NEW HORIZON COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

The Trust is a Recipient of Prestigious Rajyotsava State Award 2012 Conferred by the Government of Karnataka
Awarded Outstanding Technical Education Institute in Karnataka-2016
Ring Road, Bellandur Post, Near Marathalli, Bangalore -560 103, INDIA

2016 & 2017 BATCH

BE - Mechanical Engineering

Seventh and Eighth Semesters
Scheme and Syllabus

NEW HORIZON COLLEGE OF ENGINEERING

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Department of Mechanical Engineering

Academic Year 2018-19

Seventh and Eighth Semesters B.E

Scheme and Syllabus

New Horizon College of Engineering												
Department of Mechanical Engineering												
Scheme of Seventh Semester B.E Program												
Sl.No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	P	T	S				CIE	SEE	Total
1	MEE71	MECHANICAL VIBRATIONS + LAB	3	2	0	0	5	4	3	75	75	150
2	MEE72	CONTROL ENGINEERING + LAB	3	2	0	0	5	4	3	75	75	150
3	MEE73X	PROFESSIONAL ELECTIVE (PE3)	3	0	0	0	3	4	0	50	50	100
4	MEE74X	PROFESSIONALELECTIVE (PE4)	3	0	0	0	3	4	0	50	50	100
5	MEE75X	PROFESSIONAL ELECTIVE (PE5)	3	0	0	0	3	4	0	50	50	100
6	NHOPX**	OPEN ELECTIVE	3	0	0	1	4	4	0	50	50	100
TOTAL							23	24	6	350	350	700

** OPEN ELECTIVE SYLLABUS IS AVILABLE IN SEPARATE BOOK

X value	PROFESSIONAL ELECTIVE (MEE73X)	PROFESSIONAL ELECTIVE (MEE74X)	PROFESSIONAL ELECTIVE (MEE75X)
1	OPERATION RESEARCH	FUNDAMENTALS OF TRIBOLOGY	DESIGN FOR MANUFACTURING & ASSEMBLY
2	PRODUCTION AND OPERATIONAL MANAGEMENT	COMPUTER GRAPHICS	APPLIED NUMERICAL TECHNIQUES AND COMPUTING
3	RESEARCH METHODOLOGY	FUNDAMENTALS OF PLASTIC MOLD DESIGN AND DIE DESIGN	TOTAL QUALITY MANAGEMENT
4	ORGANIZATIONAL BEHAVIOUR & PROFESSIONAL ETHICS	EMERGING AUTOMOTIVE TECHNOLOGIES	HYDRAULICS AND PNEUMATICS
5	MACHINE LEARNING &ARTIFICIAL INTELLIGENCE	ADVANCED ROBOTICS	RAPID PROTOTYPING

New Horizon College of Engineering												
Department of Mechanical Engineering												
Scheme of Eight Semester B.E Program												
Sl.No	Course Code	Course	Credit Distribution				Overall Credits	Contact Hours Weekly (Theory)	Contact Hours Weekly (Lab)	Marks		
			L	P	T	S				CIE	SEE	Total
1	MEE84	FRACTURE MECHANICS	3	0	0	1	4	4	0	50	50	100
2	MEE81X	PROFESSIONAL ELECTIVE (PE6)	3	0	0	0	3	4	0	50	50	100
3	MEE82	Internship	0	4	0	0	4	-	-	50	50	100
4	MEE83	Project Work	12	0	0	0	12	0	5	200	200	400
TOTAL							23	8	5	350	350	700

MEE815- Non-Conventional Manufacturing Technologies
MEE816- Foundry Technology
MEE817- Agile Manufacturing
MEE818-Conventional and Non- Conventional Energy Resources
MEE819- Industrial Robotics
MEE810- Sustainable Energy Sources

MECHANICAL VIBRATIONS + LAB

Course code : MEE71 **Credits: 5**
L:P:T:S : 3:2:0:0 **CIE marks: 50+25**
Exam hours : 3 hours **SEE marks: 50+25**

Course outcomes: At the end of the course the students will be ableto

MEE71.1	Utilize the basic knowledge of physics and mechanics in understanding the theory behind free & forced vibrations, frequencies, damping, degrees of freedom and vibrations measuring instruments.
MEE71.2	Examine and identify the methods of determining the frequencies in cases of free, forced, damped, un-damped, multiple DOF and continuous systems
MEE71.3	Impart the solutions through detailed investigation & analysis of vibrations of machines and shafts under different loading conditions and evaluation of vibration of vibration measuring instruments.
MEE71.4	Use adequate theory, formula and analysis techniques to provide vibration solution for mechanical machine elements of specific application.
MEE71.5	Develop feasible engineering products with thorough vibrations investigation & analysis so as to benefit the industry and environment.
MEE71.6	Cultivate new products with the fundamental knowledge on vibrations by latest technological advancement in design of vibrating machine parts and components.

Mapping of the course outcome to program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE71.1	3													
MEE71.2		3	3	3										
MEE71.3				3	2	2								
MEE71.4	3	3	3	3										2
MEE71.5					2	2	1							2
MEE71.6					2				1		1			2

Module no.	Module content	Hrs	COs
1	**Introduction to vibrations:** Basic concepts and definitions. Simple harmonic motions, addition by analytical and graphical methods. Super position of waves. Beats. Representation of wave forms using Fourier series and work done by a wave (derivations and problems)	**8**	**MEE71.1** **MEE71.2**
	List of experiments: **1) Natural frequency of simple pendulum by experiment and MATLAB software.** **2) Natural frequency of compound pendulum by experiment and MATLAB software.**		
2	**Free Vibrations:** Differential equation for aundamped spring mass system using Newton's, Energy and rayleigh's methods. Natural frequency of simple and compound pendulum, and spring mass system considering the mass of the spring. Determination of natural frequencies of pendulum systems and disc-suspended mass spring systems by newtons method. Types of damping systems, Differential equation for damped spring mass system with solution for under damped, critically damped and over damped systems. Log decrement. Problems on damped systems.	**10**	**MEE71.1** **MEE71.2**

	List of experiments: **3) Natural frequency of spring mass system by experiment and MATLAB software.** **4) Natural frequency of torsional system by experiment and MATLAB software.**		
3	**Forced vibrations:** Excitation sources, equation of motion for a forced spring mass damper system, rotating and reciprocating unbalanced system response. Absolute and relative motion. Vibrations isolations and transmissibility. Problems on forced vibrations. **Vibrations measuring instruments:** Vibrometer and accelerometer. Whirling of shafts with and without air damping. Critical speed of a shaft. Problems on a vibrometer and accelerometer. Problems on critical speed of shaft.	**9**	**MEE71.2** **MEE71.4** **MEE71.6**
	List of experiments: **5) Determination of natural frequency for rigid body-spring system by experiment and MATLAB software.**		
4	**Multi degree freedom systems:** Introduction, influence coefficients, Maxwell's reciprocal theorm, Determination of natural frequency using Rayleigh's method, Dunkerley's method, Holzer's method, Stodola method and Matrix iteration method.(spring mass systems and torsional systems)	**9**	**MEE71.3** **MEE71.4**
	List of experiments: **6) Whirling of shafts and critical speed by experiment and MATLAB software.**		
5	**Continuous systems:** Introduction to continuous systems, vibrations of a string, longitudinal vibrations of rods, torsional vibrations of rods, Euler's equation of beams. Problems. **Signal conditioning and monitoring techniques:** Signal analysis and spectrum analyzers, band pass filter, dynamic testing of machines and structures, experimental modal analysis, machine condition monitoring techniques and diagnosis.	**8**	**MEE71.5**
	List of experiments: **1) Determination of natural frequency and mode shapes of longitudinal vibrations of rod.** **2) Determination of natural frequency and mode shapes of torsional vibrations of rods.**		

Text books:

1. Mechanical vibrations by V. P Singh, DhanpatRai& Co (P) Ltd, 5th edition 2015. **ISBN-978-81-7700-031-3**
2. Mechanical vibrations by S. S. Rao, Peason Prentice Hall, 6th edition 2016,**ISBN-10-0134361307**

Reference Books:

1) Mechanical vibrations, S. Graham Kelly, Schaum outline series, McGraw-Hill Education, 2016,**ISBN- 10: 007034041.**

2) Mechanical vibrations by Srinath.M.K, Sanguine Technical Publishers Bangalore, 2015. **ISBN-978 9383506 48-4**

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5		
Apply	5	5	5
Analyze	5	5	5
Evaluate	5	5	
Create			

2. SEE – (50 Marks)

Bloom's Category	**Tests(theory)**
Remember	8
Understand	7
Apply	15
Analyze	15
Evaluate	5
Create	

CIE- for lab 25 Marks

Bloom's Category	**Tests**	**Assignments**	**Quizzes/Viva**
	10	10	5
Remember			1
Understand			1
Apply		2	1
Analyze	5	4	1
Evaluate	5	4	1
Create			

SEE - 25 Marks - Lab

Bloom's Category	**Tests(theory)**
Remember	2
Understand	2
Apply	1
Analyze	10
Evaluate	10
Create	

CONTROL ENGINEERING + LAB

Course Code	**: MEE72**	**Credits**	**: 05**
L: P: T: S	**: 3:2:0:0**	**CIE Marks**	**: 50 + 25**
Exam Hours	**: 03 + 03**	**SEE Marks**	**: 50 + 25**

Course Outcomes: At the end of the Course, the student will be able to:

MEE72.1	Apply the concepts of various control systems to mechanical models and identify the Control parameters for safe usage of the system.
MEE72.2	Analyzeand categorizethe transient and steady state response of mechanical control systems to interpret the practical problems
MEE72.3	Recoil the reduction methods and evaluatethe outputs fortransfer function of control systems with suitable representations and documentation
MEE72.4	Determine the stability conditions and represent the values using graphical methods so as to facilitate the learning process further and recommend improvements if needed
MEE72.5	Design and develop system with controlled parameters and compensate the system responses to maintain the optimal functionality.
MEE72.6	Formulate,analyze and solve the problem using MAT Lab programming.

