NEW HORIZON
COLLEGE OF ENGINEERING
New Horizon Knowledge Park, Ring Road, Marathalli
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

BE – Mechanical Engineering

Seventh and Eighth Semesters B.E

Scheme and Syllabus

CONTENTS

VISION

To create competent mechanical engineers capable of working in diversified disciplines fortransformative impact on societal progressive development in the field of mechanicalengineering through creative research and lifelong learning.

MISSION

- To impart excellent education by proving state of art research facilities in the field of mechanical engineering.
- To develop alliances with industries and other organizations for excellence in teaching learning process, research and consultancy projects.
- To enhance the students in intellectual, entrepreneurial and ethical challenges through active participation by critical thinking.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- **PEO 1**: The graduates will be able to apply the overall knowledge of Mechanical Engineering along with concepts of Mathematics, Science, Communication and Computing skills to understand specific problem areas and finding the optimal solutions for the same.

- **PEO 2**: The graduates will be able to implement ideas of Mechanical Engineering for the challenging tasks in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

- **PEO 3**: The graduates will be widely talented in the fields of manufacturing, service and design industries, which will not only improve their employability but also aid in establishing the above said industries.

- **PEO 4**: The graduates will develop lifelong learning attitudes, ethics and values that will help their career employability and growth in engineering, academia, defence, state and central government sectors.

MAPPING OF PEOs TO DEPARTMENT MISSION

Program Educational Objectives	M1	M2	M3
PEO 1	3	2	3
PEO 2	2	1	3
PEO 3	3	2	2
PEO 4	2	2	3

PROGRAM OUTCOMES (POs)

Graduate Attributes	PO #	Program Outcomes
Engineering knowledge	1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex mechanical engineering problems
Problem Analysis	2	Identify, formulate, review research literature, and analyze complex engineering problems in Mechanical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
Design Development of Solutions	3	Design solutions for complex engineering problems and design system components or processes of Mechanical Engineering 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	4	Use research-based knowledge and research methods including design of experiments in Mechanical Engineering, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
Modern tool usage	5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities in Mechanical Engineering with an understanding of the limitations.
The Engineer and society	6	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 in Mechanical Engineering.
Environment and Sustainability	7	Understand the impact of the professional engineering solutions of mechanical Engineering in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
Ethics	8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
Individual & team work	9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
Communication	10	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	11	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, manage projects and in multidisciplinary environments.
Lifelong learning	12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of mechanical Engineering Program, the graduates will be able to:

PSO1	Specify, fabricate, test and operate various machines along with essential documentations.
PSO2	Analyze, design, develop and implement the concepts of mechanical systems and processes towards product development

New Horizon College of Engineering

Department of Mechanical Engineering

Seventh Semester Scheme											
Sl. No.	Course Code	Course Name	Credit Distribution				Overall Credits	Contact Hours	Marks		
			L	T	P	S			CIE	SEE	Total
1	20MEE71A	Mechanical Vibrations	2	1	0	0	3	4	50	50	100
2	20MEE72A	Control Engineering	2	1	0	0	3	4	50	50	100
3	20MEE73A	Automation Engineering	2	1	0	0	3	4	50	50	100
4	20MEE74XA	Professional Elective-IV	3	0	0	0	3	3	50	50	100
5	20MEE75XA	Professional Elective-V	3	0	0	0	3	3	50	50	100
6	20NHOP7XXX	Open Elective-II	3	0	0	0	3	3	50	50	100
7	20MEL71A	Mechanical Vibrations Lab	0	0	1	0	1	2	25	25	50
8	20MEL72A	Simulation Lab	0	0	1	0	1	2	25	25	50
9	20MEL73A	Automation Engineering Lab	0	0	1	0	1	2	25	25	50
10	20MEE76A	Mini Project-IV	0	0	2	0	2	4	25	25	50
Total							23	32	400	400	800

Professional Elective-IV		
Sl. No.	Course Code	Course Name
1	20MEE741A	Operations Research
2	20MEE742A	Production and Operations Management
3	20MEE743A	Research Methodology
4	20MEE744A	Organizational Behavior & Professional Ethics
5	20MEE745A	Machine Learning & Artificial Intelligence

Professional Elective-V		
Sl. No.	Course Code	Course Name
1	20MEE751A	Design For Manufacturing & Assembly
2	20MEE752A	Applied Numerical Techniques And Computing
3	20MEE753A	Hybrid & Electric Vehicles
4	20MEE754A	Hydraulics and Pneumatics
5	20MEE755A	Rapid Prototyping

New Horizon College of Engineering

Department of Mechanical Engineering

Eighth Semester Scheme											
Sl. No.	Course Code	Course Name	Credit Distribution				Overall Credits	Contact Hours	Marks		
			L	T	P	S			CIE	SEE	Total
1	20MEE81XA	Professional Elective-VI	3	0	0	0	3	3	50	50	100
2	20MEE82XA	Professional Elective-VII	3	0	0	0	3	3	50	50	100
3	20MEE83A	Internship	0	0	4	0	4	3	50	50	100
4	20MEE84A	Project Work	0	0	10	0	10	20	200	200	400
Total							20	29	350	350	700

Professional Elective-VI		
Sl. No.	Course Code	Course Name
1	20MEE811A	Non-Conventional Manufacturing Technologies
2	20MEE812A	Foundry Technology
3	20MEE813A	Agile Manufacturing
4	20MEE814A	Conventional and Non- Conventional Energy Resources
5	20MEE815A	Total Quality Management

Professional Elective-VII		
Sl. No.	Course Code	Course Name
1	20MEE821A	Non Destructive Testing
2	20MEE822A	CNC Machining
3	20MEE823A	Industrial Robotics
4	20MEE824A	Product Design & Development
5	20MEE825A	Tribology

List of Open Electives (for 175 credits scheme)		
Sl. No.	Course Code	Course Name
1	20NHOP601/701	Big Data Analytics using HP Vertica-1
2	20NHOP602/702	VM Ware Virtualization Essentials-1
3	20NHOP604/704	Big Data Analytics using HP Vertica-2
4	20NHOP605/705	VM Ware Virtualization Essentials-2
5	20NHOP607/707	SAP
6	20NHOP608/708	Schneider - Industrial Automation
7	20NHOP609/709	CISCO- Routing and Switching - 1
8	20NHOP610/710	Data Analytics
9	20NHOP611/711	Machine Learning
10	20NHOP612/712	CISCO- Routing and Switching - 2
11	20NHOP613/713	IIOT- Embedded System
12	20NHOP614/714	Block Chain
13	20NHOP615/715	Product Life Cycle Management
14	20NHOP617A/717A	Network Security and Cryptography
15	20NHOP618A/718A	Physical Design
16	20NHOP619A/719A	AI Data Analysis with Python

SEVENTH SEMESTER SYLLABUS

MECHANICAL VIBRATIONS

Course Code	20MEE71A
L: T: P:S	2:1:0:0
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:

20MEE71A.1	Utilize the fundamental knowledge of physics and mechanics in understanding the theory behind free & forced vibrations, frequencies, damping, degrees of freedom and vibrations measuring instruments.
20MEE71A.2	Examine and identify the methods for determining the frequencies in cases of free, forced, damped, un-damped, multiple DoF and continuous systems.
20MEE71A.3	Impart the solutions through detailed process, investigations& analysis of vibrations of machines and shafts under distinctive loading conditions and evaluation of vibration of vibration measuring instruments.
20MEE71A.4	Use adequate theory, formula, and analysis techniques to provide vibration solution for mechanical machine elements of specific functions.
20MEE71A.5	Develop feasible engineering components with thorough vibrations investigation & analysis so as to benefit the industry and environment.
20MEE71A.6	Analyze new products with the fundamental knowledge on vibrations by latest technological advancement in design of vibrating machine parts and components.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE71A.1	3	3												
20MEE71A.2	3	3	3											
20MEE71A.3		3	3	2										
20MEE71A.4		3	3	2										2
20MEE71A.5		3		2		1	1							2
20MEE71A.6			3	2		1	1							2

