

**M.D UNIVERSITY, ROHTAK(HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION SEMESTER-1**  
**M.E Degree Course In Mechanical Engineering (Design of Mechanical Equipment)**

Course No.	Course title	Teaching schedule			Marks for		Credits for			Duration of Exam
		L	T	P	Sessional	Exam	Sessional	Exam	Total	
MEE 501	Numerical Techniques	4	-	-	50	100	2	4	6	3
MEE 503	Advanced Mechanics of Solids	4	-	-	50	100	2	4	6	3
MEE 505	Computer Methods in Mechanical Design	4	-	-	50	100	2	4	6	3
MEE 507	Design of Mechanisms And Manipulators	4	-	-	50	100	2	4	6	3
MEE 509	Vibrating Engineering	4	-	-	50	100	2	4	6	3
MEE 511	Computer Methods in Mechanical Design Lab	-	-	3	50	50	2	2	4	3
MEE513	Vibrating Engg. Lab	-	-	3	50	50	2	2	4	3
	Total	20	-	6	350	600	14	24	38	

Note :

- The paper setter will set each theory paper of 100 marks covering the entire syllabus.  
However, the examiner will evaluate the performance of the student in the theory course finally by assigning one of the grades out of A,A(-),B,B(-),C, C(-),D& F. examination of practical shall also be evaluated on the basis these grades.
- The sessionals of Theory and Practical Courses shall also be evaluated on the basis of above grades.
- The gracing system is defined at the end of the Scheme of Studies and Examination.

**M.D UNIVERSITY, ROHTAK (HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION SEMESTER-II**  
**M.E Degree Course In Mechanical Engineering (Design of Mechanical Equipment)**

Course No.	Course title	Teaching schedule			Marks for		Credits for			Duration of Exam
		L	T	P	Sessional	Exam	Sessional	Exam	Total	
MEE 512	Optimum Design of Mechanical System	4	-	-	50	100	2	4	6	3

MEE 514	Advanced Mechanical Design	4	-	-	50	100	2	4	6	3
MEE 516	Instrumentation And Automatic Control	4	-	-	50	100	2	4	6	3
MEE 518	Industrial Tribology	4	-	-	50	100	2	4	6	3
MEE	*Elective -1	4	-	-	50	100	2	4	6	3
MEE 524	Instrumentation And Automatic Control Lab	-	-	3	50	50	2	2	4	3
MEE	*Elective -1 Lab	-	-	3	50	50	2	2	4	3
	Total	20	-	6	350	600	14	24	38	

Note :

1. The paper setter will set each theory paper of 100 marks covering the entire syllabus.

However, the examiner will evaluate the performance of the student in the theory course finally by assigning one of the grades out of A,A(-),B,B(-),C, C(-),D& F. examination of practical shall also be evaluated on the basis these grades.

2. The sessional of Theory and Practical Courses shall also be evaluated on the basis of above grades.

3. Any elective course to be offered from the above lists will be finalized by the HOD, depending upon the availability of the expertise as well as the faculty strength in the department. The choice of the student for any elective shall not be a binding for the department to offer it.

4. The grading system is defined at the end of the Scheme of Studies and Examination. (\*Find details of Elective-1 and Lab on page 4.)

**M.D UNIVERSITY, ROHTAK (HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION SEMESTER-III**  
**M.E Degree Course In Mechanical Engineering (Design of Mechanical Equipment)**

Course No.	Course title	Teaching schedule			Marks for		Credits for			Duration of Exam
		L	T	P	Sessional	Exam	Sessional	Exam	Total	
	*Elective II	4	-	-	50	100	2	4	6	3
	*Elective III	4	-	-	50	100	2	4	6	3
	*Elective IV	4	-	-	50	100	2	4	6	3
	*Elect II Lab		-	3	50	50	2	2	4	3
	*Elect III Lab		-	3	50	50	2	4	4	3
MEE621	Dissertation (Phase-1)	-	-	6	100	-	4	-	4	-
MEE623	Seminar - 1	-	-	2	50	-	2	-	2	-
	Total	12	-	14	400	400	16	16	32	

Note :

1. The paper setter will set each theory paper of 100 marks covering the entire syllabus.  
However, the examiner will evaluate the performance of the student in the theory course finally by assigning one of the grades out of A,A(-),B,B(-),C, C(-),D& F. examination of practical shall also be evaluated on the basis these grades.
2. The sessional of Theory and Practical Courses shall also be evaluated on the basis of above grades.
3. The grading system is defined at the end of the Scheme of Studies and Examination.

**M.D UNIVERSITY, ROHTAK (HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION**  
**M.E Degree Course in Mechanical Engineering (Design of Mechanical Equipment)**

**Details of Electives and Elective Labs**

Course No.	Course title	Teaching schedule			Marks for		Credits for			Duration of Exam
		L	T	P	Sessional	Exam	Sessional	Exam	Total	
	*Elective I									
MEE 510	Machine Tool Design	4	0	0	50	100	2	4	6	3
MEE 512	Product design	4	0	0	50	100	2	4	6	3
	*Elect II & III									
MEE 601	Finite Element Methods	4	0	0	50	100	2	4	4	3
MEE603	Computer Aided Vehicle Design	4	0	0	50	100	2	4	6	3
MEE605	Robotics	4	0	0	50	100	2	4	6	3
MEE 607	Mechatronics Product Design	4	0	0	50	100	2	4	6	3
	*Elective IV									
MEE 609	Properties and Selection of Engineering Materials	4	0	0	50	100	2	4	6	3
MEE 611	Product Reliability and Maintenance	4	0	0	50	100	2	4	6	3

MEE 516	Machine Tool Design Labs	0	0	3	50	50	2	4	6	3
MEE 518	Product Design Lab	0	0	3	50	50	2	4	6	3
MEE 613	Finite Element Methods Lab	0	0	3	50	50	2	4	6	3
MEE 615	Computer Aided Vehicle Design Lab	0	0	3	50	50	2	4	6	3
MEE 617	Robotics Lab	0	0	3	50	50	2	4	6	3
MEE 619	Mechatronics Product Design Lab	0	0	3	50	50	2	4	6	3

\*Student has to take one subject out of subjects offered by department from this list.

\*\* Student has to take two subjects out of subjects offered by department from this list.

\*\*\*Student has to take lab courses according to electives chosen.