Mapping of the course outcome to program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Pso1	Pso2
MEE72.1	1													
MEE72.2		1												2
MEE72.3										1				2
MEE72.4						1	1							2
MEE72.5			1	1										
MEE72.6					2									

Module No	Module Contents	Hrs.	COs
1	**Introduction:** Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers **Mathematical Models:** Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current	09	**MEE72.1** **MEE72.2**
	Experiments: 1. Introduction to MATLAB 2. MATLAB command prompt for performing calculations, creating variables and simple Exercises		
2	**Transient and Steady State Response Analysis:** Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion.	09	**MEE72.2**
	Experiments:		

	1. Transient response analysis using MATLAB programming. 2. Steady state response analysis using MATLAB programming.		
3	**Block Diagrams and Signal Flow Graphs:** Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. MAT lab simple program for representation of block diagrams.	09	**MEE72.3** **MEE72.4**
	Experiments: 1. Construction of block diagram using MATLAB program (Minimum 5 problems)		
4	**Frequency Response Analysis:** Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles. **Frequency Response Analysis Using Bode Plots:** Bode attenuation diagrams, Stability analysis using Bode plots (Graphical method and also MAT Lab programming), Simplified Bode Diagrams	09	**MEE72.5**
	Experiments: 1. Construction of Nyquist Plot using MATLAB program (Minimum 3 problems) 2. Bode Plot analysis of control system using MATLAB (Minimum 3 problems)		
5	**Root Locus Plots:** Definition of root loci, General rules for constructing root loci, Analysis using root locus plots using graphical representation**.** **System Compensation:** types of compensation system.	08	**MEE72.6**
	Experiments: 1. Root locus analysis of control system model in z-domain using MATLAB (Minimum 5 Problems)		

TEXT BOOKS:

1. **Control Engineering,** V.U.Bakshi&U.A.Bakshi, Technical Publications, 2014 edition, ISBN-13: 978-9350996577
2. **Control System Engineering**, I J Nagrath& M Gopal, New Age International Pvt Ltd; Sixth edition (1 January 2017), ISBN – 13: 978-9386070111

REFERENCE BOOKS:

1. **Control Engineering,** D. Ganesh Rao,Pearson Education, 2010 edition, ISBN-13: 978-8131732335
2. **MATLAB: Easy Way of Learning,** S. Swapna Kumar&S. V. B. Lenina, Prentice-Hall of India Pvt.Ltd, 2016 edition, **ISBN-13:** 978-8120351653
3. **MATLAB: An Introduction with Applications,** Amos Gilat, Wiley; Fourth edition (9 August 2012), **ISBN-13:** 978-8126537204
4. **MATLAB and Simulink for Engineers,** Agam Kumar Tyagi, Oxford; Pap/Cdr edition (24 November 2011), **ISBN-13:** 978-0198072447

CIE- (50 Marks Theory)

Bloom's Category	Tests	Assig nments	Quizzes
Marks (out of 50)	**25**	**15**	**10**
Remember	2		
Understand	3		
Apply	5		
Analyze	10		5
Evaluate	5	7.5	5
Create		7.5	

SEE –(50 Marks)

Bloom's Category	Tests(theory)
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

CIE- 25 Marks for lab

Bloom's Category	Tests	Assignments	Quizzes/Viva
	10	10	5
Remember			1
Understand			1
Apply			1
Analyze	5	4	1
Evaluate	5	4	1
Create		2	

SEE - 25 Marks - Lab

Bloom's Category	Tests(theory)
Remember	2
Understand	2
Apply	1
Analyze	10
Evaluate	10
Create	

OPERATIONS RESEARCH

Course Code	**: MEE731**	**Credits**	**: 03**
L: P: T: S	**: 3:0:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**

Course Outcomes: At the end of the Course, the student will be able to:

MEE731.1	**Apply** mathematical formulations for solving linear part programming problems
MEE731.2	**Evaluate** for optimization using Simplex method, dual simplex method and Big M method
MEE731.3	**Apply** the transportation algorithm and assignment algorithm for real life problems
MEE731.4	**Analyze** and determine the optimal solutions by PERT and CPM
MEE731.5	**Understand** the significance of Game theory and determine the optimal solution
MEE731.6	**Analyze** the sequence of jobs on various machines

Mapping of Course Outcomes to Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
MEE731.1	3	3	3	3							3	3		3
MEE731.2	3	3	3	3							3	3		3
MEE731.3	3	3	3	3							3	3		3
MEE731.4	3	3	3	3							3	3		3
MEE731.5	3	3	3	3							3	3		3
MEE731.6	3	3	3	3							3	3		3

Module No	Module Contents	Hrs.	COs
1	**INTRODUCTION:** Linear programming, Definition, scope of Operations Research (OR) approach and limitations of OR Models, Characteristics and phases of OR, computer software for OR,Mathematical formulation of Linear Programming Problems. Graphical solution methods	08	**MEE731.1 MEE731.2**
2	**LINEAR PROGRAMMING PROBLEMS:** The simplex method - slack, surplus and artificial variables. Concept of duality, two phase method, dual simplex method, degeneracy and procedure for resolving degenerate cases	09	**MEE731.2**
3	**TRANSPORTATION PROBLEM:** Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, prohibited route, maximization problems, Applications of Transportation problems **ASSIGNMENT PROBLEM:**Formulation, Hungarian method, maximization problem, restrictions on assignments unbalanced	09	**MEE731.2 MEE731.3**

	assignment problem, Travelling salesman problem		
4	**PERT-CPM TECHNIQUES:** Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks, time-cost trade off procedure	09	**MEE731.4**
5	**SEQUENCING:** Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule- 'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method **GAME THEORY:** Formulation of games, Two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property	09	**MEE731.5 MEE731.6**

TEXT BOOKS:

1. **Operations Research: An Introduction,** H A Taha,Pearson; 10th edition (17 January 2017), **ISBN-13:** 978-1292165547
2. **Operation Research**, S D Sharma, KedarNathRamNath publication, 2014 edition, ISBN-13: 1234567142552

REFERENCE BOOKS:

1. **Introduction to Operation Research,**Frederick S. Hillier ,Gerald J. Lieberman, McGraw-Hill Education; 10th edition (1 June 2014), ISBN-13: 978-1259253188.
2. **Operation Research,** Gupta Prem Kumar, Hira D.S, S Chand; Revised edition (1 November 2014), ISBN-13: 978-8121902816.

Assessment pattern:

1. CIE- (50 Marks Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	2		
Understand	3		
Apply	8	5	5
Analyze	8	5	5
Evaluate	4		
Create		5	

2. SEE – (50 Marks)

Bloom's Category	**Tests(theory)**
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

PRODUCTION AND OPERATIONS MANAGEMENT

Course Code : MEE732 **Credits: 03**
L: P: T: S : 3:0:0:0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE732.1	Discuss the prominence role played by operations managers in Industries/Corporate and their decision making
MEE732.2	Forecasting and its importance in accuracy & health of the business organization
MEE732.3	Planning the various stages, departments of business organization & managing inventory
MEE732.4	Analysis of operation processes from various perspectives such as efficiency, responsiveness, quality and productivity.
MEE732.5	Managing the various stages of Supply chain in a business organization & maintain the things & operations
MEE732.6	Managing the various business concepts and functions in an integrated manner.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE732.1	3									3	3			
MEE732.2	3	2									3			
MEE732.3	3									3	3			3
MEE732.4		2							2					3
MEE732.5	3									3	3			3
MEE732.6											3			3

Module No	Contents	Hr's	CO's
1	**Introduction to Production and Operations Management-** Functions within business organizations, the operation management function, Productivity, factors affecting productivity, **Decision Making:** The decision process, characteristics of operations decisions, economic models-break even analysis, decision tree analysis-numerical.	09	**MEE732.1** **MEE732.4**
2	**Forecasting:** Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast, **Capacity Planning:** Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives.	09	**MEE732.2,** **MEE732.3**

3	**Aggregate Planning:** Aggregate planning – Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques. **Material Requirement Planning (MRP):** Dependent versus independent demand, an overview of MRP	09	**MEE732.3** **MEE732.6**

	– MRP inputs and outputs, MRP processing, numerical, an overview of MRP-II benefits and limitations of MRP.		
4	**Inventory Management:** Types of Inventories, independent and dependent demand, reasons for holding inventory, objectives of inventory control, requirements for effective inventory management – information, cost, priority system. Inventory control and economic-order-quantity models.	08	**MEE732.3, MEE732.4**
5	**Maintenance Management:** Maintenance Management: Definition of Maintenance Management, Need for Maintenance, Objectives of Maintenance Management, Types of Maintenance Systems, Activities in Maintenance Management. **Supply Chain Management (SCM):** Introduction, Importance of purchasing and SCM, The procurement process, Concept of tenders, Vendor development, Measures of purchasing and SCM, Make or buy decision, Types of buying, E-procurement.	09	**MEE732.4 MEE732.5**

TEXT BOOKS:

1. **Operations Management,** K R Phaneesh, 6th Edition, Sudhapublications-2014, ISBN-978-8120329287

2. **Operations Management,** R K Hegde, 6th Edition, Sapna Publictions-2014, ISBN- 978-8128004360

3.**Operations Management-Theory and Practice**, B Mahadevan, Pearson Education, 3rd Edition-2017, ASIN: B074RBDGKC

REFERENCE BOOKS:

1. **Operations Management,** Heizer, Pearson Publication, 11th Edition, 2015, 978-9332586703

2.**Operations Management for Competitive Advantage**, R.B.Chase, N.J.Aquilino, F. Roberts Jacob; McGraw Hill Companies Inc., 11th Edition-2014,ISBN-978-0070604483

3. **Production and Operations Management**, William J Stevenson, 10th Ed-2013, Tata McGraw Hill. ISBN- 978-0070091771

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. SEE – (50 Marks)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

RESEARCH METHODOLOGY

Course Code: MEE733 **Credits: 03**
L: P: T: S: 3:0:0:0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE733.1	**Define** the significance and suitability of research for various engineering applications
MEE733.2	**Demonstrate**the various processing techniques of research
MEE733.3	**Apply** the research in the development of engineering materials/process
MEE733.4	**Analyze** the properties/process of research through various techniques
MEE733.5	**Evaluate** the influence of design, analysis and testing of research
MEE733.6	**Develop** the art of scholarly writing and evaluate its quality

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE733.1	3													3
MEE733.2	3													3
MEE733.3	3													3
MEE733.4	3	3												3
MEE733.5	3	3												3
MEE733.6	3		1											3

Ratings: 3 for high, 2 for substantial, 1 for low

Module No	Contents of Module	Hrs	Cos
1	**Introduction:**Objectives of research, limitations in research, qualities of good research worker, criteria of good research, limitations of research. **Types of research and approaches**: fundamental, pure or theoretical research, applied research, descriptive research, evaluation research, experimental research, historical research. **Literature review:**Purpose of review of literature, literature research procedure, sources of literature, importance of review of literature.	**9**	**MEE733.1 MEE733.2**
2	**Research Design**: Concept and Importance in Research – Features of a good research design, Exploratory Research Design, concept, types and uses, Descriptive Research Designs, concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. **Qualitative and Quantitative Research**: Qualitative research, Quantitative research, Concept of measurement, causality, generalization, and replication. Merging the two approaches.	**8**	**MEE733.3**

3	**Sampling**: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.	**9**	**MEE733.4**
4	**Data Analysis**: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	**9**	**MEE733.4 MEE733.5**
5	Interpretation of Data and paper Writing – layout of a research paper, Journals in Computer Science, Impact factor of Journals, When and Where to publish, Ethical issues related to publishing, plagiarism and Self-Plagiarism References: Encyclopedias, Research Guides, Handbook etc.	9	**MEE733.5 MEE733.6**

Text Books:

1. **Kothari,** C.R., 2018. Research Methodology: Methods and Techniques. New AgeInternational. ISBN-13: 978-8122436235
2. **Garg, B.L., Karadia, R., Agarwal, F. and Agarwal,** U.K., 2015, An introduction toResearch Methodology, RBSA Publishers. ISBN-13: 978-8176111652
3. . **Ranjithkumar**, 2014, research methodology, saga publications,4th edition ISBN-13-978-9351501336

Reference Books:

1. **Anderson, T. W.,** 2011, An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi. ISBN-13: 978-8126524488
2. **Montgomary, Douglas C. &Runger, George C.** (2016) 6/e, Applied Statistics & probability for Engineers (Wiley India) ISBN-13: 978-1118539712
3. **Montgomary, Douglas C.** (2012) 8th edition, Design and Analysis of Experiments (Wiley India) ISBN: 978-1-118-14692-7
4. **Sinha, S.C. and Dhiman**, A.K., 2012. Research Methodology, EssEss Publications. 2 volumes. ISBN : 81-7000-324-5, 81-7000-334-2

Assessment pattern:

1. **CIE- (50 Marks Theory)** **SEE – (50 Marks)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

ORGANIZATIONAL BEHAVIOUR AND PROFESSIONAL ETHICS

Course Code	**: MEE734**	**Credits: 03**
L: P:T: S	**: 3:0:0:1**	**CIE Mark:50**
Exams Hours	**: 03**	**SEE Marks: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE734.1	**Understand** the importance of organizational behavior, behavior models, personality types, emotions, attitudes and motivation.
MEE734.2	**Remember** the importance of group behaviour and apply the principles for team building.
MEE734.3	**Apply** the concept of leadership, the power of managers and apply for stress management and balancing life and work.
MEE734.4	**Analyze** the human values and practice of ethics in the workplace and apply engineering to social experimentation.
MEE734.5	**Apply** ethics in society, safety, discuss the ethical issues related to engineering
MEE734.6	**Analyze** the responsibilities and rights in the society and understand global issues.

