

**University of Calicut**  
**Scheme and Curriculum**  
**B. Tech. - Mechanical Engineering**  
**2009**

## **B. Tech. Mechanical Engineering**

### **2009 – Scheme & Curriculum**

#### **Combined First and Second Semesters (Common for all branches)**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN08 101	Engineering Mathematics I	2	1	-	30	70	3	4
EN08 102	Engineering Mathematics II	2	1	-	30	70	3	4
EN08 103	Engineering Physics	2		-	30	70	3	3
EN08 103(P)	Physics Lab	-	-	1	50	50	3	1
EN08 104	Engineering Chemistry	2		-	30	70	3	3
EN08 104(P)	Chemistry Lab	-	-	1	50	50	3	1
EN08 105	Engineering Mechanics	2	1	-	30	70	3	4
EN08 106	Basics of Civil & Mechanical Engg.	2	1	-	30	70	3	4
EN08 107	Basics of Electrical, Electronics and Communication Engg.	2	1	-	30	70	3	4
EN08 108	Engineering Graphics	0	-	3	30	70	3	3
EN08 109(P)	Computer Programming in C	1	-	1	50	50	3	3
EN08 110A(P)	Mechanical Workshop	-	-	2	50	50	3	2
EN08 110B(P)	Electrical and Civil Workshops	-	-	2	50	50	3	2
TOTAL		15	5	10				38

#### **Third Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN09 301	Engineering Maths III	3	1	-	30	70	3	4
EN09 302	Humanities and Communication Skills	2	1	-	30	70	3	3
ME09 303	Fluid Mechanics	4	1	-	30	70	3	5
ME09 304	Computer Assisted Machine Drawing	1	-	3	30	70	3	4
ME09 305	Electrical Technology	3	1	-	30	70	3	4
ME09 306	Metallurgy & Material Science	3	1	-	30	70	3	4
ME09 307(P)	Electrical Engineering Lab	-	-	3	50	50	3	2
ME09 308(P)	Production Engineering Lab-I	-	-	3	50	50	3	2
TOTAL		16	5	9				28

**Fourth Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
EN09 401A	Engineering Maths IV	3	1	-	30	70	3	4
EN09 402	Environmental Science	2	1	-	30	70	3	3
ME09 403	Mechanics of Solids	4	1	-	30	70	3	5
ME09 404	Casting and Joining	3	1	-	30	70	3	4
ME09 405	Fluid Machinery	3	1	-	30	70	3	4
ME09 406	Thermodynamics	3	1	-	30	70	3	4
ME09 407(P)	Material Testing Lab	-	-	3	50	50	3	2
ME09 408(P)	Production Engineering Lab-II	-	-	3	50	50	3	2
TOTAL		18	6	6				28

**Fifth Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 501	Heat and Mass Transfer	4	1	-	30	70	3	5
ME09 502	Advanced Mechanics of Solids	3	1	-	30	70	3	4
ME09 503	Engineering Economics and Principles of Management	3	1	-	30	70	3	4
ME09 504	IC Engines and Gas Turbines	3	1	-	30	70	3	4
ME09 505	Mechanics of Machinery	3	1	-	30	70	3	4
ME09 506	Metal Cutting and Forming	2	1	-	30	70	3	3
ME09 507(P)	Fluids Lab	-	-	3	50	50	3	2
ME09 508(P)	Thermal Lab-I	-	-	3	50	50	3	2
TOTAL		18	6	6				28

**Sixth Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 601	Dynamics of Machinery	4	1	-	30	70	3	5
ME09 602	Finite Element Method	3	1	-	30	70	3	4
ME09 603	Machine Design - I	3	1	-	30	70	3	4
ME09 604	Operation Research	3	1	-	30	70	3	4
ME09 605	Computer Integrated Manufacturing	2	1	-	30	70	3	3
ME09 Lxx	Elective - I	3	1	-	30	70	3	4
ME09 607(P)	Mini Project / Lab	-	-	3	50	50	3	2
ME09 608(P)	Thermal Lab-II	-	-	3	50	50	3	2
TOTAL		18	6	6				28

**Electives (Sixth Semester):**

ME09 L01	Composite Materials
ME09 L02	Computational Methods in Engineering
ME09 L03	Industrial Maintenance
ME09 L04	Mechatronics
ME09 L05	Tool Engineering and Design