**M.D UNIVERSITY, ROHTAK (HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION SEMESTER-IV**  
**M.E Degree Course in Mechanical Engineering (Design of Mechanical Equipment)**

Course No.	Course title	Teaching schedule			Marks for		Credits for			Duration of Exam
		L	T	P	Sessional	Exam	Sessional	Exam	Total	
MEE 602	Seminar – 2	-	-	2	50	-	2	-	2	-

MEE 604	Dissertation	-	-	26	100	100	4	20	24	3
	Total	-	-	28	150	100	6	20	26	

Note:

1. The sessional of seminar-II and Dissertation shall be evaluated on the basis of grades i.e. A,A(-),B,B(-),C, C(-),D& F.
2. Dissertation shall be evaluated through an examination by an external Committee consisting of In –charge MM Programmer, dissertation supervisor and one external expert. The evaluation shall be based on above grades.
3. The grading system is defined at the end of the Scheme of Studies and Examinations.

**M.D UNIVERSITY, ROHTAK (HARYANA)**  
**SCHEME OF STUDIES & EXAMINATION SEMESTER S**  
**M.E Degree Course in Mechanical Engineering (Design of Mechanical Equipment)**

The grade awarded to student in any particular course will be based on his/her performance in class Work, sessional tests, tutorial tests, home assignments ,laboratory work, via-voce examination ,main examination et c.

The letter grades that can be awarded and their equivalent grade points are listed below

Grade	Grade points	Description of performance
A	10	Outstanding
A (-)	09	Excellent
B	08	Very Good
B(-)	07	Good
C	06	Average
C(-)	05	Below average
D	04	Marginal
F	0	Very poor

The grade point average (GPA) or SGPA or CGPA will be calculated as follows:

$$\text{GPA} = \frac{\sum (\text{Number of credit} * \text{Point grade})}{\sum \text{Number of credits}}$$

Where,  $\Sigma$  implies summation of the bracketed terms, as applicable for the semester(s).

A student who is awarded 'F' Grade in a course shall be required to repeat this course and his/her GPA will be recomputed with the fresh grade point obtained. To convert the percentage of marks into the relative grade point, following guidelines may be allowed:

1. All students pursuing a particular MEE Course in all the Engineering Colleges affiliated with with M.D. University; Rohtak will form a single group. The answer books of this group will be examined by the same examiner in a particular subject to maintain uniformity of awards.
2. As the grading system is the relative one, the grades will be so awarded that their distribution follows the normal distribution curve. However, the 'A' grade may not be awarded in case the absolute marks scored are less than 90 percent.
3. While awarding any of the above grades, fractional percentage equal to or more than 0.5 percent will be rounded off to 1.0 percent while that less than 0.5 percent shall be treated as 0.0 percent.
4. In case a candidate with 'F' grade reappears & improves his/her grade in subsequent exam(s), he/she will be awarded the grade one level lower than the grade he/she actually had obtained. For example, if a student obtains 'B' (-) grade in a course in the second attempt as per the above guidelines, he/she will be finally awarded 'C' grade. Therefore, the grade point corresponding to "C" grade shall be applicable in the SGPA/CGPA calculations by the university.
5. If a student fails to attend the regular classes of a semester or he/she fails to appear in the semester examination in any one or more subjects for any reasons, he/she shall be required to repeat that semester or course(s) next time in regular semester.

## **DETAILED COURSE CONTENTS**

### **MEE-501 Numerical Techniques (4-0-0)**

- Unit 1 Linear equations – Matrix theory, Solution of general linear system of equations, Existence and uniqueness of solution, Echelon form of matrix, Gauss elimination method for homogeneous & non-homogeneous systems of Linear equation, Gauss-Jordan method, Round of errors, Ill conditioned matrices, Eigen value and Eigen vectors, Unitary, Hermitian & normal matrices.
- Unit 2 Non linear equations-Bisection method, Linear interpolation method, Newton's method, Muller's method, Bairstow's method for the quadratic factors, Other methods for the Polynomials.
- Unit 3 Interpolation problems – Lagrangian polynomial, Divided differences, interpolating with cubic spline, Bezier curves and B-spline curves, Polynomial approximation of the surfaces, least square method.
- Unit 4 Differentiation and integration- Derivatives from difference table, Higher order derivatives, Extrapolation techniques, Integration formulas – Simpson's rule, Trapezoidal rule, Gaussian quadrature, Adaptive INTEGRATION, Multiple integrals.
- Unit 5 Solution of ordinary differential equation- Modified Euler method, Milne's method, Adam's – Moulton method, Convergence criteria, Errors and error propagation, Comparison of different methods.
- Unit 6 Boundary value problems-Shooting method, Rayleigh-Ritz, Collocation and Galerkin methods, Characteristic value problem, Eigen values by Iteration and QR method, Application of eigen values.
- Unit 7 Solution of Partial differential equation – Laplace's Equation on a rectangular region, Iterative method for the Laplace equation by Crank Nicholson method, Theta Method, solution of Wave Equation by finite differences, Wave Equation in two dimensions,

### **Reference Books-**

1. Jain, M.K; Iyengar, S.R.K and Jain R.K., "Numerical Methods for Scientific and Engineering Computation." New Age Fourth Edition, 2003.
2. Gerald curtis F & Wheatley, Patrick o, 2003, "Applied Numerical Analysis" Fifth Ed. Wesley 1998.
3. Greenberg, Michael d, "advances Engineering Mathematics".
4. Jain, R.K & Iyengar, S.R.K, "advanced Engineering Mathematics" Narosa 2002.

### **Note:-**

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
2. Use of Scientific calculator will be allowed in the examination. However Programmable calculator and cellular phone will not be allowed.
3. The scheme of awarding the Grades to a student in the course will be supplied by the University to the examiner of answer books.
- 4.

## **MEE-502 Optimum Design of Mechanical Systems (4-0-0)**

Unit 1 Introduction to Optimum Design of Mechanical systems. Need of optimization of preliminary design by identification of design requirements and by use of appropriate design strategy. Introduction to detail design optimization by simulation, prototyping and optimum selection of configuration, materials and processes.

Unit 2 Mechanical system Design problems Economic political environment issues of human safety & welfare and Professional ethics.

Unit 3 Optimum mechanical design concept. Overview and application of optimization methods to machine elements and mechanical system design.

