APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Cluster No.10 for PG Programs

(Engineering Colleges in Kannur, Wayanad & Kasaragod Districts)

Curriculum, Scheme of Examinations and Syllabi for M. Tech. Degree Program with effect from Academic Year 2015 - 2016

Mechanical Engineering

M. Tech.

in

Advanced Manufacturing and Mechanical Systems Design

(No. of Credits : 66)

CONTENTS

SEMESTER I

Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME6101	Computational Methods	3-1-0	40	60	3	100	4
B	10ME6103	Principles of Machining and Manufacturing Systems	3-0-0	40	60	3	100	3
C	10ME6105	Discrete Event System Simulation	3-0-0	40	60	3	100	3
D	10ME6107	Production Automation and Trends in Manufacturing	3-0-0	40	60	3	100	3
E	10ME6xxx	Elective I	3-0-0	40	60	3	100	3
S	10GN6001	Research Methodology	0-2-0	100			100	2
T	10ME6109	Seminar I	0-0-2	100			100	2
U	10ME6111	Engineering Software Lab	0-0-2	100			100	1
		TOTAL	**15-3-4**	**500**	**300**	**-**	**800**	**21**

Elective I

10ME6113 Theory of Vibration
10ME6115 Fracture Mechanics and Fatigue
10ME6117 Mechanics of Composites
10ME6119 Advanced Mechanics of Solids

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME6202	Modeling and Analysis of Manufacturing Systems	3-1-0	40	60	3	100	4
B	10ME6104	Intelligent Manufacturing	3-0-0	40	60	3	100	3
C	10ME6106	Micro and Nano Machining	3-0-0	40	60	3	100	3
D	10ME6xxx	Elective II	3-0-0	40	60	3	100	3
E	10ME6xxx	Elective III	3-0-0	40	60	3	100	3
V	10ME6108	Mini Project	0-0-4	100			100	2
U	10ME6112	Advanced Manufacturing Lab	0-0-2	100			100	1
		TOTAL	**15-1-6**	**400**	**300**	**-**	**700**	**19**

Elective II

10ME6114	Soft Computing Techniques
10ME6116	Design of Experiments
10ME6118	Management Information System
10ME6122	Quality and Reliability Engineering
10ME6124	Project Engineering and Management

Elective III

10ME6126	Industrial Automation and Robotics
10ME6128	Mechatronics
10ME6132	Finite Element Methods and Applications
10ME6134	Metrology and Computer Aided Inspection

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
A	10ME7xxx	Elective IV	3-0-0	40	60	3	100	3
B	10ME7xxx	Elective V	3-0-0	40	60	3	100	3
T	10ME7101	Seminar II	0-0-2	100			100	2
V	10ME7103	Project (Phase I)	0-0-12	50			50	6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**350**	**14**

Elective IV

10ME7105	Industrial Tribology
10ME7107	Concurrent Engineering and Product Life Cycle Management
10ME7209	Sensors and Controls in Manufacturing
10ME7211	Process Planning and Cost Estimation

Elective V

10ME7113	Energy Management
10ME7215	Expert System and Artificial Intelligence in Manufacturing
10ME7117	Machine Tool Design
10ME7119	Material Selection in Mechanical Design

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Total Marks	Credits
					Marks	Duration (hours)		
V	10ME7104	Project (Phase II)	0-0-23	70	30		100	12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**100**	**12**

TOTAL NUMBER OF CREDITS: 66

SEMESTER 1

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6101	COMPUTATIONAL METHODS	3-1-0 : 4	2015

Course Prerequisites
Basic knowledge in mathematical methods at UG level

Course Objectives
1. To be capable of developing a thorough knowledge in computational techniques to aid in the modeling and analysis of manufacturing processes and systems.
2. To lay a sound computational foundation for further independent research in manufacturing engineering

Syllabus
First order differential equations, Second order differential equations, Non homogenous differential equations, Laplace transforms, Systems of differential equations, Series solutions, Higher order differential equations, Boundary value problems and fourier series, Partial differential equations, Probability, distributions, Moments, Estimation Theory, Correlation, Regression, optimization, Unconstrained optimization Nonlinear programming.

Expected Outcomes
On successful completion of the course, the students will
- Have a strong foundation in modeling with differential equations and laplace transforms
- Be able to solve problems involving probability and probability distributions
- Be able to model engineering problems as linear programming problems and solve them
- Gain good understanding on the formulations and solutions of nonlinear programming problems

References

1. 1.Erwin Kreyzig Advanced Engineering Mathematics, John Wiley 2006.
2. Shepley L Ross,Differential Equations, JohnWiley&Sons, Third Edition, 2004.
3. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi 2001
4. Kalyanmoy Deb,.Optimisation for Engineering Design-Algorithms and Examples., Prentice Hall India- 1998
5. S.S.Rao, .Engineering Optimization., 3rd Ed.,New Age International (P) Ltd,New Delhi, 2007

Course Plan

Module	Contents	Hours	Semester Exam Marks (%)
I	First order differential equations, modeling with first order equations, equilibrium solutions, euler's method, Second order differential equations, fundamental sets of solutions, wronskian method, Non homogenous differential equations, mechanical vibrations, Laplace transforms, inverse laplace transforms, step	8	15

	function, solving IVP's with laplace transforms, dirac delta function, convolution integral.		
II	Systems of differential equations, solutions to systems, phase plane, solution involving real, complex, repeated eigen values and laplace transforms, solving non homogenous differential equations, Modeling using systems of differential equations, Series solutions, series solution about an ordinary point, solutions to euler differential equations.	10	15
First Internal Examination			
III	Higher order differential equations, linear homogenous differential equations, solution using undetermined coefficients, variation of parameters and laplace transforms, systems of differential equations, series solution, Boundary value problems and fourier series, eigen values and eigen functions in BVP, periodic functions and orthogonal functions, fourier sine, cosine and full series, convergence of fourier series, Partial differential equations, heat equation, wave equation, solution of heat equation with non zero temperature boundaries, laplace equation, vibrating string.	12	15
IV	Probability, Random variables, Binomial, Poisson, Geometric, Uniform, Normal, Exponential distributions, Moments, Moments generating functions and their properties, Functions of Random variables. Estimation Theory, Correlation, Regression, Partial and Multiple correlations, Partial and Multiple regression, Estimation of parameters using maximum likelihood estimator and method of moments.	10	15
Second Internal Examination			
V	Concepts of optimization: Engineering applications-Statement of optimization problem-Classification - type and size of the problem. Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity - formulation of LP problems - simplex method and algorithm -Matrix form- two phase method. Duality- dual simplex method- LU Decomposition. Sensitivity analysis .Artificial variables	12	20
VI	Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear programming - gradient and Hessian. Unconstrained optimization: First & Second order necessary conditions-Minimisation & Maximisation Local & Global convergence-Speed of convergence. Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-Lagrange multiplier method - Kuhn-tucker conditions . Quasi-Newton method- separable convex programming - Frank and Wolfe method.	12	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6103	PRINCIPLES OF MACHINING AND MANUFACTURING SYSTEMS	3-0-0: 3	2015

Course Prerequisites

Basic Understanding of Manufacturing Processes at UG level

Course Objectives

To introduce the principles of machining and to equip the students with the manufacturing systems adopted internationally. It aims at developing the necessary skills to work in international factory environments. It also details the importance of flexibility and flexible manufacturing systems.

Syllabus

Principles of Machining- Tool Geometry and Reference Systems-Mechanism of Chip Formation by Single Point Tools-Types and Characteristics of Chips-Cutting Force Measurements-Cutting Tools – Failures-Wear-Tool Life- -Performance Evaluation of Manufacturing Systems-Virtual Organizations

Expected Outcomes

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

- prepare drawings indifferent reference systems like machine reference system, tool reference system and work reference system for machining.
- solve specific geometrical problems in Tool geometry involving in machining.
- to evaluate the performance of manufacturing systems using Lean manufacturing assessment.
- improve the performance of manufacturing systems using VSM.
- get the basic idea of Six Sigma to improve the performance of manufacturing systems
- get the idea of flexibility in manufacturing systems.

References

1.HMT ,Production Technology , Tata Mc Graw Hill
2. Ghosh & Mallik ,Manufacturing Science , affiliated –West Press
3. Sharma P C , A Text book of Production Engineering
4. Askin R G and Gold berg J B "Design and Analysis of Production systems " , John Wieley and sons Inc .. 2003
5. ASTME ,Fundamentals of Tool Design , Prentice Hall of India
6. Bhattacharya A Metal cutting : Theory and Practice , Central Book Publishers

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Machining, definition and objectives. Geometry of cutting tools; turning, milling and drilling - indifferent reference systems like machine reference system, tool reference system and work reference system. Sharpening and resharpening of cutting tools.	8	15
II	Mechanism of chip formation by single point tools, drills and milling cutters. Types of chips and their characteristics.	8	15

	Effective rake. Mechanics of machining, theoretical estimation and experimental determination of cutting forces and power consumption.		
First Internal Examination			
III	Cutting tools; methods of failure, mechanics of tool wear, essential properties, assessment of tool life cutting tool materials and cutting fluids.	8	15
IV	Flexible Manufacturing Systems (FMS), architecture of FMS,Evaluation of performance measures of FMS, Bottleneck Model, FMS Operation parameters, Extended Bottleneck Model, Sizing of FMS,performance evaluation problems	8	15
Second Internal Examination			
V	Performance evaluation of manufacturing systems –Lean manufacturing assessment ,Lean Tools, Value stream Mapping ,OEE ,and six sigma on advanced manufacturing systems DMAIC Methodology,	8	20
VI	Virtual Organization –Introduction to virtual Manufacturing and its applications	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6105	**DISCRETE EVENT SYSTEM SIMULATION**	**3-0-0: 3**	**2015**

Course Prerequisites
Basic knowledge of probability and statistics

Course Objectives
To understand how computer simulation can be used as an effective tool to model and analyze complex systems

Syllabus
System Modeling and Analysis – Monte Carlo Simulation – Random Number Generation – Analysis of Simulation Data- Simulation Languages and Packages- Simulation using Spreadsheets- Simulation of Manufacturing and Material Handling Systems

Expected Outcomes
On successful completion of the course, the students will have the

- Ability to model and analyse discrete systems using simulation.
- Ability to use simulation software to carry out projects and case studies.

References

1. Jerry Banks and John S, Carson II "Discrete Event system Simulation", Prentice Hall.
2. Kelton, W. David, and Averill M. Law. "Simulation modeling and analysis". McGraw Hill.

3. Francis Neelamkovil, "Computer Simulation and Modelling", John Willey and sons.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to systems and modeling - Discrete and continuous system - areas of application –Limitations- Monte Carlo simulation	6	15
II	Discrete event simulation and their applications- Queuing and inventory problems- Simulation as a decision making tool	10	20
	First Internal Examination		
III	Random numbers-Techniques for generating random numbers-Linear congruential method-Test for random numbers-Frequency and run tests- Tests for autocorrelation- Random variate generation- Inverse transformation technique.	8	15
IV	Analysis of simulation data. - Data collection- Identifying the distribution with data-Goodness of fit tests-Verification and validation of simulation models	8	15
	Second Internal Examination		
V	Simlation languages and packages – Simulation using spreadsheets – Simulation optimization	6	15
VI	Simulation of manufacturing and material handling systems-Performance analysis of flow shop and job shopsystems-Modelling of supply chains- Case studies.	10	20
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6107	**PRODUCTION AUTOMATION AND TRENDS IN MANUFACTURING**	**3-0-0: 3**	**2015**

Course Prerequisites

Fundamental knowledge in Manufacturing systems is desirable.

Course Objectives

To learn the concepts of automation, Discrete Control Systems, Advanced Manufacturing Processes, Computerized Numerical Control Technology.