**Seventh Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 701	Machine Design - II	4	1	-	30	70	3	5
ME09 702	Operations Management	3	1	-	30	70	3	4
ME09 703	Metrology and Instrumentation	2	1	-	30	70	3	3
ME09 704	Power Plant Engineering	2	1	-	30	70	3	3
ME09 Lxx	Elective - II	3	1	-	30	70	3	4
ME09 Lxx	Elective - III	3	1	-	30	70	3	4
ME09 707(P)	CAD Lab	-	-	3	50	50	3	2
ME09 708(P)	Instrumentation Lab	-	-	3	50	50	3	2
ME09 709(P)	Project	-	-	1	100	-	-	1
TOTAL		17	6	7				28

**Eighth Semester - Mechanical Engineering**

Code	Subject	Hours per week			Marks		Sem-end duration-hours	Credits
		L	T	P/D	Internal	Sem End		
ME09 801	Refrigeration and Air Conditioning	4	1	-	30	70	3	5
ME09 802	Compressible Fluid Flow	2	1	-	30	70	3	3
ME09 Lxx	Elective - IV	3	1	-	30	70	3	4
ME09 Lxx	Elective - V	3	1	-	30	70	3	4
ME09 805(P)	Seminar	-	-	3	100	-	3	2
ME09 806(P)	Project	-	-	11	100	-	3	7
ME09 807(P)	Viva Voce	-	-	-	-	100	-	3
TOTAL		12	4	14				28

**Electives (Seventh and Eighth Semester):**

ME09 L06	Aerospace Engineering
ME09 L07	Automobile Engineering
ME09 L08	Combustion Engineering
ME09 L09	Computational Fluid Dynamics
ME09 L10	Computerised Materials Management
ME09 L11	Control System Engineering
ME09 L12	Cryogenic Engineering
ME09 L13	Design of Heat Transfer Equipments
ME09 L14	Design of Jigs and Fixtures
ME09 L15	Design of Pressure Vessels and Piping
ME09 L16	Financial Management
ME09 L17	Fracture Mechanics
ME09 L18	Heating, Ventilation and Air-conditioning Design
ME09 L19	Industrial Automation
ME09 L20	Industrial Tribology
ME09 L21	Logistics and Supply Chain Management
ME09 L22 *	Quality Engineering and Management
ME09 L23 *	Industrial Safety Engineering
ME09 L24 *	Marketing Management

ME09 L25 *	Energy Engineering and Management
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(\* Global)

**GLOBAL ELECTIVES:**

PE09 L25	Entrepreneurship
EC09 L25	Bio-medical Instrumentation
CS09 L23	Simulation and Modelling
CE09 L23	Experimental Stress Analysis
EE09 L22	Soft Computing Techniques
EE09 L25	Robotics and Automation
CH09 L22	Solid Waste Management
CH09 L24	Industrial Pollution Control
CH09 L25	Project Engineering
BM09 L24	Virtual Instrumentation
IT09 L24	Management Information Systems
AM09 L25	Technology Forecasting
BT09 L25	Biomaterials
AI09 L23	Microelectronic Electro-Mechanical Systems
AN09 L25	Research Methodology

## ME09 601: Dynamics of Machinery

### Teaching scheme

Credits: 5

4 hours lecture and 1 hour tutorial per week

### Objectives

- *To impart knowledge on Force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines. This forms the second part of the basics needed in the area of Mechanisms for Design courses in future.*
- *To introduce the fundamentals in Vibration, Vibration analysis of Single degree and multi degree freedom systems. To impart knowledge required to understand the physical significance and design vibration systems with desired conditions*

### Module I (16 hours)

Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms - graphical method - principle of superposition - matrix methods - method of virtual work - complex number method – Force Analysis of Spur- Helical - Bevel and Worm gearing

### Module II (18 hours)

Flywheel analysis - balancing - static and dynamic balancing - balancing of masses rotating in several planes - balancing of reciprocating masses - balancing of multicylinder in line engines - V Engines - balancing machines. Gyroscope – Gyroscopic couples- Stabilisation of ships and aeroplanes – Effect on automobiles.