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

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**

Module No	Module Contents	Hrs	COs
1	**Introduction to vibrations:** Basic concepts and definitions. Simple harmonic motions, addition by analytical and graphical methods. Types of vibrations, elements of vibrating system. Super position of waves, Beats. Representation of wave forms using Fourier series and work done by a wave (derivations and problems)	**8**	**20MEE71A.1 20MEE71A.2**
2	**Un-damped Free Vibrations:** Differential equation for undamped 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. **Damped Free Vibrations:** 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**	**20MEE71A.1 20MEE71A.2**
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**	**20MEE71A.2 20MEE71A.4**
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 andMatrix iteration method.(spring mass systems and torsional systems)	**9**	**20MEE71A.3 20MEE71A.4**
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**	**20MEE71A.5 20MEE71A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	5
Understand	10
Apply	15
Analyze	15
Evaluate	5
Create	

CONTROL ENGINEERING

Course Code	20MEE72A
L: T: P:S	2:1:0:0
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:

20MEE72A.1	Apply various control systems concepts to mechanical models and identify the control parameters for safe usage of the system.
20MEE72A.2	Analyze and categorize the transient and steady state response of mechanical control systems to interpret the practical problems
20MEE72A.3	Apply the reduction methods and evaluate the outputs for transfer function of controlsystems with suitable representations and documentation
20MEE72A.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
20MEE72A.5	Design and develop system with controlled parameters and compensate the system responses to maintain the optimal functionality.
20MEE72A.6	Formulate, analyze and solve the problem using MAT Lab programming.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE72A.1	1													3
20MEE72A.2		1												3
20MEE72A.3										1				3
20MEE72A.4						2	2							3
20MEE72A.5			1	1										3
20MEE72A.6					2									3

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

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
3) **Modern Control Engineering**, Katsuhiko Ogata, Pearson Publication, 5th Ed. ISBN-13: 978-0136156734

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 ofIndia Pvt.Ltd, 2016 edition, **ISBN-13:** 978-8120351653
3) **MATLAB: An Introduction with Applications,** Amos Gilat, Wiley; Fourth edition (9August 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

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, basic state space representation, linearization of non-linear systems, state space canonical form, state space solution and matrix exponential, designing using statespace model.	**9**	**20MEE72A.1**
2	**Transient and Steady State Response Analysis:** Introduction, firstorder and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance inspeed of response. System stability: Routh's-Hurwitz Criterion.	**9**	**20MEE72A.2**
3	**Block Diagrams and Signal Flow Graphs:** Transfer Functionsdefinition, function, block representation of systems elements,reduction of block diagrams, Signal flow graphs: Mason's gainformula. MAT lab simple program for representation of block diagrams.	**9**	**20MEE72A.3**
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:** Bodeattenuation diagrams, Stability analysis using Bode plots(Graphical method and also MAT Lab programming), Simplified Bode Diagrams	**9**	**20MEE72A.4**
5	**Root Locus Plots:** Definition of root loci, General rules for constructing root loci, Analysis using root locus plots using graphical representation**,** relative stability**.** **System Compensation:** types of compensation system, design of lead and lag compensator, designing proportional controller for desired angle.	**8**	**20MEE72A.5** **20MEE72A.6**

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	2		
Understand	3		
Apply	5	5	
Analyze	10	5	5
Evaluate	5	5	5
Create			

SEE (50 Marks – Theory)

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

AUTOMATION ENGINEERING

Course Code	21MEE73A
L: T: P:S	2:1:0:0
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:

21MEE73A.1	Apply the concepts of Automation in manufacturing industries using mathematical models
21MEE73A.2	Implement Group Technology and Flexible manufacturing concepts in production lines
21MEE73A.3	Understand the different types of automated material handling systems, storage systems and automated identification methods implemented in industries
21MEE73A.4	Create process plans and production plans for various part and assembly designs
21MEE73A.5	Inspect the parts and products manufactured in industries using automated inspection techniques
21MEE73A.6	Apply the concepts of IoT in manufacturing industries for production, scheduling and maintenance

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE73A.1	3	3	3											3
20MEE73A.2	3	3	3											3
20MEE73A.3	3	3												3
20MEE73A.4	3	3	3											3
20MEE73A.5	3	3												3
20MEE73A.6	3	3												3

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

TEXT BOOKS / REFERENCE BOOKS:

1) Automation, Production systems and Computer Integrated Manufacturing , Mikell P Groover, Pearson learning, 4th edition, 2015, ISBN: 978-9332572492
2) Computer Based Industrial Control– Krishna Kant, EEE-PHI, 2nd edition, 2011, ISBN: 978-8120339880
3) Overview of Industrial Process Automation, KLS Sharma, 2016, Elsevier, ISBN:9780128053546

REFERENCE BOOKS:

4) Internet of Things (IoT): Digitize or Die: transform your organization: Embrace the digital evolution, rise above the competition, IoT hub, Black and white edition, ISBN-979-1097580032
5) Internet of things: A hands on approach, Arshdeep Bahga and Vijay Madidetti, Unversity press, 2015, ISBN- 978-8173719547

Module No	Module Contents	Hrs	COs
1	**Introduction to CIM and Automation:** Introduction to production system facilities, manufacturing support systems, Automation in Production Systems, automated manufacturing systems- types, reasons, strategies of automation, Computer Integrated Manufacturing, elements of a CIM system, CAD/CAM and CIM, Production concepts & Mathematical models: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems. **Automated Manufacturing System:** Production lines, configurations, work part transfer mechanisms, storage buffers, control functions, Analysis of transfer line with and without storage buffers, numerical problems	**9**	**20MEE73A.1**
2	**Group technology and Cellular Manufacturing:** part families, parts classification and coding, Production flow analysis, cellular manufacturing **Flexible Manufacturing System (FMS):** FMS Components, FMS types, applications, benefits, implementation issues	**9**	**20MEE73A.2**
3	**Automated Material Handling and storage:** Material Handling equipment, AGV-types, vehicle guidance technology, management and safety, Automated storage and retrieval systems (AS/RS) **Automatic Data Capture:** Automatic identification methods, Bar code technology, Radio frequency identification (RFID)	**9**	**20MEE73A.3**
4	**Process Planning:** Introduction, Computer aided Process planning (CAPP)-retrieval/variant CAPP, Generative CAPP **Production Planning:** Master Production Schedule (MPS), Material Requirement Planning (MRP), outputs and benefits of MRP, capacity planning, shop floor control, Manufacturing Resource Planning (MRP-II), Just in Time (JIT)	**9**	**20MEE73A.4**
5	**Automated Inspection Technologies:** Automated inspection, contact & non-contact inspection, Coordinate Measuring machine (CMM)-construction, types, operation, Machine Vision **Automated Factory:** Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	**8**	**20MEE73A.5** **20MEE73A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	10
Understand	15
Apply	15
Analyze	10
Evaluate	
Create	

OPERATIONS RESEARCH

Course Code	20MEE741A
L: T: P:S	3:0:0:0
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:

20MEE741A.1	**Apply** mathematical formulations for solving linear part programming problems
20MEE741A.2	**Evaluate** for optimization using Simplex method, dual simplex method and Big M method
20MEE741A.3	**Apply** the transportation algorithm and assignment algorithm for real lifeproblems
20MEE741A.4	**Analyze** and determine the optimal solutions by PERT and CPM
20MEE741A.5	**Understand** the significance of Game theory and determine the optimalsolution
20MEE741A.6	**Analyze** the sequence of jobs on various machines

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE741A.1	3	3	3	3							3	3		3
20MEE741A.2	3	3	3	3							3	3		3
20MEE741A.3	3	3	3	3							3	3		3
20MEE741A.4	3	3	3	3							3	3		3
20MEE741A.5	3	3	3	3							3	3		3
20MEE741A.6	3	3	3	3							3	3		3

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

TEXT BOOKS:

1. **Operations Research: An Introduction,** H A Taha,Pearson; 10th edition (17 January2017), 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 (1November 2014), ISBN-13: 978-8121902816.