Unit 4 Prototyping, simulation and use of standards for detail designs optimization. Optimum selection of material & processes in mechanical design using material selection charts and optimization methods.

Unit 5 Optimizing product design functionality, aesthetics and economics by employing industrial design principles and by suitable selection of material & processing including use of polymers, composites and other non metallic materials.

Unit 6 Development of Optimisation procedure and computer programmes for the same.

### **Reference Books:**

1. Papalambros, P.Y. and Wilde D.J. 2000. "Principles of Optimal Design", Cambridge University 2000.
2. Ashby, M.F. "Materials selection in Mechanical Design", Butterworth Heinemann 1999.
3. Rao, S.S. "Engineering Optimization- Theory and practice" New Age 1996.
4. Arora J.S. Introduction to Optimum Design", McGraw Hill 1989.
5. Dieter, George E. "Engineering design, A Material and Processing approach", Third Ed. Mc-Graw Hill 2000.
6. Bralla J.G. "Handbook of Product Design for Manufacturing". McGraw-Hill 1986.
7. Chitale Ak and Gupta RC, "Product Design and Manufacturing" Second Ed. Prentice Hall 2002.
8. Otto K and Wood k, "Product Design Techniques in Reverse Engineering and New Product Development" Pearson 2001.

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## **MEE-503 Advanced Mechanics of Solids (4-0-0)**

- Unit 1 Analysis of stress, Analysis of strain, Compatibility conditions, Generalized Hooke's law, Stress-strain relations, Theories of failure, Factor of Safety in design, Ideally Plastic solid, Yield surfaces of Tresca and Von-Mises, Prandtl-Reuss and saint Venant-von-Mises equations.
- Unit 2 Energy methods, First and second theorems of Castigliano, Engesser's Theorem, Maxwell-Mohr integrals, Asymmetric bending of beams, Shear Centre, Bending of curved beams and thick curved bars, shear centre.
- Unit 3 Bending of a plate, Bending of a uniformly loaded rectangular plate, Deflection of a long rectangular plate with initial curvature, Bending of a circular plate with various loading conditions.
- Unit 4 Torsion of circular and non-circular bars. Torsion of rolled section bars, Membrane analogy, Torsion of thin walled tubes, Torsion of rolled section bars, Torsion of thin walled multiple-cell closed sections, Centre of twists and flexural centre.
- Unit 5 Thick walled cylinder subject to internal and external pressures, Stresses in Composite tubes, Stresses in rotating disks, shafts and cylinders, Thermal stresses in thin circular disc, Long circular cylinder, Sphere and straight and curved beams.
- Unit 6 Elastic stability, Beam-columns with concentrated load, with several concerned loads, with end couple buckling problem as eigen value problem, Orthogonality relations, Energy methods for buckling problem.

### **Reference Books-**

1. Srinath, L.S., "Advanced Mechanics of solids", Tata McGraw Hill 2002.
2. Timoshenko, S, "Strength of Materials Part-II Advanced Theory and Problems." Third Ed. First Indian Ed. CBS 1986.
3. Popov, Egor P, "Engineering Mechanics of Solids", Second Ed., Pearson 1998.
4. Xu, Zhilun "Applied Elasticity' New Age.
5. Craig, "Mechanics of Materials" second Ed. Joh Wiley 1999.
6. Raju, N Krishan and Gururaje, "Advanced Mechanics of Solids and Structures" Narosa 1997.

### **Note:-**

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## **MEE-504 Advanced Mechanical Engineering Design (4-0-0)**

- Unit1 Introduction Review of materials & processes for machine elements. Case studies of mechanical engineering design failures. Review of static strength failure analysis Theories of failure including von-Mises theory based strength design.
- Unit 2 High cycle and low cycle fatigue. Fatigue Strength Design of Mech, Equipment Elements. Exercises of fatigue design of shafting and gears. Surface fatigue design failures. Exercises of surface fatigue design of rolling contact bearings including linear bearings.
- Unit 3 Stiffness based design. Design for creep. Combined creep and fatigue failure prevention. Design to prevent buckling and instability.
- Unit 4 Tribodesign with applications to design of sliding bearings and mechanical seats. Selection of lubrication systems.
- Unit 5 Design for corrosion, wear, Hydrogen embrittlement, Fretting fatigue and other Combined modes of mechanical failure.
- Unit 6 Dynamically sound designs of machine elements like springs and shafts. Introduction to dynamic design of mech. equipment and its implementation.

### **Reference Books:**

1. Shigley J.E and Mischke C.R, "Mechanical Design (in SI units)" Sixth Ed. Mc Graw Hill 2003.
2. Norton Robert L, "Machine Design Integrated Approach" Second Edition Pearson 2000.
3. Spotts M.F, Shoup T.E, "Design of Machine Elements" Seventh Ed. Pearson 1998.
4. Maleev and Hartman's (edited by O.P.Grover) "Machine Design in S.I. units" CBS 1999.
5. Dieter G, "Engineering Design, A Material and Processing Approach" McGraw Hill 2000. , -
6. Dukkupati, RV, Ananda Rao and Bhat R, "Computer Aided Analysis and Design of Machine Elements" New Age 2004.

### **Note:**

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
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## **MEE-505 Computer Methods in Mechanical Design (4-0-0)**

Unit 1 Introduction and overview. Need and scope of computer aided machine design. Role of geometric modeling, FE and Optimization; Principles of interactive computer graphics, Overview of hardware available for use in CAD.

Unit 2 Geometric transformations and Projections. Windowing and view-porting;

Unit 3 Geometric modeling, modeling of curves, cubics, splines, beziers and b-splines; Modeling of surfaces.

Unit 4 Modeling of solids —b-rep, CSG, Octree, Feature based modeling.

Unit 5 Introduction to Finite Element Method, Principle of potential energy; 1 D elements, Derivation of Stiffness and Mass matrices for a bar, a beam and a shaft, Comparison with analytical results.

Unit 6 Solution of static problems and case studies in stress analysis of mechanical components; FEA using 2D and 3D elements; Plain strain and plain stress problems, FE using plates I shell elements.

Unit 7 Importance of Finite element mesh, Automatic meshing techniques; interfacing with CAD software.

Unit 8 Case studies using FEM for design of simple element geometries such as a tapered bar, a plate with a hole and a spanner; Introduction to dynamic analysis; Limitations of FEM.