### Module III (20 hours)

Introduction to vibrations – Free vibrations of single degree freedom systems – Energy Method – un damped and Damped free vibrations – Viscous damping – Critical Damping - Logarithmic decrement - Coulomb damping – Harmonically excited vibrations – Response of an Un damped and Damped system – beat phenomenon - Transmissibility - whirling of shafts – Critical speed - free torsional vibrations – Self excitation and Stability analysis - Vibration control - Vibration Isolation – Vibration absorbers.

### Module IV (18 hours)

Two degree of freedom systems - coordinate coupling and principal coordinates – Torsional systems - orthogonality principle - undamped vibration absorbers - Torsional vibrations – Free torsional vibration of Single, two and three rotor systems - Torsionally equivalent shaft - Vibration of continuous systems - Transverse vibrations - axial vibration of rods - bending vibration of bars - Eigenvalue problem - Introduction to nonlinear vibration - exact methods – Approximate numerical methods - Phase plane representation - vibration measurement - accelerometer – seismometer – vibration exciters.

### Text Books

1. S. S. Rattan, *Theory of Machines*, 2<sup>nd</sup> Edition,, Tata Mc Graw Hill
2. Lasithan L G, *Elementary Engineering Vibration and Industrial Noise Control*, 1<sup>st</sup> edition, Pentex Book Publishers and Distributors

### Reference Books

1. J. E. Shigley, J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw Hill
2. C. E. Wilson, P. Sadler, *Kinematics and Dynamics of Machinery*, 3<sup>rd</sup> edition, Pearson Education.
3. A. Ghosh, A. K. Malik, *Theory of Mechanisms and Machines*, Affiliated East West Press
4. S. S. Rao., *Mechanical Vibrations*, 4<sup>th</sup> Edition, Pearson Education.
5. W. T. Thompson. *Theory of Vibrations with Applications*. Prentice Hall of India.

### Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

**Note:** Computer oriented assignments using spread sheet or any suitable software packages are to be included

### University Examination Pattern

**PART A:** *Short answer questions (one/two sentences)* 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions* 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions* 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*



## ME09 602: Finite Element Method

### Teaching scheme

Credits: 4

3 hours lecture and 1 hour tutorial per week

### Objectives

- *To acquaint with basic concepts of finite element formulation methods.*
- *To practise finite element methodologies through simple structural and heat transfer problems.*

### Module 0 (2 hours)

Review : Matrices and matrix operations – solution of system of linear equations – Gauss elimination. Basic equations of elasticity – strain-displacement relations – compatibility - stress-strain relationship – boundary condition – St. Venant's principle - theorem of minimum potential energy – principle of virtual work. Steady state heat conduction equation – Fourier's law – boundary conditions.

(No direct questions from the above part)

### Module I (13 hours)

Introduction: Finite element method as a numerical tool for design – basic concepts – formulation procedures – historical development – current trends – free and commercial FE packages.

FE modelling Direct approach: 1-D bar element – element stiffness – assembly of elements – properties of [K] matrix – treatment of boundary conditions – temperature effects – stress computation – support reaction – simple problems. Analogous (1-D) problems of torsion, heat conduction and laminar pipe flow.

Beam element: Beam relationships – 1-D beam element FE formulation - element stiffness matrix – load considerations – boundary conditions – member end forces.

### Module II (13 hours)

FE modelling Direct approach : Plane truss element formulation – coordinate transformation – local and global coordinates – element matrices – assembly of elements – treatment of boundary conditions – stress calculation – simple problems - band width of the stiffness matrix – node numbering to exploit matrix sparsity – conservation of computer memory.

Interpolation – shape function – Lagrange interpolation - 1D linear and quadratic, 2D linear triangle and bilinear rectangular elements.

FE formulation from virtual work principle – B-matrix – element matrices for bar and CST elements – load considerations – consistent nodal loads – simple problems.

### Module III (13 hours)

Variational methods : – Functionals – weak and strong form – essential and non- essential boundary conditions - Principle of stationary potential energy – Rayleigh-Ritz method – simple examples.

FE formulation from a functional: 2-D steady state heat conduction – element matrices for a triangular element – boundary conditions – simple problems. FE formulation for 2-D stress analysis from potential energy - element matrices - plane bilinear element.