Syllabus

Concept and scope of industrial automation- Industrial Robots-Discrete Control, PLC, CNC systems, Part Programming, APT programming, Latest trends in Manufacturing.

Expected Outcomes

After completing the course, the students will be able to identify and describe the different areas of production automation and conversant with the latest trends in manufacturing.

References

1. Serope Kalpakjian,, "Manufacturing Processes for Engineering Materials", Addision Wesley
2. Serope Kalpakjian , Schmid.,"Manufacturing Engineering and Technology", Prentice Hall
3. Radhakrishnan, P., "Computer Numerical Control Machines", New Central Book Agencies
4. Mikell P. Groover., " Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Concept and scope of industrial automation – Sensors, Actuators and other control system components.	8	15
II	Industrial Robotics- Robot anatomy-Robot control systems- Sensors in robotics. Concepts of discrete control, Programmable Logic Controllers.	8	15
First Internal Examination			
III	Concepts, features, fundamentals, components, classification, Design considerations of NC machine tools –Tooling, Maintenance of CNC machines.	8	15
IV	Controls and System devices - Control loops of NC system, Reference pulse and sampled data techniques – CNC adaptive control – ACO and ACC systems.	8	15
Second Internal Examination			
V	Fundamentals of part programming. Manual part programming, Computer aided part programming - APT programming	8	20
VI	Concepts of GT, FMS, CIM. Additive manufacturing concepts, Green and sustainable manufacturing. Latest trends and developments in Manufacturing.	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
10ME6113	THEORY OF VIBRATION	2 - 1 - 0 - 3	2015

Prerequisites

Engineering Mechanics-Statics and dynamics (basics), Strength of materials (basics).

Objectives

To help the students fully understand and appreciate the importance of mechanical vibrations.

To enable them acquire the skill to develop mathematical models and analyse the vibration of mechanical systems.

Syllabus

Single degree-of-freedom systems-Undamped and damped free vibration problems, Forced response of undamped and damped systems, Vibration isolation and base excitation cases, Duhamel's integral and transient response, periodic excitation inputs, Instrumentation for vibration measurements.

Two degree-of-freedom systems-Vibration absorber. Multi degree-of-freedom systems, coordinate transformation, definition of normal modes and modal coordinates, modal superposition based free and forced vibration responses, proportional and non-proportional damping. Continuous systems-Axial, bending and torsional vibration of bars and beams.

Expected Outcomes

The students will be able to:

1. understand the concepts of vibration modes and natural frequencies.
2. predict the dynamic behaviour of mechanical systems using simple models.

References

1. Leonard Meirovitch, *Elements of vibration analysis*, Tata McGraw-Hill Publishing Company Ltd., 2007
2. William T Thomson, *Theory of vibration with applications*, Marie Dillon Dahleh, Pearson Education, Inc., 1998.
3. Singiresu S. Rao, *Mechanical Vibrations*, Pearson Education, Inc., 2011
4. Mallik A.K., *Principles of vibration control*, East-West Press Pvt. Ltd., New Delhi, 1990.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Single degree-of-freedom systems- Undamped and damped free vibration problems, Forced response of undamped and damped systems	8	15
II	Vibration isolation and base excitation cases, Duhamel's integral and transient response, Periodic excitation inputs,	8	15
	First Internal Examination		
III	Instrumentation for vibration measurements, Two degree-of-freedom systems-Vibration absorber	8	15
IV	Multi degree-of-freedom systems, coordinate transformation, definition of normal modes and modal coordinates	8	15
	Second Internal Examination		
V	Modal superposition based free and forced vibration responses, proportional and non-proportional damping	8	20
VI	Continuous systems-axial, bending and torsional vibration of bars and beams.	8	20
	Cluster Level End Semester Examination		

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6115	FRACTURE MECHANICS AND FATIGUE	2-1-0: 3	2015

Course Prerequisites

A course on Mechanics of Solids at the UG level

Course Objectives

To impart the basic knowledge on fracture mechanics and to facilitate the incorporation of cracks and fatigue in engineering design

Syllabus

Micro and Macro Cracks – Fracture Criterion – Stress Analysis – Plastic zone – Elastic-Plastic Fracture Mechanics – Fatigue and Fatigue Crack Growth - Linear static fracture Mechanics Design- Dynamic Fracture – Experimental Determination of dynamic Stress Intensity Factor

Expected Outcomes

On completion of the course, the students are expected to

- Be familiar with the therories of failure
- Be able to understand the science of failure and steps for its mitigation
- Design mechanical systems overcoming the problems of fatigue and failures
- Experimentally determine stress intensity factors

References

1. S.A. Maguid,, "Engineering Fracture Mechanics", Elsevier, 1996
2. David Broke., "Elementary Engineering Fracture Mechanics", Noordhoff, 1995.
3. Karen Hellan, "Introduction to Fracture Mechanics", Mc Graw Hill, 1982.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction -sources of micro and macro cracks - fracture criterion based on stress concentration and theoretical strength Griffith's energy - various approaches - Stress Analysis for Members with Cracks.	8	15
II	Crack tip Plastic Zone: Plastic zone estimation - yielding fracture mechanics.	8	15
	First Internal Examination		
III	Elastic–Plastic Fracture Mechanics - Path-independent integrals, J-integral , J-integral fracture criterion, crack opening displacement(COD), experimental determination of J integral and COD - Fatigue and Fatigue crack growth rate.	8	15
IV	Linear static fracture Mechanics Design Concepts - Introduction, the stress criterion, strain energy density, 2-D linear elastic crack problems.	8	15
	Second Internal Examination		
V	Dynamic Fracture: Mohr's model, strain energy release rates, crack branching, practical applications of crack arresting	8	20

	techniques.		
VI	Experimental determination of dynamic SIF. -NDT and Fracture Mechanics	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6117	**MECHANICS OF COMPOSITES**	**3-0-0: 3**	**2015**

Course Prerequisites

The student must have basic knowledge on mechanical engineering at UG level

Course Objectives

Introduces knowledge on advanced composite material and its properties and method of fabrication and analysis.

Syllabus

Definition of composites- Micromechanics of composites- Ply mechanics- Static and dynamic analysis of laminated composite structures- Analysis of impact on laminates- Analysis of smart composite structures.

Expected Outcomes

On completion of the course, the student will be able to

- Understand the different types of composites and their applications
- Understand the micromechanics of composites
- Perform static and dynamic analysis of composite structures
- Analyse smart composite structures

References

1. Robert M. Jones, Mechanics of composite materials, Scripta Book Company.
2. Ronald F. Gibson, Principles of Composite Material Mechanics, Second Edition .

Course plan

Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Definition of composites; Classification and Applications	8	15
II	Micromechanics of composites: effective properties of long and short fiber reinforced composites, effective strength of composites, effective properties of piezoelectric fiber reinforced composites;	8	15
First Internal Examination			
III	Ply mechanics; Macrobehaviour of laminate- classical lamination theory –Stress distribution through the thickness; Macromechanics of laminated composite structures: description of laminates, laminate moduli,	8	15

IV	Static and dynamic analysis of laminated composite structures (beams, plates and shells) using shear deformation theories, failure theories,	8	15
Second Internal Examination			
V	Analysis of impact on laminates	8	20
VI	Analysis of smart composite structures.	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6119	**ADVANCED MECHANICS OF SOLIDS**	**3-0-0 :3**	**2015**

Course Prerequisites

Basic knowledge of mechanics of solids at the UG level

Course Objectives

To enable the students to understand the complex theories and practices related to advanced mechanics and solids which shall help them in engineering design

Syllabus

Theory of stresses and strains- linear elasticity – solutions- energy methods – finite deformation – application to thick cylinders, curved beams on elastic foundation – torsion of non circular shafts

Expected Outcomes

On successful completion of the course, the students should be able to

- Apply the theory of stress and strain in engineering design
- Solve problems on liner elasticity
- Design and analyse thik cylinders, rotating discs and curved beams
- Apply the principles of torsion in non circular cross-sections
- Understand the various theories of failure

References

1. .Durelli, Philips and Tsao, Introduction to the Theoretical and Experimental Analysis of Stress and Strain, McGraw Hill; New York.
2. Timoshenko S and Goodier J N, Theory of Elasticity, McGraw Hill.
3. Fung Y.C., Foundations of Solid Mechanics, Prentice Hall of India.
4. Boresi A.P. Schmidt R J and Sidebottom O M, Advanced Mechanics of Materials, John Wiley.
5. Fenner R T, Engineering Elasticity Application of Numerical and Analysis Techniques, Ellis Hordwood Ltd

Course plan

Module	**Content**	**Hours**	**Semester Exam Marks (%)**

I	Theory of stresses and strains. Introduction of tensors. Constitutive modeling.	8	15
II	Linear elasticity. Solutions of plane problems. Solutions using polynomials.	8	15
First Internal Examination			
III	Energy methods. Introduction to finite deformation, plasticity, stability, vibration, and wave propagation.	8	15
IV	Application to thick cylinders, rotating discs, curved beams, beams on elastic foundations,	8	15
Second Internal Examination			
V	Torsion of non-circular cross-sections, stress concentration problems, Hertzian contact stresses.	8	20
VI	Theories of failures. Static failure theories. Fatigue failure theories. Case studies, Design for fatigue	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L - T - P - Credits**	**Year of Introduction**
10GN6001	**RESEARCH METHODOLOGY**	**0 - 2 - 0 - 2**	**2015**

Course Prerequisites

(1) Basic skill of analyzing data earned through the project work at UG level;
(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To understand the methodology of doing research;
(2) To develop skills related to professional communication and technical report writing.

As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator's role

Syllabus

Overview of research methodology - research process - scientific methods -research problem and design - research design process - formulation of research task, literature review and web as a source - problem solving approaches - experimental research - ex post facto research. Thesis writing - reporting and presentation - interpretation and report writing - principles of thesis writing- format of reporting, oral presentation - seminars and conferences, Research proposals - research paper writing - publications and ethics - considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – modeling and simulation - mathematical modeling – graphs - heuristic optimization - simulation modeling - measurement design – validity – reliability – scaling - sample design - data collection methods and data analysis.

Expected Outcomes

The students are expected to :
(1) Be motivated for research through the attainment of a perspective of research methodology;
(2) Analyze and evaluate research works and to formulate a research problem to pursue research;
(3) Develop skills related to professional communication, technical report writing and publishing papers.