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
MEE734. 1						**2**	**2**	**2**	**2**	**2**		**2**
MEE734.2						**2**	**2**	**2**	**2**	**2**		**2**
MEE734.3						**2**	**2**	**2**	**2**	**2**		**2**
MEE734.4						**2**	**2**	**2**	**2**	**2**		**2**
MEE734.5						**2**	**2**	**2**	**2**	**2**		**2**
MEE734.6						**2**	**2**	**2**	**2**	**2**		**2**

Module No	Contents of Module	Hrs	Cos
1	**FOCUS AND PURPOSE, INDIVIDUAL BEHAVIOUR:** Definition, need and importance of organizational behaviour Nature and scope Frame work Organizational behaviour models. Personality types Factors influencing personality Theories Learning Types of learners The learning process Learning theories Organizational behaviour modification. Misbehavior Types Management Intervention. Emotions Emotional Labour Emotional Intelligence Theories. Attitudes Characteristics Components Formation Measurement Values. Perceptions ImportanceFactors influencing perception Interpersonal perception Impression Management. Motivation Importance Types Effects on work behavior.	9	**MEE734.1**
2	**GROUP BEHAVIOUR:** Organization structure Formation Groups in organizations Influence Group dynamics Emergence of informal leaders and working norms Group decision making techniques	8	**MEE734.2**

	Teambuilding Interpersonal relations Communication Control.		
3	**LEADERSHIP AND POWER, DYNAMICS OF ORGANIZATIONAL BEHAVIOUR:** Meaning Importance Leadership styles Theories Leaders Vs Managers Sources of power Power centers Power and Politics. Organizational culture and climate Factors affecting organizational climate Importance. Job satisfaction Determinants Measurements Influence on behavior. Organizational change Importance Stability Vs Change Proactive Vs Reaction change the change process Resistance to change Managing change. Stress Work Stressors Prevention and Management of stress Balancing work and Life. Organizational development Characteristics objectives Organizational effectiveness Developing Gender sensitive workplace.	9	**MEE734.3**
4	**HUMAN VALUES, ENGINEERING ETHICS, ENGINEERING AS SOCIAL EXPERIMENTATION :** Morals, values and Ethics Integrity Work ethic Service learning Civic virtue Respect for others Living peacefully Caring Sharing Honesty Courage Valuing time Cooperation Commitment Empathy Self-confidence Character Spirituality Introduction to Yoga and meditation for professional excellence and stress management. Senses of 'Engineering Ethics' Variety of moral issues Types of inquiry Moral dilemmas Moral Autonomy Kohlberg's theory Gilligan's theory Consensus and Controversy Models of professional roles Theories about right action Self-interest Customs and Religion Uses of Ethical Theories. Engineering as Experimentation Engineers as responsible Experimenters Codes of Ethics A Balanced Outlook on Law.	9	**MEE734.4**
5	**SAFETY, RESPONSIBILITIES AND RIGHTS, GLOBAL ISSUES :** Safety and Risk Assessment of Safety and Risk Risk Benefit Analysis and Reducing Risk Respect for Authority Collective Bargaining Confidentiality Conflicts of Interest Occupational Crime Professional Rights Employee Rights Intellectual Property Rights (IPR) Discrimination. Multinational Corporations Environmental Ethics Computer Ethics Weapons Development Engineers as Managers Consulting Engineers Engineers as Expert Witnesses and Advisors Moral Leadership Code of Conduct Corporate Social Responsibility.	9	**MEE734.5** **MEE734.6**

TEXT BOOKS

1. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 15th edition, 2015.
2. Fred Luthans, Organisational Behavior, McGraw Hill, 12th Edition, 2016.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi,4TH EDITION, 2014.

REFERENCES

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, 4TH Edition New Jersey, 2017
2. Ivancevich, Konopaske&Maheson, OranisationalBehaviour& Management, 7th edition, Tata McGraw Hill, 2014.
3. . Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2013
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi,7th Edition 2013
5. UdaiPareek, Understanding OrganisationalBehaviour, 2nd Edition, Oxford Higher Education, 2011.

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Course Code: MEE735 **Credits : 03**
L: P: T: S: 3:0:0:0 **CIE Marks: 50**
Exam Hours: 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE735.1	**Recognize** the origin and practical applications of machine learning
MEE735.2	**Identify** the applications suitable for different types of machine learning algorithms with appropriate justification
MEE735.3	**Understand** the types of Machine Learning algorithms.
MEE735.4	Use and **manipulate** several core data structures: Lists, Dictionaries, Tuples, and Strings
MEE735.5	**Understand** the significance of artificial intelligence and expert systems in real time environment
MEE735.6	**Understand** the features of neural network and its applications

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
20MEE652.1	**3**											
20MEE652.2	**3**	**3**		**3**								
20MEE652.3			**1**	**3**								
20MEE652.4	**3**				**1**							
20MEE652.5		**3**		**3**								
20MEE652.6		**3**										

Module No	Contents of Module	Hrs	Cos
1	**Introduction to Machine Learning**: What is Machine Learning? When do we need machine learning? Types of learning, The origins of machine learning, Uses and abuses of machine learning, Ethical considerations, How do machines learn? Abstraction and knowledge representation, Generalization, Assessing the success of learning, Steps to apply machine learning to data, Choosing a machine learning algorithm, the input data, types of machine learning algorithms, Matching data to an appropriate algorithm, Machine Learning Models, Applications of Machine Learning.	**9**	**MEE735.1 MEE735.2**
2	**Machine Learning Algorithms:** Back Propagation Algorithms, Decision Tree, Bayesian Method - Naïve Bayes Classification, Instance Based Learning – K Nearest Neighbor. Regression - Linear Regression, Logistic Regression, Clustering	**9**	**MEE735.2 MEE735.3**
3	**Python Programming**: Python Basics: Data Types, Operators, Input/output Statements, Creating Python Programs. Python Flow Control statements Decision making statements, Indentation, Conditionals, loops, break, continue, pass statements Strings	**9**	**MEE735.4**
4	**Introduction to AI**: What is AI? Intelligent agents – Agents and Environments, the concept of rationality, the nature of environments, and structure of agents Problem-Solving by Searching: Problem Solving agents – Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic	**9**	**MEE735.5**

	functions.		
5	**Neural Networks(Introduction & Architecture**) Auto-associative and hetro-associative memory Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule	**9**	**MEE73 5.5 MEE73 5.6**

Text Books:

1. Machine Learning, Tom M Mitchel, McGraw Hill Education, July 2017, ISBN: 978-1-25-9096952.
2. Artificial Intelligence - A Modern Approach, Stuart Russell, Pearson Education / PHI, 3rd Edition, 2015, ISBN: 978-9332543515.

Reference Books:

1. Introduction to Machine Learning with Python, Andreas Muller, Shroff/O'Reilly,2016, ISBN: 978-9352134571.
2. Machine Learning, An Algorithmic Perspective, Stephen Marsland, Chapman and Hall, Nov 2014, ISBN: 978-1466583283.
3. Neural Networks – A classroom Approach, Satish Kumar, McGraw Hill Education, 2nd Edition, July 2017, ISBN: 978-1259036166.

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

FUNDAMENTALS OF TRIBOLOGY

Course Code : MEE741 **Credits: 03**
L: P: T: S : 3:0:0:0 **CIE Marks: 50**
Exam Hours : 03 **SEE Marks: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE741.1	**Understand**the basics of Tribology, Wear mechanism & Friction
MEE741.2	**Evaluate** Hagen's Poiseuille's theory & Reynolds's equation
MEE741.3	**Analyze** the characteristics of idealized journal bearing and slider bearings.
MEE741.4	**Apply** the concepts of Hydrostatic Lubrication and Hydrodynamic Lubrication
MEE741.5	**Remember the** laws of friction with respect to bearings.
MEE741.6	**Know** the different types and properties of bearing materials and Characterize the behavior of Tribological components

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE51.1		3					3							3
20MEE51.2	3												3	
20MEE51.3		3		1										3
20MEE51.4	3												3	3
20MEE51.5													3	
20MEE51.6	3					1	3						3	

Module No	Contents	Hr's	CO's
1	**Introduction:** Bearings, Friction, Wear and its phenomena , Lubrication, Boundary Lubrication, Film Lubrication, Absolute Viscosity, Newton's Law of viscosity, Hagen-Poiseuille's Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants. **surface interaction and friction**: Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction —Thermal considerations in sliding contact.	09	**MEE741.1, MEE741.2**
2	**Idealized Journal Bearing:** Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; numerical problems. **Slider / Pad Bearing With A Fixed Shoe:** Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples	09	**MEE741.3**
3	**Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical	09	**MEE741.4,**

	example. **Hydrodynamic Lubrication**: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, numerical, mechanism of pressure development in an oil film, Reynold's equation in 2D.		
4	**Friction** – Laws of friction - Stick-slip phenomenon- Friction characteristics of metals and non-metals - Adhesion and Ploughing theory of friction **Antifriction Bearings:** Introduction, Advantages and selection of Bearings, Selection Procedure, life rating of Antifriction Bearings, Rigidly and load on Roller bearing supported units, Load bearing capacity, Preloaded bearings, Radial and Axial Rigidity of spindle supports for various types.	09	**MEE741.5**
5	**Bearing Materials:** Commonly used bearings materials, properties of typical bearing materials. Advantages and disadvantages of bearing materials **Behaviour of Tribological Components:** Selection of bearings, Plain bearings, Gears, Wire ropes, Seals and packings, Conveyor belts, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure.	08	**MEE741.5, MEE741.6**

TEXT BOOKS:

1) **Fundamentals of Tribology** , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2013, ISBN-13: 978-8120327238
2) **Introduction to Tribology Bearings,** Mujumdar B. C., S. Chand company pvt. Ltd,2010, ISBN-13: 978-8121929875
3) **Lubrication of bearings – Theoretical Principles and Design,** Redzimovskay E I., Oxford press company 2013, ISBN-13: 978-1461270607
4) **Design data hand book,** volume-II, Prof. KLINGAIAH,Suma publications,8th edition-2006**.**

REFERENCE BOOKS:

1) **Principles and Applications of Tribology,** Moore, Pergamaon press 2013, ASIN: B01DDMZB3W
2) **Tribology,** R Suresh Kumar, Subhas Stores Publications, 2016
3) **Tribology in Industries,** Srivastava S., S Chand and Company limited, Delhi 2011, ISBN-13: 978-8121920452
4) **Theory and Practice of Lubrication for Engineers,** Fuller, D., New York company 1998, ISBN-13: 978-0471047032

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

COMPUTER GRAPHICS

Sub Code : MEE742 **Credits: 03**

L: P: T: S : 3:0:0:0 **CIE Marks: 50**

Exam Hours : 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to

MEE742.1	**Analyze** the concept of scan conversion & clipping representation
MEE742.2	**Demonstrate** Two dimensional & three dimensional transformations
MEE742.3	**Describe** plane curves, space curves and mathematical representations of solids
MEE742.4	**Create** the visual realism for planes and solid objects
MEE742.5	**Develop** computer animation for engineering and entertainment applications.
MEE742.6	**Apply** knowledge gained to practical applications in engineering

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE642.1	3	2												3
20MEE642.2	3		3											3
20MEE642.3	3	2	3											3
20MEE642.4	3			1										3
20MEE642.5	3				1									3
20MEE642.6	3					1						1		3

Module No	Contents of Module	Hrs	Cos
1	**Scan Conversion and Clipping Representation**of points, lines, Line Drawing Algorithms: DDA algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, mid point line and circle, Polygon filling algorithms: scan conversion, seed filling, scan line algorithm. Viewing transformation, Clipping –points, lines, text, polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.	**8**	**MEE742.1**
2	**Two Dimensional Transformations**Representation of points, Transformations: Rotation, Reflection, Scaling, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, rotation about an arbitrary point, Reflection through an arbitrary line. **Three Dimensional Transformations**and Projections 3D Transformation matrix: general matrix, Translation, scaling, Shearing, Rotation, Reflection, Multiple transformations, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane, Orthographic, Parallel projection Transformations, one, Perspective projections- one point, two point and three point.	**9**	**MEE742.2**

3	**Plane and Space Curves** Curve representation, Nonparametric curves, parametric curves, parametric representation and generation of line, circle, ellipse, parabola, hyperbola, generation of circle, ellipse, parabola, hyperbola, Cubic spline, normalized cubic splines, Bezier curves: blending function, properties, generation, B-	**9**	**MEE742.3**

	spline curves- Cox-deBoor recursive formula,properties,open uniform basis functions, Non-uniform basis functions, periodic B-spline curve.**Types and Mathematical Representation**of Solids, Solid Models, Solid entities, Solid representation, Solid modeling-set theory, regularized set operations, set membership classification, Half spaces, Half spaces of plane, cylinder, sphere, conical half-space, Boundary representation, Constructive Solid Geometry- basic elements, Building operations.		
4	**Visual Realism-I**: Introduction, hidden line removal- visibility of object views, Visibility techniques: minimax test, containment test, surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden line priority algorithm, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal- ray tracing algorithm. **Visual Realism-II**: Shading, shading models- diffuse reflection, specular reflection, ambient light, Shading surfaces- constant shading, gourmand shading, Phong shading, Shading enhancements, Shading Solids- Ray tracing for CSG, z- buffer algorithm for B-rep and CSG, octree encoded objects, Colouring-RGB, CMY, HSV, HSL colour models.	**9**	**MEE742.4**
5	**Computer Animation:** Introduction, Conventional animation-key frame, Inbetweening, Line testing, Painting, Filming, Computer animation entertainment and engineering animation, Animation system hardware, software architecture, Animation types- frame buffer, colour table, zoompan- scroll, cross bar, real time play back, Animation techniques- key frame, skeleton. Path of motion and p-curves.	**9**	**MEE742.5, MEE742.6**

Text Books:

1. Mathematical Elements for Computer Graphics, David Rogers, J. Alan Adams McGraw Hill. 2017, ISBN-13: 978-0070535275
2. CAD/CAM-Theory and Practice, IbrahamZeid, R. Siva Subramanian , McGraw Hill, 2010, ISBN-13: 978-0070151345

Reference Books:

1. Computer Graphics, Xiang z, Plastock, R. A., Schaums outlines, 2nd Edition, McGraw Hill. 2015, ISBN-13:978-0070601659
2. Computer Graphics, principles and practice, .Foley, Van- Damn, Finner and Hughes, Addison Wesley, 3rd Edition. 2014, ISBN-13:978-0321399526
3. Computer Graphics, Sinha A. N., Udai A. D., Tata McGraw Hill, 2014, ISBN-13:978-0070634374
4. Computer Graphics, Steven Harrington, 2nd Edition McGraw Hill, 2014, ISBN-13:978-0071004725

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

FUNDAMENTALS OF PLASTIC MOLD DESIGNAND DIE DESIGN

Course Code : MEE743 **Credits : 03**
L: P:T: S : 3:0:0:0 **CIE Marks :50**
Exams Hours : 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE743.1	**Understand** the basics concepts of Injection mold design
MEE743.2	**Apply** knowledge in Compression molddesign
MEE743.3	**Understand** the casting techniques and the essential parts for the design of moulds
MEE743.4	**Remember** thefundamentals of press tool design.
MEE743.5	**Analyze** basics of pressure die casting, forging die design, extrusion dies and rolling dies
MEE743.6	**Apply** the knowledge gained to practical applications.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MEE743.1	3	2	2	2							2	
MEE743.2	3	2	2	2							2	
MEE743.3	3	2	2	2							2	
MEE743.4	3	2	2	2							2	
MEE743.5	3	2	2	2							2	
MEE743.6	3	2	2	2							2	

Module No	Contents of Module	Hrs	Cos
1	**Injection Mold Design-** Plastics product design Concepts Essential factors Principles Methodical approach -process variables v/s product design. Uniform and symmetrical wall thickness Draft angle Rib design Fillets & Radius Bosses Holes Threads standard thread forms undercuts Hinges metal inserts parting line Tolerances- General mold constructionIntroduction , Mold design concepts - mold elements parting line and parting surface construction of core and cavities Bolsters moldalignment, Feed systemSprue, runner, gate & position of gate runner & gate balancing, Ejection types of ejections mold cooling venting-ancillary parts and split mold	9	**MEE743.1**
2	**Compression Mold Design** - Types of compression mold, open flash, semi-positive type, positive, displacement molds, types of loading chambers, bulk factor, flash thickness, pot design,	9	**MEE743.2**

	projected area, compression pressure, clamping force, no. of impression by technological method, heating system, types of heaters, heat loss, heat requirement & heater capacity.		
3	**Design of molds for castings:**Introduction: Classification of Castings, Sand casting, Metal mold castings, Plastic molds casting, Investment casting, Gravity die casting, Pressure die casting, Advantages of Die casting, Die casting process, vacuum casting. Die Casting Alloys Low fusion alloys, High fusion alloys, Properties Simple problems.	**8**	**MEE743.3**
4	**Press tool design**: types of presses, types of dies, Clearance,die sets,materials of die sets, cutting force, die block design, punch design,punch holder and die support, stripper plate, die springs, die wear, blanking die design.Introduction to bending, forming and drawing dies.Simple problems.	**9**	**MEE743.4**
5	**Introduction to pressure die casting, forging, extrusion and rolling die design:** Die Casting die design: Hot chamber machine, cold chamber machine, Horizontal machine, Vertical machine, Die locking, Toggle locking, Hydraulic locking, Injection systems, knock out pins and plates, ejector system furnaces, loading of metal into hot chamber-.Forging dies, parts,upset forging, trimming, design of forging dies,-introduction to extrusion die and rolling die design. Industrial applications of above.	**9**	**MEE743.5** **MEE743.6**

TEXT BOOKS:

1. Injection mold design engineering, David O Kazmer, 2nd edition 2016, Hanser publications.
2. Fundamentals of Plastics Mould Design- Sanjay K Nayak , Pratap Chandra Padhi, Y. Hidayathullah, Publication Tata McGraw Hill Education Private Limited ,2012
3. Injection Mould Design : An Introduction And Design For The Thermoplastics Industry by Pye R G W (Author). Publisher: Affiliated East-West Press Pvt. Ltd. (2000)

Reference Books

1. Complete Casting Handbook,2ndEdition,Metal Casting Processes, Metallurgy, Techniques and Design,Authors: John Campbell, Imprint: Butterworth-Heinemann,Published Date: 25th August 2015.
2. Fundamentals of Die CastignDesign,byGenick Bar-Meir, Ph.D, 2009.
3. Press Tools Design and Construction, 2012, by Joshi P.H. (Author), S.Chand and publications.
4. A Textbook of Production Engineering, 11/e, by P.C.Sharma, S. Chand Publishing, 2010.
5. Tool Engineering and design by G.R. Nagpal., Khanna Publishers,2013 edition.

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

EMERGING AUTOMOTIVE TECHNOLOGIES

Course Code : MEE744 **Credits : 03**
L:P:T:S : 3:0:0:0 **CIE Marks: 50**
Exams Hours : 03 **SEE Marks:**
100

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE744.1	Apply the knowledge of engineering fundamentals in order to know the specifications and functions of IC engine components and fuel supply systems.
MEE744.2	Analyze the performance of the engine using super charger and turbo charger.
MEE744.3	Analyze the concept of dual fuel engines, free piston engines and Automotive Emission Control System with the knowledge of different ignition systems used in IC engines.
MEE744.4	Analysis and interpretation of various transmission system, braking and safety Mechanisms and recognize the need of modern safety systems.
MEE744.5	Engage in independent study as a member of a team and make an effective oral presentation on topics related to the latest technological developments in automotive engineering field.
MEE744.6	Select and use modern Engineering techniques in application of new emission standards through Modern Technology in concern with health, safety, legal responsibilities relevant to Engineering practice.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE744.1	1												1	
MEE744.2		1												
MEE744.3	1	1												
MEE744.4				2								3		2
MEE744.5						3			3	3		3		
MEE744.6			1		1									

Module No	Contents of Module	Hrs	Cos
1	**Engine Components and Specifications** : cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, Types of combustion chambers for S.I. Engine and C.I. Engines, choice of materials for different engine components. **Fuel Supply Systems For Si And Ci Engines**: normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, Electronic Fuel Injection(EFI) system, merits and demerits of EFI system, multi-point fuel injection system , D-MPFI system, L-MPFI system, Common rail injection system, i-VTECH,VVT	9	**MEE744.1**

2	**Superchargers And Turbochargers**: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. **Ignition Systems**: Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **Non Conventional Engine**: Working principle of dual fuel engine, Combustion in dual fuel engine, Free piston engine basics. Wankle Engine used for UAV.	9	**MEE744.2 MEE744.3 MEE744.5**
3	**Power Trains**: General arrangement of clutch, Principle of friction clutches, Torque transmitted, Constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches. Gearbox: Necessity for gear ratios in transmission, synchromesh gear boxes, 5 speed gear boxes. Free wheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, principle of automatic transmission.	9	**MEE744.4**
4	**Drive To Wheels**: Propeller shaft and universal joints, differential, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steerand neutral steer. **Modern safety systems**: Traction Control, Air bags, Hill ascent and decent control, Cruise Control, Driverless Car.	9	**MEE744.4 MEE744.5**
5	**Brakes**: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, Antilock – Braking systems **Automotive Emission Control Systems**: Controlling crankcase emissions, Controlling evaporative emissions, Exhaust gas recirculation, Catalytic converter, Treating the exhaust gas,Air-injection system, Air-aspirator system, Emission Standards : BS-I,BS-II, BS-III, BS-IV.	8	**MEE744.4 MEE744.6**

TEXT BOOKS:

1. **Automobile Engineering**, R. B. Gupta, SatyaPrakashan, 4th edition,2016, ISBN-978-8176848589.
2. **Automobile engineering**, Dr. KirpalSingh.Standard Publisher & Distributers, 2017 ISBN 978-8180142420 Vol I.
3. **Automobile engineering**, Dr. KirpalSingh.Standard Publisher & Distributers, 2014ISBN 978-8180142062Vol II.