Convergence requirements – patch test – modelling aspects – symmetry – element size and shape – sources of error.

### Module IV (13 hours)

Weighted residual methods: Galerkin FE formulation – axially loaded bar – heat flow in a bar.

Isoparametric formulation: Natural coordinates – linear and quadratic bar element – linear triangle and plane bilinear elements for scalar fields – jacobian matrix – element matrices - Gauss quadrature – requirements for isoparametric elements – accuracy and mesh distortion.

Advanced topics: Introduction to non-linear and dynamic finite element procedures, error estimation, coupled problems (only brief details are needed).

**Text Books**

1. T. R. Chandrupatla, *Finite Element Analysis for Engineering and Technology*, University Press
2. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons
3. D. V. Hutton, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill
4. S. S. Bhavakatti, *Finite Element Analysis*, New Age International

**Reference Books**

1. J. N. Reddy, *An Introduction to the Finite Element Method*, McGraw Hill International Edition
2. S. S. Rao, *The Finite Element Method in Engineering*, Butterworth Heinemann
3. K. J. Bathe, *Finite Element Procedures in Engineering Analysis*, Prentice Hall of India
4. O. C. Zienkiewics, R. L. Taylor, *The Finite Element Method*, Vol I & II, McGraw Hill

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.

10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ME09 603: Machine Design-I

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

**Credits: 4**

### Objectives

- To provide basic knowledge on the design considerations and methodology of various machine elements.

### Module I ( 15 Hrs)

System design cycle - Different phases in design process – design factors and considerations – tolerances and fits – Hole basis & Shaft basis system - standardization – selection of materials – stress concentration – Methods to reduce stress concentration - theoretical stress concentration factor - theories of failure – Guest's theory – Rankine's theory – St. Venant's theory – Haigh's theory – Von Mises & Hencky theory - shock and impact loads – fatigue loading – endurance limit stress- Factors affecting endurance limit - Factor of safety - creep and thermal stresses.

### Module II ( 13 Hrs)

Threaded joints – thread standards- thread nomenclature - stresses in screw threads- bolted joints- preloading of bolts- eccentric loading- fatigue loading of bolts - gasketed joints- power screws - design of riveted joints- Failure of riveted joints and efficiency of joint -boiler and tank joints- structural joints- cotter and knuckle joints

### Module III ( 14 Hrs)

Design of welded joints- Representation of welds - stresses in fillet and butt welds- design for static loads - bending and torsion in welded joints- eccentrically loaded welds - design of welds for variable loads. Springs- stresses and deflection of helical springs with axial loading – curvature effect – resilience - design of spring for static and fatigue loading- surging- critical frequency- stress analysis and design of leaf springs- nipping.

### Module IV (12 Hrs)

Shafts and axles design- stresses- causes of failure in shafts - design based on strength, rigidity and critical speed- design for static and fatigue loads- repeated loading- reversed bending-design of couplings- rigid and flexible couplings-design of keys and pins.

*Note:* The following data books are permitted for reference in the final examination:

- PSG Design Data, DPV Printers, Coimbatore.
- Prof. Narayana Iyengar B.R & Dr Lingaiah K, Machine design Data Handbook, Vol I & II

### Text Books

1. J. E. Shigley, *Mechanical Engineering Design*, McGraw Hill Book Company.
2. M. F. Spotts, T. E. Shoup, *Design of Machine Elements*, Pearson Education.

### Reference Books

1. Juvinall R.C & Marshek K.M., *Fundamentals of Machine Component Design*, John Wiley

**Internal Continuous Assessment** (*Maximum Marks-30*)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.

10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences)*

*5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions*

*4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions*

*4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ME09 604: Operations Research

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

### Objectives

- *To impart knowledge on linear programming, transportation problem, assignment problem, game theory and queuing theory.*

### Module I (13 hours)

Review of the properties of matrices and matrix operations - Lines and hyper planes – linear inequalities – convex sets – extreme points – fundamental theorem of linear programming - Development of OR – Phases of OR – Scope of OR – Advantages and limitations of OR.  
Formulation and application of linear programming to production, marketing, finance and other areas – Concepts of Solution space, convex region, basic feasible solution, optimal solution – Solving LPP by graphical method

### Module II (14 hours)

Solving LPP by Simplex method– slack and surplus variables – basic feasible solutions – reduction of a feasible solution to a basic feasible solution – artificial variables – optimality conditions – unbounded solutions –big M method- two phase method- degeneracy – duality.