References

1. C.R Kothari, *Research Methodology : Methods & Techniques*, New Age International Publishers
2. R. Panneerselvam, *Research Methodology*, Prentice Hall of India, New Delhi, 2012.
3. K. N. Krishnaswamy, Appa Iyer Sivakumar, and M. Mathirajan, *Management Research Methodology, Integration of Principles*, Pearson Education.
4. Deepak Chawla, and MeenaSondhi, *Research Methodology – Concepts & Cases,* Vikas Publishing House.
5. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
6. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
7. Willktnsion K. L, Bhandarkar P. L, *Formulation of Hypothesis*, Himalaya Publication.
8. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
9. Ranjit Kumar, *Research Methodology : A step by step guide for beginners,* Pearson Education.
10. Donald Cooper, *Business Research Methods*, Tata McGraw Hill, New Delhi.
11. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co
12. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
13. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.
14. Sople, *Managing Intellectual Property: The Strategic Imperative*, Prentice Hall of India, New Delhi, 2012
15. Manna, Chakraborti, *Values and Ethics in Business Profession*, Prentice Hall of India, New Delhi, 2012.
16. Vesilind, *Engineering, Ethics and the Environment*, Cambridge University Press.
17. Wadehra, B.L. *Law relating to patents, trademarks, copyright designs and geographical indications,* Universal Law Publishing

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	**Overview of Research Methodology** : Research concepts, meaning, objectives, motivation, types of research, research process, criteria for good research, problems encountered by Indian researchers, scientific method, research design process.	5	15
II	**Research Problem and Design** : Formulation of research task, literature review, methods, primary and secondary sources, web as a source, browsing tools, formulation of research problems, exploration, hypothesis generation, problem solving approaches, introduction to TRIZ (TIPS), experimental research, principles,	5	15

	laboratory experiment, experimental designs, ex post facto research, qualitative research.		
First Internal Examination			
III	**Thesis Writing, Reporting and Presentation** : Interpretation and report writing, techniques of interpretation, precautions in interpretation, significance of report writing, principles of thesis writing, format of reporting, different steps in report writing, layout and mechanics of research report, references, tables, figures, conclusions, oral presentation, preparation, making presentation, use of visual aids, effective communication, preparation for presentation in seminars and conferences.	4	15
IV	**Research proposals, Publications, Ethics and IPR** : Research proposals, development and evaluation, research paper writing, layout of a research paper, journals in engineering, considerations in publishing, scientometry, impact factor, other indexing like h-index, citations, open access publication, ethical issues, plagiarism, software for plagiarism checking, intellectual property right (IPR), patenting case studies.	5	15
Second Internal Examination			
V	**Research Methods - Modeling and Simulation** : Modeling and simulation, concepts of modeling, mathematical modeling, composite modeling, modeling with ordinary differential equations, partial differential equations (PDE), graphs, heuristics and heuristic optimization, simulation modeling.	5	20
VI	**Research Methods - Measurement, Sampling and Data Acquisition** : Measurement design, errors, validity and reliability in measurement, scaling and scale construction, sample design, sample size determination, sampling errors, data collection procedures, sources of data, data collection methods, data preparation and data analysis.	4	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6109	**SEMINAR – 1**	**0- 0-2: 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;

(2) Basic knowledge in technical writing and communication skills earned through seminar at UG level.

Course Objectives

(1) To enhance the reading ability required for the literature review regarding the project work;

(2) To develop skills regarding professional communication and technical report writing.

Guidelines

The student shall prepare a paper and present a seminar on any current topic related to the branch of specialization under the guidance of a staff member. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester. The student shall submit a printed copy of the paper to the Department. Grades will be awarded on the basis of the contents of the paper and the quality of presentation. A common format (in PDF format) shall be given for students for preparing the report. All such reports submitted by students shall be in this given format, for uniformity.

Expected Outcomes

The students are expected to :

(1) Be motivated in reading which enhances the literature review required for doing project work;

(2) Develop skills regarding professional communication and technical report writing.

References

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2. Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3. Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	2 Weeks	
3	Presentation Sessions	4 Weeks	
4	Report Submission	4 Weeks	
5	Publishing Grades	2 Weeks	

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6111	**ENGINEERING SOFTWARE LAB**	**0-0-2: 1**	**2015**

Course Prerequisites

Basic knowledge of simulation design and analysis software at UG level

Course Objectives

To get the students acquainted with the state of the art software for data analysis, optimization and modeling and analysis of mechanical engineering problems..

Expected Outcomes

The students are expected to have the

- Ability to use simulation and optimization software to solve different engineering problems.
- Ability to design and analyse components and systems. Ability to carry out data analysis using statistical packages.

List ofExperiments

1. Simulation of engineering and manufacturing systems using tools like ARENA, WITNESS etc

2. Modeling and optimization of linear and non-linear engineering problems using tools like LINGO,LINDO etc
3. Design and modeling of engineering components and systems using high end software like Pro/E, CATIA,UNIGRAPHICS, SolidWorks etc
4. Engineering analysis of components and systems using high end software like ANSYS, ABAQUS, Pro/E, CATIA,UNIGRAPHICS, SolidWorks etc
5. Using project management tools like Primavera, MSProjectetc
6. Using software like MATLAB, Scilabetc, for special problems in Mechanical Engineering
7. Data analysis using SPSS, MINITAB etc

SEMESTER II

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6202	MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS	3-1-0 : 4	2015

Course Prerequisites
Basic knowledge in Manufacturing/Production Engineering at UG level

Course Objectives
To impart the basic ideas to enable the modelling, simulation and analysis of advanced manufacturing systems

Syllabus
Principles of manufacturing systems; Types of manufacturing models; Assembly line balancing algorithms; Flexible manufacturing systems; Group technology; Coding schemes; Material handling systems.

Expected Outcomes
After the completion of the course the student should be able to:

- Independently conduct a study of a manufacturing system
- Model, simulate, analyze and optimize the manufacturing system
- Suggest and design modified/new system for better performance

References

1. Ronald G. Askin and Charles R. Standridge *Modeling and analysis of manufacturing systems* John Wiley & Sons Inc.
2. Groover M.P. *Automation Production Systems and Computer Integrated Manufacturing* Prentice-Hall of India Pvt. Ltd.
3. Jha N.K. *Handbook of Flexible Manufacturing Systems* Academic Press Inc.
4. Kalpakjian *Manufacturing Engineering and Technolog* Addison-Wesley Publishing Co.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to manufacturing systems models, types and principles of manufacturing systems, manufacturing models, types and uses physical models, mathematical models, model uses, model building, numerical problems/simulation exercises.	10	15
II	Introduction to assembly lines, line balancing algorithms, COMSOL random sequence generation, ranked positional weight, heuristics, optimal solutions, practical issues, mixed models, sequencing un-paced lines, shop scheduling with many products, order release, flow shop sequencing, single and two machine flow shops, job shop scheduling, dispatching rules and schedule generation, numerical problems/simulation exercises.	10	15
First Internal Examination			

III	Introduction to FMS, components of FMS machines, part movement system, work stations, system controller, planning and control hierarchy, system design, system set up, scheduling and control, flexible assembly system.	8	15
IV	Group technology principles, coding schemes, assign machines to groups, production flow analysis, binary ordering algorithm, assigning parts to machines.	8	15
Second Internal Examination			
V	Introduction, types and principles of material handling systems, equipment selection, conveyor analysis, closed loop conveyor, AGV systems, design and operation of AGVs vehicle, requirements, analysis, pallet sizing and loading, use of petrinets.	12	20
VI	Introduction to warehousing and storage and retrieval system, warehouse components, warehouse design, stacking pattern, location in warehouses, dedicated storage, open storage, class base storage, storing complementary items, order picking, forming pick list, pick sequencing.	12	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6104	**INTELLIGENT MANUFACTURING**	**3-0-0 : 3**	**2015**

Course Prerequisites

Basic knowledge of computer aided manufacturing at UG level

Course Objectives

- To impart basic ideas of intelligent manufacturing systems
- To focus on cell and part family formulation
- To familiarize the concepts of Computer Integrated Manufacturing and Group Technology

Syllabus

Intelligent manufacturing system, architecture, common type of facility layout, numerical demonstration of effect of set up time reduction on WIP, production flow analysis, key machine approach, linear model, design of work cells and cellular manufacturing, functional areas of CIM and CAD,CAPP, group technology: part classification and coding systems, part family formation, models and algorithm-different methods.

References

1. Andre Kusaic, “Intelligent Manufacturing Systems”.
2. Mikell P Groover, “Automation Production systems, Computer Integrated Manufacturing”, Prentice Hall.
3. Yagna Narayana., “Artificial Neural Networks ".
4. Andrew.S.Tanenbaum, " Computer Networks ", Prentice Hall

Expected Outcomes

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

- Understand the globally adopted manufacturing systems.
- Solve specific problems in machining by using different Layouts and Group Technology.
- Produce different part families to improve the performance of manufacturing systems.
- Get familiarized with new modern methods and tools used for design and control of manufacturing systems with respect to automated manufacturing.
- Get the basic idea of Coding methods.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Intelligent manufacturing-system components-system architecture and data flow, system operation. World Class Manufacturing and Organizational Restructuring, ways of performing manufacturing work**,** Common type of facility layout, Variety/volume trade-off, cellular manufacturing system	8	15
II	Numerical Demonstration of Effect of Setup Time Reduction on WIP and Waiting Time Demonstration Using Mathematical Model ,Production Flow Analysis Machine-Part Matrix some results for single server Markovian queuing system (m/m/1 queue), Factors to be Considered for Cell and Part Family Formation,	8	15
First Internal Examination			
III	Key machine approach Nonlinear Model: Cell Formation 0-1Integer Programming Formulation Cellular manufacturing and pull production, design of work cells and cellular manufacturing	8	15
IV	Computer integrated manufacturing systems-structure and functional areas of CIM system-CAD, Variant Process Planning ,CAPP,	8	15
Second Internal Examination			
V	Group technology (GT)-part classification and coding systems-opitz system, difference between opitz and multicode systems. Part Family Formation When Codes Available, Similarity Coefficient-Based Clustering Binary Ordering Algorithm, Rank order clustering	8	20
VI	Group technology-models and algorithms-visual method-coding method, cluster analysis method, similarity coefficient method, sorting-based algorithm,	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6106	MICRO AND NANO MACHINING	3-0-0 : 3	2015

Course Prerequisites

Basic knowledge on different types of machining processes.

Course Objectives

To enable the students to understand different types of micro and nano machining processes.

Syllabus

Introduction: Definition of micro-machining and nano-machining, Nanotechnology. Micro-machining processes - Mask-based methods &Tool based micro-machining methods. Electrochemical, Nano-mechanical, Nano-physical and Nano-chemical processes. Nano-physical and chemical processing of atomic bits: electron and ion beam processing, plasma surface processing, principles of chemical and electro-chemical processing. Nano processing systems.

Expected Outcomes

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

- Gain good understanding of micro and nano machining processes
- Undertake tool based machining methods with perfection
- Execute special nano processing systems like diamond turning, nano-grinding etc

References

1. McGeough J., *Micromachining of engineering materials*, Marcel Dekker, Inc. NY, 2002.
2. Taniguchi N., *Nanotechnology: Integrated processing systems for ultra-precision and ultra-fine products*, Oxford University Press Inc., NY, 1996

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction: Definition of micro-machining and nano-machining, Nanotechnology.	8	15
II	Micro-machining processes: Mask-based methods: Wet etching, ion beam machining, LIGA, laser beam machining, plasma etching, electroforming.	8	15
	First Internal Examination		
III	Tool based micro-machining methods: cutting, grinding, milling, punching, pressing, EDM, ECM, laser beam machining, electron beam machining, ion beam machining.	8	15
IV	Electrochemical, Nano-mechanical, Nano-physical and Nano-chemical processes, benefits. Methods and mechanism of nano-mechanical processing of atomic clusters: size effect, specific energy, atomic bit processing, nano-indentation.	8	15
	Second Internal Examination		
V	Nano-physical and chemical processing of atomic bits: electron and ion beam processing, plasma surface processing, principles of chemical and electro-chemical processing.	8	20

VI	Nano processing systems: Diamond turning, Nano-grinding, Precision polishing.	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6114	**SOFT COMPUTING TECHNIQUES**	**3-0-0 : 3**	**2015**

Course Prerequisites
Basic knowledge of operations research and computer programming.

Course Objectives
To understand and appreciate the application of various soft computing techniques in engineering systems.

Syllabus
Combinatorial optimization – Evolutionary methods – Genetic algorithm – single and multi-objective applications -Simulated annealing-Fuzzy logic – Artificial neural networks.

