. # Down to earth application and innovative idea should have been attempted. # Report in Digital format with all drawings using software package to be submitted. # Assessment on a continuous basis with a min of 3 reviews.	
	Sample Projects: 1. Evaluate the machinability of difficult to machine materials and super alloys using any of the advanced machining processes. 2. Study the surface integrity of the electric discharge machined parts by analyzing the surface finish, surface and subsurface cracks, heat affected zone, etc. 3. Analyse the geometry of small holes drilled by spark erosion machining using coordinate measuring machine and video measurement system. 4. Development of new attachments for enhancing the utility of EDM and Wire EDM machines beyond their intended purpose. (e.g. orbital EDM, wire EDM turning, Electric discharge grinding, etc.) 5. Sustainable manufacturing practices in advanced machining (e.g. near dry/dry EDM). 6. Analyze the surface characteristics of Electro Chemical Machined component. 7. Evaluate the performance of new wire material in wire-EDM. 8. Analyze the surface characteristics of components machined using advanced finishing process.	**60**[Non-contact hours]

Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017

Course code	MICRO AND NANO MACHINING	L	T	P	J	C
MEE4003		3	0	0	0	3
Pre-requisite	MEE2006 / MEE2031	Syllabus version				
		v. 2.2				

Course Objectives:

1. To acquaint the basic concepts and applications of micro and nano machining processes
2. To encourage the students for developing the models (experimental/theoretical) of micro and nano machining processes.
3. To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Classify the appropriate micro and nano machining process based on material removal mechanism.
2. Recognize the traditional micro and nano machining process and their process parameters.
3. Identify various advanced mechanical energy based Micro-Nano Machining processes, and their process parameters on the desired product.
4. Demonstrate the material removal mechanism of various Advanced Thermo-electric Micro-Nano machining Processes
5. Extend the mechanism of High Energy Advanced Thermo-electric Micro-Nano machining Processes and their process parameters for required output.
6. Select suitable Advanced Electro-chemical, Micro-Nano Machining Processes relevant to the desired product.
7. Utilize various micro and nano finishing processes.

Module:1	Introduction to Micro and Nano machining	4 hours

Classification and types of machining processes, Fundamentals of Micro and Nano machining processes, Nano materials and their applications in various industrial applications.

Module:2	Traditional Micro and Nano machining Processes	6 hours

Theory of micromachining, Operating principles and process parameters of Micro turning, Micro-milling, Micro-grinding, Applications and Limitations of micro machining.

Module:3	Advanced Mechanical Micro-Nano Machining processes	6 hours

Introduction -Classification of advanced Mechanical Micro - Nano Machining processes, Operating principles and process parameters of Abrasive Jet Micromachining (AJM), Water jet micro machining (WJM), Abrasive Water Jet Machining (AWJM),Ultrasonic Micromachining (USM), Abrasive Flow Nano finishing, Magnetic Abrasive Nano finishing.

Module:4	**Advanced Thermo-electric Micro-Nano machining Processes**	**6 hours**
Operating principles and process parameters of Electric Discharge Micromachining, Electric Discharge Grinding and Electric Discharge Diamond Grinding, Wire Electric Discharge Micromachining.		
Module:5	**High Energy Advanced Thermo-electric Micro-Nano machining Processes**	**5 hours**
Operating principles and process parameters of Laser Beam Micromachining (LBM), Electron Beam Micromachining (EBM), Focused Ion Beam Machining (IBM)		
Module:6	**Advanced Electro-chemical Micro-Nano Machining Processes**	**6 hours**
Operating principles and process parameters of Electrochemical Micromachining, Electrochemical Micro Grinding, Electro stream Micro drilling, Electro-chemical Micro deburring.		
Module:7	**Modern Finishing Processes**	**10 hours**
Advanced finishing processes (AFPs), abrasive flow machining (AFM), magnetic abrasive finishing (MAF), magnetorheological finishing (MRF), magnetorheological abrasive flow finishing (MRAFF), magnetic float polishing (MFP), elastic emission machining (EEM), ion beam machining (IBM), and chemical mechanical polishing (CMP). MEMS and Actuators - Sensors and Actuators, MEMs, Wet and Dry Etching-Surface Micromachining, Metrology For Micro manufactured Products.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Golam Kibria, B. Bhattacharyya, J. Paulo Davim, Non-traditional micro machining processes: Fundamentals and applications, Springer International publishing, 2017.
2.	V.K.Jain, Micro manufacturing processes, CRC press Taylor & Francis group, 2013. (e-book)
Reference Books	
1.	H. El-Hofy, Fundamentals of Machining Processes: conventional and non-conventional, 2ndedition, CRC press, Taylor & Francis group, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	15-10-2017

Course code	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	J	C
MEE4007		2	2	0	4	4
Pre-requisite	MEE2004/ MEE3001/MEE2032	Syllabus version				
		v. 2.2				

Course Objectives:

4. To understand the various elements involved in a transmission system.
5. To analyse the various forces acting on the elements of a transmission system.
6. To design the system based on the input and the output parameters.
7. To produce working drawings of the system involving various machine elements like pulleys, gears, clutches and brakes.

Expected Course Outcome:

Upon successful completion of the course the students will be able to

1. Design of pulleys, chain drives, rope drives and belt drives.
2. Design journal bearings and select rolling contact bearings
3. Analyze forces acting on elements of transmission systems
4. Determine performance requirements in the selection of commercially available transmission drives.
5. Design of various types of gears and gear boxes.
6. Apply various systems, materials and methods and design transmission systems

Module:1	Flexible transmission elements	7 hours

Introduction to transmission systems –factors -materials selection –stresses – belt &chain drives, Design of flat and V- belts, Design of chain drives, Design of rope drives.

Module:2	Design of bearings	4 hours

Lubrication, Design of journal bearings – using Sommerfeld number – using McKee's equations, Selection of rolling contact bearings – problems.

Module:3	Design of spur gears	4 hours

Introduction - gear kinematics – forces & stresses – factors –materials selection – design of spur gears.

Module:4	Design of helical gears	4 hours

Introduction – types - gear kinematics – virtual number of teeth - forces & stresses – factors – design of helical gears.

Module:5	Design of bevel gears	3 hours

Introduction – classifications - gear kinematics – factors – design of bevel gears – force analysis.

Module:6	Design of worm gears	3 hours

Introduction – classifications – applications – efficiency – design of worm gears.		
Module:7	**Design of gear boxes**	**3 hours**
Introduction – Types – Components – gear box housing – progression ratio – kinematic arrangement – ray diagram – design of multi speed gear boxes.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Richard G. Budynas, J.Keith Nisbett, Shigley's Mechanical Engineering Design, 10th edition, McGraw–Hill Education, 2014.
2.	Robert L.Norton, Machine Design – An Integrated Approach, 5th edition, Pearson Higher Education, 2014.
Reference Books	
1.	Juvinal, R.C and Kurt M.Marshek, Machine component design, John Wiley, 2012.
2.	V.B. Bhandari, Design of Machine elements, 3rd Edition, Tata Mc Graw Hill, 2010.
3.	Design Data, PSG College of Technology, DPV Printers, Coimbatore, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Mode of assessment:			
Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	47	Date	05-10-2017