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	**8**	**20MEE741A.1 20MEE741A.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	**9**	**20MEE741A.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 assignment problem, Travelling salesman problem	**9**	**20MEE741A.2 20MEE741A.3**
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	**9**	**20MEE741A.5**
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	**9**	**20MEE741A.5 20MEE741A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

PRODUCTION AND OPERATIONS MANAGEMENT

Course Code	20MEE742A
L: T: P:S	3:0:0:0
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:

20MEE742A.1	Discuss the prominence role played by operations managers in Industries / Corporate and their decision making.
20MEE742A.2	Forecasting and its importance in accuracy & health of the business organization.
20MEE742A.3	Planning the various stages, departments of business organization & managing inventory.
20MEE742A.4	Analysis of operation processes from various perspectives such as efficiency, responsiveness, quality and productivity.
20MEE742A.5	Managing the various stages of Supply chain in a business organization & maintain the things & operations.
20MEE742A.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
20MEE742A.1	3									3	3			
20MEE742A.2	3	2									3			
20MEE742A.3	3									3	3			3
20MEE742A.4		2							2					3
20MEE742A.5	3									3	3			3
20MEE742A.6											3			3

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

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

Module No	Module Contents	Hrs	COs
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.	**9**	**20MEE742A.1 20MEE742A.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.	**9**	**20MEE742A.2 20MEE742A.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 – MRP inputs and outputs, MRP processing, numerical, an overview of MRP-II benefits and limitations of MRP.	**9**	**20MEE742A.3 20MEE742A.6**
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.	**8**	**20MEE742A.3 20MEE742A.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.	**9**	**20MEE742A.4 20MEE742A.5**

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	

RESEARCH METHODOLOGY

Course Code	20MEE743A
L: T: P:S	3:0:0:0
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:

20MEE743A.1	Define the significance and suitability of research for various engineeringapplications
20MEE743A.2	Demonstrate the various processing techniques of research
20MEE743A.3	Apply the research in the development of engineering materials/process
20MEE743A.4	Analyze the properties/process of research through various techniques
20MEE743A.5	Evaluate the influence of design, analysis and testing of research
20MEE743A.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
20MEE743A.1	3													3
20MEE743A.2	3													3
20MEE743A.3	3													3
20MEE743A.4	3	3												3
20MEE743A.5	3	3												3
20MEE743A.6	3		1											3

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

TEXT BOOKS:

1) **Kothari,** C.R., 2018. Research Methodology: Methods and Techniques. New Age International. ISBN-13: 978-8122436235
2) **Garg, B.L., Karadia, R., Agarwal, F. and Agarwal,** U.K., 2015, An introduction to Research 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. 2volumes. ISBN : 81-7000-324-5, 81-7000-334-2

Module No	Module Contents	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**	**20MEE743A.1** **20MEE743A.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 ofIndependent & Dependent variables. **Qualitative and Quantitative Research**: Qualitative research, Quantitative research, Concept of measurement, causality, generalization, and replication. Merging the two approaches.	**8**	**20MEE743A.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**	**20MEE743A.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**	**20MEE743A.4** **20MEE743A.5**
5	**Interpretation of Data and paper Writing** – layout of a researchpaper, 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**	**20MEE743A.5** **20MEE743A.6**

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	

ORGANIZATIONAL BEHAVIOUR & PROFESSIONAL ETHICS

Course Code	20MEE744A
L: T: P:S	3:0:0:0
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:

20MEE744A.1	**Understand** the importance of organizational behavior, behavior models, personality types, emotions, attitudes and motivation.
20MEE744A.2	**Remember** the importance of group behaviour and apply the principles for team building.
20MEE745A.3	**Apply** the concept of leadership, the power of managers and apply for stress management and balancing life and work.
20MEE744A.4	**Analyze** the human values and practice of ethics in the workplace and apply engineering to social experimentation.
20MEE744A.5	**Apply** ethics in society, safety, discuss the ethical issues related to engineering
20MEE744A.6	**Analyze** the responsibilities and rights in the society and understand global issues.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE744A.1						1	1	1	1	1		1		
20MEE744A.2						1	1	1	1	1		1		
20MEE745A.3						1	1	1	1	1		1		
20MEE744A.4						1	1	1	1	1		1		
20MEE744A.5						1	1	1	1	1		1		
20MEE744A.6						1	1	1	1	1		1		

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

TEXT BOOKS:

1) Stephen P. Robins, Organizational Behavior, PHI Learning/Pearson Education, 18th edition,2018.
2) Fred Luthans, Organizational Behavior, McGraw Hill, 12th Edition,2016, ISBN: 978-0-07-353035-2
3) MikeW.MartinandRolandSchinzinger,"EthicsinEngineering",TataMcGrawHill, New Delhi, 4TH EDITION, 2014, ISBN 10: 933920445X ISBN 13: 9789339204457

REFERENCE BOOKS:

1) CharlesB.Fleddermann,"EngineeringEthics",PearsonPrenticeHall,4THEditionNew Jersey,2017, ISBN: 0-13-214521-9
2) Ivancevich,Konopaske &Maheson,OranisationalBehaviour&Management,7th edition, Tata McGraw Hill,2014, ISBN 10- 9780070620117.
3) Charles E. Harris, MichaelS. Pritchard and Michael J. Rabins, "Engineering Ethics– Concepts and Cases", Cengage Learning,2013, ISBN-13: 978-0-495-50279-1.
4) John R Boat right, Jeffrey Smith, "Ethics and the Conduct of Business", Pearson Education, New Delhi,8th Edition2013, ISBN-13: 978-0-13-416765-7
5) Udai Pareek, Understanding Organizational Behaviour, 2nd Edition, Oxford Higher Education,2011.

Module No	Module Contents	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 Importance Factors influencing perception Interpersonal perception Impression Management. Motivation Importance Types Effects on work behavior.	**9**	**20MEE744A.1**
2	**GROUP BEHAVIOUR:** Organization structure Formation Groups in organizations Influence Group dynamics Emergence of informal leaders and working norms Group decision making techniques Team building Interpersonal relations Communication Control.	**8**	**20MEE744A.2**
3	**LEADERSHIP AND POWER, DYNAMICS OFORGANIZATIONAL 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**	**20MEE744A.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**	**20MEE744A.4**
5	**SAFETY, RESPONSIBILITIES AND RIGHTS, GLOBAL ISSUES :** Safety and Risk Assessment of Safety and 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 as Expert Witnesses and Advisors Moral Leadership Code of Conduct Corporate Social Responsibility.	**9**	**20MEE744A.5 20MEE744A.6**

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	

MACHINE LEARNING & ARTIFICIAL INTELLIGENCE

Course Code	20MEE745A
L: T: P:S	3:0:0:0
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:

20MEE745A.1	**Recognize** the origin and practical applications of machine learning
20MEE745A.2	**Identify** the applications suitable for different types of machine learning algorithms with appropriate justification
20MEE745A.3	**Understand** the types of Machine Learning algorithms.
20MEE745A.4	Use and **manipulate** several core data structures: Lists, Dictionaries, Tuples, and Strings
20MEE745A.5	**Understand** the significance of artificial intelligence and expert systems in real time environment
20MEE745A.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	PSO1	PSO2
20MEE745A.1	3													
20MEE745A.2	3	3		3										
20MEE745A.3			1	3										
20MEE745A.4	3				1									
20MEE745A.5		3		3										
20MEE745A.6		3												

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

TEXT BOOKS:

1) Machine Learning, Tom M Mitchel, McGraw Hill Education, July 2017, ISBN: 978-1-25-9096952.
2) Business Analytics, U Dinesh Kumar, Wiley India Pvt Ltd, 2017, ISNB:978-81-265-6877-2.
3) 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.