### **Reference Books:**

1. Rogers David F and Adams J.A.Ian, "Mathematical Elements for computer graphics." Tata Mc Graw-Hill, 2000.
2. Radhakrishnan and Kothandaraman, "Computer Graphics and Design" Dhanpat Rai 1997.
3. Bath Klaus — Jungen, "Finite Element Procedures." Prentice Hall India 1997.
4. Chandru patla, Tirupathi R and Belegundu Ashok D, "Introduction to Finite Elements in Engineering" Prentice Hall India 2000.
5. Rogers David F "Procedures Elements for computer graphics" second Ed. Tata Mc Graw Hill, 2001.
6. Reddy, "An Introduction to the Finite Element Method" Second Ed. Mc.Graw Hill.
7. Zienkiewicz, "The Finite Element Method" Third Ed. Mc. Graw Hill.
8. Rao S.S., "The Finite Element Method Engineering" Third Ed. Butterworth Heinemann 1999.
9. Dukhipati, R.V., Ananda Rao and Bhat E "Computer Aided Analysis and Design of Machine Elements" New Age 2004.

### **Note: -**

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
2. Use of Scientific calculator will be allowed in the examination .However Programmable calculator and cellular phone will not be allowed.
3. The scheme of awarding the Grades to a Student in the course will be supplied by the University to the examiner of answer books.

## **MEE-506 Instrumentation and Automatic control**

- UNIT 1** Classification and representation of control system. Influence of type of control  
On steady state and transient response. Time and frequency domain analysis.
- UNIT 2** Stability analysis using Routh & Nyquist criteria. Root locus method.
- UNIT 3** Modern control theory. Sequence control and programmable logic controllers
- UNIT 4** Control component comparators, hydraulic, pneumatic and electrical type of  
Controllers and servomotors.
- UNIT 5** Electromechanical & electro-optical transducer and control elements. Signal  
Conditioning and indicating /recording elements.
- UNIT 6** Computer based data acquisition systems, A-D and D-A converters  
Microprocessors application in measurement and control
- UNIT 7** Static and dynamic analysis of instrument systems. Signal and system analysis  
FFT analysers.
- UNIT 8** Current developments and measurement and control of motion, force, torque  
Pressure, temperature, flow, noise etc. Virtual instrumentation, Laser based  
Instrumentation.

### **Reference Books:**

1. Doebllin, Ernest O, "Measurement system application and design". Tata  
Mc Graw Hill 1990.
2. Raven Francis N, "Automatic Control Engineering" 5<sup>th</sup> Ed Mc Graw Hill.
3. Yuu Benjamin C and Gelnarghi farid, "Automatic control System" 8<sup>th</sup> Ed  
John Wiley 2003.
4. Dorf Richard C Bishop Robert H, "Modern control system" Addison Wiley 1998.
5. Filliola, "Theory of design and mechanical measurements" 3<sup>rd</sup> Ed john Wiley.
6. Bechwith TG, Marangono RD and Lienhard VJH, "Mechanical measurements" 5<sup>th</sup> Ed, 2nd  
Indian reprint Addison Wesley 2000.

### **NOTE:-**

1. In the semester examination the examiner will set 8 questions in all covering the  
Entire syllabus and students will be required to attempt only 5 questions.
2. Use of scientific calculator will be allowed in the examination .however  
programmable calculator and mobile phones will not be allowed.
3. The scheme of awarding the grades to a student in the course will be supplied by the  
university to the examiner of answer books

## **MEE-507 Design of Mechanism and Manipulators (4-0-0)**

- UNIT 1** Classification of closed and open- loop kinematic systems, Definition of Mechanism and manipulators, kinematic constraints, Degree of freedom And mobility; denavit hartenberg parameters, coordinate transformations, Matrix method.
- UNIT 2** Structural analyses and synthesis of mechanism.
- UNIT 3** Forward kinematics of robot manipulators with example; Inverse kinematics
- UNIT 4** Jacobian and singularity; alternative design solution of mechanisms and Manipulators.
- UNIT 5** Evaluation and selection of optimum mechanism; type and number synthesis Design of mechanisms; indexes of merit; graphical, algebraic and optimization Technique.
- UNIT 6** design of function, path, and motion generators
- UNIT 7** Dynamic considerations, rigid body dynamics, Newton-Euler formulation Equation of motion; methodologies for inverse and forward dynamics

### **Reference Books:**

1. Uicker, J.J. Pennock GR, Shigley J, "Theory of Machines and Mechanism" Oxford 2003.
2. Norton, R.L. "Design of Machinery, An Introduction to the synthesis and Analysis of Mechanisms and Machines." Second Ed.McGraw Hill 1999.
3. Ghosh A and Malik AK "Theory of Machines and Mechanisms"Third Ed.Affiliated East West 1998.
4. Craig J.J. "Introduction to Robotics, Mechanics and Control" Fourth India Person 2003 Reprint.
5. Schilling, Robert J, "Fundamentals of Robotics Analysis and Control" Prentice Hall India 2000.
6. Mittal R.K. and Nagrath I.J. "Robotics and Control" Tata Mc Graw Hill 2003.
7. Malik A.K. Ghosh A and Diltrich G "Kneumatic Synthesis of Mechanisms CRC Press 1994.
8. Erdman AG and Sander GN "Mechanism Design Analysis and Synthesis Vol.I "Prentice Hall, 1994.
9. Yoshikawa T "Foundation of Robotics, Analysis and Control" Prentice Hall India 1998.
10. Sandor G.N. and Erdmam AG "Advanced Mechanism design, Analysis and Synthesis, Vol.2" Prentice Hall 1994.

### **NOTE:-**

1. In the semester examination the examiner will set 8 questions in all covering the Entire syllabus and students will be required to attempt only 5 questions.
2. Use of scientific calculator will be allowed in the examination .however programmable calculator and mobile phones will not be allowed.
3. The scheme of awarding the grades to a student in the course will be supplied by the university to the examiner of answer books

## 1. MEE- 509 Vibration Engineering (4-0-4)

- Unit 1** Introduction to unwanted mechanical vibrations and their harmful effects including those on Human beings. Vibration control strategies and case studies. Experimental and theoretical Routes to vibration engineering. Vibration Testing.
- Unit 2** Spatial, Modal and Response models of vibrating systems. Lumped parameter and distributed Parameter modeling of mechanical vibratory system. Free vibrations and forced response Solutions of single and multi degree of freedom models including modeling of damping.
- Unit 3** Applications of numerical procedures to determine natural frequencies and mode shapes Finite element method for dynamic analysis. Distributed parameter model of rods, bars and Beams.
- Unit 4** Vibration control solutions. Balancing of rotating and reciprocating machines. Design of Vibration isolators. Auxiliary mass system including tuned dampers for vibration control. Application of damping treatment for vibration control in machines and structures. Dynamic instability control.
- Unit 5** Introduction to model testing, model updating and structural dynamic modification to Improve dynamic design of machine structures.
- Unit 6** Active control of vibrations, Introduction of NVH (Noise and vibration hazards) and its Control.