### Module III (13 hours)

Transportation problem – coefficient matrix and its properties – basic set of column vectors – linear combination of basic vectors – tableau format – stepping stone algorithm – UV method – inequality constraints – degeneration in transportation problems  
Assignment problem as a maximally degenerate transportation problem – Koning's method

### Module IV (14 hours)

Game theory –Two person zero sum games– saddle points – pure and mixed strategies - dominance – graphical solutions  
Basic structure of queuing models – exponential and Poisson distributions - queuing models based on Poisson inputs and exponential service times – basic model with constant arrival rate and service rate – Poisson-exponential single server model, infinite population– Poisson-exponential single server model, finite population - Poisson-exponential multiple server model, infinite population  
Dynamic programming – Bellman's principle of optimality – formulation and solution of simple problems

### Reference Books

1. Ravindran A., Phillips D. T., Solberg J. J., *Operations Research Principles and Practice*, John Wiley
2. Vohra N. D. *Quantitative Techniques for Management*, Tata McGraw Hill, New Delhi
3. Hadley G., *Linear Programming*, Addison Wesley
4. Hillier F. S., Lieberman G.J. *Introduction to Operations Research*, McGraw Hill
5. Taha H. A., *Operations Research, An introduction*, P.H.I.
6. Wagner H.M., *Principles of Operations Research with Application to Managerial Decision*,
7. R. Panneerselvam, "Operations Research", PHI (2002).
8. S. D. Sharma, *Operation Research*, Kedamath and Rannalt Pub.
9. Hira and Gupta, *Operation Research*, S. Chand and Co.

### Internal Continuous Assessment (Maximum Marks-30)

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

### University Examination Pattern

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70



## ME09 605: Computer Integrated Manufacturing

### Teaching scheme

2 hours lecture and 1 hour tutorial per week

**Credits: 3**

### Objectives

- To impart fundamental knowledge of Numerical Control, NC part programming, Controls in CIM, material handling systems.
- To acquire comprehensive idea on FMS and Robotics.

### Module I (7 hours)

Introduction- fundamentals of numerical control- advantages of NC system - classification of NC system - NC and CNC - open loop and closed loop systems - features of NC machine tools - fundamentals of machining- design considerations of NC machine tools- methods of improving machine accuracy and productivity- special tool holders.

### Module II (10 hours)

NC part programming - manual programming - part programming examples- point to point programming and contour programming- computer aided programming concepts- post processor- program languages- APT- programming - part programming examples.

### Module III (10 hours)

Controls in CIM- material handling in CIM- AGV- Vehicle guidance- vehicle management and safety- automated storage systems- ASRS components and operations- features of ASRS- automatic data capture- barcode technology- magnetic strips- optical character recognition- group technology- part family- part classification and coding - features OPITZ classification and multi class coding system.

### Module IV (9 hours)

Flexible manufacturing system- types of FMS- components of FMS- FMS workstations- material handling and storage systems- FMS layout- configurations- computer control systems in FMS- applications and benefits of FMS- industrial robotics- robot anatomy- configurations- joints- drive systems- robot control systems- end effectors- sensors in robots- industrial robot applications- robot programming- on line and off line programming

### Text Books

1. Yoram Koran, *Computer control of manufacturing systems*, Mc Graw Hill Intl. Book Co., John Wiley & Sons, N. Y., 2002
2. Mickel. P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education



### Reference Books

1. H.M.T, *Mechatronics*, Tata Mc Graw Hill
2. Mickel. P. Groover, *Industrial Robotics Technology, Programming and Applications*, Mc Graw Hill.
3. Radhakrishnan P., *Computer Numerical Control Machines*, New Central Book Agency.
4. Radhakrishnan P., Subramanian S., *CAD/CAM and CIM*, Wiley Eastern, 1994.
5. Groover, *Automation, Production Systems and CIM*, Prentice Hall, 1990.
6. Nagpal G.R. , *Machine Tool Engineering*, Khanna Publishers, 2000

### Internal Continuous Assessment (Maximum Marks-30)

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

### University Examination Pattern

**PART A:** *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ***ME09 607(P): Mini Project***

### **Teaching scheme**

**Credits: 2**

2 hours practical per week

### **Objectives**

- *To practise the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

A team of students having a maximum of five members shall constitute a batch for the mini-project. The head of the department will decide the framing of the project batches. The subject content of the mini project shall be from emerging /thrust areas, topics of current relevance having research aspects or shall be based on industrial visits undergone in 4<sup>th</sup>, 5<sup>th</sup> semesters. At the end of the semester, each group of students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. Internal marks will be awarded by respective guides as per the stipulations given below.