REFERENCE BOOKS:

1. **Automotive mechanics: Principles and Practices**, Joseph Heitner, 2017,CBS publications ISBN-978-8123908915.
2. **Automotive mechanics,** William H Crouse & Donald L Anglin, 10th Edition 2017, Tata McGraw Hill Publishing Company Ltd., ISBN-978-0070634350,
3. **Automotive Mechanics** S Srinivasan, 2nd Edition,2017, Tata McGraw Hill , ISBN-978-0070494916

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5		
Apply	10		
Analyze	5	5	5
Evaluate		5	5
Create		5	

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

ADVANCED ROBOTICS

Course Code : MEE745 **Credit: 03**
L: P: T: S : 3:0:0:0 **CIE Marks: 50**
Exams Hours : 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE745.1	**Remember** a broad fundamental understanding of concepts in autonomous, robotic manipulation.
MEE745.2	**Analyse** Kinematics and Dynamics of Robots
MEE745.3	**Understand** different control techniques (linear and nonlinear) used to control the motion of a robot
MEE745.4	Systematically **evaluate** the structure and operation of the essential components of the robot system.
MEE745.5	**Analyse** trajectory planning in robotics systems.
MEE745.6	**Apply** knowledge in robot programming methods and applications.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE745.1	3	3											2	
MEE745.2	3	3	3										2	
MEE745.3		3	3		3									
MEE745.4	3	3	3		3									3
MEE745.5	3	3	3											3
MEE745.6			3		3	1	1							3

Module No	Contents of Module	Hrs	Cos
1	**Introduction** History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers- different methods of gripping, Mechanical grippers- Slider crank mechanism, Screw type, Rotary actuators, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.	**8**	**MEE745.1**
2	**Kinematics and Dynamics of Robots:** 2D, 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation, Simple problems. Matrix representation, Forward and Reverse Kinematics Of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning	**9**	**MEE745.2**
3	**Velocity and Static's of Manipulators:** Differential	**9**	

	relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain.		**MEE745.3**
4	**Trajectory Planning:** Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning.	**9**	**MEE745.3 MEE745.4**
5	**Robot Control, Programming and Applications**: Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT , Motion Interpolations, Adaptive control. **Introduction to Robotic Programming**, On-line and off-line programming, programming examples. **Robot applications**-Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting.	**9**	**MEE745.5 MEE745.6**

TEXT BOOKS:

1. "Industrial Robotics, Technology programming and Applications", Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, AshishDutta, McGraw Hill, 2012 **ISBN-13:** 978-0071004428
2. "Introduction to Robotics: Analysis, Control, Applications", Saeed B Niku, Wiley 201, ISBN-13: 978-812653312
3. "Robotics and control" R Mittle, I Nagrath, McGraw Hill Education, 2017, ISBN-13: 978-0070482937

REFERENCE BOOKS:

1. "Robotics Technology and Flexible Automation" S. R. Deb, Sankha Deb, McGraw Hill Education, 2017, ISBN-13: 978-0070077911
2. "Robotics: Fundamental Concepts and Analysis" AshitavaGhosal, Oxford, 2016, ISBN-13: 978-0195673913
3. "Fundamentals of Robotics, Analysis and Control", Schilling R. J, Pearson Education India, 2015 ISBN-13: 978-9332555235

CIE- Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	2		
Understand	3	5	5
Apply	8	5	5
Analyze	7	5	
Evaluate	3		
Create	2		

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	5
Understand	5
Apply	20
Analyze	15
Evaluate	5
Create	

DESIGN FOR MANUFACTURING & ASSEMBLY

Sub Code	**: MEE751**	**Credits**	**03**
L: P: T: S	**: 3:0:0:0**	**CIE Marks**	**50**
Exam Hours	**: 03**	**SEE Marks**	**50**

COURSE OUTCOMES: at the end of the course, the students will be able to

MEE751.1	**Understand** the basic knowledge of tolerance analysis.
MEE751.2	**Describe** the group models & datum features.
MEE751.3	**Develop** the component design- machining consideration**.**
MEE751.4	**Analyze**different types of casting consideration.
MEE751.5	**Apply** design principles for gauges & economic costing.
MEE751.6	**Evaluate**the uneconomical design of casting and Modification of the design.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
xxMEE751.1	3	3											3	
xxMEE751.2	3	3											3	
xxMEE751.3			3											3
xxMEE751.4			3		1									3
xxMEE751.5			3											3
xxMEE751.6	3										1			3

Module No	Contents of Module	Hrs	Cos
1	**TOLERANCE ANALYSIS:** Introduction Concepts, definitions and relationships of tolerance Matching design tolerances with appropriate manufacturing process manufacturing process capability metrics Worst case, statistical tolerance Analysis Linear and Non-Linear AnalysisSensitivity Analysis Taguchi's Approach to tolerance design.	10	MEE751.1
2	**SELECTIVE ASSEMBLY AND DATUM FEATURES:** Selective assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1: Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, laminated shims, examples Datum features: Functional datum, Datum for manufacturing, changing the datum, examples.	10	MEE751.2
3	**COMPONENT DESIGN -MACHINING CONSIDERATION:** Design features to facilitate machining drills milling cutters keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation simplification by amalgamation - Design for machinability Design for economy - Design for clampability Design for accessibility Design for assembly.	10	MEE751.3

4	**COMPONENT DESIGN – CASTING CONSIDERATION:** Redesign of castings based on parting line considerations Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design group technology Computer Applications for DFMA	**08**	**MEE751.4 MEE751.6**
5	**DESIGN OF GAUGES:** Designs of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft.	**06**	**MEE751.5**

Text Books:

1. **Harry Peck,** "Designing for Manufacturing", Pitman Publications, 2017, ISBN-13: 978-0273000075
2. **A K Chitale, RC Gupta**, "Product Design and Manufacturing", PHI, 2014, ISBN-13: 978-8120348738

Reference Books:

1. **ASM Hand book,** "Material selection and Design", Vol. 20, 2012, ISBN-13: 978-0871703866
2. **C.M. Creveling,** "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 2013, ISBN-13: 978-0133052343
3. **James G. Bralla,** "Handbook of Product Design for Manufacturing", McGraw Hill, 2014, ISBN-13: 978-0070071308
4. **Kevien Otto and Kristin Wood,** "Product Design", Pearson Publication, 2012, ISBN-13: 978-8177588217

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

APPLIED NUMERICAL TECHNIQUES AND COMPUTING

Course Code : MEE752 **Credits: 03**
L: P:T: S : 3:0:0:0 **CIE Mar: 50**
Exams Hours : 03 **SEEMark: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE752.1	**Understand** the consequences of finite precision and the inherent limits of the numerical methods considered.
MEE752.2	**Demonstrate** the mathematics concepts underlying the numerical methods considered.
MEE752.3	**Apply** these methods to academic and simple practical instances
MEE752.4	**Show** the knowledge of mathematics and computing to the design and analysis of optimization methods
MEE752.5	**Analyze** a problem and identify the computing requirements appropriate for its solution
MEE752.6	**Design** and conduct experiments and numerical tests of optimization methods, and to analyze and interpret their results.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE752.1	3	3												
MEE752.2	3	3												3
MEE752.3	3	3		3										3
MEE752.4			3	3										3
MEE752.5		3	3	3										3
MEE752.6		3	3	3										3

Module No	Contents of Module	Hrs	Cos
1	**ERRORS IN NUMERICAL CALCULATIONS:** Introduction, Numbers and their accuracy, Absolute,relative and percentage errors and their analysis, General error formula.**INTERPOLATION AND CURVE FITTING:** Taylor series and calculation of functions, Introduction to interpolation, Lagrange approximation, Newton Polynomials, Chebyshev Polynomials, Least squares line, curve fitting, Interpolation by spline functions.	**9**	**MEE752.1 MEE752.3 MEE752.6**
2	**NUMERICAL DIFFERENTIATION AND INTEGRATION:** Approximating the derivative, Numerical differentiation formulas, Introduction to Numerical quadrature, Newton-Cotes formula, Gaussion Quadrature.**SOLUTION OF NONLINEAR EQUATIONS:** Bracketing methods for locating a root, Initial approximations and convergence criteria, Newton-Raphson and Secant methods, Solution of problems through a structural programming language	**9**	**MEE752.2 MEE752.6**
3	**SOLUTION OF LINEAR SYSTEMS:** Direct Methods, Gaussian elimination and pivoting,Matrix inversion, UV factorization,	**9**	**MEE752.2 MEE752.4**

	Iterative methodsfor linear systems, Solution of problems through astructured programming language. **EIGEN VALUE PROBLEMS:** Jacobi, Given's and Householder's methods for symmetric matrices, Rutishauser method for general matrices, Power and inverse power methods.		**MEE752.6**
4	**SOLUTION OF DIFFERENTIAL EQUATIONS:** Introduction to differential equations, Initial valueproblems, Euler's methods, Heun's method, Runge-Kutta methods, Taylor series method, Predictor-Corrector methods, Systems of differential equations,Boundary valve problems, Finite-difference method,Solution of problems through a structured programming language	**8**	**MEE752.4 MEE752.6**
5	**PARTIAL DIFFERENTIAL EQUATIONS, EIGENVALUES AND EIGENVECTORS:** Solution of hyperbolic, parabolic and ellipticequations, The eigenvalue problem, The power method and the Jacobi's method for eigen value problems, Solution of problems through a structural programming language	**9**	**MEE752.4 MEE752.6**

Text Books :

1. Numerical Methods for Mathematics, Science and Engineering by John H.Mathews, PHI New Delhi, 2015,ISBN-13-978-0130652485
2. Applied Numerical Methods – Carnahan, B.H., Luthar, H.A. and Wilkes, J.O., Pub.- J. Wiley, New York, ISBN-13-978-0471135074
3. Numerical Methods for Engineers; Steven C. Chapra and Raymond P. Canale, 7th edition, McGraw-Hill, 2017, ISBN-9789356202131

Reference Books :

1. Introduction to Numerical Analysis, S.S. Sastry; Prentice Hall of India,2015. ISBN-978-81-203-4592-8
2. Numerical Methods for Engineers, Santhosh .K. Gupta, New Age International; 2015. ISBN-978-81-224-3359-3
3. Numerical Solution of Differential Equations, by M.K. Jain, Published by Wiley Eastern, New York. ISBN-978-0852264324
4. Introduction to numerical analysis, J S TOER and R BULIRSCH, springer 2016, ISBN-13-978-1441930064