### Reference Books:

1. Rao S.S., "Mechanical Vibration" IV Edition Pearson 2004.
2. Meirowitch L. "Elements of vibration Analysis" Mc Graw Hill 1974.
3. Malik Ashok Kumar, "Principles of vibration control", Affiliated EWP 1990.
4. Thomson WT, "Theory of vibration with applications" CBS 2002.
5. Rama Murthy, "Mechanical Vibration Practice with basics" Narosa 2001.
6. Dukkipati R.V., "Vibration Analysis" Narosa 2002.
7. Rao J.S. "Advanced Theory of Vibrations" John Wiley 1992.
8. Clough Ray & Penzien Joseph, "Dynamics of Structures." Mc Graw Hill 1993.
9. E.Wins, D.J., "Modal Testing Theory and Practice" John Wiley 1986.
10. Harris Cyril M, "Harris' Shock and Vibration Handbook" Fifth Ed. Mc Graw Hill.

### NOTE:-

1. In the semester examination the examiner will set 8 questions in all covering the Entire syllabus and students will be required to attempt only 5 questions.
2. Use of scientific calculator will be allowed in the examination .however programmable calculator and mobile phones will not be allowed.
3. The scheme of awarding the grades to a student in the course will be supplied by the university to the examiner of answer books

## **MEE-510 Machine Tool Design (4-0-0)**

### **MEE 511 Computer Methods in Mechanical Design Lab (0-0-3)**

- Unit 1** Introduction: Kinematics of Different Types of Machine Tools, Selection of Cutting Conditions and Tools, Calculation of cutting Force on Single Point and Multipoint Tools, Hole, Machining, Calculation of Power Accuracy Requirements and Standards of FEM Models for
- Unit 2** Design of Rotary Drives: Design of Spindle Drive, AC Motors with Stepped Drive, DC and AC Variable Speed Drive Motors Characteristics and Selection, Principle of Speed Controllers, Timings Belt and other Type of Transmission Belting Pulleys, Closed Loop Operation of Main Drives, rotary Indexing Drives Design of Feed drives, Feed Drives Using Feed Boxes, Axes Feed Drive of CNC Drives, DC and AC Servomotors.
- Unit 3** Types Characteristics of Controllers and their Selection, Ball Screws and Friction Screws-Guide Ways, Linear Motion Systems, Design calculation of Drives, Closed Loop Operations of Feed Drives, Linear Indexing Drives, Control Elements: Single and multi Axis CNC Controllers, Hydraulic Control, Pneumatic Control, Limit Switches, Proximity Switches, Sequencing Control Using Hard Wired and PLC Systems
- Unit 4** Design of Machine Tool Structures: Static and Dynamic Stiffness, Dynamic Analysis of Cutting process, Stability, Forced Vibration, Ergonomics and Aesthetics in Machine Tool Design, Design of Spindle and Spindle Supports: Function of Spindles, Design Requirements, Standard Spindle Noses, Design Calculations of Spindles, Bearing Selection and Mounting.
- Unit 5** Finite Elements Analysis of M/C Tool Structures: Examples of Static, Dynamic and Thermal Analysis and Optimization of typical Machine Tool Structures Like Column, Table, Overarm, and Knee using a Finite Element Analysis Package.
- Unit 6** Design of Special Purpose Machines: Modular Design Concepts, Standard Modules.
- Unit 7** Example of Design of a Typical SPM with CNC and Transfer Machines.

#### **Reference Books:**

1. Mehta N. K., "Machine Tool Design and Numerical Control" Tata McGraw Hill 1996.
2. Koenig Berger F. "Design Principle of Cutting Machine Tools" Pergamon Press 1964
3. Basu SK and Pal DK "Design of Machine Tools", Fourth Ed. Oxford and BH 1995.
4. Acherkan N, "Machine Tool Design Vol. 1-1V" Mir Pub.Mocow.

#### **NOTE:-**

1. In the semester examination the examiner will set 8 questions in all covering the Entire syllabus and students will be required to attempt only 5 questions.
2. Use of scientific calculator will be allowed in the examination .however programmable calculator and mobile phones will not be allowed.
3. The scheme of awarding the grades to a student in the course will be supplied by the university to the examiner of answer books

### **MEE 511: Computer Methods in Mechanical Design Lab (0-0-3)**

Practice of transformation. Use of CAD package for developing typical objects using Boolean and sweep operations on primitives, use of CAD models for other applications. Development of FEM models for static/Dynamic analysis for a bar, beam and a shaft. Practice in using FEM software on other real life problem like spanners, connecting rods etc. Covering the contents of MEE 505.

### **MEE 512 Product Design (4-0-0)**

Unit 1: Product Design Process –Importance, considerations of a good design, design morphology, designing to codes and standards technological innovation and design process, identification of customer needs, quality function deployment, product design specification.

Unit 2 Concept Generation and Evaluation — Credulity and problem solving, Inventive problem solving, Generating design concepts, Axiomatic design evaluation methods, Decision making, conceptual design, embodiment design and detail design, Product architecture, configuration design.

Unit 3 Material in Design — Materials solution process, Economics of Materials, Methods of material selection, Material performance Indices, Decision Matrices, Value analysis, Design for brittle fracture for Fatigue failure and for corrosion resistance, Design for assembly.

Unit 4 Material Processing and Design — Role of Processing in design, Factors determining process selection, Design for manufacturability (DFM), Designs for assembly (DFA), Design for casting, forging sheet metal forming, machining, power metallurgy, welding, residual stresses in design, Design for plastic processing.

Unit 5 Design of Plastic and Non-ferrous material components

Unit 6 Design for reliability, Failure mode and effect analysis techniques of failure analysis, design for safety, Robust design, Design optimization, Economic decision making, Benefit cost analysis.