Module No	Module Contents	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**	**20MEE745A.1 20MEE745A.2**
2	**Descriptive Statistics and Introduction to Python Programming** **Descriptive statistics:** Measure of Central Tendency and Dispersion, Types of distribution, Types of Plots and Graphs. **Python Programming:** Decision and loop controls: Simple if, if-else and if-elif statements, Python Data-types, Data handling with Python, Numpy basic operations, Pandas and Matplotlib, Case study	**9**	**20MEE745A.2 20MEE745A.3**
3	**Regression Techniques** **Linear Regression:** SLR and MLR model building, Estimation of parameters using OLS, Standardized regression coefficient, Validation of model- R-square, Residual analysis. Case study. **Logistic Regression:** Introduction to classification problems and binary logistic regression, Estimation of parameters, classification table, Sensitivity, Specificity, ROC curve, Optimal Cut-off probability, Gain chart and Lift chart, Case Study	**9**	**20MEE745A.4**
4	**Decision Tree and Random Forest** Decision Trees: Classification Technique, C4.5 and CART introduction, Gini Gain, Entropy and Information Gain computation Random Forest: Ensemble Modelling, Bagging, Random Forest Algorithm, Out of Bag Error Rate, GridSearchCV, Case Study	**9**	**20MEE745A.5**
5	**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 functions.	**9**	**20MEE745A.5 20MEE745A.6**

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	

DESIGN FOR MANUFACTURING & ASSEMBLY

Course Code	20MEE751A
L: T: P:S	3:0:0:0
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:

20MEE751A.1	Select appropriate manufacturing process to match design tolerances and analyze tolerance by various methods
20MEE751A.2	Assemble the components manufactured by the methods of group tolerance
20MEE751A.3	Development of design for Machinability, accessibility, clampability and assembly requirements
20MEE751A.4	Designing the component to be casted as per feasibility in casting and application of modern computer tools for group technology
20MEE751A.5	Designing the gauges useful in gauging components to be assembled
20MEE751A.6	Identification & modification of the uneconomical design of casting to save the manufacturing cost

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE751A.1	3	3											3	
20MEE751A.2	3	3											3	
20MEE751A.3			3											3
20MEE751A.4			3		1									3
20MEE751A.5			3											3
20MEE751A.6	3										1			3

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

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

Module No	Module Contents	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 Analysis Sensitivity Analysis Taguchi's Approach to tolerance design.	**10**	**20MEE751A.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**	**20MEE751A.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**	**20MEE751A.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	**8**	**20MEE751A.4 20MEE751A.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.	**6**	**20MEE751A.5**

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	

APPLIED NUMERICAL TECHNIQUES AND COMPUTING

Course Code	20MEE752A
L: T: P:S	3:0:0:0
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:

20MEE752A.1	**Understand** the consequences of finite precision and the inherent limits of the numerical methods considered.
20MEE752A.2	**Demonstrate** the mathematics concepts underlying the numerical methods considered.
20MEE752A.3	**Apply** these methods to academic and simple practical instances.
20MEE752A.4	**Show** the knowledge of mathematics and computing to the design and analysis of optimization methods.
20MEE753A.5	**Analyze** a problem and identify the computing requirements appropriate for its solution.
20MEE752A.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
20MEE752A.1	3	3												
20MEE752A.2	3	3												3
20MEE752A.3	3	3		3										3
20MEE752A.4			3	3										3
20MEE753A.5		3	3	3										3
20MEE752A.6		3	3	3										3

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

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

Module No	Module Contents	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**	**20MEE752A.1 20MEE752A.3 20MEE752A.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**	**20MEE752A.2 20MEE752A.6**
3	**SOLUTION OF LINEAR SYSTEMS:** Direct Methods, Gaussian elimination and pivoting, Matrix inversion, UV factorization, 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.	**9**	**20MEE752A.2 20MEE752A.5 20MEE752A.6**
4	**SOLUTION OF DIFFERENTIAL EQUATIONS:** Introduction to differential equations, Initial value problems, 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**	**20MEE752A.4 20MEE752A.6**
5	**PARTIAL DIFFERENTIAL EQUATIONS, EIGENVALUES AND EIGENVECTORS:** Solution of hyperbolic, parabolic and elliptic equations, The eigen value problem, The power method and the Jacobi's method for eigen value problems, Solution of problems through a structural programming language	**9**	**20MEE752A.4 20MEE752A.6**

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	

HYBRID & ELECTRIC VEHICLES

Course Code	20MEE753A
L: T: P:S	3:0:0:0
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:

20MEE753A.1	Understand Basic of hybrid and electric vehicles
20MEE753A.2	Explain Different energy storage devices
20MEE753A.3	Describe different Characteristics of Fuel Cells
20MEE753A.4	Analyze the Performance of electric vehicles
20MEE753A.5	Understand Concepts of hybrid electric drive
20MEE753A.6	Classify Electric motors and controllers

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE753A.1	3	2				1	1		1	1	3	1		3
20MEE753A.2	3	2	1		2	1	1	3	1	1	3	1		3
20MEE753A.3	3	2	1	2		1	1		1	1		1		3
20MEE753A.4	3	2	1	2	2		1	3	1	1	3	1		3
20MEE753A.5	3	2	1			1			1	1		1		3
20MEE753A.6	3	2				1	1		1	1		1		3

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

TEXT BOOKS:

1) James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003

2) Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003 3. MehrdadEhsan

REFERENCE BOOKS:

1) *Ron HodKinson, " light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005 2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005*

Module No	Module Contents	Hrs	COs
1	**Introduction to need for Alternative System**: History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles. Limitations of electric vehicles. Specification of different electric and hybrid vehicles	**9**	**20MEE753A.1**
2	**Energy Storage Devices and Fuel Cells**: Electromechanical batteries-types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell-Connecting cell in series- water management in the PEM fuel cell-Thermal Management of the PEM fuel cell	**9**	**20MEE753A.2 20MEE753A.3**
3	**Electric Vehicles**: Electric vehicle layout, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system, safety and challenges in electric vehicles.	**9**	**20MEE753A.4**
4	**Hybrid Vehicles**: Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.	**9**	**20MEE753A.5**
5	**Propulsion Motors and Controllers**: Types of electric motors – working principle of AC and DC motors. Characteristic of shunt, series and compound type of DC motors- permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers	**8**	**20MEE753A.6**

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	

HYDRAULICS AND PNEUMATICS

Course Code	20MEE754A
L: T: P:S	3:0:0:0
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:

20MEE754A.1	Understand various hydraulic power concepts to mechanical models and identify the Pump parameters for safe usage of the system.
20MEE754A.2	Analyze and categorize the prime movers and using symbolic representations of mechanical systems to interpret the practical problems
20MEE754A.3	Recoil the hydraulics and pneumatic systems to evaluate the outputs for control valves with suitable representations.
20MEE754A.4	Determine the control stability conditions and represent using hydraulic circuits so as to facilitate the implementation process of hydraulic systems
20MEE754A.5	Design and develop system with controlled parameters to maintain the optimal functionality by selection of proper fluids, seals and maintenance system
20MEE754A.6	Formulate, analyze and solve the problem identifying support systems and circuit designs.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE754A.1	1												2	
20MEE754A.2		1											2	
20MEE754A.3										1			2	
20MEE754A.4						1	1						2	
20MEE754A.5			1	1									2	
20MEE754A.6					2								2	

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

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 HillPublishing 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) **Hydraulics and Pneumatics, 1/e** Jagadeesha T, I K International publishers (2015), ISBN- 13: 9789384588908

Module No	Module 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, pumping theory 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**	**20MEE754A.1**
2	**Hydraulic Prime Movers**: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators, single and double actingcylinder, Mechanics of Hydraulic Cylinder Loading, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and FlowRate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators problems on cylinders, Installation and mounting of hydraulic cylinders	**8**	**20MEE754A.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 type Load 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**	**20MEE754A.3** **20MEE754A.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**	**20MEE754A.4** **20MEE754A.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**	**20MEE754A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

RAPID PROTOTYPING

Course Code	20MEE755A
L: T: P:S	3:0:0:0
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:

20MEE755A.1	Apply the knowledge of physics and material science in understanding the working principle of additive manufacturing.
20MEE755A.2	Analyze the limitations and advantage of each additive manufacturing technique.
20MEE755A.3	Test the quality of the products built through additive manufacturing technique in soft tooling and hard tooling applications.
20MEE755A.4	Synthesize the information of process parameters with adequate optimization techniques using Internet based software.
20MEE755A.5	Demonstrate the knowledge of additive manufacturing in the application at Medical and product development Industries by executing the projects.
20MEE755A.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
20MEE755A.1	3												3	
20MEE755A.2	3	2											3	
20MEE755A.3	3	2											3	
20MEE755A.4	3				1								3	
20MEE755A.5	3		1										3	
20MEE755A.6	3				1								3	

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

TEXT BOOKS:

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 VerlogLondon2015. ISBN 978-1-4471-0703-3
3) Stereo Lithography and other RP & M Technologies, Paul F. Jacobs: SME,NY2009. 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 Association2014.

