SCHEME OF TEACHING AND EXAMINATION M.TECH. MACHINE DESIGN (MMD)

1 SEMESTER

Revised at the BOS meeting on 31.05.2014

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Contact Hours/Week</th>
<th>Duration of Sem. End Exam in Hours</th>
<th>Marks for</th>
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Elective–I

14MMD111 Experimental Stress Analysis
14MMD112 Tribology & Bearing Design
14MMD113 Smart Materials & Structures

Elective–II

14MMD121 Computer Graphics
14MMD122 Computer Applications in Design
14MMD123 Mechatronics System Design
14MMD124 Rotor Dynamics
SCHEME OF TEACHING AND EXAMINATION M.TECH. MACHINE DESIGN (MMD)

II SEMESTER

Revised at the BOS meeting on 31.05.2014

<table>
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<tr>
<th>Sl. No.</th>
<th>Subject Code</th>
<th>Name of the Subject</th>
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**Elective–III**
- 14MMD211 Fracture Mechanics
- 14MMD212 Theory of Plates & Shells
- 14MMD213 Design for Manufacture
- 14MMD214 Condition Monitoring and Condition based maintenance

**Elective–IV**
- 14MMD221 Optimum Design
- 14MMD222 Theory of Plasticity
- 14MMD223 Robotics
- 14MMD224 Robust Design
# Scheme of Teaching and Examination

**M.TECH. MACHINE DESIGN (MMD)**  
**III Semester**

Revised at the BOS meeting on 31.05.2014

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
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<td>14MMD 301</td>
<td>Industrial Training Mini-Project</td>
<td>Full time 8 weeks</td>
<td>50 (report)  50(presentation)</td>
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<tr>
<td>14MMD 302</td>
<td>Seminar on special topics</td>
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<tr>
<td>14MMD303</td>
<td>Project-part I</td>
<td>Full time 8 weeks</td>
<td>100 (report)  100(presentation)</td>
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SCHEME OF TEACHING AND EXAMINATION  
M.TECH. MACHINE DESIGN (MMD)  

IV SEMESTER  

Revised at the BOS meeting on 31.05.2014  

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
<th>Duration</th>
<th>Duration of Exam in hrs</th>
<th>Marks for CIE</th>
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<tr>
<td>14MMD401</td>
<td>Project -part II</td>
<td>Full time 30 weeks</td>
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<td>Report =200 Viva-voce =200</td>
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**TOTAL** | **400** | **30** |

GRAND TOTAL From 1st to 4th semester: 100 credits (2100 marks)

Note:
1. 13MMD301: Industrial Training /mini-project: Practical training report and oral presentation are to be evaluated by the Department for 50 marks each. Alternatively, if mini-project is carried out, it is evaluated for 100 marks by the Department
2. 13MMD 302: The Seminar Marks are to be awarded by the Department committee
constituted for the purpose.

3. 13MMD 303: Progress of work to be assessed by the Department Committee including the guide for 100 + 100 marks.

4. 13MMD 401: The project report valuation will be carried out separately by the guide and the external examiner for 100 marks each. Viva-Voce will carry 200 marks and will be conducted by a committee consisting of the following:
   a. Chairman, BOE (PG) or his nominee and PG Coordinator
   b. Guide
   c. External examiner

ADVANCED DYNAMICS AND MECHANISM DESIGN

Sub Code: 14 MMD 101
Hrs / week: 4
Total hrs: 52

No. of Credits: 4
CIE: 50 marks
SEE: 50 marks

Unit – I

Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grubblers rule, Grashoffs law, Equivalent mechanisms,
Kinematic Analysis: Displacement Analysis, Transmission angle, Deviation angle, Range of motion.  

Unit – II


Acceleration Analysis: Relative acceleration, Coriolis Acceleration, Mechanism with higher pair.  

Unit – III

Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing. Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle, Time ratio. Motion Generation: Poles and relative poles, Location of poles and relative poles.

Two position synthesis of Slider crank, crank and rocker mechanisms.  

Unit - IV

Graphical Methods of Dimensional Synthesis: different types of three position synthesis, Four position synthesis (point precision reduction), Overlay method, Coupler curve synthesis.

Analytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch’s method of synthesis.

Unit - V


Spatial Mechanisms: Introduction, Planar transformation, spatial transformation, Concatenation of displacements, Rotation about an axis, Problems.