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

TOTAL QUALITY MANAGEMENT

SubCode :MEE753 **Credits: 03**

L: P:T: S : 3:0:0:0 **CIEMarks: 50**

ExamHours :03 **SEE Marks: 50**

Course Outcomes: At the end of the Course, the Student will be able to do the following:

MEE753.1	**Understand** the concepts of quality for business.
MEE753.2	**Evaluate** process capabilities & customer focus
MEE753.3	**Analyze** the system approach & organization behaviour
MEE753.4	**Remember**& implement the TQM qualities for leadership qualities
MEE753.5	**Apply** the principles of Kaizen & error proofing
MEE753.6	**Understand** and implement six sigma concepts

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE63.1	3													
MEE63.2	3	3												
MEE63.3	3	3	3											
MEE63.4	3	3	3											
MEE63.5	3	3	3							2				
MEE63.6	3	3	3							2				

SYLLABUS			
Module No	**Contents of the Module**	**Hours**	**COs**
1	**Introduction:** The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. **Management of Process Quality:** Definition of quality, Quality Control, a brief history, Product Inspection vs. Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.	**9**	**MEE753.1 MEE753.2**
2	**Customer Focus and Satisfaction**: Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer — Supplier relationships. **Control Charts** - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	**9**	**MEE753.2 MEE753.3**
3	**Organizing for TQM**: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organization, Quality Circles, seven Tools of TQM: Startification, check sheet, Scatter diagram, Ishikawa diagram, paneto diagram, Kepner&Tregoe Methodology.	**9**	**MEE753.4**

4	**TQMPRINCIPLES: Leadership** - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement -PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating, Seven new management tools. Bench marking and POKA YOKE	**9**	**MEE753.5**
5	**Statistical process control and process capability** Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed. Process capability – meaning, significance and measurement – Six sigma concepts of process capability	**8**	**MEE753.6**

TEXT BOOKS

1. Dale H.Besterfield et al, Total Quality Management, 4th edition, Pearson Education,2015, ISBN-978-9332534452

2. ShridharaBhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, 2010, ISBN-978-8178662527

REFERENCE BOOKS:

1. ClydeBank Business, Lean Six Sigma, ClydeBank Media LLC; 1 edition, 2014, ASIN: B00ND9OMXG

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

HYDRAULICS AND PNEUMATICS

Course Code: MEE754 **Credits: 03**

L:P:T:S : 3:0:0:0 **CIE Marks: 50**

Exam Hours: 03 **SEE Marks:50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE754.1	Apply the concept of Fluid power, differentiating hydraulic and pneumatic structures and functions in the working of hydraulic and pneumatic system
MEE754.2	Analyze and Evaluate performance of different hydraulic pumps
MEE754.3	Identify the symbolic representation and various mountings of the Hydraulic and Pneumatic power concepts.
MEE754.4	Evaluate the performance of Hydraulic prime movers
MEE754.5	Identify the need and functions of various control components used in Fluid power systems
MEE754.6	Design &Analyze the performance of hydraulic circuits for Industrial applications.

Mapping of course outcomes to program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
MEE754.1	1												3	
MEE754.2		3												1
MEE754.3		3											3	
MEE754.4		3		1									3	
MEE754.5		3											3	
MEE754.6		3	1			1								1

Course syllabus			
Module No	Contents	Hrs	**Cos**
1	**Overview to Hydraulic Power:** Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. **The source of Hydraulic Power:** Pumps Classification of pumps, pumpingtheory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, combination pumps,Pump performance characteristics, pump Selection factors, problems on pumps.	**9**	**MEE754.1**

2	**Hydraulic Prime Movers**: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators, single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuatorsproblems on cylinders, Installation and mounting of hydraulic cylinders	**8**	**MEE754.2**
3	**Outline to Hydraulic & Pneumatic Control: Control Components in Hydraulic Systems:** Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves,Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated typeLoad control valves, Special purpose control valves – Exhaust Mufflers **Pneumatic Control**: Types and construction, use of memory valve, Quick exhaust valve, time delay valve, twin pressure valve, symbols. Structure of Pneumatic Control System, fluid conditioners and FRL unit	**9**	**MEE754.3** **MEE754.4**
4	**Hydraulic Circuit Design And Analysis:** Control of Single and Double - Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors-Bleed-off control, Safety circuit, Accumulators, types, construction.	**9**	**MEE754.4** **MEE754.5**
5	**Maintenance of Hydraulic System:** Hydraulic Oils - Desirable properties, general type of Fluids, Seals &Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid -particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting. Maintenance and performance monitoring of hydraulic systems. **Pneumatic Actuators:** Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, mounting arrangements- Applications. Rod - Less cylinder's types,	**9**	**MEE754.6**

TEXT BOOKS:

1. **"Fluid Power with Applications"**Anthony Esposito**,** Seventh edition, Pearson New International Edition, 7th edition 2013, ISBN-13: 9781292023878

2. 'Hydraulics and Pneumatics, A Technician's and Engineer's Guide, Andrew Parr, 3rd Edition 2011,Butterworth-Heinemann 2011 publication, ISBN:9780080966748

REFERENCE BOOKS:

1. **'Oil Hydraulic systems', Principles and Maintenance** S. R. Majumdar, Tata McGraw Hill Publishing Company Ltd. – 2001, ISBN-13: 978-0074637487
2. **Principles of Hydraulic Systems Design,** Peter Chapple, 2nd Edition ((Dec 31 2014), Momentum Press publishing, ISBN: 9781606504529
3. **Fluid Power: Hydraulics and Pneumatics,** James R Daines2nd Edition (Aug 30, 2012), Goodheart-willcox Publication, ISBN: 9781605259369
4. **'Pneumatic Systems',** S. R. Majumdar, McGraw-Hill Professional; 2004 Publication,ISBN 13: 9780074602317
5. '**Industrial Hydraulic Systems: Theory and Practice,** JojiParambath, Universal-Publishers (06-Apr-2016), ISBN-13: 978-1627341752,
6. **Hydraulics and Pneumatics, 1/e**Jagadeesha T, I K International publishers (2015), ISBN-13: 9789384588908

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5		
Apply	5	5	5
Analyze	5	5	5
Evaluate	5		
Create		5	

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

RAPID PROTOTYPING

Course Code : MEE755 **Credits: 03**
L: P: T: S : 3:0:0:0 **CIE Marks: 50**
Exams Hours : 03 **SEE Marks: 50**

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE755.1	Apply the knowledge of physics and material science in understanding the working principle of additive manufacturing.
MEE755.2	Analyze the limitations and advantage of each additive manufacturing technique.
MEE755.3	Test the quality of the products built through additive manufacturing technique in soft tooling and hard tooling applications.
MEE755.4	Synthesize the information of process parameters with adequate optimization techniques using Internet based software.
MEE755.5	Demonstrate the knowledge of additive manufacturing in the application at Medical and product development Industries by executing the projects.
MEE755.6	Understand the nature of errors in software and to rectify the same with the knowledge of latest software in terms of software and hardware integration.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE755.1	2													
MEE755.2		2												2
MEE755.3	2												3	
MEE755.4				1	2									2
MEE755.5						1					2		3	
MEE755.6		2			2								3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Co's
1	**Introduction:** Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **Stereo Lithography Systems**: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	9	**MEE755.1 MEE755.2 MEE755.3**
2	**Selective Laser Sintering:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. **Fusion Deposition Modelling**: Principle, Process parameter, Path generation, Applications.	9	**MEE755.1 MEE755.2 MEE755.3**
3	**Solid Ground Curing:** Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	9	**MEE755.1 MEE755.2 MEE755.3**

4	**Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer. GenisysXs printer HP system 5, object Quadra systems. **Rapid Tooling:** Indirect Rapid tooling, Silicon rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM.	9	**MEE755.4 MEE755.5 MEE755.6**
5	**Rapid Tooling:** Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. Hard tooling. **Software For RP:** STL files, Overview of Solid view, magics, imics, magic. **Rapid Manufacturing Process Optimization:** factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation. communicator, etc. Internet based software, Collaboration tools.	8	**MEE755.4 MEE755.5 MEE755.6**

Text Book

1. Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, by Frank W Liou, 2016,ISBN-13: 978-0849334092
2. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London 2015. ISBN 978-1-4471-0703-3
3. Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 2009. ISBN-10: 087263467

REFERENCE BOOKS:

1. Rapid prototyping and allied manufacturing techniques, by M S Ganesha Prasad and Nagendra, 2016, ISBN-13: 978-9384893408
2. Rapid Prototyping, Terry Wohlers Wohler's Report 2000"Wohler's Association 2014.

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5		
Apply	15		
Analyze		5	10
Evaluate		5	
Create		5	

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	5
Understand	5
Apply	15
Analyze	15
Evaluate	5
Create	5

EIGHT SEMESTER SYLLABUS

FRACTURE MECHANICS

Course Code : MEE84 **Credits: 04**
L: P: T: S : 3:0:0:1 **CIE Marks: 50**
E2ams Hours : 03 **SEE Mark: 50**

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE84.1	Apply the basic concepts of Fracture Mechanics in engineering design and manufacture for brittle and ductile materials.
MEE84.2	Acquire knowledge on different modes of crack propagation and analyze the plane stress and plane strain condition.
MEE84.3	Investigate the difference between Linear Elastic Fracture Mechanics and Elastic Plastic Fracture Mechanics in the field of engineering.
MEE84.4	Design the different types of specimen for fatigue and fracture analysis.
MEE84.5	Evaluate CTOD by using different methods of FM approach, and analyze by using analysis software.
MEE84.6	Conduct investigations on various NDT methods to determine the fracture, crack and flaws in the materials.