Module No	Module Contents	Hrs	COs
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**	**20MEE755A.1 20MEE755A.2**
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**	**20MEE755A.1 20MEE755A.2**
3	**Solid Ground Curing:** Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	**9**	**20MEE755A.1 20MEE755A.2**
4	**Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs 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**	**20MEE755A.5**
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**	**20MEE755A.3 20MEE755A.4 20MEE755A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

MECHANICAL VIBRATIONS LAB

Course Code	20MEL71A
L: T: P:S	0:0:1:0
Exams Hours	03

Credits	01
CIE Marks	25
SEE Marks	25

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

20MEL71A.1	Utilize the basic knowledge of physics and mechanics in understanding the working process behind free & forced vibrations, frequencies, damping, degrees of freedom and vibrations measuring instruments.
20MEL71A.2	Experimentally Examine and identify the methods of determining the frequencies in cases of free, forced, damped, un-damped, multiple DOF and continuous systems
20MEL71A.3	Impart the solutions through detailed experimental investigation & analysis of vibrations of machines and shafts under different loading conditions and evaluation of vibration of vibration measuring instruments.
20MEL71A.4	Use adequate theory, formula, software, and analysis techniques to provide vibration solution for mechanical machine elements of specific application.
20MEL71A.5	Develop feasible engineering products with thorough experimental vibrations investigation & mathematical analysis so as to benefit the industry and environment.
20MEL71A.6	Cultivate and evaluate new products with the fundamental knowledge on vibrations by latest technological advancement in design of vibrating machine parts and components.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL71A.1	3	3	3	3									3	
20MEL71A.2	3	3	3	3									3	
20MEL71A.3	3	3	3	3									3	
20MEL71A.4	3	3	3		3								3	
20MEL71A.5	3	3	3		3								3	
20MEL71A.6	3	3	3		3								3	

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

TEXT BOOKS:

1) Mechanical vibrations by V. P Singh, Dhanpat Rai& 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 938350648-4

Exp. No.	Contents of Experiment	Hrs	COs
1	Natural frequency of Simple pendulum	**3**	**20MEL71A.1**
2	Natural frequency of compound pendulum	**3**	**20MEL71A.1**
3	Natural frequency of spring mass system	**3**	**20MEL71A.2**
4	Natural frequency of torsional system	**3**	**20MEL71A.2**
5	Natural frequency for rigid body-spring system	**3**	**20MEL71A.2**
6	Whirling of shafts and critical speed	**3**	**20MEL71A.3**
7	Natural frequency and mode shapes of longitudinal vibrations of rod.	**3**	**20MEL71A.3**
8	Natural frequency and mode shapes of torsional vibrations of rod.	**3**	**20MEL71A.3**
9	Solution to natural frequency of Simple pendulum using MATLAB	**3**	**20MEL71A.4**
10	Solution to Natural frequency of compound pendulum using MATLAB	**3**	**20MEL71A.4**
11	Solution to Natural frequency of spring mass system using MATLAB	**3**	**20MEL71A.4**
12	Solution to Natural frequency of torsional system using MATLAB	**3**	**20MEL71A.5**
13	Solution to Natural frequency for rigid body-spring system using MATLAB	**3**	**20MEL71A.5**
14	Solution to Whirling of shafts and critical speed using MATLAB	**3**	**20MEL71A.6**

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

SIMULATION LAB

Course Code	20MEL72A
L: T: P:S	0:0:1:0
Exams Hours	03

Credits	01
CIE Marks	25
SEE Marks	25

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

20MEL72A.1	Apply various control systems concepts to mechanical models and identify the Control parameters for safe usage of the system.
20MEL72A.2	Analyze and categorize the transient and steady state response of mechanical control systems to interpret the practical problems
20MEL72A.3	Recoil the reduction methods and evaluate the outputs for transfer function of control systems with suitable representations and documentation
20MEL72A.4	Determine the stability conditions and represent the values using graphicalmethods so as to facilitate the learning process further and recommend improvements if needed
20MEL72A.5	Design and develop system with controlled parameters and compensate the system responses to maintain the optimal functionality.
20MEL72A.6	Formulate, analyze and solve the problem using MAT Lab programming.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL72A.1	1													
20MEL72A.2		1												
20MEL72A.3										1				
20MEL72A.4						2	2							
20MEL72A.5			1	1										
20MEL72A.6					2									

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

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

Exp. No.	Contents of Experiment	Hrs	COs
1	Matlab Basics	**3**	**20MEL72A.1**
2	Matlab Basics	**3**	**20MEL72A.1**
3	Matlab Basics	**3**	**20MEL72A.2**
4	Matlab Basics	**3**	**20MEL72A.2**
5	Determination of number of poles and zeroes for a giventransfer function	**3**	**20MEL72A.3**
6	Determination of time response of system in steady state	**3**	**20MEL72A.3**
7	Determination of time response of system in transient state	**3**	**20MEL72A.5**
8	To obtain the roots locus of a given transfer function	**6**	**20MEL72A.5**
9	obtain the Bode plot of a given transfer function	**6**	**20MEL72A.6**
10	To obtain the polar plot and Nyquist plot of a given transfer function	**3**	**20MEL72A.6**
11	Study the effects of controllers in system	**3**	**20MEL72A.6**

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			1
Understand			1
Apply		3	1
Analyze	5	3	1
Evaluate	5	4	1
Create			

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	5
Understand	5
Apply	5
Analyze	5
Evaluate	5
Create	

AUTOMATION ENGINEERING LAB

Course Code	20MEL73A
L: T: P:S	0:0:1:0
Exams Hours	03

Credits	01
CIE Marks	25
SEE Marks	25

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

20MEL73A.1	Understand the importance of G and M codes in CNC programming
20MEL73A.2	Create CNC programs for given part/product design
20MEL73A.3	Simulate the CNC programs using simulation software for verifying the tool path
20MEL73A.4	Create production plans and execute the production order using SAP S/4 HANA GBI

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEL73A.1	3		2											2
20MEL73A.2	3	2	2		2									2
20MEL73A.3	3	2	2		2									2
20MEL73A.4	3	2	2		2									2

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

TEXT BOOKS / REFERENCE BOOKS:

1) "Computer Based Industrial Control" – Krishna Kant, EEE-PHI, 2nd edition, 2011, ISBN: 978-8120339880
2) "Computer control of Manufacturing systems"- Yoram Korem, McGraw Hill Education, 1 st edition, 2017, ISBN-78-0070607439
3) "CAD/CAM- Principles and applications"-P N Rao, McGraw Hill Education, 3rd edition, 2017, ISBN-978-0070681934
4) "Computer Numerically Controlled Machining handbook", James Madison, Industrial Press Inc., 1996, ISBN-978-0831130640