Unit 7 Detail Design - Detail design and drawings, Bill of materials, Impact of CAE on detail design, Design review.

#### **Reference Books:**

1. Dieter George E., "Engineering Design, A Materials and Processing Approach" Third ed. McGraw Hill 2000.
2. Ulrich K.T. and Eppinger S.D, "Product Design and Development" Third ed. Tata Mc Graw Hill 2003.
3. Otto K & Wood K., "Product Design Techniques in Reverse Engineering and New Product Development", Pearson 2001.
4. Chitale A.K. & Gupta R.C., "Product Design and Manufacturing" Second ed. Prentice Hall 2002.
5. Parameswaran M.A., "An Introduction to Design Engineering" Narosa 2004. Haik Yousef, "Engineering Design Process" Thomson 2003.

Note: -

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
2. Use of Scientific calculator will be allowed in the examination .However Programmable calculator and cellular phone will not be allowed.
3. The scheme of awarding the Grades to a Student in the course will be supplied by the University to the examiner of answer books.

**MEE 513 Vibration Engg. Lab (0-0-3)**

Experiments on Free and Forced Undamped and Damped Vibrations of single, Two including Vibration Absorber Multiple Degrees of Freedom and Continuous Systems, Whirling of Shafts, covering contents of MEE 51 0

**MEE 514 Instrumentation And Control Lab (0-0-3)**

Static and dynamic Behaviour of some important transducers, calibration procedure, Development of Computer aided experimentation systems. Experimental studies on Hydraulic, Pneumatic, Electrical controller, electromechanical actuators, covering the contents of MEE 506

**MEE 516 Machine Tool Design Lab (0-0-3)**

Practicals will include carrying out Design and Drafting of Machine Tool Components such as Structure, Spindles and Dryies, Bearings etc, Covering the contents of MEE 510

**MEE 518 Product Design Lab (0-0-3)**

Practicals will include Application of Systematic Design Procedures for Design of Chosen Industrial Products etc, covering the contents of MEE 512

## **MEE-601 Finite Element Method (4-0-0)**

- Unit1 Introduction, Historical Back ground, Stress and Equilibrium, Boundary Conditions, Strain-Displacement and Stress-Strain Relations, Temperature Effects, Potential Energy and Equilibrium, Rayleigh-Ritz Method, Galerkins Method, Saint Venat's Principle, Von Mises Stress. .
- Unit2 One-Dimensional Finite Element Modeling, Coordinates and Shape Functions, The Potential Energy Approach, The Galerkins Approach, Assembly of the Global Stiffness Matrix and Load Vector, The Finite Element Equations, Treatment of Boundary Conditions, Quadratic Shape Functions, Temperature Effects. Plane Trusses, Element Stiffness Matrix, Stress Calculations, Temperature Effects, Three Dimensional Trusses, Assembly of Global Stiffness Matrix for the Banded and Skyline Solutions.
- Unit3 Two Dimensional Problems using constant strain Triangular, Isoparametic Representation, Potential Energy Approach, Element Stiffness, Galerkin Approach, Stress Calculation Temperature Effects, Problem Modeling and Boundary Conditions, Orthotropic Materials, Temperature Effects.
- Unit4 Axisymmetric Solids Subjected to Axisymmetric Loading, Formulation, Finite Element Modeling, Triangular Element, Potential Energy Approach, Rotating Flywheel Surface Traction Galerkin Approach, Stress Calculation Temperature Effects Cylinder subjected to Internal Pressure. Press Fit on Rigid and Elastic Shafts, Belleville Spring, Two Dimensional Isoparametic Elements, Four Node Quadrilateral Numerical Integration, Higher Order Elements, Nine-Node Quadrilateral, Six Node Triangle, Four Node Quadrilateral for Axisymmetric Problems, Conjugate Gradient Implementation. Bars and Frames, Potential-Energy and Galerkin Approaches, Finite Element Formulation, Load Vector, Boundary conditions, Shear Force and Bending Moments, Beams on Elastic Supports, Plane and Three Dimensional Frames.
- Unit5 Three Dimensional Problems in Stress Analysis, Element Stiffness, Force Terms, Stress Calculations, Mesh Preparation Hexahedral Elements and Higher Order Elements, Frontal Method for Finite Element Matrices, Connectivity and Prefront Routine, Element Assembly and Consideration of specified degrees of freedom, Back substitution, Consideration of Multipoint Constraints.
- Unit6 Dynamic Considerations, Formulation, Element Mass Matrices, Eigen values and Eigenvectors Evaluation Generalized Jacobi Method, Tridiagonalization, Implicit Symmetric QR Step with Wilkinson, Shift for Diagonalization, Guyan Reduction.
- Unit7 Preprocessing and Post Processing, Mesh Generation Post processing, Deformed Configuration and Mode shape contour plotting, Nodal values from known constant Element Values, Least Square Fit for a Four Noded Quadrilateral.

### **Reference Books:**

1. Bath Klaus — Jungen, "Finite Element Procedures" Prentice Hall India 1997.
2. Chandru Patla, Tirupathi R and Belegundu Ashok D, "Introduction to Finite Elements in Engineering". Prentice Hall India 2000.
3. Reddy, "An Introduction to the Finite Element Method" Second Ed. McGraw
4. Zienkiewicz, "The Finite Element Method, "Third Ed. McGraw Hill.
5. Rao S.S, "The Finite Element Method Engineering" Third Ed. Butterworth Heinemann 1999.

### **Note: -**

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
2. Use of Scientific calculator will be allowed in the examination .However Programmable calculator and cellular phone will not be allowed.
3. The scheme of awarding the Grades to a Student in the course will be supplied by the University to the examiner of answer books .

## **MEE-602/ MEE 623 Seminar2 / Seminar 1 (0-0-2)**

Student has to choose topic of his interest in an emerging area with approval of supervisor and Committee, appointed by Head of the Department for this purpose. He has to do an indepth exhaustive study on his topic through out the semester under the guidance of his supervisor. At the end of the semester, student has to submit report. He will present his work in a seminar. Evaluation will be based on continuous monitoring of his contribution during the semester by his supervisor and the report and seminar evaluation by the Committee appointed by Head of the Department.