Expected Outcomes
On successful completion of the course, the students are expected to solve combinatorial optimisation problems using the following tools-

- Genetic Algorithm for single objective and multiobjective optimisation
- Simulated Annealing
- Fuzzy Logic
- Artificial Neural Network

References

4. Deb, Kalyanmoy, *Optimization for engineering design: Algorithms and examples*. PHI Learning Pvt. Ltd., 2012.
5. Deb, Kalyanmoy, *Multi-objective optimization using evolutionary algorithms*. John Wiley & Sons, 2001.
6. Goldberg, D.E., *Genetic Algorithms in Search, Optimization, and Machine Learning*, Addison-Wesley, 1989.
7. Schalkoff ,R.J., *Artificial Neural Networks*, McGraw-Hill Companies Inc., 1997.
8. Sundareswaran, K*., A Learner's Guide to Fuzzy Logic Systems*, Jaico Publishing House, 2005.
9. Yegnanarayanan, B., *Artificial Neural Networks*, Prentice Hall of India, 1999

Course plan

Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction to combinatorial optimization – Meta heuristics- Genetic algorithm -Terminology of GA – Strings - Coding - Fitness function - GA operators - Algorithm	8	15
II	Multi-objective genetic algorithm – Weighted sum approach –	8	15

	Algorithm for non-dominated solutions – Diversity preserving mechanism		
First Internal Examination			
III	Simulated Annealing: Introduction - Algorithm - Applications	6	15
IV	Fuzzy Logic: The concept of uncertainty and associated solutions - Fuzzy sets - Basic properties and characteristics of fuzzy sets - Fuzzy set operations - Fuzzy reasoning - Major components of a fuzzy logic system - Design aspects of fuzzy systems - Applications of fuzzy logic	10	15
Second Internal Examination			
V	Artificial Neural Networks (ANN): Characteristics of ANN - Terminology -Models of neuron – Topology - Basic learning laws - Overview of neural computing - Neural approaches to computing - Engineering approaches to computing	8	20
VI	ANN's learning approches - Training set and test set - Generalization - Learning curves - Applications of ANN in optimization - Simple examples	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6116	**DESIGN OF EXPERIMENTS**	**3-0-0 : 3**	**2015**

Prerequisites
Fundamentals of statistics at the UG level

Objectives
This course exposes the students to the basic statistical concepts, sampling techniques, principles and applications of Design of Experiments.

Syllabus
History of design of experiment; strategy, principle and application of DOE-A rationale for randomization Restricted randomization- Testing significance of effects in a 2^k factorial experiment-Developing a mathematical model - Experiments with single factorial design and application of ANOVA- 2k and 3k factorial design

Expected Outcomes
On completion of this course, the students will able to

- Conduct the experiments using factorial designs.
- Get the basic idea of Factorial design, 2k and 3k factorial design; blocking and confounding techniques in 2k factorial design.
- Get familiarized with the purpose of randomization.
- Interpret experimental results

References

1. Lawson, J. & Erjavec, J., "Modern Statistics for Engineering and Quality Improvement ", Thomson Duxbury, Indian EPZ edition
2. Nibtginertm Diygkas C, "Design and Analysis of Experiments". Fifth ed,-John Wiley & Sons
3. Box, George E P, Hunter William G, Hunter Sturat J : "Statistics for Experimenters" John Wiley & Sons
4. Douglas C. Montgomery, "Design and Analysis of Experiments", 8th Edition, , John Wiley

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	History of design of experiment; strategy, principle and application of DOE; basic statistical concepts, sampling techniques and distributions; inferences about means and standard deviations and considerations of different hypothesis; Experiments with single factorial design and application of ANOVA; randomized blocking and Latin squares.	6	15
II	An Introduction to Design of Experiments; The problem of interpreting experimental results; The purpose of randomization; A rationale for randomization, Restricted randomization.	6	15
First Internal Examination			
III	Hypothesis Testing rationale; Comparing two methods experimentally; Introduction to Factorial Experiments and DOE Terminology; Yate's algorithm for calculation of effects in a 2^k design; Testing significance of effects in a 2^k factorial experiment; Normal Probability Plot on ordinary graph paper.	8	15
IV	Developing a mathematical model; Residual Analysis, testing for model adequacy; Finding the Alias Structure of a Fractional Factorial; strategy, principle and application of DOE; basic statistical concepts, sampling techniques and distributions	8	15
Second Internal Examination			
V	Inferences about means and standard deviations and considerations of different hypothesis; Factorial design, 2k and 3k factorial design; blocking and confounding techniques in 2k factorial design;	8	20
VI	Concept of fractioning of factorial design; Response surface method; Introduction to robust design, robust parameter design for single response system; Experiments with non-normal data.	8	20
Cluster Level End Semester Examination			

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Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6118	MANAGEMENT INFORMATION SYSTEM	3-0-0 : 3	2015

Course Prerequisite:
Basic knowledge on computer programming and management at UG level

Course Objective:
This course comprises an introduction to the foundations, technology and applications of Management Information Systems (MIS). It is intended to provide a critical understanding of the context within which IS professionals perform specific technical tasks.

Syllabus:
Introduction to Management Information Systems – Information Systems Development Life Cycle – System Requirements Specification documents – Data Flow Diagrams – Decision Tools and Models - Introduction to data structures and relational database – Modern Software Design Techniques - Introduction to Capability Maturity Model(CMM) and Quality Management in software organizations – Software Testing – Software Reliability - System implementation issues and solution procedures - Multimedia technology, Distributed data management, Data mining and warehousing

Expected Outcomes:
On completion of the course, the students are expected to have the ability to

- Understand the basic components of a management information systems
- Gather and document the system requirements
- Design and develop an Information System
- Test, Implement and maintain a management information system

Reference Books:

1. Burch and Gruditski, Information Systems-Theory and Practice, Fifth edition, John Wiley & Sons, New York, 1989.
2. Hawryszkiewycz, I.T., Introduction to Systems Analysis and Design, Prentice Hall of India, 1989.
3. Ian Sommerville, Software Engineering, 6th. Edition, Pearson Education Asia, 2001.
4. Lucas, Henry C., Analysis, Design, and Implementation of Information Systems, 4th Edition, McGraw Hill, New York, 1992.
5. O'Brien J.A., Management Information Systems, 4/e, Tata McGraw Hill, 1999

Course Plan

Module	Contents	Contract hours	Semester Exam marks %
I	Management Information Systems- Building blocks in information systems-input, output, model, technology, database, and control blocks, System view of business and information system design forces, Information systems development life cycle, Information systems for strategic planning	8	15
II	System Investigation and requirements engineering, System	8	15

	requirements specification documents, Feasibility studies, System analysis and general system design, Charting tools in data base design, Data flow diagrams and E-R diagrams, Decision tools and models, Prototyping, Detailed system design, Form design, Code design, Database normalisation, Introduction to data structures and relational database.		
First Internal Examination			
III	Modern software design techniques, Verification and validation methods, Performance of software systems, Software metric and models, Software standards, Introduction to Capability Maturity Model(CMM) and Quality Management in software organizations.	10	15
IV	Software testing, Review, walkthrough and inspection, Testing approaches, Software reliability, Errors, faults, repair and availability, Reliability and maintenance.	6	15
Second Internal Examination			
V	System implementation issues and solution procedures, training and post implementation audit, System fine-tuning, Monitoring and updating.	8	20
VI	Multimedia technology, Distributed data management, Data mining and warehousing, Security features in global information systems.	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6122	**QUALITY AND RELIABILITY ENGINEERING**	**3-0-0 : 3**	**2015**

Course Prerequisites
Fundamental knowledge in probability theory and statistics is desirable.

Course Objectives
To learn in depth the quality and reliability aspects with emphasis on an industrial organizational environment.

Syllabus
Traditional Quality Control-Total Quality management-QMS-ISO9000 standards- Taguchi methods-Six sigma concepts- Design of experiments- Reliability- Total Productive Maintenance-Reliability management.

Expected Outcomes
After completing the course, the students will be able to

- Identify and describe various areas in the quality control and reliability engineering fields.
- Plan and design a quality control program in an industry/organization.
- Estimate the reliability of complex engineering systems

- Gain good understanding of the principles of total productive maintenance

References

1. Dale H; Besterfield, Total quality Mangement,Pearson Education Inc
2. Caplen, Practical Approach to Quality Control, Random House
3. O'Connor, Practical Reliability Engineering, John Wiley and Sons
4. Ryan, Statistical Methods for Quality Improvement, John Wiley and Sons
5. Ross, Taguchi Techniques for Quality Engineering, McGraw Hill Publishers
6. Douglas C. Montgomery. Design and Analysis of Experiments, John Wiley and Sons
7. Balaguruswami E. , Reliability Engineering, Tata Mc Graw Hill Publishing Co. Pvt Ltd

Course plan

Module	Content	Contact Hours	Semester Exam Marks (%)
I	Basic concepts and definition, Traditional Quality Control,Total Quality management, Deming's principles, Customer focus, Employee involvement, Continuous process improvement, PDCA cycle	8	15
II	Seven step process, Kaizen, Quality measurements, Quality costs, QFD, QMS-ISO9000 standards-requirements and documentation, Taguchi methods, quality loss function, Parameter design and Tolerance design concepts	8	15
First Internal Examination			
III	Six sigma concepts –define and measure phase, flow charting, basic tools, probability and hazard plotting, Six sigma measurements, basic control charts and process performance matrices, Measurement systems analysis.	8	15
IV	Design of experiments-basics, single factor, two factor experiments. ANOVA, Taguchi approach to design of experiments, orthogonal arrays, Signal to noise ratio, RSM-concepts and methods.	8	15
Second Internal Examination			
V	Fundamental aspects of reliability, Reliability mathematics, Reliability testing and evaluation methods. FMEA, Failure data analysis.	8	20
VI	Total Productive Maintenance, maintainability and Availability Concepts, Reliability management.	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6124	PROJECT ENGINEERING AND MANAGEMENT	3-0-0 : 3	2015

Course Prerequisites
Basic knowledge of Industrial Engineering or Management at the UG Level

Course Objectives
This course examines project management in theory and practice and the roles and responsibilities of the project manager. The course offers a practical approach to managing projects, focusing on organizing, planning, and controlling the efforts of the project.

Syllabus
Overview of Project Management - Project Management Concepts and Techniques - Project Cost Estimation - Project Planning and Scheduling- Resource Constrained Scheduling - Project Monitoring and Control - Management of Special Projects.

Expected Outcomes
On completion of the course, the students are expected to have

- A thorough understanding of the principles of project management;
- The ability to lead a project team;
- The ability to accomplish projects on schedule without cost and time overruns;
- The knowledge on the procedure for implementing big and special projects.

Reference Books

1. Shtub, Bard and Globerson Project Management: Processes, Methodologies, and Economics, 2/E, Prentice Hall Inc, 2005.
2. Lock, Project Management Handbook, Gover Publishing Ltd, 1981.
3. Cleland and King, Project Management Handbook 2nd Edition, Wiley, 1988.
4. Wiest and Levy, A Management Guide to PERT/CPM Prentice Hall of India New Delhi.
5. Horald Kerzner, Project Management: A Systemic Approach to Planning, Scheduling and Controlling, CBS Publishers, 2002.
6. S. Choudhury, Project Scheduling and Monitoring in Practice, South Asian Publishers, Delhi, 1983.

Course Plan

Module	Content	Contract hours	Semester Exam Marks %
I	Introduction to Project management, Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization, role of Project Manager-.	6	15
II	Project screening and Selection Techniques - Structuring concepts and Tools - Work Breakdown Structure, Organisation Breakdown Structure, and Linear Responsibility Chart - Project Planning Tools- Bar charts, Line of Balance – Critical Path Method, and Project Evaluation and Review Technique- Risk Analysis and Management	10	15

First Internal Examination			
III	Types of Estimates and Estimating Methods- Capital Cost Estimation - Project Budgeting - Project cash flow analysis	6	15
IV	Project Scheduling with Resource Constraints- Resource Leveling- Resource constrained scheduling with multiple resources- linear programming formulation – Introduction to staff scheduling and rostering	10	15
Second Internal Examination			
V	Monitoring Techniques and time control System- Project Cost Control -Time cost Tradeoff procedure, lowest cost schedule- Computer applications in project management	8	20
VI	Management of Software Engineering Projects, New Product Development Projects, R&D Projects and Large Scale Construction Projects -Case Studies	8	20
End Semester Cluster Level Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6126	**INDUSTRIAL AUTOMATION AND ROBOTICS**	**3-0-0 : 3**	**2015**

Course Prerequisites
Basic knowledge in Robotics at UG level

Course Objectives
To be capable of modeling, simulating and analyzing industrial automation and robotic systems

Syllabus
Automation introduction; Industrial control systems; Fundamentals of automated assembly systems; Group technology; Kinematics of manipulator frames and transformations; Manipulators; Dynamic analysis.