Exp. No.	Contents of Experiment	Hrs	COs
1	CNC part programming using ISO format G/M codes, selection and assignment of tools, syntax correction.	**6**	**20MEL73A.1**
2	Simulation of CNC Program for profiles with simple plain and step Turning operations.	**3**	**20MEL73A.2 20MEL73A.3**
3	Simulation of CNC Program for profiles with grooving and thread cutting operations.	**3**	**20MEL73A.2 20MEL73A.3**
4	Simulation of CNC Program for profiles with Drilling operations.	**3**	**20MEL73A.2 20MEL73A.3**
5	Simulation of CNC Program for profiles with simple Milling operations.	**3**	**20MEL73A.3**
6	Simulation of CNC Program for profiles with combined Milling and Drilling operations.	**3**	**20MEL73A.2 20MEL73A.3**
7	Production planning case study by using SAP S/4 HANA GBI- Create/change material data, change routing, create Sales & operation plan (SOP), transfer SOP to demand management, Run MPS with MRP, check stock/requirement status, convert planned order to production order	**3**	**20MEL73A.4**
8	Production execution case study by using SAP S/4 HANA GBI- Goods receipt in inventory, good issue to production, review & confirm production completion, receive goods from production, review costs assigned to production order.	**3**	**20MEL73A.4**

Assessment Pattern

CIE (25 Marks – Lab)

Bloom's Category	Experiments / Tests	Record	Viva
Marks	**10**	**10**	**5**
Remember			
Understand			2
Apply	5	3	2
Analyze		3	1
Evaluate			
Create	5	4	

SEE (25 Marks – Lab)

Bloom's Category	Test
Remember	
Understand	5
Apply	5
Analyze	5
Evaluate	
Create	10

EIGHTH SEMESTER SYLLABUS

NON-CONVENTIONAL MANUFACTURING TECHNOLOGIES

Course Code	20MEE811A
L: T: P:S	3:0:0:0
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:

20MEE811A.1	Understand the concept of Non-conventional manufacturing technologies
20MEE811A.2	Analyze the different Non-conventional manufacturing technologies
20MEE811A.3	Evaluate the Non-conventional manufacturing technologies, application and limitations.
20MEE811A.4	Understand the latest trends of Non- conventional manufacturing technologies.
20MEE811A.5	Evaluate the conventional and compare with Non-conventional manufacturing technologies
20MEE811A.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
20MEE811A.1	3	3										3		3
20MEE811A.2	3	3										3		3
20MEE811A.3	3	3										3		3
20MEE811A.4	3	3										3		3
20MEE811A.5	3	3										3		3
20MEE811A.6	3	3										3		3

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

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.Mc Geough, 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

Module No	Module Contents	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**	**20MEE811A.1 20MEE811A.2 20MEE811A.3 20MEE811A.5 20MEE811A.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**	**20MEE811A.2 20MEE811A.3 20MEE811A.4 20MEE811A.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**	**20MEE811A.2 20MEE811A.3 20MEE811A.4 20MEE811A.6**
4	**Electrical Discharge Machining (EDM):** Introduction, Principal, Equipment, Process characteristics, spark generator, Types, Functionsand 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**	**20MEE811A.2 20MEE811A.3 20MEE811A.4 20MEE811A.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**	**20MEE811A.2 20MEE811A.3 20MEE811A.4 20MEE811A.6**

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	20MEE812A
L: T: P:S	3:0:0:0
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:

20MEE812A.1	Understand special casting techniques.
20MEE812A.2	Design and develop the conventional foundries.
20MEE812A.3	Analyze casting defects, special moulding techniques.
20MEE812A.4	Understand Foundry metallurgy & Design gating system.
20MEE812A.5	Evaluate the fettling processes, patterns and mould making.
20MEE812A.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
20MEE812A.1	3	3												
20MEE812A.2	3	3	2										1	
20MEE812A.3	3	3	2	1										
20MEE812A.4	3	3	2	1										
20MEE812A.5	3	3												
20MEE812A.6	3	3			1							1		

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

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

REFERENCE BOOKS:

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.ISBN: 9781483192307
3) Tiwari,"CastIronTechnology",CBSPublications,2007,ISBN:9788123914893
4) ASM Metals Handbook - Castings,Vol.15, ASM Int. MetalsPark, OHIO,2008.

Module No	Module Contents	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**	**20MEE812A.1** **20MEE812A.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, coke less cupola, cupola charge calculations.	**9**	**20MEE812A.1** **20MEE812A.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**	**20MEE812A.2** **20MEE812A.3** **20MEE812A.5**
4	**ALLOYSHANDLEDBYFOUNDRIES:** 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-bakes and systems, vacuum moulding, flask less moulding, and high pressure moulding.	**9**	**20MEE812A.1** **20MEE812A.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**	**20MEE812A.4** **20MEE812A.6**

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	20MEE813A
L: T: P:S	3:0:0:0
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:

20MEE813A.1	Understand and develop the concepts of Agile Manufacturing.
20MEE813A.2	Analyze the Product/Process development and its application in Agile Manufacturing.
20MEE813A.3	Understand Supply Chain Management and its link with Agile Manufacturing.
20MEE813A.4	Apply the Computer Control in Agile Manufacturing.
20MEE813A.5	Apply Corporate Knowledge of Management in Agile Manufacturing.
20MEE813A.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	PSO1	PSO2
20MEE813A.1	3												3	
20MEE813A.2	3												3	
20MEE813A.3	3										1		3	
20MEE813A.4	3				1								3	
20MEE813A.5	3										1		3	
20MEE813A.6	3												3	

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

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.
2) **World Class manufacturing -** Paul T Kidd – Addition Wesley Pub – 2014. Notlisted
3) **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

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.	**8**	**20MEE813A.1**
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**	**20MEE813A.2**
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.	**8**	**20MEE813A.3**
4	**Computer Control Of Agile Manufacturing:** CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts,	**8**	**20MEE813A.4**
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**	**20MEE813A.5 20MEE813A.6**

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 SOURCES

Course Code	20MEE814A
L: T: P:S	3:0:0:0
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:

20MEE814A.1	Understand the basic working principles of non-conventional power plants like Nuclear, Solar, Geo-thermal, Tidal and Ocean Thermal Energy power plant.
20MEE814A.2	Evaluate cycle efficiency and performance of Various Power Plants.
20MEE814A.3	Distinguish the various types of fuels used in power plants and estimate their Heating values.
20MEE814A.4	Analyze the applications of Bio Mass and Hydrogen energy.
20MEE814A.5	Investigate the ways to increase the thermal efficiency of power plant by the use of accessories.
20MEE814A.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:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE814A.1	3					3							3	
20MEE814A.2	3	3											3	
20MEE814A.3	3	3											3	
20MEE814A.4	3					3							3	
20MEE814A.5	3	3											3	
20MEE814A.6	3	3											3	

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

TEXT BOOKS:

1) Non-Conventional Energy Sources by *G.D Rai K*, KhannaPublishers, 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.

Module No	Module Contents	Hrs	COs
1	**Steam Power Plant:** Layout of steam power plant, Different Typesof Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Advantages and Disadvantages of using pulverized fuel, Equipment for preparationand 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**	**20MEE814A.2** **20MEE814A.4** **20MEE814A.5**
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, Layoutof 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**	**20MEE814A.6**
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.	**9**	**20MEE814A.1** **20MEE814A.2**
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**	**20MEE814A.1** **20MEE814A.4**
5	**Geothermal Energy Conversion**: Principle of working, types ofgeothermal 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**	**20MEE814A.1** **20MEE814A.4**

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	

TOTAL QUALITY MANAGEMENT

Course Code	20MEE815A
L: T: P:S	3:0:0:0
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:

20MEE815A.1	Understand the concepts of quality for business.
20MEE815A.2	Evaluate process capabilities & customer focus
20MEE815A.3	Analyze the system approach & organization behaviour
20MEE815A.4	Remember& implement the TQM qualities for leadership qualities
20MEE815A.5	Apply the principles of Kaizen & error proofing
20MEE815A.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
20MEE815A.1	3			1									1	
20MEE815A.2	3	2		1									1	
20MEE815A.3	3	2	3	1										
20MEE815A.4	3	2	3											2
20MEE815A.5	3	2	3							2				2
20MEE815A.6	3	2	3							2				