## **MEE-603 Computer Aided Vehicle Design (4-0-0)**

Unit1 Vehicle Frame and Suspension: Study of Loads — Moments and Stresses on Frame Members. Computer Aided Design of Frame for Passenger and Commercial Vehicles.

Unit2 Computer Aided Design of Leaf Springs-Coil Springs and Torsion Bar Springs.

Unit3 Front Axle and Steering Systems: Analysis of Loads-Moments and Stresses at different sections of Front Axle. Determination of Bearing Loads at Kingpin Bearings. Wheel Spindle Bearings. Choice of Bearings.

Unit4 Determination of Optimum Dimension and Proportions: for Steering Linkages ensuring minimum error in Steering.

Unit5 Clutch: Torque capacity of Clutch. Computer Aided Design of Clutch Components. Design details of Roller and Spring Type of Clutches.

Unit 6 Gear Box: Computer Aided Design of Three Speed. and Four Speed Gear Boxes. Drive Line and Rear Axle: Computer Aided Design of Propeller Shaft. Design of Final Drive Gearing. Design details of Full-floating., Semi-floating and Three Quarter Floating, Rear Axle Shafts and Rear Axle Housings.

### **Reference Books:**

1. Dean Averbs, "Automobile Chassis Designs" Illiffe Books 1992.
2. Heldt. P.M., "Automotive Chassis" Chilton Book Co., New York 1992.
3. Steeds. W., "Mechanics of Road Vehicles" liliffes Books 1990.
4. Giles, J.G. "Steering, Suspension and Tyres" liliffes Books 1988.
5. Newton, Steeds & Garret."The Motor Vehicle", Illiffes Books 1982.
6. Heldt., P.M. "Torque Converter". Chilton Book Co., New York, 1982.
7. Gin, N.K., "Automobile Technology" Khanna Publisher, 2004

### **Note:**

1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and Students will be required to attempt only 5 questions.
2. Use of Scientific calculator will be allowed in the examination .However Programmable calculator and cellular phone will not be allowed.
3. The scheme of awarding the Grades to a Student in the course will be supplied by the University to the examiner of answer books.

## **MEE-604 Dissertation Phase II (0-0-24) & MEE-621 Dissertation Phase II (0-0-6)**

Project is a vital and important of Post Graduate Programme. Project work must involve extensive literature survey, design and development, analysis, fabrication and experimental work. Informally students are expected to search topics of their interest for the project from the very beginning of the programme. Formally the work is initiated in the third semester and continues as full time work on fourth semester. The internal evaluation will be held at the end of the third semester on the basis of progress during the semester during the semester monitored by supervisor and report and seminar talk evaluation by a committee appointed by Head of Department. At the end of the fourth semester student will submit complete final project report and will be internally evaluated for this progress during the semester during the semester monitored by supervisor and report and seminar talk evaluation by a committee appointed by Head of Department. The final presentation of his project and report will be evaluated by external examiner appointed by university.

### **MEE 605 Robotics (4-0-0)**

**Unit 1:** Introduction, spatial descriptions and Transformations, Positions and Orientations, Operations, Translations, and Rotations, Transform equations, Computational considerations.

**Unit 2:** Kinematics and inverse Kinematics, Link and connections descriptions, Manipulator kinematics, Actuator space, Joint space, and Cartesian space. Inverse Kinematics solvability, Solution by reduction to polynomial, Pieper's solution for three interesting axes. Solving a manipulator, repeatability and accuracy.

**Unit 3:** Jacobians, Velocities and Static Forces: Linear and rotational velocities of rigid bodies. Motion of the links of a robot, velocity propagation from link to link, Jacobians, Singularities, Static forces, Jacobians in the force domain.

**Unit 4:** Manipulator dynamics iterative Newton- Euler dynamic formulation, iterative vs. closed form. Manipulator dynamic equations, LaGrange formulations of manipulator dynamics, Manipulator dynamics in Cartesian space, inclusion of Coulomb friction, Dynamic simulation.

**Unit 5:** Trajectory Generation – Path description and generation, joint space and Cartesian space schemes, Problems with Cartesian space.

**Unit 6:** Manipulator mechanism design – Basing the design of task requirements, Kinematics configuration, Work space attributes, Redundant and closed chain structures, Actuation schemes, Stiffness and deflection, Position and force sensing.

**Unit 7:** Controls of Manipulators – Control of second order linear system. Control law partitioning. Trajectory following control, continuous and discrete time control. Modeling and control of single joint, non linear and time varying systems, Control problem, Practical considerations and present industrial robot control systems, Lyapunov stability analysis, Cartesian based control system, Adaptive control. Application of industrial robots to assembly task, the hybrid position and force control, present industrial robot control schemes.

**Unit 8:** Robot Programming Languages and Systems – The three levels of robot programming, requirements of a robot programming language. An example application coded in three RPLs, off-line programming systems.

**Reference Books:**

1. Craig, John "Introduction to robotics Mechanism and control "Second Ed. Pearson 2004.
2. Yoshikawa, T. "Foundation of Robotics: Analysis and control" Prentice Hall India 1998.
3. Schilling, R.J. "Fundamental of Robotics Analysis and control" " Prentice Hall India 1990.
4. Klafter, R.D. Chimielewski T.A. and Negin Michael "Robotics Engineering – An integrated approach" Prentice Hall India 1989.
5. Mittal, R.K. and Nagrath, I.J. "Robotics and Control" Tata Mc Graw Hill 2003.
6. Nikku Saeed N. "Introduction to Robotics Analysis System, Application" Prentice Hall India 2001.
7. Keramas J.G. "Robotic Technology fundamentals" Thomson Delmar 1999.
8. Schilling, R.J. "Fundamental of Robotics Analysis and control" " Prentice Hall India 2000.
9. Wolfram Stadler, "Analytical Robotics & Mecatronics" Mc. Graw Hill.

- Note – 1. In the semester examination the examiner will set 5 questions in all covering the entire syllabus and students will be required to attempt only 5 questions.
2. Use of Scientific Calculator will be allowed in the examination. However Programmable calculator and cellular phone will not be allowed.
  3. The scheme of awarding the grade to a student in the course will be Supplied by the University to the examiner of answer books.