Expected Outcomes
After the completion of the course the student should be able to:

- Independently study the manufacturing system for potential inclusion of automation and robotics.
- Conceive, design, implement and operate industrial automation and robotics system.

References

1. John J. Craig Introduction To Robotics Mechanics and Control Addison –Wesley.
2. Saeed B Niku Introduction to Robotics Analysis Systems and Applications. Prentice Hall India.
3. Groover Mikell.P. Automation Production systems and Computer Integrated Manufacturing Prentice hall India.
4. Mark W. Spong & M. Vidyasagar Robot Dynamics and Control John Wiley & Sons.

Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction to automation, definition, types, merits and criticism, manufacturing plants and operations, automation strategies, basic elements of automated system, advanced automation functions, levels of automation..	6	15
II	Industrial control systems, process discrete manufacturing industries, continuous and discrete control systems, an overview of computer process control, fundamentals of automated assembly system.	8	15
First Internal Examination			
III	Group technology, part families, part classification and coding, production flow analysis, introduction to robotics, robotics system, classification of robots, robot characteristics, applications of robots.	8	15
IV	Kinematics for manipulator, frames and transformations, forward and inverse kinematics, DH representation, derivation of forward and inverse kinematic equations for various types of robots.	6	15
Second Internal Examination			
V	Introduction to manipulator, jacobian tool, jacobian, velocity propagation from link to link, static forces in manipulators, jacobian in force domain.	10	20
VI	Introduction to dynamic analysis, lagrangian formulation, trajectory planning, joint space and cartesian space.	10	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6128	**MECHATRONICS**	**3-0-0 : 3**	**2015**
Course Prerequisites Basic knowledge in Mechatronics at UG level			
Course Objectives To be capable of modeling, simulating and analyzing mechatronic systems			
Syllabus Key elements of a mechatronics system; Actuators and sensors; Signals systems and controllers; Digital controllers; Condition monitoring mechatronics; Micro sensors in mehchatronics			

Expected Outcomes

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

- Have good understanding of the fundamentals of mechatronics systems
- Use actuators, sensors and controllers effectively
- Apply advanced mechatronics tools in modern manufacturing systems

References

1. Bolton W *Mechatronics* Pearson Education Asia.
2. Devadas Shetty Richard A Kolk *Mechatronics System Design* Thomson Learning.
3. Dan Necsulescu *Mechatronics* Parson Education Asia.
4. HMT Ltd *Mechatronics* TMH

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to mechatronics system, key elements, mechatronics design process, types of design, traditional and mechatronics designs, advanced approaches in mechatronics, real time interfacing.	6	15
II	Actuators, sensors and transducers, fluid power and electrical actuators, piezoelectric actuators, sensors for position, motion, force and temperature, flow sensors, range sensors, ultrasonic sensors, fibre optic sensors, magnetostrictive transducer, selection of sensors.	8	15
First Internal Examination			
III	Signals system and controllers, introduction to signals, system and controls system representation, linearization, time delays, measures of system performance, closed loop controllers, PID controllers.	8	15
IV	Digital controllers, controller tuning, adaptive control, introduction to microprocessors, micro-controllers and programmable logic controllers, components, PLC programming, elements of data acquisition system.	6	15
Second Internal Examination			
V	Advanced applications in mechatronics, sensors for condition monitoring, mechatronics control in automated manufacturing, artificial intelligence in mechatronics	10	20
VI	Fuzzy logic application in mechatronics, microsensors in mechatronics, case studies of mechatronics systems.	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6132	FINITE ELEMENT METHODS AND APPLICATIONS	3-0-0 : 3	2015

Course Prerequisites

Basic knowledge in Mechanics of Solids and Fluids and Thermal Engineering at UG level

Course Objectives

To be capable of using FEM tool to formulate, simulate and analyze industrial problems

Syllabus

Basics of finite element analysis; Scalar and vector field problems; Elasticity problems; Eigen value and time dependent problems; Formulation of computer codes for FEM analysis; Pre-processing solution of FEM analysis

Expected Outcomes

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

- Have good foundation in the fundamentals of finite element methods
- Use finite element methods in the solutions of problems on theory of elasticity
- Generate computer codes for finite element analysis
- Use commercially available finite-element based software packages in real life problems

References

1. ReddyJ.N. An introduction to the infinite element method – McGraw Hill book company
2. Zienkiwiez C. The finite element method - McGraw Hill Book company New York
1. Huebner K.H. **The finite element method of engineers** – John Wily & Sons New York
2. Segerlind L.J. **Applied finite element analysis** – John Willy & Sons New York

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction basic concepts, steps involved in finite element analysis, variational methods of approximation, galerkin's method, shape functions, family of elements, assembly and solution techniques, one dimensional problems.	6	15
II	Analysis of scalar field problems and vector field problems, finite element analysis of fluid mechanics and heat transfer problems, heat conduction energy and navier stokes equations.	8	15
	First Internal Examination		
III	Elasticity problems, two and three dimensional elasticity problems, bending of beams, the euler-bernoulli beam element, plane stress and euler bernoulli element, bending of elastic plate, classical plate model, shear deformable plate model.	8	15
IV	Eigen value and time dependent problems, formulation of eigen value problems, time dependent problems, applications, non-linear problems, finite element error analysis, classification of errors, error tests, mesh revision methods, automatic mesh generation.	6	15

Second Internal Examination			
V	Formulation of computer codes for FEM analysis, philosophy of codes, stages, codes for 1D and 2D problems, program input, FEM analysis packages, features of the commercial software packages, graphical user interface, steps in FEA.	10	20
VI	Pre-processing solution, solution of FE equations, direct solvers, iterative solvers, post-processing, types of data available for post processing, reviewing results, general analysis procedure	10	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME6134	**METROLOGY AND COMPUTER AIDED INSPECTION**	**3-0-0 : 3**	**2015**

Course Prerequisites
Basic knowledge of metrology at the UG level

Objectives
To enable the students to understand the various techniques and devices related to advanced Metrology and inspection in Engineering Scenarios.

Syllabus
Metrology and Techniques- Laser Applications in Metrology-Special Measuring Instruments and Techniques-CMM-sensor in inspection- Applications

Expected Outcomes
On completion of the course, students will be able to

- Gain good understanding of standards and techniques in metrology
- Apply Laser for measurement
- Use special measurement equipments using both contact and noncontact methods
- Operate coordinate measuring machine effectively
- Integrate different types of sensors for inspection and control in manufacturing

References
1. Busch T and Harlow R, *Fundamentals of dimensional Metrology,*Delmar.
2. Thomas G.G., *Engineering Metrology*, ButterWorth.
3. Sabne Soloman, *Sensors and Control systems in Manufacturing,*McGraw Hill Book.
4. Doeblin *Measurement systems: Applications & Design,* Doebelin International Student Edition
5. Robert G. Seippel, *Optoelectronics for Technology and Engineering*, Prentice Hall India

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Metrology and Techniques:Standards in metrology-definition, Traceability, Characteristics Length & Angular measurements-	8	15

	Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology-Instruments, Methods and new approaches.		
II	Laser Applications in Metrology:LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements, straightness and flatness measurement	8	15
First Internal Examination			
III	Special Measuring Instruments and Techniques: Optoelectronic devices, contact and noncontact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.	8	15
IV	Co-ordinate Measuring Machine**:** Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.	8	15
Second Internal Examination			
V	Sensors in Inspection:Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection,	8	20
VI	Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors.	8	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L - T - P - Credits**	**Year of Introduction**
10ME6108	**MINI PROJECT**	**0- 0 - 2 - 2**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Skills in hardware/software implementation techniques earned through UG studies.
(3) Seminar I

Course Objectives

(1) To support the problem based learning approach and to enhance the reading habit among students;
(2) To enhance the skills regarding the implementation aspects of small hardware/software projects.

Guidelines

Each student has to do a mini project related to the branch of specialization under the guidance of a faculty member. It has to be approved by a committee constituted by the institute concerned. It is recommended that the same faculty member may serve as his/her Project Supervisor during 3rd& 4th semesters. The mini project is conceptualized in such a way that, some the outcomes of the work can be utilized in the selection of the thesis. Hence on completion of mini project the student can suggest possible list of their thesis topic in the second semester itself. The implementation of the mini project can be software and/or hardware based one. Mini project is envisaged as a way for implementing *problem based learning*. Problems of socially relevance and/or problems identified by the institute/ research organizations/ industry/ state should be given high priority. In such interdisciplinary and inter institutional projects, a student can have co-guide(s) from other department/ institute/ research organizations/ industry. The university encourages *interdisciplinary projects* and *problem based learning strategy*. References cited shall be authentic.

Expected Outcomes

The students are expected to :
(1) Develop skills regarding enumerating and selecting problems, subsequent analysis, and effective implementation of the solution;
(2) Be motivated and successful in the selection of the topic for the main project.

References

1. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
2. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
3. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
4. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co

Course plan

Item	Description	Time	
1	Abstract Submission	2 Week	
2	Allotment of Topic	1 Week	
3	Preliminary Presentation Sessions	1 Week	
4	Implementation Phase	9 Weeks	
5	Final Presentation-cum Demonstration	1 Week	

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME6112	ADVANCED MANUFACTURING LAB	0-0-2 : 1	2015

Course Prerequisites

Basic knowledge of CAD/CAM software and concepts of Modern Manufacturing Methods is desirable

Course Objectives

This laboratory shall primarily address the practical aspects of the key areas of advanced manufacturing. The list of experiments shall include the latest manufacturing design tools and on hand experience on CNC machines, Robots, FMS, PLC etc

Expected Outcomes

After completing the laboratory, the students will be able to operate and work on advanced machinery and will be able to plan and design programs for different applications in the manufacturing field.

List of Experiments

1. Exercises on Manual CNC Part programming using G& M codes.
2. Machining of parts on CNC Machines including preparation of part program, after simulation of tool path using suitable CAM software package.
3. Part Programming using CAM software like MASTERCAM
4. Robotics programming.
5. Experiments on micro-machining
6. Study and experimentation with CMM
7. Experimental investigation of machining parameters like cutting force, tool wear, life etc using instrumentation like Lathe/Mill tool dynamometers.
8. Experiments on CAI and Quality control
9. Experiments with NDT techniques
10. Study and experimentation with intelligent control systems
11. Experiments with non conventional machining processes.
12. Experiments on FMS
13. Experiments with PLC automation
14. Use of Tool Makers Microscope and experiments on TMM
15. Use of Surface roughness meter and related experiments
16. FDM, experiments on 3D printer
17. Use of 3D scanner and experiments
18. Own experimentation by students with latest research & developments in the advanced manufacturing field

SEMESTER III

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME7105	INDUSTRIAL TRIBOLOGY	3-0-0 : 3	2015

Course Prerequisites
Basic knowledge of engineering mechanics and mathematics at UG level.

Course Objectives
To make the students capable of developing a thorough knowledge on surface interaction, friction and wear of various components and to lay a sound foundation on lubrication and application of tribology.