Text books:

References Books:

Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
UNIT-I
1. **Introduction to Finite Element Method**: Definition of FEM, General Description of FEM, Engineering applications of FEM, Discretization process, Types of Elements – 1D, 2D, 3D and Axisymmetric elements, location of nodes, node numbering scheme, boundary conditions, half band width, Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design, Mathematical Preliminaries, 5 Hours

2. Differential equations formulations, Variation formulations, weighted residual methods

6 Hours

UNIT-II

4. **One-Dimensional Elements-Analysis of Trusses**, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector of truss element. Numerical problems. 4 Hours

UNIT-III
5. **Two-Dimensional Elements-Analysis of Plane Elasticity Problems**: Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8) 6 Hours

6. **Axi-symmetric Solid Elements-Analysis of Bodies of Revolution under axi-symmetric loading**: Axi symmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements. 4 Hours

UNIT-IV

8. **Beam Elements-Analysis of Beams and Frames**: 1–D Beam Element, 2–D Beam
Element, Problems.

UNIT-V


   6 Hours

10. **Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilatateral element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

   4 Hours

**Text Books:**

**Reference Books:**

**Scheme of Examination:**

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**Theory of Elasticity**

Sub Code: 14 MMD 103  
No. of Credits: 4  
Hrs / week: 4  
CIE: 50 marks  
Total hrs: 52  
SEE: 50 marks

**Unit – I**

**Introduction to Stress:** Definition and Notation for forces and stresses, Components of stresses, equations of Equilibrium, Specification of stress at a point and Principal stresses.
Mohr's diagram in three dimensions, Boundary conditions, Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress and Stress transformation.  

-10 hours

Unit – II

Introduction to Strain : Deformation, Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations and Cubical dilatation

Stress -Strain Relations and the General Equations of Elasticity: Generalized Hooke's; law in terms of engineering constants, Formulation of elasticity Problems, Existence and uniqueness of solution, Saint - Venant's principle, Principle of super position and reciprocal theorem

-10 hours

Unit – III

Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems.

Elastic Stability: Axial compression of prismatic bars, Elastic stability, Buckling load for column with constant cross section.

-10 hours

Unit- IV

Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, Pure bending of curved bar

Strain components in polar co-ordinates, Rotating disk and cylinder, concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate.

-12 hours

Unit – V

Torsion of Prismatic Bars: Torsion of Circular and elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open and closed tubes.

**Text books:**


**References Books:**

1. T.G.Sitharam" Applied Elasticity"- Interline publishing.

**Scheme of Examination:**

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

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<th>Dynamics Laboratory</th>
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**LIST OF EXPERIMENTS**

<table>
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<tr>
<th>Sl. No.</th>
<th>Title of Experiment</th>
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<tr>
<td>1.</td>
<td>Determination of Time Period and Acceleration due to Gravity using Simple Pendulum</td>
</tr>
<tr>
<td>2.</td>
<td>Determination of Time Period, Radius of gyration &amp; Acceleration due to Gravity of Kater's Reversible Pendulum</td>
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### EXPERIMENTAL STRESS ANALYSIS

Sub Code: 14 MMD 111  
No. of Credits: 4  
Hrs / week: 4  
CIE: 50 marks  
Total hrs: 52  
SEE: 50 marks

#### Unit – I

**Overview of Experimental stress analysis** – analytical, numerical and experimental approaches, specific domain of these approaches, advantages and disadvantages  
- 2 hours

**Introduction to stress and strain**  
- 3 hours

**Recent developments in experimental stress analysis techniques** - Shearography, Speckle Interferometry, Thermoelastic stress analysis and Digital Image Correlation  
- 3 hours

**Total - 8 hours**
Unit – II

**Electrical resistance gauges** - Introduction - physical principle, strain sensitivity of gage metals, gage construction, gage sensitivity and gage factor, transverse sensitivity factor performance characteristics, environmental effects, strain gage circuits – Potentiometer, Wheatstone bridge, constant current and voltage circuits. 6 hours

**Strain rosettes** - introduction, two element, three element, rectangular and delta rosettes. 3 hours

**Strain gauge construction** - alloys, carriers and adhesives, strain gauge selection, bonding of strain gauges and temperature compensation. 3 hours

**Total -12 hours**

Unit – III

**Transmission photoelasticity** – physical principle, historical development, birefringence, nature of light, Polarization, methods to get polarized light, plane and circular polariscope, stress-optic law, waveplates, Isoclinics and Isochromatics, Fringe order determination, Tardy’s Compensation method and fringe multiplication techniques