- Attendance, regularity and individual contribution of each student (20 marks)
- Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester End examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

- |                                  |            |
|----------------------------------|------------|
| • Report                         | = 25 marks |
| • Concept/knowledge in the topic | = 15 marks |
| • Presentation                   | = 10 marks |
| Total marks                      | = 50 marks |

## ***ME09 608(P): Thermal Lab - II***

### **Teaching scheme**

3 hours practical per week

**Credits: 2**

### **Objectives**

- *To strengthen the knowledge on heat engines, and heat transfer principles through advanced experiments.*
  - *To equip the students to carry out independent experiments, and to train them to analyse, report and infer the results.*
1. Test on IC engines:
    - Variable speed performance test on petrol and diesel engines
    - Determination of friction power – retardation test and morse test
    - Study of the effect of cooling water on engine performance
    - Heat balance test
    - Analysis of the exhaust gas of IC engines
  2. Heat transfer experiments:
    - Performance studies on a shell and tube heat exchanger
    - Performance studies on parallel and counter flow arrangements in a concentric pipe heat exchanger
  3. Performance tests on air compressor and blower
  4. Performance test on refrigeration plant

### **Reference Books**

1. P. L. Bellani, *Thermal Engineering*, Khanna Publishers
2. J. P. Holman, *Heat Transfer*, McGraw Hill
3. Obert, *Internal Combustion Engines*, McGraw Hill

### **Internal Continuous Assessment (Maximum Marks-50)**

60% - Practicals and Record (30 marks)  
30% - Test /s (15 marks)  
10% - Regularity in the class (5 marks)

### **Semester End Examination (Maximum Marks-50)**

70% - Procedure, conducting experiment, results, tabulation, and inference (35 marks)  
20% - Viva voce (10 marks)  
10% - Fair record (5 marks)



## ME09 L01: Composite Materials

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

### Objectives

- To provide knowledge on characteristics of composites, manufacturing and testing methods, mechanical behaviour, recent trends and its application.

**Pre-requisites:** Basic knowledge of material science and mechanics of solids

### Module I (13 hours)

Introduction to composites: Characteristics and classifications of composites – study of fibers, flake and particulate composites.

Manufacturing methods: Production of various fibers – matrix materials and surface treatments – fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites.

### Module II (13 hours)

Testing aspects of composites: Experimental characterisation of composites – uniaxial tension, compression and shear tests – determination of interlaminar fracture toughness – damage identification through non-destructive evaluation techniques – ultrasonic, acoustic emission and X-radiography.

### Module III (13 hours)

Mechanical behaviour of UD composites: Longitudinal strength and stiffness – transverse strength and stiffness – failure modes – analysis of laminated composites – stress-strain variation in a laminate.

### Module IV (13 hours)

Special laminates: Symmetric laminates, uni-directional, cross-ply and angle-ply laminates, quasi-isotropic laminates. Recent trends in composite materials – carbon-carbon composites, Bucky Paper. Application of composite materials in aerospace, automotive, defence and industry.

#### Text Books

1. B. D. Agarwal, L. J. Broutman, *Analysis and Performance of Fiber Composites*, John Wiley.

#### Reference Books

1. R. F. Gibson, *Principle of Composite Material Mechanics*, McGraw Hill
2. M. M. Schwartz, *Composite Materials Handbook*, McGraw Hill. Inc.
3. R. M. Jones, *Mechanics of Composite Materials*, McGraw Hill. Inc
4. S. W. Tsai, *Introduction to Composite Materials*, Technomic Publishing Company.