Syllabus
Scope of tribology, Contact of solids, Surface topology, Surface interaction. Friction laws, Modern theory of dry solid friction, Temperature of sliding surface, Mechanism of rolling friction, Friction instability, Friction of elastomers. Theories of adhesives, Abrasives, Surface fatigue and corrosive wear, Miscellaneous wear theory such as Erosive, cavitation and Fretting wear, Wear of miscellaneous machine components such as gears, Plane bearings and rolling elements. Lubricant, Mineral Oil, Grease, Solid lubricant, Lubrication regime, Reynolds equation and its limitations. Hydrodynamic lubrication, Hydrostatic lubrication, Elasto-hydrodynamic lubrication, Boundary lubrication, Squeeze films. Application of tribology in manufacturing processes.

Expected Outcomes
On completion of the course, students are expected to

- Have a good understanding of the surface topology, surface interaction and friction
- Be thorough with the science of lubrication and the properties of various lubricants
- Apply the principles of tribology to industrial manufacturing processes

REFERENCES:
1. Sahoo P, *Engineering Tribology*, Prentice Hall of India
2. Moore D.F., *Principles and Applications of Tribology* , Pergamon Press
3.Basu and Sengupta, *Fundamentals of Tribology*

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Definition and Scope of tribology, Contact of solids, Surface topology, Surface interaction.	6	15
II	Friction: Definitions, Types, Friction laws, Modern theory of dry solid friction, Temperature of sliding surface, Mechanism of rolling friction, Friction instability, Friction of elastomers.	8	15
	First Internal Examination		
III	Wear: Definition, Classification, Theories of adhesives, Abrasives, Surface fatigue and corrosive wear, Miscellaneous wear theory such as Erosive, cavitation and Fretting wear, Wear of miscellaneous machine components	10	15

	such as gears, Plane bearings and rolling elements.		
IV	Lubrication of bearing, Lubricant, Mineral Oil, Grease, Solid lubricant, Lubrication regime, Viscous flow, Reynolds equation and its limitations.	6	15
Second Internal Examination			
V	Hydrodynamic lubrication, Hydrostatic lubrication, Elasto-hydrodynamic lubrication, Boundary lubrication, Squeeze films	6	20
VI	Application of tribology in manufacturing processes, Metal machining, Metal cutting, Tool wear, Action of lubricants, Friction welding, Extrusion process	12	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME7107	**CONCURRENT ENGINEERING AND PRODUCT LIFE CYCLE MANAGEMENT**	**3-0-0 : 3**	**2015**

Course Prerequisites

Basic understanding of mechanical and industrial engineering at the UG level.

Course Objectives

To help understand product design and concurrent engineering and product life cycle

Syllabus

. Introduction: Extensive definition of Concurrent Engineering (CE).Use of Information Technology: IT support, Solid modelling, Product data management. Design Stage: Lifecycle design of products. Need for PLM: Importance of PLM, Implementing PLM, Responsibility for PLM. Components of PLM: Product lifecycle activities, Product organizational structure.

Expected Outcomes

On successful completion of the course, the students should be able to

- Gain good understanding of the concurrent engineering principles and design methodologies
- Undertake collaborative product development
- Use information technology for modeling and product data management
- Use product life cycle management tools and techniques for solving product life cycle problems.

References

1. M.M. Anderson and L Hein, *Integrated Product Development*, IFS Publications
2. J. Cleetus, *Design for Concurrent Engineering* , CE Research Centre, Morgantown
3. Prasad, *Concurrent Engineering Fundamentals: Integrated Product Development* , Prentice hall India
4. I. Moustapha , *Concurrent Engineering in Product Design and Development*, New Age International
5. John Stark, Product Life cycle Management Springer-Verlag, UK
6. Michael Grieves, Product Lifecycle Management, McGraw Hill

7. Andrew Kusiak , *Concurrent Engineering: Automation tools and Technology* , Wiley Eastern			
Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks (%)**
I	Introduction: Extensive definition of Concurrent Engineering (CE), CE design methodologies, Review of CE techniques like DFM (Design for manufacture), DFA (Design for assembly)	6	15
II	QFD (Quality function deployment), RP (Rapid Prototyping), TD (Total design), for integrating these technologies, Organizing for CE, CE tool box, Collaborative product development.	6	15
First Internal Examination			
III	Use of Information Technology: IT support, Solid modeling, Product data management, Collaborative product commerce, Artificial Intelligence, expert systems, Software hardware component design.	10	15
IV	Design Stage**:** Lifecycle design of products, Opportunities for manufacturing enterprises, Modality of concurrent engineering design, Automated analysis Idealization control, CE in optimal structural design, Real time constraints.	8	15
Second Internal Examination			
V	Need for PLM**:** Importance of PLM, Implementing PLM, Responsibility for PLM, Benefits to different managers, Components of PLM, Emergence of PLM, Lifecycle problems to resolve, Opportunities to seize.	8	20
VI	Components of PLM**:** Components of PLM, Product lifecycle activities, Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards.	10	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME7209	**SENSORS AND CONTROLS IN MANUFACTURING**	**3-0-0 : 3**	**2015**
Course Prerequisites Basic knowledge in Optics, Electronics, CAD/CAM/CAE at UG level			
Course Objectives To enable the use of sensors and control systems to monitor and control manufacturing			
Syllabus			

. Classification and types of sensors, classification of control processes, fiber optics in sensors and control system, networking of sensors and control systems in manufacturing, Role of sensors and control technology in CIM, Advanced sensor technology in precision manufacturing applications, Industrial sensors and control, sensor materials, Process control sensors sensor network architecture in manufacturing, Sensors in flexible manufacturing systems, industrial robotics, collection and generation of process signals in manufacturing systems.

References

1. Sabrie Solomon, *Sensors and Control Systems in Manufactring*, McGraw Hill, New Delhi.
2. Sabrie Solomon, *Sensors Handbook.* McGraw Hill, New Delhi
3. S.C., Gupta, Optoelectronic Devices and Systems, PHI Learning Pvt. Ltd
4. Sanjay B. Joshi and Jeffrey S. Smith (Ed), *Computer Control of Flexible Manufacturing Systems: Research and Development*, Springer-Science+Business Media, B.V.

Expected Outcomes

After completion of the course the student should be able to:

- Independently carry out a comprehensive study of the manufacturing system for implementation of sensors and control system.
- Conceive, design, install and operate a manufacturing system integrated with sensors and control system.
- Demonstrate and project the use of sensors and control system in manufacturing.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Classification and types of sensors, classification of control processes, photoelectric sensors, proximity sensors, limit switches, microwave sensors, confocal microscopy sensors, laser sensors, fiber optics in sensors and control system, principles of fiber optics in data communication, configuration of fiber optics for sensors, testing of fiber optics,	6	15
II	networking with electro-optic links, high-clad fiber-optic cables, networking of sensors and control systems in manufacturing, mean time of intervention, yield, mean processing time etc., sensor networks detecting machinery faults, layers of communication, networks in manufacturing, RS-232, Ethernet, TCP/IP, MAP, AbNET, universal memory network, satellite sensor network	6	15
First Internal Examination			
III	Role of sensors and control technology in CIM, CIM plan in manufacturing, engineering and research, production planning, physical distribution, business management, enterprise etc., the manufacturing enterprise model, design of CIM with sensors and control systems, decision support system with sensors and control systems, CIM data base, multi-objective support decision system, analysis and design of CIM with sensors and control system, SADT, data acquisition for sensors and control systems	6	15

	in CIM environments, CIM strategy.		
IV	Advanced sensor technology in precision manufacturing applications, OCR, bar code, electromagnetic identification, surface acoustic waves, position encoder, fuzzy logic for optoelectronic colour sensors, available light sensing techniques, phtotodiodes, phototransistors and photo darlingtons, photoconductive sensors, sensor electronic assemblies, selection of a sensor, hybrids of photomulitiplier options, fault detecting sensors in dynamic machine parts, vibration measurement, optoelectronic feedback signals for servomotors, acousto-optic sensors, optoelectronic/vision associate memory, sensors for hand-eye coordination of microbotic motion, force and optical sensors for robot grippers, ultrasonic stress sensor, predictive monitoring sensors, reflective strip imaging camera sensor, sensors for biomedical technology	10	15
Second Internal Examination			
V	Industrial sensors and control, sensors in manufacturing, temperature and pressure sensors, fiber-optic pressure sensor, nano-positioning capacitive metrology sensors, electrode geometry, sensor for surface flatness and finish, special design to eliminate cable influences, sensor materials, mounting, calibration and measuring ranges, electronics support, sensor installation, integrated linearization system, robotic displacement sensors, Process control sensors for flow, gas spectroscopy, avalanche photo diode, APD, dark current and noise current, crack detection sensors, laser doppler velocity sensor, ultrasonic/laser non destructive evaluation sensor, process control sensors for acceleration, sensor network architecture in manufacturing,	10	20
VI	Sensors in flexible manufacturing systems, robot control through vision sensors, end effctor camera sensor for edge detection and extraction, ultrasonic end effector, end effector sound-vision recognition, end effector LVDT sensor, Robot control through sensors, multisensory controlled robot assembly, industrial robotics, robot programming, introduction to data communication, sensors for input control, microcomputer interactive development system, NC controller, industrial handling and packaging, linear and synchronous indexing, parallel and serial data transmission, collection and generation of process signals in manufacturing systems.	10	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME7211	PROCESS PLANNING AND COST ESTIMATION	3-0-0 : 3	2015

Course Prerequisites
Basic knowledge in Industrial Engineering at UG level

Course Objectives
To be capable of carrying out process planning and cost estimation effectively

Syllabus
. Work study and ergonomics, process planning, cost estimation, production cost estimation, labour cost and overheads

References
1. Sinha B. P., Mechanical Estimation and Costing, Tata McGraw-Hill
2. Philips F. Ostwal and Jairo Munez, Manufacturing Processes and Systems, John Wiley
3. Russel R.S. and Tailor B.W., Operations Management, PHI
4. Chitale A. V. and Gupta R.C., Producti Design and Manufacturing, PHI.

Expected Outcomes
After completion of the course the student should be able to
- Independently carry out process planning and cost estimation in a manufacturing environment.
- Model, simulate, analyze and optimize the system.

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction to work study and ergonomics, method study, definition, objectives, motion economy, principles, tools and techniques, applications, work measurements, purpose, use, procedure tools and techniques, standard time, ergonomics, principles, applications	6	15
II	Introduction to process planning, definition, Objective, scope, approaches to process planning, Process planning activities, finished part requirements, operating sequences, machine selection, material selection parameters, set of documents for process planning,	8	15
	First Internal Examination		
III	Developing manufacturing logic and knowledge, production time calculation, selection of cost, optimal processes; Introduction to cost estimation, objective of cost estimation, costing, cost accounting	6	15
IV	Classification of cost, elements of cost, types of estimates, methods of estimates, data requirements and sources, collection of cost, allowance in estimation.	8	15
	Second Internal Examination		

V	Introduction to production cost estimation, estimation of material cost, case studies	10	20
VI	Labour cost and over heads, allocation of overheads, estimation for different types of jobs, case studies	10	20
Cluster Level End Semester Examination			

Course No.	**Course Name**	**L-T-P: Credits**	**Year of Introduction**
10ME7113	**ENERGY MANAGEMENT**	**3-0-0 : 3**	**2015**

Course Prerequisites

Fundamental ideas of motors, pumps, fans and boilers at UG level.

Course Objectives

To highlight the importance of energy consciousness while dealing with various energy involved areas so as to operate the energy systems in the most judicious manner.

Syllabus

Energy management concepts, Energy efficient operation of pumps, fans, motors, air compressors, air conditioning systems, boilers, water heaters - steam distribution -Demand side management,, Energy conservation in Lighting Schemes, Cogeneration.