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

TEXT BOOKS:

1) Dale H. Besterfield et al, Total Quality Management, 4th edition, Pearson Education,2015, ISBN-978-9332534452
2) Shridhara Bhat K, Total Quality Management–Text and Cases, Himalaya Publishing House, 2010, ISBN-978-8178662527

REFERENCE BOOKS:

1) Clyde Bank Business, Lean Six Sigma, ClydeBank Media LLC; 1 edition, 2014, ASIN: B00ND9OMXG

Module No	Module Contents	Hrs	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**	**20MEE753A.1** **20MEE753A.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**	**20MEE753A.2** **20MEE753A.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: Stratification, check sheet, Scatter diagram, Ishikawa diagram, paneto diagram, Kepner &Tregoe Methodology.	**9**	**20MEE753A.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**	**20MEE753A.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**	**20MEE753A.6**

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	

NON DESTRUCTIVE TESTING

Course Code	20MEE821A
L: T: P:S	3:0:0:0
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:

20MEE821A.1	Apply the knowledge of quality inspection method using Non destructive Technique (NDT).
20MEE821A.2	Analyze nature of defects and microstructure of component s using NDT technique.
20MEE821A.3	Evaluate and document the detailed analysis report of the tested components.
20MEE821A.4	Apply the latest techniques like radiography, thermal inspection, holography, ultrasonic etc. towards the development of inspection methods for industrial applications.
20MEE821A.5	Select appropriate NDT techniques for product evaluation based on materials, nature of defects and their environmental conditions.
20MEE821A.6	Analyze the process and monitor the changes with passage of time.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE821A.1	3				3									
20MEE821A.2	3	3												2
20MEE821A.3				1						1			3	
20MEE821A.4		3	1		3									2
20MEE821A.5		3			3		1						3	
20MEE821A.6	3	3	1	1	3		`						3	

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

TEXT BOOKS:

1) Introduction to Nondestructive Testing, Paul E Mix, Publisher: John Wiley (original), ISBN: 9780471420293, 0471420298, 2005
2) Non Destructive Testing, Barry Hull and Vernon John, Publisher: Springer2012 ISBN-13: 978-1468462999.
3) Non Destructive Testing and evaluation of materials-J Prasad and C G K Nair, McGraw hill 2017 ISBN: 978-0070707030.

REFERENCE BOOKS:

1) Non-Destructive Testing Technique , Laodeno Rem N ,Yoshida Kenichi, Publisher: LAP Lambert Academic Publishing, 2013, ISBN-13: 978-3659335587.
2) Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9 edition Asia internal. ISBN-13: 978-3659336592.

Module No	Module Contents	Hrs	COs
1	**Introduction to Non destructive Testing:** Introduction, defects in manufacturing process, comparison of destructive and non destructive test**,** advantages and limitations, Non destructive evaluation: selection of ND methods, flaw detection and evaluation, types of flaws, types of leaks, methods of leak testing, techniques, visual inspection, replication microscopy techniques for Non destructive Evaluation: specimen preparation, replication techniques, micro structural analysis.	**8**	**20MEE821A.1 20MEE821A.2 20MEE821A.3 20MEE821A.4 20MEE821A.5**
2	**Radiography Inspection:** principles, methods of inspection, uses of radiography, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications. **Computed tomography**: introduction, principles, equipment capabilities, detection, application	**9**	**20MEE821A.1 20MEE821A.2 20MEE821A.3 20MEE821A.4 20MEE821A.5**
3	**Thermal inspection:** introduction, principles, heat transfer mechanisms, characteristics, thermal inspection, inspection method, application **Optical Holography:** introduction, principles, Basics of Holography, recording and reconstruction – Acoustical Holography: systems and techniques applications.	**9**	**20MEE821A.1 20MEE821A.2 20MEE821A.3 20MEE821A.4 20MEE821A.5**
4	**Eddy Current Inspection:** introduction, principles, operation variables, procedure, functions of eddy current system, inspection coils, and detectable discounts by the method. Eddy current instruments, read out instruments, Microwave Inspection**:** Microwave holography, applications and limitations **Ultrasonic Inspection:** Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks	**9**	**20MEE821A.1 20MEE821A.2 20MEE821A.3 20MEE821A.4 20MEE821A.5**
5	**Acoustic Emission Inspection:** Introduction, basic principle, relationship to other test methods, Acoustic emission waves and propagation, factors in source location and typical AE measurements, AE sensors, Instrumentation principles, Signal detection and emission counts, Hit-driven AE systems, data displays. **Fundamentals of image processing and enhancement**: Introduction, NDE digital image enhancement systems, work station configuration, image capture and acquisition system, image processing, image enhancement, contouring and thresholding, Color models, image display	**9**	**20MEE821A.1 20MEE821A.2 20MEE821A.3 20MEE821A.4 20MEE821A.5 20MEE821A.6**

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	

CNC MACHINING

Course Code	20MEE822A
L: T: P:S	3:0:0:0
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:

20MEE822A.1	Understand the concepts of CNC machines in manufacturing.
20MEE822A.2	Empathize the construction details of CNC machines.
20MEE822A.3	Analyze the various parameters used in CNC machining such as co-ordinate system, dimensions, datum point, compensations etc.
20MEE822A.4	Recognizing the different G and M codes used in CNC machining.
20MEE822A.5	Create the part programs using the codes for various contours during turning, milling and drilling.
20MEE822A.6	Evaluate the part programs for any errors.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE822A.1	3												3	
20MEE822A.2	3												3	
20MEE822A.3	3	1											3	
20MEE822A.4	3												3	
20MEE822A.5	3												3	
20MEE822A.6	3												3	

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

TEXT BOOKS:

1) CAD/ CAM/CIM, P Radhakrishnan, S. Subramanyan, V. Raju, New Age International Publishers, 2008, ISBN: 8122412483, 9788122412482.
2) CNC Programming Hand Book, Peter Smid, Industrial Press Inc, ISBN: 0831133473, 978-0831133474
3) CNC Technology, Samuel Raja, Dhanpat Rai Publication, ISBN: 1234567162834
4) CNC Machines, Pabla, B.S. & Adithan, New Age Publishers, New Delhi, ISBN: 8122434266, 978-8122434262
5) Programming of Computer Numerically Controlled Machines, Ploywka, John &Gabrel, Stanley, Industrial Press Inc., New York, ISBN: 0831130350, 978-0831130350

REFERENCE BOOKS:

1) T.K Kundra, P.N. Rao and N.K. Tewari, “Numerical control and computer Aided Manufacturing” Tata Mc Graw Hill Company, 1995, ISBN: 0074517341, 9780074517345.
2) Yoram Koren, “Computer control of Manufacturing Systems”, TMH, 2009, ISBN: 0070607435, 978-0070607439

Module No	Module Contents	Hrs	COs
1	Introduction to NC and CNC, Basics and need of CNC machines, Types of CNC machines, Parts of CNC Machine, Advantages of CNC machines, Applications of CNC machines in manufacturing.	**8**	**20MEE822A.1**
2	Constructional Details of CNC Machines: Machine structure, Slide – ways, Motion transmission elements, Swarf removal and safety considerations, Automatic tool changers and multiple pallet systems, Sensors and feedback devices in CNC machines, Constructional detail of CNC turning centre and CNC machining centre. Tooling requirements of CNC machines, Pre-set and qualified tools, Work and tool holding devices in CNC machines.	**9**	**20MEE822A.2**
3	CNC Co-ordinate System, Dimensioning System, Dimension Instruction, axes designation, Interpolation concepts, cutter compensation Datum point & Reference point, Datum point shift, Spindle control, Tool offset & length.	**9**	**20MEE822A.2 20MEE822A.3**
4	Basic Programming in Turning, Introduction to G & M Codes, ISO Program format, Sample Program on Facing, Plain Turning, Create Programming for Step Turning, Contour Program, Taper Turning, Drilling, Grooving, Boring, Threading and parting.	**9**	**20MEE822A.2 20MEE822A.3 20MEE822A.4**
5	Basic Programming in Milling, Create Programming for Components, Contour Program Using ATC, Standard Milling, Pocket Milling, Slot milling, Circular Pocketing, drilling (Pecking), mirror image	**9**	**20MEE822A.4 20MEE822A.5 20MEE822A.6**