**Photoelastic model materials** – properties and types, calibration. 7 hours

**Two dimensional photoelasticity** 2 hours

**Three dimensional photoelasticity** – introduction, stress freezing, slicing, scattered light photoelasticity. 3 hours

**Total -12 hours**

Unit- IV

**Photoelastic coatings** – introduction, strain-optic relation for coating, evaluation of coating and specimen stresses, correction factors for photoelastic coatings, coating materials, properties of coating materials, selection of coating thickness 5 hours

**Brittle coatings** – introduction, brittle coating technique principles, crack patterns produced, steps in brittle coating tests, coating selection and surface preparation. 3 hours

**Digital photoelasticity** – introduction and over view. 2 hours

**Total -10 hours**

Unit - V

**Moiré technique** – introduction, geometrical approach, displacement approach, in-plane and out-plane moiré methods, moiré photography and moiré grid production. 5 hours
Holography - introduction, difference between normal photography and holography, equation for plane and spherical waves, recording and reconstruction process, intensity and coherence, Holographic interferometry, Real time and Double exposure methods

- 5 hours

Total -10 hours

Text books:


Reference books:


Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

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MECHATRONICS SYSTEM DESIGN

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<tbody>
<tr>
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Unit-I


System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, pneumatic systems build blocks. Electro-mechanical systems, hydro-mechanical systems.

10 Hours

Unit-II

Sensors

Introduction, Sensors for Motion and Position Measurement, Proximity sensors, Electrical strain and stress measurement, Force measurement, Vibration—Acceleration Sensors, Time of flight
sensors, Binary force sensors, Temperature measurement, Sensors for Flow Measurement, Pressure measurement, Problems

**Actuators**

10 Hours

**Unit-III**
**Signal Conditioning**
Amplifiers, ideal operational amplifier model, inverting amplifier, non-inverting amplifier, unity-gain buffer, summing amplifier, difference amplifier, instrumentation amplifier, integrator amplifier, differentiator amplifier, comparator, sample and hold amplifier, active filters, Problems, Data acquisition, Introduction, Sampling and aliasing, Quantization theory, Digital-to-analog conversion hardware, Analog-to-digital conversion hardware, Problems, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition

10 Hours

**Unit-IV**
**Interfacing**
Interfacing microcontrollers with actuators Introduction Interfacing with general-purpose three-state transistors Interfacing relays Interfacing solenoids Interfacing stepper motors Interfacing permanent magnet motors, Interfacing sensors Interfacing with a DAC Interfacing power supplies Interfacing with RS 232 and RS 485 Compatibility at an interface, Problems

**Control theory-Modeling:** Introduction Modeling in the frequency domain Modeling in the time domain Converting a transfer function to state space Converting a state-space representation to a transfer function Block diagrams, Problems

**Control theory-Analysis:** Introduction System response Dynamic characteristics of a control system Zero-order systems First-order systems Second-order systems General second-order transfer function Systems modeling and interdisciplinary analogies Stability The Routh-Hurwitz stability criterion Steady-state errors, Problems.

12 Hours

**Unit-V**
**Micro Electro Mechanical Systems (MEMS)**
Working principles of MEMS and microsystems, micro sensors, acoustic wave sensors, biomedical sensor, chemical sensors, optical sensors, micro pressure sensors, micro thermal sensors, microactuators, microactuation using thermal forces, actuation using shape memory alloys (SMA), microactuation using electrostatic forces, applications of microactuations, micro-valves, micro-pumps and micro heatpipes, micro-accelerometers and microgyroscopes

**Microfabrication Processes:** Photolithography, Ion implantation, Diffusion, Oxidation Chemical vapor deposition, Physical vapor deposition (Sputtering), Deposition by expitaxy, Etching.

**Micromanufacturing:** Bulk micromanufacturing, Surface micromachining, LIGA process
Text Books:
3. HSU “MEMS and Microsystems design and manufacture”- TMH

Reference Books:
2. Mahalik “Mechatronics”- TMH.
3. “Mechatronics”– HMT, TMH.

Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

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<td>Hrs/ Week : 04</td>
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UNIT-I
1. Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepregs, and sandwich construction.  
6 Hours

4 Hours

UNIT-II
8 Hours

UNIT-III
4. Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsa-Hill
theory, Tsai, Wu tensor theory, Numerical problems.

5. **Macro Mechanical Analysis of Laminate**: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems.

6 Hours

**UNIT-IV**


7. **Fabrication of Composite Structures**: Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, tooling, fabrication equipments. Introduction, material qualification, Types of defects, NDT methods

6 Hours

**UNIT-V**

8. **Application Developments**: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

9. **Metal Matrix Composites**: Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications.