Expected Outcomes

On completion of the course, the students are expected to

- Have a thorough understanding of the processes for efficient energy management.
- Efficiently design and use equipments such as pumps, fans, motors and air conditioners for maximum energy saving
- Use energy saving mechanics in lighting and heating applications
- Independently conduct energy audit and give practical suggestions for energy conservation

References

1. Abbi Y.P. and Shashank Jain, *Handbook on Energy Audit and Environment Management*, TERI, 2006
2. Sunil S.Rao, *Utilization, Generation & Conservation of Electrical Energy*, Khanna publishers, 2007.
3. Anthony J.Pansini, Kenneth D. Smalling, *Guide to Electric Load Management*, Pennwell Pub; (1998)
4. Partab H., *Art and Science of Utilisation of Electrical Energy*, DhanpatRai and Sons, New Delhi. 1975
5. Tripathy S.C., *Electric Energy Utilization And Conservation*, Tata McGraw Hill, 1991
6. Witte, L.C, Schmidt,P.S., Brown, D.R , *Industrial Energy Management and Utilisation*, Hemisphere Publ, Washington,1988.
7. *Industrial Energy Conservation Manuals*, MIT Press, Mass, 1982.
8. *Guide Book for National Certification Examination for Energy Managers & Energy Auditors* – Bureau of Energy Efficiency, Ministry of Power, Govt of India.

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Importance of energy management. Energy auditing: methodology System approach and End use approach to efficient use of Electricity; Electricity tariff types. Audit instruments-consumption models-Case study. Demand side management.	8	15
II	Electric motors-Energy efficient controls and starting -Motor Efficiency and Load Analysis- Energy efficient motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Case study Reactive Power management-Capacitor Sizing-	8	15
First Internal Examination			
III	Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study.	8	15
IV	Energy conservation in Pumps , Fans (flow control), Compressed Air Systems, Refrigeration & air conditioning systems	8	15
Second Internal Examination			
V	Boiler -efficiency testing, excess air control, Steam distribution & use- steam traps, condensate recovery, flash steam utilization	8	20
VI	Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study. Electric water heating-Gysers-Solar Water Heaters	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME7215	**EXPERT SYSTEM AND ARTIFICIAL INTELLIGENCE IN MANUFACTURING**	**3-0-0 : 3**	**2015**
Course Prerequisites Basic knowledge in CAD/CAM/CAE at UG level			
Course Objectives To enable the students to integrate Artificial Intelligence and Expert system into manufacturing			
Syllabus Artificial intelligence; Knowledge sources; Expert system languages; Robotics; Database management systems; Process control and office automation			

Expected Outcomes

After the completion of the course the student should be able to:

- Utilize expert system and AI in manufacturing system analysis
- Use commercial software packages for manufacturing system analysis.

References

1. Famili, Dana S. Nau and Steven H. Kim (Ed) *Artificial Intelligence Applications in Manufacturing*, AAAI Press.
2. Robert J. Schalkoff, *Artificial Intelligence: An Engineering Approach*, McGraw Hill

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Artificial intelligence, definition, components, scope, application areas, knowledge-based systems (expert systems), definition, justification, structure, characterization	6	15
II	Knowledge sources, expert knowledge acquisition, knowledge representation, knowledge base, interference strategies, forward and backward chaining	8	15
First Internal Examination			
III	Expert system languages, ES building tools or shells, typical examples of shells, expert system software for manufacturing applications in CAD, CAPP, MRP , adaptive control.	8	15
IV	Robotics, process control, fault diagnosis, failure analysis, process selection, GT etc.,	6	15
Second Internal Examination			
V	Linking expert systems to other software such as DBMS, MIS, MDB, case studies.	8	20
VI	Process control and office automation, case studies of typical applications in tool selection, process selection, part classification, inventory control, process planning etc.	12	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME7117	**MACHINE TOOL DESIGN**	**3-0-0 : 3**	**2015**

Prerequisites

Basic ideas of design of machine elements at UG level.

Objectives

To impart the capability to design different types of machine tools by understanding the functional and operational requirements.

Syllabus

Machine tool drives, Regulation of speed and feed rates, Design of machine tool structure, Design of guide-ways and power screws, Design of spindles and spindle supports, Dynamics of machine tools.

Expected Outcomes

The students will be able to :

1. develop and evaluate cutting tools and work holders for product
2. develop the conceptual design, manufacturing framework and systematic analysis of design problems of the machine tools

References

1. Mehta N.K., *Machine Tool Design*, Tata McGraw Hill
2. *Machine Tool design Handbook* - CMTI Bangalore

Course plan

Module	Content	Hours	Semester Exam Marks (%)
I	Machine Tool Drive: working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools.	10	15
II	Regulation of Speed and Feed Rates: Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.	8	15
First Internal Examination			
III	Design of Machine Tool Structure: Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure.	10	15
IV	Design of Guide-ways and power Screws: Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Design of power screws.	6	15
Second Internal Examination			
V	Design of Spindles and Spindle Supports: Materials for spindles, Design of spindles, Antifriction bearings, Sliding bearings.	8	20
VI	Dynamics of Machines Tools: General procedure of assessing dynamic stability of EES, Cutting processing, Closed loop system, Dynamic characteristic	6	20
Cluster Level End Semester Examination			

Course No.	Course Name	L-T-P: Credits	Year of Introduction
10ME7119	MATERIAL SELECTION IN MECHANICAL DESIGN	3-0-0 : 3	2015

Course Prerequisites

Basic understanding of material selection and mechanical design processes at UG level.

Course Objectives

The primary objective is to help the students understand how to effectively select a material for designing a mechanical component satisfying all the design constraints like availability, safety, cost, manufacturability. It also details the use of the various codes and standards for the mechanical design process.

Syllabus

. The evolution of engineering materials-Materials and the design process-Functional requirements of engineering materials-Material selection based on properties alone-Material selection based on properties and shape-Processing-Materials and design-Materials property data-Latest developments in the use of materials-New materials-Case studies.

Expected Outcomes

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

- Understand the properties of various materials for design
- Select the appropriate material for a particular design application
- Use smart materials and composites for modern applications
- Apply the knowledge acquired for designing of complex mechanical systems.

References

5. Charles, J. A., Crane, F. A. A., and Furness, J. A. G., Selection and Use of EngineeringMaterials, Butterworth-Heinemann, Oxford.
6. Ashby, M. F., Materials Selection in Mechanical Design,Butterworth-Heinemann, Oxford.
7. Ashby, M. F., The Engineers Guide to Materials Selection - Modern Methods and Best Practices, AEA Technology.
8. Watermann, N. A., and Ashby, M. F., (eds), Materials Selection, Chapmann and Hall, 1996

Course Plan

Module	Content	Hours	Semester Exam Marks (%)
I	Introduction: The evolution of engineering materials, Materials and the design process, families of engineering materials.	8	15
II	Functional requirements of engineering materials, The definitions of material properties, Material selection based on properties alone.	8	15
	First Internal Examination		
III	Material selection based on properties and shape, Processing, Property changes based on processing.	8	15
IV	Materials and design, Materials property data, Exploring material properties, The material property charts.	8	15
	Second Internal Examination		

V	Latest developments in the use of materials, New materials like smart materials, composites and materials used for defence and space applications.	8	20
VI	Case studies, Simple case of a shaft material to complex materials like those used in space applications.	8	20
Cluster Level End Semester Examination			

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10ME7101	**SEMINAR II**	**0 - 0 - 2**	**2015**

Course Prerequisites

1. The habit of reading technical magazines, conference proceedings, journals etc.
2. Knowledge in technical writing and communication skills earned through seminar at UG level and in first semester
3. The course Seminar I in first semester

Course Objectives

- To enhance the reading ability required for identification of the thesis area and its literature review
- To develop skills regarding professional communication and technical report writing.
- To establish the fact that student is not a mere recipient of ideas, but a participant in discovery and inquiry.
- To arrive at a conclusion for doing Project Phase 1;
- To learn how to prepare and publish technical papers.

Guidelines

Students have to present a second seminar in 3rd semester. It is highly recommended that seminar-2 may report the literature survey being conducted as a requirement for doing the main project. Since the topic for the main project topic is to be finalized at the end of the second semester/ in the beginning of the 3rd semester, one can perform the literature search and present it as a seminar towards the middle of the semester. The Progress Evaluation Committee (PEC) formed in the second semester itself, may be the panel of evaluators for Seminar-2 also. The presentation of seminar-2 shall be of 20 minutes duration with another 5 minutes allocated for a discussion session. The committee shall evaluate the seminar based on the style of presentation, technical context, coverage of the topic, adequacy of references, depth of knowledge and the overall quality. Moreover, each student has to submit a seminar report in the prescribed format given by the Institution. It is recommended that the report for seminar-2 may be in the form of a technical paper which is suitable for publishing in Conferences / Journals as a review paper. This makes a student learn how to publish a paper and consequently develops a publishing culture among the PG student community. The references cited in the report shall be *authentic*.

Expected Outcomes

The students are expected to

- Be motivated in reading which equip them in identification of thesis area and its literature review;
- Develop the capacity to observe intelligently and propose and defend opinions and ideas with tact and conviction;
- Develop skills regarding professional communication and technical report writing;
- Arrive at a conclusion for doing Project Phase 1;
- Learn the methodology of publishing technical papers.

References

1.M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw Hill, New Delhi, 2005
2.Day R A, *How to Write and Publish a Scientific Paper,* Cambridge University Press, 1989
3.Coley S M and Scheinberg C A, *Proposal Writing,* 1990, Newbury Sage Publications.

Course plan

Item	Description	Time	
1	Abstract Submission 3 Weeks	3 Weeks	
2	Allotment of Topic and Scheduling Seminars	1 Weeks	
3	Literature Review and Presentation Sessions	6 Weeks	
4	Report Submission	3 Weeks	
5	Publishing Grades	1 Weeks	

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10ME7103	**PROJECT** (PHASEI)	**0 - 0 - 12**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Interest solving in socially relevant or research problems
(3) Skills in hardware/software implementation techniques earned from UG and mini project in semester 1
(4) Course Mini project, Seminar II &b Research Methodology

Course Objectives

(1). The student is expected to finalise the thesis topic from the areas identified during seminar II. Background studies towards the project have to be done through literature survey in relevant fields.
(2). (S)he will work on the topic, familiarize with the design and analysis tools required for the project work and plan the experimental platform, if any, required for project work.
(3) To develop the skill of identifying research problems/socially relevant projects
(4) To enhance the skills regarding the implementation aspects of small hardware/software projects.

Guidelines

Each student has to identify the topic project (phase I) related to the branch of specialization under the guidance of a faculty member. It has to be approved by a committee constituted by the institute concerned. It is recommended that the same faculty member may serve as his/her Project Supervisor during 4th semester also. This project phase is conceptualized in such a way that,

some the outcomes of the work may be continued for thesis work. Hence on completion of thisproject phase, (S)he will make a presentation based on the work and suggest future plan for his thesis work. The implementation of this phase of project can be software and/or hardware based one. This project phase is also envisaged as a way for implementing *problem based learning*. Problems of socially relevance and/or problems identified by the institute/ research organizations/ industry/ state should be given high priority. In such interdisciplinary and inter institutional projects, a student can have co-guide(s) from other department/ institute/ research organizations/ industry. The university encourages *interdisciplinary projects* and *problem based learning strategy*.References cited shall be authentic.The following guidelines also have to be followed.