**MEE 607 Mechatronic Product Design (4-0-0)**

**Unit 1:** Introduction to mechatronic systems and components. Principles of basic electronics. Analog and Digital.

**Unit 2:** Programmable Logic Controllers (PLC). Microprocessors and their applications, Integrated Circuits.

**Unit 3:** Sensors, Actuators, and other electrical\electronic hardware in mechatronic systems. Principles of electronic\ system communication (PC Based)

**Unit 4:** Interfacing and DA and AD Converters, software and hardware principles and tools to build mechatronic systems.

**Unit 5:** Design and selection of mechatronic elements namely sensors like encoders and revolvers, stepper and servomotors, ball screws, solenoid like actuators and controllers.

**Unit 6:** Design of mechatronic products for CNC systems, Robotics and consumer Electronics.

**Reference Books:**

1. Bolton W, "Mechatronics" Addison Wesley, Second Ed. 1999.
2. Alciator P DG and Histan M B, "Introduction to Macaronis and Measurement System" Tata Mc Graw Hill 2002.
3. Shetty Devdas, Kolk Richard A, "Mechatronics System Design" PWS pub Co 1997.
4. Venkataramana C.R. "Mechatronics – Sensing to Implementation" S.B.S. Publishers 2001.
5. Stadler Wolform, "Analytical Robotics and Mechatronics" Mc Graw Hill 1995.
6. HMT Ltd., "Mechatronics" Tata Mc Graw Hill 1998.

## **MEE – 609 Properties and selection of engineering Materials (4-0-0)**

**Unit 1:** Classification of materials and structure of materials, structure property correlation.

**Unit 2:** Introduction to p[roperties – Strength, Ductility, Toughness, Stiffness, Hardness, Fracture of Toughness, Fatigue strength, Creep Strength, Oxidation Resistance, Corrosion Resistance, Friction and wear, Weld ability etc.

**Unit 3:** Properties and Processing of Engineering Materials – Plain carbon steel and alloyed structural steel and stainless steels, high strength, high temperature materials.

**Unit 4:** Properties and processing of Non-ferrous Materials Cu Alloys Al-Alloys, Ti – Alloys, Engineering Ceramics.

**Unit 5:** Properties and processing of Polymeric Materials, Metal Matrix composites, Polymer Matrix Composites, New Materials.

**Unit 6:** Materials selection principles, case studies in material selection, e.g. materials for structural applications, Power Plants, Chemical Plants, aerospace applications, machineries, transport industries, defense etc.

### **Reference Books:**

1. Ashby MF "Material Selection in Mechanical Design" Second Ed. Elsevier 2001.
2. Sharma "Engineering Materials Properties and Application of metals and alloys" Prentice Hall India.
3. "Properties and Application of Engineering materials – Metals, Alloys, Polymers, Ceramics and Composites" NIIT Prentice Hall India.
4. Budinski K.G. and Budinski M.K., " Engineering Material Properties and Selection" Seventh Ed. Prentice Hall India.

- Note –
1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and students will be required to attempt only 5 questions.
  2. Use of Scientific Calculator will be allowed in the examination. However Programmable calculator and cellular phone will not be allowed.
  3. The scheme of awarding the grade to a student in the course will be Supplied by the University to the examiner of answer books.

## **MEE 611 Product Reliability and Maintenance (4-0-0)**

**Unit 1:** Reliability: Definition, Probability Concept: Addition of Probabilities; Complimentary Events; Kolmogorov Axioms, Maintainability and Availability, Reliability and quality.

**Unit 2:** Failure – Data Analysis: Introduction; Mean Failure Rate; Mean Time to Failure (MTTF); Mean Time Between Failures(MTBF); Graphical Plots; MTTF in terms of Failure density; MTTF in integral form.

**Unit 3:** Hazard Models : Introduction, Constant Hazard, Linearly increasing Hazard, The Weibull Model; Density function and distribution function; Reliability Analysis; Important Distributions and their choice; Standard Deviation and Variance.

**Unit 4:** Conditional Probability; Introduction; Manipulation Rule, Independent Events, Venn Diagram; Hazard rates as and conditional Probability , Bayes's Theorem.

**Unit 5:** System Reliability: Series Parallel and Mixed Configurations; Complex Systems; Logic Diagram; Markov Models.

**Unit 6:** Reliability Improvement & Repairable Systems: Redundancy Element; Unit and Standard Redundancy; Optimization, Reliability – cost trade – off; Introduction to Repairable system; Instantaneous Repair Rate; MTTR; Reliability and Availability functions; Important applications. Fault - Tree Analysis and other Techniques: Fault – Tree Construction; Calculation of Reliability; Tie-set and minimal Tie-set.

**Unit 7:** Maintainability and Availability: Maintainability functions, system effectiveness and related availability, dependability models; mathematical models; failure mode effect and critically analysis (FMEECA) total quality management.

### **Reference Books:**

1. Ebeling C.E., "Reliability and Maintainability Engineering" Tata Mc Graw Hill 2000.
2. Srinath L.S. "Mechanical Reliability" East West Pub. 2002.
3. Balaguruswamy. "Reliability Engineering" Tata Mc Graw Hill 1984.
4. Dhillon B.S. "Engineering Maintainability" Prentice Hall 2000.

- Note –
1. In the Semester examination the examiner will set 8 questions in all covering the entire syllabus and students will be required to attempt only 5 questions.
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### **MEE 613 Finite Element Method Lab (0-0-3)**

Development FEM based computer Programs for Stress Analysis of simple and complex Mechanical Equipment Elements and Vibration Analysis of Beams, plates and shafts etc. Use of software packages such as NASTRAN, ANSYS or equivalent packages etc, Covering the contents of **MEE 603**.

### **MEE 615 Computer Aided Vehicle Design Lab (0-0-3)**

Practicals will include illustrative design of sub systems e.g. Manual Computer Solutions of inverse Kinematics Problems of Robot Manipulators and their Simulations in computer will also be carried out etc. Covering the Contents of **MEE 605**.

### **MEE 617 Robotics Lab (0-0-3)**

Practicals will include Experiments on Robots in the laboratory. Computer Solutions of Inverse kinematics of robot Manipulators and their Simulations in Computer will also be carried out etc, covering the contents of **MEE 605**.

### **MEE 619 Mechatronic Product Design Lab (0-0-3)**

Practicals will include Design of Mechatronics products using available Software's and Fabrication of some simple Mechatronics product will also be undertaken etc. Covering the Contents of **MEE 607**.

MEE 621 Find on Page 20

MEE 623 Find on Page 19