Assessment Pattern

CIE (50 Marks – Theory)

Bloom's Category	Tests	Assignments	Quizzes
Marks	**25**	**15**	**10**
Remember	5		2
Understand	5	5	
Apply	5	5	5
Analyze	5	5	3
Evaluate	5		
Create			

SEE (50 Marks – Theory)

Bloom's Category	Tests (theory)
Remember	10
Understand	10
Apply	15
Analyze	10
Evaluate	5
Create	

INDUSTRIAL ROBOTICS

Course Code	20MEE823A
L: T: P:S	3:0:0:0
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:

20MEE823A.1	Understand robots, its needs, controls, importance, and applications.
20MEE823A.2	Apply the robot drives and components in practical cases.
20MEE823A.3	Understand the basics of robotic dynamics.
20MEE823A.4	Analyze how robots use sensors and sensing.
20MEE823A.5	Distinguish the methods and types of robot programming.
20MEE823A.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
20MEE823A.1		3												3
20MEE823A.2	3		3											3
20MEE823A.3		3												
20MEE823A.4		3	3		3									3
20MEE823A.5	3		3		3									3
20MEE823A.6		3	3			1								

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

TEXT BOOKS:

1) Mikell P.Groover,MitchellWeiss,"Industrialrobotics,technology,Programming and Applications", McGraw-Hill International Editions, 2nd Ed, **ISBN:**9781259006210
2) Saeed B Niku, "Introduction to Robotics: Analysis, Control, Applications", Wiley 201, **ISBN**-13: 978-812653312

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

Module No	Module Contents	Hrs	COs
1	**Introduction:** definition of robot, Need and importance, Type of robots, Robot Classification, Degrees of Freedom; Degrees of Movements, Robot Configuration; Accuracy and Repeatability, Robot Applications.	**8**	**20MEE823A.1 20MEE823A.2**
2	**Drives and component systems:** Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators - Brief Robot dynamics. Types of Robot and effectors-Grippers-Tools as end effectors - Robot/End - effort interface.	**10**	**20MEE823A.2 20MEE823A.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**	**20MEE823A.4**
4	**Robot Programming:** Teaching robots, Manual, walk through**,** teach pendant**,** Methods - languages - Capabilities and limitation.	**9**	**20MEE823A.5**
5	**Industrial Applications:** Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.	**8**	**20MEE823A.6**

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	

PRODUCT DESIGN AND DEVELOPMENT

Course Code	20MEE824A
L: T: P:S	3:0:0:0
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:

20MEE824A.1	Understand the characteristics of successful product development, industrial design and design for manufacture and robust design
20MEE824A.2	Identify customer needs, specifications and generate concepts
20MEE824A.3	Select, test concepts and establish the product architecture
20MEE824A.4	Assess the need for prototyping
20MEE824A.5	Apply PDM concepts in designing a survey
20MEE824A.6	Analyze and infer on customer response

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE824A.1	3													2
20MEE824A.2		2												2
20MEE824A.3			3		2									2
20MEE824A.4	3				2									2
20MEE824A.5			3	2										2
20MEE824A.6			3	2										2

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

TEXT BOOKS:

1) Product Design and Development: Karl.T.Ulrich, Steven D Eppinger,. Irwin McGrawHill2000.

REFERENCE BOOKS:

1) New Product Development: Timjones. Butterworth Heinmann, , Oxford. UCI. 1997 2.
2) Product Design for Manufacture and Assembly: Geoffery Boothroyd, Peter Dewhurst and Winston Knight.

Module No	Module Contents	Hrs	COs
1	**Introduction:** Characteristics of successful product development who Designs and develops products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process. **Product Planning**: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Case studies.	**08**	**20MEE824A.1**
2	**Identifying Customer Needs:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Case studies. **Product Specifications**: What are specifications, when are specifications established, establishing target specifications setting the final specifications. **Concept Generation**: The activity of concept generation clarifies the problem search externally, search internally, explore systematically, and reflect on the results and the process.	**10**	**20MEE824A.2**
3	**Concept Selection**: Overview of methodology, concept screening, concept scoring, caveats. **Concept Testing**: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. Case studies. **Product Architecture**: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Case studies	**10**	**20MEE824A.3**
4	**Industrial Design**: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Case studies. **Design for Manufacturing**: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Case studies.	**09**	**20MEE824A.4**
5	**Robust Design**: Introduction to robust design, design of experiments, seven step robust design process, case studies.	**08**	**20MEE824A.5** **20MEE824A.6**

Assessment Pattern

CIE (50 Marks – Theory)

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

SEE (50 Marks – Theory)

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

TRIBOLOGY

Course Code	20MEE825A
L: T: P:S	3:0:0:0
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:

20MEE825A.1	Understand the fundamentals of tribology and associated parameters.
20MEE825A.2	Apply concepts of tribology for the performance analysis, principles of surface engineering for different applications of tribology.
20MEE825A.3	Design hydrodynamic journal and plane slider bearings for a given application, hydrostatic bearing.
20MEE825A.4	Select appropriate bearing materials and lubricants for a given tribological application.
20MEE825A.5	Estimate power lost in friction in various bearings.
20MEE825A.6	Compute the design parameters for a bearing.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
20MEE825A.1	3	3												2
20MEE825A.2	3	3												2
20MEE825A.3	3	3	3											2
20MEE825A.4	3	3												2
20MEE825A.5	3	3	3	1										2
20MEE825A.6	3	3	3	1										2

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

TEXT BOOKS:

1) Introduction to Tribology, B. Bhushan, John Wiley & Sons, Inc., New York, 2002
2) Engineering Tribology, Prasanta Sahoo, PHI Learning Private Ltd, New Delhi, 2011.
3) Engineering Tribology, J. A. Williams, Oxford Univ. Press, 2005.

REFERENCE BOOKS:

1) Introduction to Tribology in bearings, B. C. Majumdar, Wheeler Publishing.
2) Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London,1992.
3) Engineering Tribology, G. W. Stachowiak and A. W. Batchelor, Butterworth Heinemann,1992.
4) Friction and Wear of Materials, Ernest Rabinowicz, John Wiley & sons,1995.
5) Basic Lubrication Theory, A. Cameron, Ellis Hardwoods Ltd., UK.
6) Handbook of tribology: materials, coatings and surface treatments, B.Bhushan, B.K. Gupta, McGraw-Hill,1997

Module No	Module Contents	Hrs	COs
1	**Introduction to Tribology:** Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants. **Friction**: Origin, friction theories, measurement methods, friction of metals and non-metals. **Wear**: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.	**08**	**20MEE825A.1**
2	**Hydrodynamic journal bearings**: Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D.	**10**	**20MEE825A.2**
3	**Introduction to idealized journal bearing:** load carrying capacity, condition for equilibrium, Sommerfeld's number and its significance; partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only. **Plane slider bearings with fixed/pivoted shoe**: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples.	**10**	**20MEE825A.5** **20MEE825A.6**
4	**Hydrostatic Lubrication**: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. **Bearing Materials**: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials.	**09**	**20MEE825A.4**
5	**Introduction to Surface engineering**: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.	**08**	**20MEE825A.1** **20MEE825A.2**

Assessment Pattern

CIE (50 Marks – Theory)

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

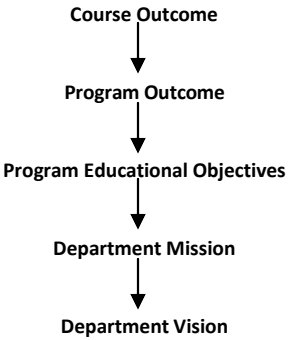
Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, 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. **[eduglosarry.org]**