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
MEE84.1	3		1											
MEE84.2		2			1									
MEE84.3				2		2								
MEE84.4					1					1				2
MEE84.5	3			2	1									2
MEE84.6	3	2										1		

Module No	Contents of Module	Hrs	Cos
1	**Fracture Mechanics Principles:** Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach **Stress Analysis For Members With Cracks:** Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. Dugdale approach, Spectacular Failures-Discussion on Boston molasses failure, Liberty ship failure, Ductile-brittle transition temperature and its relevance.	9	**MEE84.1 MEE81 2.3 MEE84.6**
2	**Elastic – Plastic Fracture Mechanics: I**ntroduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R- curve in fracture mechanics, The use of Crack Tip Opening Displacement (CTOD) criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD.	9	**MEE84.2 MEE84.6**

3	**Dynamic And Crack Arrest:** Introduction, the dynamic stress intensity and elastic energy release rate, crack branching, the	**9**	**MEE84.2**
	principles of crack arrest, the dynamic fracture toughness.Comparison of crack growth and critical value of K by MTS and SED **Fatigue And Fatigue Crack Growth Rate:** Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.Paris Law and Sigmoidal Curve, crack clouser.		**MEE84.3** **MEE84.6**
4	**Fracture Resistance Of Materials:** Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure. **Computational Fracture Mechanics:** Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching,	**8**	**MEE84.4** **MEE84.6**
5	**Fracture Toughness Testing Of Metals:** Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods,NASGRO, AFGROW, Summary of empirical fatigue crack growth models, Crack initiation, Intrusion and extrusion, Evidence of slip bands.	**9**	**MEE84.4** **MEE84.6**

TEXT BOOKS:

1. **Introduction to fracture mechanics,** Dietmar and Thomas seeling**, 2017** ISBN-13: 978-3319710891,ISBN-10: 3319710893
2. **Fracture of Engineering Brittle Materials,** Jayatilake, Applied Science, London**.** 2014. ISBN-13-978-3345457810.
3. **Introduction to Fracture Mechanics, Karen Hellan,** 2000, ISBN-13-978-3348561654

REFERENCE BOOKS:

1. **Fracture Mechanics –** Fundamentals and Application, T.L. Anderson, CRC press ,4TH EDITION,**2017,ISBN-13:** 978-1498728133
2. **Elementary Engineering Fracture Mechanics,** David Broek, ArtinusNijhoff, London **2015. ISBN-13:** 978-9024726561
3. **Fracture and Fatigue Control in Structures,** Rolfeand Barsom, Printice Hall **2015. ISBN-13:** 978-0133298635
4. **Fundamentals of Fracture Mechanics, Knott,** Butterworth & Co Publishers Ltd**,2014.**

Assessment pattern:

1. **CIE- (50 Marks Theory)**

Bloom's Category	**Tests**	**Assign ments**	**Quizzes**
Marks (out of 50)	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

2. **SEE – (50 Marks)**

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

NON-CONVENTIONAL MANUFACTURING TECHNOLOGIES

Course Code	MEE815
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: at the end of the course, the students will be able to:

MEE815.1	Understand the concept of Non-conventional manufacturing technologies
MEE815.2	Analyze the different Non-conventional manufacturing technologies
MEE815.3	Evaluate the Non-conventional manufacturing technologies, application and limitations.
MEE815.4	Understand the latest trends of Non- conventional manufacturing technologies.
MEE815.5	Evaluate the conventional and compare with Non-conventional manufacturing technologies
MEE815.6	Apply of the process and extending to industrial usages.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE815.1	3	3										3		3
MEE815.2	3	3										3		3
MEE815.3	3	3										3		3
MEE815.4	3	3										3		3
MEE815.5	3	3										3		3
MEE815.6	3	3										3		3

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module	Contents of Module	Hrs	Cos
1	**Introduction:** History, Classification, Need, process selection, comparison between conventional and un-conventional manufacturing Techniques. **Ultrasonic Machining (USM):** Introduction, Principal, equipment, Process characteristics, Functions and Characteristics of Abrasive Slurry, Tool Feed System and Its Functions, Transducer, Effect of parameter, Advantages, Limitations and Application. Horn design: Shaws model of MRR, other applications of Ultrasonic machining	**8**	**MEE815.1 MEE815.2 MEE815.3 MEE815.5 MEE815.6**
2	**Abrasive Jet Machining (AJM):** Introduction, Principal, Equipment, Process characteristics, Variables in AJM, Advantages, Limitations and Application. **Water Jet Machining (WJM):** Introduction, Principal, Equipment, Advantages, Limitations and Application. **Abrasive Water Jet Machining (AWJM):** Introduction, Principal, Equipment, Advantages, Limitations and Application.	**9**	**MEE815.2 MEE815.3 MEE815.4 MEE815.6**

3	**Electrochemical Machining (ECM):** Introduction, Equipment, Process characteristics, Tooling, Advantages, Limitations and Application. Electrochemical Shaping, turning, Grinding, Honing, deburring. **Chemical Machining (CHM):** Introduction, elements of process, chemical blanking process, chemical milling, process steps –masking, Etching,process characteristics of CHM, Advantages, Limitations and Application.	**9**	**MEE815.2** **MEE815.3** **MEE815.4** **MEE815.6**
4	**Electrical Discharge Machining (EDM):** Introduction, Principal, Equipment, Process characteristics, spark generator, Types, Functions and Properties of Dielectric Fluid, Multi Lead EDM, Types And Requirements Of Electrodes. Factors Affecting Electrode Wear, Electrode feed control, Flushing, accessories, Advantages, Limitations and Application., electrical discharge grinding, Traveling wire EDM **Ion Beam Machining (IBM):** Introduction, Principle, Equipment, Advantages, Limitations and Application.	**9**	**MEE815.2** **MEE815.3** **MEE815.4** **MEE815.6**
5	**Plasma Arc Machining (PAM):** Introduction, Principal, Equipment, Process characteristics selection of gas, Safety precautions, Plasma Torch, Generation of Plasma Torch, Advantages, Limitations and Application. **Laser Beam Machining (LBM):** Introduction, Principal, Equipment, Process characteristics, and parameters, Advantages, Limitations and Application. Lasing process: Types of lasers (Gas and solid state), lasing mediums, laser material processing-cutting, drilling, surface treatment, special applications. **Electron Beam Machining (EBM):** Introduction, Principle, Equipment, Process characteristics Advantages, Limitations and Application.	**9**	**MEE815.2** **MEE815.3** **MEE815.4** **MEE815.6**

TEXT BOOKS:

1. Modern machining process, Pandey and Shan, Tata McGraw Hill ,1st Ed, **ISBN:** 9780070965539
2. Production Technology, HMT Tata McGraw Hill, 1st Ed, **ISBN:**9780070964433

REFERENCE BOOKS:

1. Non-Conventional Machining, P.K.Mishra, Narosa Publishing House, **and ISBN-13:** 978-8319138
2. Nontraditional manufacturing Processes, Gary F Benedict, CRC press, 1st Ed, **ISBN-13:** 978- 0824773526
3. Advanced methods of Machining, J.A.McGeough, Chapman and Hall, ISBN: 9788184898453
4. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM) ISBN-13:978-08700223 ISBN-10:08700220

Assessment Pattern

CIE(50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember			
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create	5		

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

FOUNDRY TECHNOLOGY

Course Code	MEE816
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE816.1	Understand special casting techniques
MEE816.2	Design and develop the conventional foundries
MEE816.3	Analyze casting defects, special moulding techniques
MEE816.4	Understand Foundry metallurgy & Design gating system
MEE816.5	Evaluate the fettling processes, patterns and mould making
MEE816.6	Apply modern tools to develop casting aids

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE564.1	3												3	
20MEE564.2	3	2											3	
20MEE564.3	3		3	1									3	
20MEE564.4	3					1	1						3	
20MEE564.5	3		3										3	
20MEE564.6	3	2											3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**INTRODUCTION:** Introduction to casting process and its potential, Chronology of the art of founding, freezing of molten metal's /alloys, grain structure and effect of heat transfer on grain structure and properties **FOUNDRY METALLURGY:** Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals.	9	**MEE816.1 MEE816.2**
2	**PATTERN AND MOULD MAKING:** Pattern - types and materials mould and mould materials, popular casting processes, core and core making, importance of pattern and core on quality and economy of the castings **CUPOLA MELTING:** Developments in cupola melting – hot blast cupola, water cooled cupola, balanced blast cupola, cokeless cupola, cupola charge calculations.	9	**MEE816.1 MEE816.5**

3	**SOLIDIFICATION OF CASTINGS:** Crystallization and development of cast structure- nucleation, growth. Feeding of metals / alloys, design of feeder, Chvorinov's rule, casting defects, remedies, Fettling and NDT of castings. **CASTING DESIGN:** Introduction to casting design, redesign considerations, design for minimum casting stresses, design for directional solidification, design for metal flow, safety factors, design for low pattern cost and model making as an aid in design.	**9**	**MEE816.2 MEE816.3 MEE816.5**
4	**ALLOYS HANDLED BY FOUNDRIES:** Discussion on foundry practices for cast iron, steel, malleable iron, SG iron and zinc alloys, copper alloys and aluminum alloys with applications. **SPECIAL MOULDING TECHNIQUES:** Principles, materials used process details and application of no-bake sand systems, vacuum moulding, flask less moulding, and high pressure moulding.	**9**	**MEE816.1 MEE816.3**
5	**MELTING OF ALLOYS AND GATING:** Melting practices, selection of furnaces, pouring methods, flow of molten metal inside the mould, design of gates and types of gates. A case study using CAD/CAE/CAM(RP) for developing pattern and core box for casting	**8**	**MEE816.4 MEE816.6**

TEXT BOOKS:

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Casting", Tata McGraw Hill, New Delhi,2nd Ed, **ISBN:** 9780070993488
2. John Campbell, "Castings", Butterworth Heinemann, Oxford,2nd Ed, ISBN-13: 978- 0750647908f

REFERENCES:

1. Jain P L, "Principles of Foundry Technology", Tata McGraw Hill, New Delhi,5th Ed, **ISBN:** 9780070151291
2. Elliot R, "Cast Iron Technology", Jaico Publications, 2009.
3. Tiwari, "Cast Iron Technology", CBS Publications, 2007, ISBN: 9788123914893
4. ASM Metals Handbook - Castings, Vole .15, ASM Int. Metals Park, OHIO, 2008.

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks	**25**	**15**	**10**
Remember			
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create	5		

SEE (50 Marks - Theory)

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

AGILE MANUFACTURING

Course Code	MEE817
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

Course Outcomes: At the end of the Course, the student will be able to:

MEE817.1	Understand and develop the concepts of Agile Manufacturing.
MEE817.2	Analyze the Product/Process development and its application in Agile Manufacturing.
MEE817.3	Understand Supply Chain Management and its link with Agile Manufacturing.
MEE817.4	Apply the Computer Control in Agile Manufacturing.
MEE817.5	Apply Corporate Knowledge of Management in Agile Manufacturing.
MEE817.6	Understand the Skill & Knowledge in Agile Manufacturing.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
MEE817.1	3												3	
MEE817.2	3												3	
MEE817.3	3										1		3	
MEE817.4	3				1								3	
MEE817.5	3										1		3	
MEE817.6	3												3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Module Contents	Hrs	Cos
1	**Agile Manufacturing:** Definition, business need, conceptual framework, characteristics, generic features. **Developing Agile Manufacturing:** Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples.	08	**MEE817.1 MEE817.2**
2	**Integration Of Product /Process Development:** Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile organization, Approaches. **Application Of It/Is Concepts In Agile Manufacturing:** Strategies, Management of complexities and information. Flow approaches, applications of multimedia to improve agility in manufacturing, system concepts.	10	**MEE817.1 MEE817.3**

3	**Agile Supply Chain Management:** Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and Leanness – comparison of concepts.	08	**MEE817.1 MEE817.4**
4	**Computer Control Of Agile Manufacturing:** CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, and	08	**MEE817.3 MEE817.5**
5	**Corporate Knowledge Management In Agile Manufacturing:** Strategies, strategic options in Agile manufacturing, Role of standards. **Design Of Skill & Knowledge**: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements. (parametric approach only)	10	**MEE817.4 MEE817.6**

TEXT BOOKS:

1. **Agile Manufacturing -Forging new Frontiers -** Paul T. Kidd - Addison Wesley- Publication Amagow Co. UK, ISBN-13: 978-0201631630
2. **Agile Manufacturing",** A Gunasekharan, the 21st Century Competitive strategy, **ISBN:** 9780080435671, Elsevier Press, India
3. **Agile Manufacturing -Proceeding of International Conference on Agile Manufacturing** Dr. M.P Chowdiah (Editor), TATA McGraw Hill Publications 2014, **ASIN:** B01NBY3E8K

REFERENCE BOOKS:

1. **Concurrent Engg -** Paul T Kidd – Addison Wesley Publication -2014. Not listed
2. **World Class manufacturing -** Paul T Kidd – Addition Wesley Pub – 2014. Not listed
3. **O Levine Transitions to Agile Manufacturing-**Joseph C Moutigomery and Lawrurence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee, Wisconsin, USA, **ISBN-13: 978-0873893473**
4. **Agile Development for Mass Customization-**David M Anderson and B Joseph Pine, Irwin Professional Publishing, Chicago, USA, **ISBN-13:** 978-07863150

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember			
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create	5		

SEE (50 Marks - Theory)

Bloom's Category	Tests(theory)
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES

Course Code	MEE818
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE818.1	Understand the basic working principles of non-conventional power plants like Nuclear, Solar, Geo-thermal, Tidal and Ocean Thermal Energy power plant.
MEE818.2	Evaluate cycle efficiency and performance of Various Power Plants.
MEE818.3	Distinguish the various types of fuels used in power plants and estimate their heating values.
MEE818.4	Analyze the applications of Bio Mass and Hydrogen energy.
MEE818.5	Investigate the ways to increase the thermal efficiency of power plant by the use of accessories.
MEE818.6	Discuss the working principle and basic components of Diesel and hydro electric power plants and the economic principles and safety precautions involved with it.