**Internal Continuous Assessment** (*Maximum Marks-30*)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

**University Examination Pattern**

**PART A:** *Short answer questions (one/two sentences)* *5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions* *4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions* *4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ME09 L02: Computational Methods in Engineering

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

### Objectives

- *To impart the concept of various numerical methods in engineering.*
- *To develop understanding about the method of applying numerical techniques with the help of computers for solving complex problems.*

**Pre-requisites:** Basic knowledge of engineering mathematics

### Module I (13 hours)

Errors in numerical calculations: Sources of errors, significant digits and numerical instability – numerical solution of polynomial and transcendental equations – bisection method – method of false position – Newton-Raphson method – fixed-point iteration – rate of convergence of these methods – iteration based on second degree equation – the Muller's method – Chebyshev method – Graeffe's root squaring method for polynomial equations – Bairstow method for quadratic factors in the case of polynomial equations.

### Module II (13 hours)

Solutions of system of linear algebraic equations: Direct methods – Gauss elimination and Gauss-Jordan methods – Crout's reduction method – error analysis – iterative methods – Jacobi's iteration – Gauss-Seidal iteration – relaxation method – convergence analysis – solution of system of nonlinear equations by Newton-Raphson method – power method for the determination of Eigen values – convergence of power method. Solution of tri-diagonal system – Thomas algorithm.

### Module III (14 hours)

Polynomial interpolation: Lagrange's interpolation polynomial – divided differences – Newton's divided difference interpolation polynomial – error of interpolation – finite difference operators – Gregory-Newton forward and backward interpolations – Stirling's interpolation formula – interpolation with a cubic spline – numerical differentiation – differential formula in the case of equally spaced points – numerical integration – trapezoidal and Simpson's rules – Gaussian integration – errors of integration formulae.

### Module IV (14 hours)

Numerical solution of ordinary differential equations: Taylor series method – Euler and modified Euler methods – Runge-Kutta methods (2<sup>nd</sup> order and 4<sup>th</sup> order only) – multistep methods – Milne's predictor-corrector formulae – Adam-Bashforth and Adam-Moulton formula – solution of boundary value problems in ordinary differential equations – shooting method – finite difference methods for solving two dimensional Laplace's equation for a rectangular region – finite difference method of solving heat equation and wave equation with given initial and boundary conditions.

**Text Books**

1. Chapra and Canale, *Numerical methods for scientist and engineers*, McGraw Hill.

**Reference Books**

1. Froberg, *Introduction to numerical analysis*, Addison Wesley.
2. Kandaswamy, *Numerical Analysis*, S Chand
3. Hildebrand, *Introduction to Numerical Analysis*, Tata McGraw Hill.

**Internal Continuous Assessment (Maximum Marks-30)**

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.
- 10% - Regularity in the class

**University Examination Pattern**

**PART A:** *Short answer questions (one/two sentences)* 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions* 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions* 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*



## ME09 L03: Industrial Maintenance

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

### Objectives

- *To provide knowledge on basic concepts of maintenance, vibration monitoring, non destructive testing and concepts of reliability*

### Module I (12 hours)

Basic concepts purpose and functions of maintenance- types of maintenance- condition monitoring- principles and method –Transducers for vibration measurement.

### Module II (14 hours)

Elementary problem diagrams – misalignment – unbalance – vibration monitoring and analysis – vibration analysis – proximity analysis – frequency analysis – spectral analysis – real time analysis vibration limits vibration severity criteria vibration severity charts – shock pulse analysis application to condition monitoring of ball and roller bearings - vibration signature analysis.

### Module III (14 hours)

Ferrography – spectral oil analysis procedure – non destructive testing – liquid penetrant testing – radio graphic inspection – ultra sonic testing acoustic emission corrosion monitoring – resistance techniques – technique providing information on plant regarding corrosion monitoring

### Module IV (14 hours)

Reliability: Basic concepts – reliability , maintainability and availability – failure rate – mean time between failures – system reliability – reliability of series and parallel systems – reliability estimation using exponential distribution function.

#### Text Books

1. L. S. Sreenath, *Vibration spectrum analysis A practical approach*., Steve Goldman Industrial Press Inc.

#### Reference Books

1. Miller, Blood, *Modern Maintenance Management*, D B Tarapur.

**Internal Continuous Assessment** (*Maximum Marks-30*)

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.