5 Hours

**Text Books:**


**Reference Books:**


**Scheme of Examination:**

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.
UNIT 1

1. **Introduction**: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr’s theory and modified Mohr’s theory, Numerical examples.  **06 Hours**

2. **Fatigue of Materials**: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens.  **04 Hours**

UNIT 11

3. **Stress-Life (S-N) Approach**: S-N curves, Statistical nature of fatigue test data, General S-N behaviour, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams.  **05 Hours**

4. **Strain-Life(-N) approach**: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish.  **05 Hours**

UNIT 111

5. **LEFM Approach**: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.  **05 Hours**

6. **Residual stresses**: Production of Residual stresses, Mechanical Methods, Thermal Methods, Plating, Machining, Relaxation of Residual stresses, Measurement of Residual stresses, Stress Intensity factors for residual stresses  **05 Hours**

UNIT 1V

7. **Fatigue from Variable Amplitude Loading**: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods.  **05 Hours**

8. **Statistical Aspects of Fatigue**: Definitions and quantification of data scatter, Probability distributions, Tolerance limits, Regression analysis of fatigue data, Reliability analysis, Problems using the Weibull distribution.  **05 Hours**

UNIT V
9. **Surface Failure**: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.  **07 Hours**

10. **Fatigue of Weldments**: Weldment Nomenclature and Discontinuities, Constant amplitude fatigue behavior of weldments, Improving weldment fatigue resistance, Weldment fatigue life estimation.  **05 Hours**

**Text Books:**


**Reference Books:**


2. Fundamentals of Metal Fatigue Analysis, Julie.A.Benantine Prentice Hall,1990


**Scheme of Examination:**

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

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**ADVANCED THEORY OF VIBRATIONS**

Sub Code: **14 MMD 203**  
No. of Credits: **4**

Hrs / week: **4**  
CIE: **50 marks**

Total hrs: **52**  
SEE: **50 marks**

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**Unit – I**

**Review of Mechanical Vibrations** - basic concepts, free vibration of single dof systems with and without damping, forced vibration of single dof system, Force and motion isolation, Two dof systems – natural frequency.  
**Total – 10 hours**
**Unit- II**

*Transient vibrations of single degree-of freedom systems* – impulse excitation, Laplace transforms formulation, step input, pulse excitation, shock response spectrum, shock isolation, Finite difference numerical computation.

- 6 hours

*Vibration Control* – introduction, vibration isolation theory, vibration isolation for harmonic excitation for different types of foundations, shock isolation, undamped dynamic vibration absorbers, types of vibration absorbers, types of vibration dampers

- 6 hours

**Total – 12 hours**

**Unit- III**

*Non linear vibrations* – introduction, sources of nonlinearity, qualitative analysis of non linear systems, phase plane, conservative systems, Stability of equilibrium, Method of Isoclinics, Perturbation method, Method of Iteration, Self-excited oscillations

- 6 hours

*Vibration measurement and applications* – introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis

- 6 hours

**Total – 12 hours**

**Unit- IV**


- 5 hours

*Modal analysis and Condition Monitoring* - Introduction, Dynamic testing of Machines and Structures, Experimental Modal analysis, Machine Condition Monitoring & Diagnosis.

- 5 hours

**Total – 10 hours**

**Unit- V**

*Continuous systems* - Vibrating string, Lateral vibration of beams, Longitudinal vibration of rods.

- 3 hours

*Eigen value problems* – Non standard and standard eigen value problems, concept of iteration, simultaneous iteration method, subspace iteration method, Lanczos method.

- 5 hours

**Total – 8 hours**
Text books:


Reference books:


Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

Advanced Modeling, Analysis and Simulation Laboratory

<table>
<thead>
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<th>Sub Code</th>
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<th>Hrs/ Week</th>
<th>Exam Hours</th>
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</table>

(1) 3D modeling of machine tool parts like gears and machine tool parts using Pro-E/CATIA modeling software.
(2) Tool Path Generation, Part Programming, G and M code development for machining operations using Pro-E
(3) Analysis of Mechanical Components – Use of FEA Packages like ANSYS/NASTRAN/LS-Dyna/Hypermesh etc.,
    Exercises shall include analysis of
    ✓ Machine elements under Static loads
    ✓ Modal Analysis and Harmonic Analysis
    ✓ Machine elements under Dynamic loads
    ✓ Thermal Analysis of mechanical systems/ Fluid flow/ Coupled Field
Non-linear systems

(4) Use of kinematics and dynamics simulation software like ADAMS, MATLAB. Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

FRACTURE MECHANICS

Sub Code: 14 MMD 211
Hrs / week: 4
Total hrs: 52

No. of Credits: 4
CIE: 50 marks
SEE: 50 marks

Unit – I
Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith’s energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems.