1. The student will submit a detailed project (phase I)report
2. The student will present at least two seminars
3. The first seminar will highlight the topic, objectives and methodology
4. A progress seminar can be conducted in the middle of the semester
5. The third seminar will be a presentation of the work they have completed till the end of third semester and the scope of the work which is to be accomplished in the fourth semester, mentioning the expected results

Expected Outcomes

The students are expected to :

- Develop the skill of identifying industrial/ research problems/socially relevant projects
- Develop skills regarding enumerating and selecting problems, subsequent analysis, and effective implementation of the solution.
- Hands on experience in design and analysis tools required for the project work
- Plan the experimental platform, if any, required for project work, which will be helpful in actual real life project planning
- To enhance the skills regarding the implementation aspects of hardware/software projects.
- Acquire documentation and problem solving skills.
- Develop professionalism.
- Communicate technical information by means of written and oral reports.

References

1. J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
2. Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
3. Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
4. Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co

Course plan

Item	Description	Time	
1	Abstract Submission	2 Week	
2	Allotment of Topic	1 Week	
3	Preliminary Presentation Sessions	1 Week	
4	Implementation Phase	9 Weeks	
5	Final Presentation-cum Demonstration	1 Week	

SEMESTER IV

Course No.	Course Name	L - T - P - Credits	Year of Introduction
10ME7104	**PROJECT** (PHASE II)	**0 - 0 - 24**	**2015**

Course Prerequisites

(1) The habit of reading technical magazines, conference proceedings and journals;
(2) Interest solving in socially relevant or research problems
(3) Skills in hardware/software implementation techniques earned from UG and mini project in semester 1
(4) Course Seminar II&b Research Methodology
(5) Course PROJECT(Phase I)

Course Objectives

- It is expected to complete the thesis work, which is normally based on Project (phase I)
- To work on the topic, and get the result.
- To develop the skill of achieving specific research target in a limited time
- To implement/completethe thesis work

Guidelines

Each student has to complete project (phase II) under the guidance of a faculty member, as specified in Phase I. It has to be approved by a committee constituted by the institute concerned. Hence on completion of this project phase, (S)he will make a presentation based on the work and suggest future possibilities. This project phase is also envisaged as a way for implementing *problem based learning*. Problems of socially relevance and/or problems identified by the institute/ research organizations/ industry/ state should be given high priority. In such interdisciplinary and inter institutional projects, a student can have co-guide(s) from other department/ institute/ research organizations/ industry. The university encourages *interdisciplinary projects* and *problem based learning strategy*. References cited shall be authentic.

The following guidelines also have to be followed.

1. The student will submit a detailed project (phase II)report
2. The student will present at least three seminars
3. The first seminar will highlight the topic, objectives and methodology
4. A progress seminar can be conducted in the middle of the semester
5. The third seminar (pre submission seminar) will be a presentation of the work they have completed till the end of forth semester and scope for future work also has to be mentioned.The pre-Submission seminar has to be presented before the Evaluation Committee for assessing the quality and quantum of work. This would be the qualifying exercise for the students for getting approval from the Department Committee for the submission of Thesis.

Expected Outcomes

The students are expected to :

- Develop the skill of identifying industrial/research problems/socially relevant projects
- Develop skills regarding enumerating and selecting problems, subsequent analysis, and effective implementation of the solution.

- Hands on experience in design and analysis tools required for the project work
- Plan the experimental platform, if any, required for project work, which will be helpful in actual real life project planning
- Enhance the skills regarding the implementation aspects of hardware/software projects.
- Acquire documentation and problem solving skills.
- Develop professionalism.
- Communicate technical information by means of written and oral reports.

References

1.J.W. Bames, *Statistical Analysis for Engineers and Scientists*, McGraw Hill, New York.
2.Schank Fr., *Theories of Engineering Experiments*, Tata McGraw Hill Publication.
3.Douglas C Montgomery, *Design and analysis of experiments,* Wiley International
4.Leedy P D, *Practical Research : Planning and Design,* 4th Edition, N W MacMillan Publishing Co

Course plan

Item	Description	Time	
(1)	Implementation Phase	10 Weeks	
(2)	Thesis Preparation	3 Weeks	
(3)	Final Internal Presentation-cum Demonstration	1 Week	
(4)	Evaluation by the External expert	4 Weeks	

ASSESSMENT CRITERIA

A. Evaluation of Theory Courses

KTU follows a continuous academic evaluation procedure. This includes two internal examinations and one end semester cluster level University examination. Besides, students should be given proper assignments / course seminars which are essential aspects of a student-centric teaching approach. The continuous assessment procedure and corresponding weights for awarding 100 marks for a theory subject are as follows.

1. Two internal tests, each having 15 marks summing to a total of 30 marks
2. Tutorials / Assignments / Course Seminars summing to a total of 10 marks, and
3. Cluster level end-semester examination having 60 marks

B. Evaluation of Research Methodology

The course Research Methodology should be a common one for all specializations, which is envisaged to provide a research orientation for PG students. The teaching - learning process for this course should be a student-centric one in which the faculty-in-charge would take the role of a facilitator in the system. Students should be given proper guidelines for practicing the various methodologies which aims at the overall improvement of their skills required for pursuing research. The continuous assessment procedure and corresponding weights for awarding 100 marks (fully internal) for Research Methodology are as follows.

1. Three internal tests, each having 20 marks summing to a total of 60 marks
2. Tutorials / Assignments / Course Seminars summing to a total of 40 marks

C. Evaluation of Practical Courses

The continuous assessment procedure and corresponding weights for awarding 100 marks for a practical subject are as follows.

1. Practical Records / Results summing to a total of 40 Marks
2. Regular Class Viva-Voce summing to a total of 20 Marks
3. Final Test (Internal & Objective Type) having 40 Marks

D. Guidelines for Seminar-1

Students have to select a topic and present a seminar in first semester on any current topic related to the branch of specialization under the guidance of a faculty member. It is recommended that the same faculty member may serve as his/her supervisor for the mini-project in 2nd semester and also for the main project during 3rd& 4th semesters. Hence it is also recommended that a topic, possibly relevant to his mini-cum-main project may be selected as the topic for seminar-1, after the consultation with the guide. The student will undertake a detailed study of the subject based on current published papers, journals, and books and present it before a committee with the Head of the Department as the chairman and two faculty members (Faculty advisor + Guide) from the department as members. The presentation shall be of 20 minutes duration with another 5 minutes allocated for a discussion session. The committee shall evaluate the seminar based on the style of presentation, technical context, coverage of the topic, adequacy of references, depth of knowledge and the overall quality. Moreover, each student has to submit a seminar report in the prescribed format given by the Institution.

The weights for awarding 100 marks (totally internal) for the seminar-1 is as follows.

1. Presentation (Verbal & Nonverbal Communication skills) : 20 Marks
2. Breadth of the topic (Coverage : Content of the slides and speech) : 20 Marks
3. Depth of knowledge (Ability to answer questions) : 30 Marks
4. Seminar Report in the prescribed format given by the Institution : 30 marks

E. Guidelines for the Mini Project

Each student has to do a mini project related to the branch of specialization under the guidance of a faculty member. It has to be approved by a committee constituted by the institute concerned. It is recommended that the same faculty member may serve as his/her Project Supervisor during 3rd& 4th semesters. The mini project is conceptualized in such a way that, some the outcomes of the work can be utilized in the selection of the thesis. Hence on completion of mini project the student can suggest possible list of their thesis topic in the second semester itself. The implementation of the mini project can be software and/or hardware based one. Mini project is envisaged as a way for implementing *problem based learning*. Problems of socially relevance and/or problems identified by the institute/ research organizations/ industry/ state should be given high priority. In such interdisciplinary and inter institutional projects, a student can have

co-guide(s) from other department/ institute/ research organizations/ industry. The university encourages *interdisciplinary projects* and *problem based learning* strategy.

There should be a Progress Evaluation Committee (PEC) for each student which is constituted by three faculty members : (1) HoD as chairman, (2) Faculty advisor, and (3) Guide. This committee should evaluate the mini project through 2 presentations - (i) a preliminary presentation which is to be held soon after finalizing the topic, and (ii) a final presentation towards the end of the semester. In between, the Guide and /or the Co-guide is entrusted for the continuous evaluation of the work progress.

The weights for awarding 100 marks (totally internal) is as follows.

(1) Preliminary Presentation (PEC) : 20 Marks
(2) Progress Evaluation (Guide and/or Co-guide) : 30 Marks
(3) Final Presentation-cum-demonstration (PEC): 30 Marks
(4) Report (Mandatory) : 20 Marks

F. Guidelines for Seminar-II

Students have to present a second seminar in 3rd semester. It is highly recommended that seminar-2 may report the *literature survey* being conducted as a requirement for doing the main project. Since the topic for the main project topic is to be finalized in the beginning of the 3rd semester, one can perform the literature search and present it as a seminar towards the middle of the semester. The Progress evaluation Committee (PEC) formed in the second semester itself, will be the panel of evaluators for Seminar-2 also. The presentation of seminar-2 shall be of 20 minutes duration with another 5 minutes allocated for a discussion session. The committee shall evaluate the seminar based on the style of presentation, technical context, coverage of the topic, adequacy of references, depth of knowledge and the overall quality. Moreover, each student has to submit a seminar report in the prescribed format given by the Institution. It is recommended that the report for seminar-2 may be in the form of a technical paper which is suitable for publishing in Conferences / Journals as a review paper. This makes a student learn how to publish a paper and consequently develops a publishing culture among the PG student community.

The weights for awarding 100 marks (totally internal) for the seminar-2 is as follows.

1. Presentation (Verbal & Nonverbal Communication skills) : 20 Marks
2. Breadth of the literature review (Coverage : Content of the slides and speech) : 20 Marks
3. Depth of knowledge (Ability to answer questions) : 30 Marks
4. Seminar Report / Paper in the prescribed format given by the Institution : 30 marks

G. Guidelines for the Project Work

Project work is to be carried out in the 3rd and 4th semesters and also to be evaluated in both semesters. It is recommended that students should execute the project work using the facilities of the institute itself. However, external projects can be taken up in the 4th semester, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the Head of Institution before taking up external project work. Project evaluation committee should study the feasibility of each project work before giving consent. The project work is also to be evaluated continuously, during 3rd & 4th semesters through presentation sessions. Based on these evaluations the grade is finalized in the fourth semester. The internal committee (PEC) and an

External Expert shall evaluate the project based on *four* presentations by the student during these semesters. The *first* presentation in 3rd semester should be held in the beginning of the semester which would highlight the topic, objectives, and the methodology. The *second* presentation in the same semester should bring out the work progress through the preliminary results and is to be conducted towards the end of the semester. These are evaluated totally internally by the PEC.
The Project Phase - II will be an extension of the Project Phase - I. A student has to prepare a project report, namely the thesis, towards the end of the 4th semester. Both the presentation and the thesis will be evaluated by the Committee and the External expert. The *third* presentation on project is to be made towards the end of 4th semester as a final internal presentation. At least one technical paper is to be published in Journals / Conferences so as to meet the requirements for final external submission. The *fourth* presentation is a *repetition* of the third one, but before an *External Expert*, appointed through the process of submitting the M. Tech. Thesis to the University (Cluster). The external expert will assess the quality and quantity of the work done by the student in the final (fourth) presentation. The comments of the examiners during this presentation should be incorporated in the work and report and is to be submitted as hard bound copies before the program exit by the student.
The weights for awarding 150 marks for Project shall be as follows.

A. 3rd Semester - Marks : 50 for Project Progress Evaluation
    1. Preliminary Presentation, evaluated by PEC : 15 Marks
    2. Progress evaluation by the Project Supervisor/s : 20 Marks
    3. End-semester presentation, evaluated by PEC : 15 Marks
B. 4th Semester - Marks : 100 for Final Evaluation
    1. Project evaluation by the supervisor/s : 30 Marks
    2. Final internal evaluation by PEC : 40 Marks
    3. Evaluation of the thesis presentation by an External Expert : 30 Marks