10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences)*

*5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions*

*4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions*

*4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ME09 L04: Mechatronics

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

**Credits: 4**

### Objectives

- *To provide basic knowledge on elements, principles and design of electronic controls for mechanical systems.*

**Pre-requisites:** *Basic knowledge of electronics and mechanical engineering.*

### Module I (13 hours)

Introduction to Mechatronics – scope - Mechatronics and Engineering Design. Sensors and transducers – classification-thermal, electrical, optical, acoustic, pneumatic, magnetic, and piezo electric sensors. Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types. Pneumatic and hydraulic systems - mechanical and electrical systems.

### Module II (13 hours)

Condition monitoring – principles - sensors for force, vibration, temperature, and noise-acoustic emission – principles and applications.  
Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - anti friction bearings, hydrostatic bearing, hydrodynamic bearing. Measuring system for NC machines - direct and indirect measuring system - Smart sensors.

### Module III (14 hours)

Closed loop controllers - proportional, derivative and integral controls - PID controller - digital controllers - controller tuning - adaptive control of machine tools.  
Mechatronics in Robotics - robot position and proximity sensing - tactile sensing. Man-machine interface.  
Micro controllers and microprocessors - digital logic circuits - micro controller architecture and programming - programmable logic controllers. Automatic control and real time systems-Neural network systems - Fundamentals of ANN – perceptions – back propagation.

### Module IV (14 hours)

System modelling - mathematical models - mechanical, electrical, fluid and thermal system building blocks - system models - dynamic response of systems - first and second order systems - modelling dynamic systems - system transfer functions - frequency response – stability.  
Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions - case studies of mechatronic systems - pick and place robot - automatic car park system - engine management system.

**Text Books**

1. W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Addison Wesley Longman Limited.

**Reference Books**

1. R. C. Dorf, R. H. Bishop, *Modern Control Systems*, Addison Wesley
2. Krishna Kant, *Computer Based Industrial Control*, Prentice Hall of Indian Private Limited
3. HMT Limited, *Mechatronics*, Tata McGraw Hill Publishing Company Limited
4. Herbert Taub, Donald Schilling, *Digital Integrated Electronics*, McGraw Hill International Editions
5. Dan Neculescu, *Mechatronics*, Pearson Education Asia, 2002(Indian reprint).

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.

10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences)

5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions

4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions

4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

## ME09 L05: Tool Engineering and Design

### Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

### Objectives

- To impart knowledge on basic concepts of tool design.

### Module I (13 hours)

Design of chips forming tool, chip removal process, principle, classification of tools, tool geometry – tool materials – multi point tools – milling cutter, drills, reamer, taps, broaches, Machining time estimation for milling, drilling, cutting power estimation in milling, drilling operations, boring bar, vibration damping of bar boring.

### Module II (13 hours)

Power presses, types, die cutting operation, press tonnage calculations – scrap-strip layout, compound & progressive dies, design of dies for simple components, drawing dies, blank development, press tonnage and blank holding pressure, draw dies for simple components.

### Module III (13 hours)

Design of thermoplastic injection moulds: Plastic materials, classes of plastics, injection moulds, specifications, injection moulding machine and its influence in mould design, phases of moulding cycle, parting surfaces, feed systems – sprue, runner and gate systems, mould casting, ejection methods, shrinkage, mould tool materials.

### Module IV (13 hours)

Design of work holders: Purpose of work holders, function, principle of location and clamping, locators, toll forces, design of work holder for tapping, fixture components, work holders for round work pieces – mandrels, collets.

### Reference Books

1. A. Bhattacharya, Metal cutting theory and practice, Central Book Publishers.
2. ASTME, *Fundamentals of tool design*, Prentice Hall.
3. G. R.. Nappel, *Machine Tool Engineering*, Khanna Publishers
4. P. S. Cracknell, R. W. Dysor, *Handbook of thermoplastic injection mould design*, Blackie Academic and Professional, Glasgow.
5. HMT, *Production Technology*, Tata McGraw Hill

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, etc. Atleast one assignment should be programming / problem solving using computers.

10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences)*

*5 x 2 marks=10 marks*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions*

*4 x 5 marks=20 marks*

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions*

*4 x 10 marks=40 marks*

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*