Unit – II
LEFM: Plasticity effects, Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Different forms of Dugdale model. Plastic constraint factor. The Thickness effect, Residual stress effect on plastic zone, Numerical problems.

Unit – III
The Crack-tip opening displacement. The Use of CTOD criteria. Parameters affecting the critical CTOD.Use of J integral. Limitation of J integral.

Unit- IV
**Unit - V**


**Fatigue crack propagation and applications of fracture mechanics:** Crack growth and the stress intensity factor. Factors affecting crack propagation, variable amplitude service loading, Means to provide fail-safety, Required information for fracture mechanics approach, Mixed mode loading and design criteria. - 4 hours

**Text books:**

**Reference Books:**
3. Fracture and Fatigue Control in Structures - Rolfe and Barsom, Prentice Hall.
6. Fracture –Liefbowitz Volime II.

**Scheme of Examination:**

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

**CONDITION MONITORING AND CONDITION BASED MAINTENANCE**

Sub Code: **14 MMD 214**  
No. of Credits: **4**  
Hrs / week: **4**  
CIE: **50 marks**  
Total hrs: **52**  
SEE: **50 marks**

**Unit – I**

**Introduction to Maintenance** – definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, Principles of Maintenance, Concepts of Maintainability, Availability and Reliability. - 4 hours

**Introduction to Condition Based Maintenance** – introduction, implementation of CBM, comparison of CBM with other maintenance techniques, case studies - 6 hours
**Unit- II**

**Introduction to Condition Monitoring** - basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring,

- 6 hours

**Basic Signal Processing techniques** - probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis.

- 6 hours

**Unit- III**

**Vibration Monitoring** – introduction, Vibration data collection, Techniques, Instruments, Transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis, Commonly witnessed machinery faults diagnosed by vibration analysis

- 7 hours

Vibration signals from rotating and reciprocating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines.

- 5 hours

**Unit- IV**

**Mechanical fault diagnosis** – wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric Oil Analysis Procedure (SOAP), Ferrography

- 5 hours

**Non destructive testing techniques** – measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection.

- 5 hours

**Unit- V**

**Condition Monitoring of rolling element bearings and gear** – introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics.

- 6 hours

Tool wear monitoring – introduction, techniques, case studies

- 2 hours
Text books:

1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
3. ISTE Course material on Condition Monitoring.

Reference books:


Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

ROBOTICS

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UNIT- I

Introduction to robotics, Robot anatomy, Links and joints, Degree Of Freedom, arm configuration, Wrist configuration, End effectors, Coordinate frames, Mapping, Mapping between rotated frames, Mapping between translated frames, Mapping between rotated and translated frames, Description of object in space, Transformation of vectors, rotation of vectors, Translation of vectors, Combined rotation and translation of vectors, Composite transformation, fundamental rotation matrices, Principal axes rotation, Fixed angle representation, Euler angle representation, Equivalent angle axis representation, Problems

UNIT-II

Direct Kinematics and Inverse kinematics
Mechanical structure and Notations, Description of links and joints, Kinematic Modeling of the manipulator, Denavit – Hartenberg notation, Kinematic relationship between adjacent links, Manipulator transformation matrix, Problems, Manipulator workspace, Solvability of inverse kinematic model.
Existence of solution, Multiple solutions, Solution technique, Closed form solution, Guidelines to obtain closed form solutions, Problems.

UNIT-III
Manipulator Differential Motion and Statics

UNIT-IV
Robot Dynamics

UNIT V
Robot Trajectory Planning and Control
Definitions and planning tasks, Terminology, joint space techniques, Use of a p-Degree polynomial as interpolation function, Cubical polynomial trajectories, Linear function with parabolic blends, Cartesian space techniques, A straight –line path, A circular path, Position path, Orientation path, Joint-space versus Cartesian space, trajectory planning, problems, Open and closed loop control, The manipulator control problems, Linear control schemes, Characteristic of the second order linear system, Linear second order SISO model of a manipulator joint, Model of a DC motor, Partitioned PD control scheme, Effect of an external disturbance, PID control scheme, Computed Torque Control, Force control of Robotic Manipulator, Description of Force – control Tasks, Force – control strategies, Hybrid position/ force control, Control architecture for hybrid position/force control scheme, Impedance Force/Torque control, Force tracking Characteristic of Impedance control, Adaptive Control, problems.

10 Hours

Text books

Reference books

Scheme of Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.