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
MEE818 .1	3						2						3	
MEE818 .2	3												3	
MEE818 .3	3												3	
MEE818 .4	3						2						3	
MEE818 .5	3												3	
MEE818 .6	3												3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping

Module No	Contents of Module	Hrs	Cos
1	**Steam Power Plant:** Layout of steam power plant, Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace. **A Brief Account Of Benson, Velox, Schmidt Steam Generators**. Chimneys: Natural, forced, induced and balanced draft. Cooling towers and Ponds. Accessories for the Steam generators such as Super heaters, De-super heater, control of super heaters, Economizers, Air pre heaters and re-heaters.	**9**	**MEE818.1 MEE818.2**

2	**Diesel Engine Power Plant:** Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, intake and exhaust system, Layout of diesel power plant. **Hydro-Electric Plants**: Hydrographs, flow duration and mass curves, unit hydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves. General layout of hydel power plants.	**9**	**MEE818.2**
3	**Solar Energy:** Solar Extra terrestrial radiation and radiation at the earth surface, radiation-measuring instruments, working principles of solar flat plate collectors, solar pond and photovoltaic conversion (Numerical Examples). **Wind Energy**: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills.		**MEE818.2** **MEE818.3**
4	**Nuclear Power Plant**: Principles of release of nuclear energy; Fusion and fission reactions. Nuclear fuels used in the reactors. Elements of the nuclear reactor; moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types- Pressurized water reactor, Boiling water reactor, Sodium graphite reactor and gas cooled reactor, Radiation hazards, Shieldings, Radio-active waste disposal. **Hydrogen Energy** : Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production, bio-chemical production.	**9**	**MEE818.3** **MEE818.4**
5	**Geothermal Energy Conversion**: Principle of working, types of geothermal station with schematic diagram, problems associated with geothermal conversion, scope of geothermal energy. **Tidal Power**: fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion**: Principle of working, Rankine cycle, problems associated with OTEC. **Energy from Bio Mass**: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, problems involved with bio-gas production.	**9**	**MEE818.4** **MEE818.5**

TEXT BOOKS:

1. Non-Conventional Energy Sources by *G.D Rai K*, Khanna Publishers,5th Ed, ISBN: 97881- 7409-073-8
2. Solar energy, by *Subhas P Sukhatme*– Tata McGraw Hill, 3rd Ed, **ISBN:** 9780070260641
3. **Power Plant Engineering**, P. K. Nag Tata McGraw Hill ,4th Ed, **ISBN:** 9789339204044
4. **Power Plant Engineering,** Domakundawar, Dhanpath Rai sons.

REFERENCE BOOKS:

1. **Power Plant Engineering,** R. K. Rajput, Laxmi publication, 5th Ed, ISBN: 9788131802557
2. **Principles of Energy conversion**, A. W. Culp Jr., McGraw Hill, 2nd Ed, **ISBN-13:** 978- 0070435599
3. Renewable Energy Sources and Conversion Technology by *N.K.Bansal, Manfred Kleeman & Mechael Meliss*, Tata McGraw Hill, 2001.

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

SEE (50 Marks - Theory)

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

INDUSTRIAL ROBOTICS

Course Code	MEE819
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE819.1	Understand the knowledge about robots, its needs, importance and applications.
MEE819.2	Apply the robot drives and components in practical cases.
MEE819.3	Understand the basics of robotic dynamics.
MEE819.4	Analyze how robots use sensors and sensing.
MEE819.5	Distinguish the methods and types of robot programming
MEE819.6	Understand the roles, advantages and application of robotics in industries.

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MEE819.1		3												3
MEE819.2	3		3											3
MEE819.3		3												
MEE819.4		3	3		3									3
MEE819.5	3		3		3									3
MEE819.6		3	3			1								

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	**Introduction: definition** of robot, Need and importance, Type of robots, Robot Classifications: degrees of freedom; degrees of movements, robot configuration; accuracy and repeatability, robot Applications.	**08**	MEE819.1 MEE819.2
2	**Drives and component systems:** Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.	**10**	MEE819.2 MEE819.3
3	**Sensors and sensing:** Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing, Linear position and displacement sensing, Image processing and object recognition.	**10**	MEE819.4
4	**Robot Programming:** Teaching of robots, Manual, walk through**,** teach pendant**,** Methods - languages - Capabilities and limitation.	**09**	MEE819.5
5	**Industrial Applications :** Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.	**08**	MEE819.6

TEXT BOOKS:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic Engineering - An Integrated Approach", Prentice Hall India, **ISBN-13:** 978-8120308428
2. Mikell P. Groover, Mitchell Weiss, "Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 2nd Ed, **and ISBN:** 9781259006210

REFERENCE BOOKS:

1. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, "Robotic engineering - An Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, **and ISBN-13:** 978-8120308428
2. K.S. Fu., R.C.Gonalez, C.S.G.Lee, "Robotics Control sensing ", Vision and Intelligence, McGraw Hill International Edition, 1st Ed, **ISBN:** 9780070265103

Assessment Pattern

CIE (50 Marks - Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**
Marks	**25**	**15**	**10**
Remember	5		
Understand	5	5	5
Apply	5	5	5
Analyze	5	5	
Evaluate	5		
Create			

SEE (50 Marks - Theory)

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

SUSTAINABLE ENERGY SOURCES

Course Code	MEE810
L: T: P	3:0:0
Exams Hours	03

Credits	03
CIE Marks	50
SEE Marks	50

COURSE OUTCOMES: At the end of the course, the students will be able to:

MEE810.1	Understand The principles that underlie the ability of various natural phenomena to deliver solar energy
MEE810.2	Analyze the technologies that are used to harness the power of solar energy
MEE810.3	Analyze The positive and negative aspects of solar energy in relation to natural and human aspects of the environment.
MEE810.4	Evaluate the challenges of designing, promoting and implementing renewable energy solutions
MEE810.5	Understand their role in lifelong learning, social responsibility, and professional and ethical responsibilities in implementing sustainable engineering solutions.
MEE810.6	Apply the major 'big picture' questions in the area of energy resources

Mapping of Course outcomes to Program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MEE810.1	2	3	2								3	
MEE810.2	2	3	2								3	
MEE810.3	2	3	2								3	
MEE810.4	2	3	2								3	
MEE810.5	2	3	2								3	
MEE810.6	2	3	2								3	

Ratings: 3 for high, 2 for substantial, 1 for low. To be followed in mapping.

Module No	Contents of Module	Hrs	Cos
1	INTRODUCTION: Energy demand growth and supply : Historical Perspectives ; Fossil fuels: Consumption and Reserve ; Environmental Impacts of Burning of Fossil fuels ; Sustainable Development and Role of Renewable Energy BIOMASS ENERGY: Biomass: Sources and Characteristics; Wet biogas plants; Biomass gasifiers: Classification and Operating characteristics; Updraft and Downdraft gasifiers; Gasifier based electricity generating systems; Maintenance of gasifiers.	9	**MEE810.1 MEE810.2**
2	SOLAR ENERGY BASICS: Solar geometry; Primary and Secondary Solar energy and Utilization of Solar Energy. Characteristic advantages and disadvantages. Low temperature applications: solar water heating, space heating, drying.	9	**MEE810.3**

3	SOLAR THERMAL ELECTRICITY GENERATION: Solar concentrators and tracking; Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants; Solar Ponds.	9	**MEE810.3**
4	SOLAR PHOTOVOLTAIC SYSTEMS: Basic principle of power generation in a PV cell ; Band gap and efficiency of PV cells ; Manufacturing methods of mono- and polycrystalline cells ; Amorphous silicon thin film cells, Single and multi junction cells ; Application of PV ; Brief outline of solar, PV stand-alone system design ; Storage and Balance of system.	9	**MEE810.4**
	GEOTHERMAL ENERGY: Geothermal sites in India; High temperature and Low temperature sites; Conversion technologies- Steam and Binary systems; Geothermal power plants.		
5	WIND Energy Systems: Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Wind farms for bulk power supply to grid; Potential of wind electricity generation in India and its current growth rate. OCEAN ENERGY: Tidal power plants: single basin and two basis plants, Variation in generation level; Ocean Thermal Electricity Conversion (OTEC); Electricity generation from Waves: Shoreline and Floating wave systems.	8	**MEE810.5** **MEE810.6**

TEXT BOOKS:

1. Twidell J and Weir T., Renewable Energy Resources, Taylor & Francis ,2nd Ed, **ISBN- 13:** 978-0419253303
2. Godfrey Boyle, Renewable energy, Oxford Press , 3rd Ed, **ISBN-13:** 978-0199545339
3. V.V.N. Kishore, Renewable Energy engineering and Technology: Principles and Practice, TERI Press. **ISBN-13:** 978-89930939
4. Rai G.D., Non-Conventional Energy Sources, Khanna publication, 5th Ed, ISBN 13- 978-81- 7409-073-8

Assessmen Pattern

CIE (50 Marks - Theory)

Bloom's Category	**Tests**	**Assignments**	**Quizzes**	**External participation**
Marks	**25**	**10**	**5**	**10**
Remember				
Understand	5			
Apply	5	5	5	5
Analyze	5	5		5
Evaluate	5			
Create	5			

SEE (50 Marks - Theory)

Bloom's Category	**Tests(theory)**
Remember	10
Understand	10
Apply	10
Analyze	10
Evaluate	10
Create	

APPENDIX- A

Outcome Based Education

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

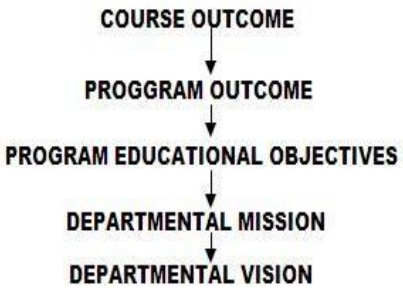
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes



APPENDIX- B

The Graduate Attributes of NBA

- **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **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.
- **Conduct investigations of complex problems**: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline that may not have a unique solution. For example, a

design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

- **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **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.
- **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.
- **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **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.
- **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.
- **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

APPENDIX-C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.