JSS SCIENCE AND TECHNOLOGY UNIVERSITY

Sri Jayachamarajendra College of Engineering, Mysore – 6
Department of Mechanical Engineering

M.Tech. in Maintenance Engineering (MMT)

Scheme of Teaching and Examination

SEMESTER I											
Sl. No.	**Subject code**	**Course Name**	**Credits**				**Contact Hours Per Week**	**Marks**		**Total**	**Exam Duration in Hrs.**
			L	**T**	**P**	**Total**		**CIE**	**SEE**		
1	MMT110	Maintenance Engineering & Management	4	1	0	5	6	50	50	100	3
2	MMT120	Tribology and Bearing Design	4	1	0	5	6	50	50	100	3
3	MMT130	Advanced Theory of Vibrations	4	1	0	5	6	50	50	100	3
4	MMT14X	Elective-I	4	1	0	5	6	50	50	100	3
5	MMT15X	Elective-II	4	1	0	5	6	50	50	100	3
6	MMT 16L	Non Destructive Testing Laboratory	0	0	1.5	1.5	3	50	-	50	-
7	MMT170	General Seminar	-	-	-	1.5	3	50	-	50	-
TOTAL						**28**	**36**			**600**	

Elective-I	
MMT141	Quality and Reliability Engineering
MMT142	Operations and Maintenance of Hydraulic and Pneumatic systems
MMT143	Advanced Topics in Metal Joining
Elective-II	
MMT151	Non Destructive Testing
MMT152	Surface Treatment and Finishing
MMT153	Computers in Maintenance Engineering

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

Sri Jayachamarajendra College of Engineering, Mysore – 6
Department of Mechanical Engineering

M.Tech. Maintenance Engineering (MMT)

Scheme of Teaching and Examination

SEMESTER II											
Sl. No.	**Subject code**	**Course Name**	**Credits**				**Contact Hours Per Week**	**Marks**		**Total**	**Exam Duration in Hrs.**
			L	**T**	**P**	**Total**		**CIE**	**SEE**		
1	MMT210	Failure Mechanism and Analysis	4	1	0	5	6	50	50	100	3
2	MMT220	Maintenance of Machinery	4	1	0	5	6	50	50	100	3
3	MMT230	Condition Based Maintenance	4	1	0	5	6	50	50	100	3
4	MMT24X	Elective-I	4	1	0	5	6	50	50	100	3
5	MMT25X	Elective-II	4	1	0	5	6	50	50	100	3
6	MMT26L	Dynamics Lab	0	0	1.5	1.5	3	50	-	50	-
7	MMT270	General Seminar	-	-	-	1.5	3	50	-	50	-
TOTAL						**28**	**36**			600	

Elective-I	
MMT241	Noise Measurement Analysis & Control.
MMT242	Rotor Dynamics.
MMT243	Maintainability.
Elective-II	
MMT251	Value Engineering.
MMT252	Plant Engineering.
MMT253	Repair Technology.

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

Sri Jayachamarajendra College of Engineering, Mysore – 6
Department of Mechanical Engineering

M.Tech. Maintenance Engineering (MMT)

Scheme of Teaching and Examination

SEMESTER III											
Sl. No.	**Subject code**	**Course Name**	**Credits**				**Contact Hours Per Week**	**Marks**		**Total**	**Exam Duration in Hrs.**
			L	**T**	**P**	**Total**		**CIE**	**SEE**		
1	MMT310	Industrial Training/ Internship	0	0	4	4	3	100	-	100	-
TOTAL CREDITS						**4**	**3**			100	

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

Sri Jayachamarajendra College of Engineering, Mysore – 6
Department of Mechanical Engineering

M.Tech. Maintenance Engineering (MMT)

Scheme of Teaching and Examination

SEMESTER IV											
Sl. No.	Subject code	Course Name	Credits				Contact Hours Per Week	Marks		Total	Exam Duration in Hrs.
			L	T	P	Total		CIE	SEE		
1	MMT410	Project Work	0	0	40	40	3	100	200	300	3
TOTAL CREDITS						**40**	**3**			**300**	

MAINTENANCE ENGINEERING MANAGEMENT

Subject Code	**MMT110**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course objectives:

1. To explain maintenance objectives and functions, factors influencing Plant Availability, Need for maintenance plan and organization, Functions of maintenance control and determine Failure probability, Survival probability and Age specific failure rates of equipments and components.
2. To determine the optimal overhaul/repair/replacement maintenance policy for an equipment subject to breakdown and to determine optimal interval between preventive replacements for individual and group replacement of equipments.
3. To explain different maintenance systems and the steps involved in establishing a maintenance plan and designing a technically sound preventive maintenance and lubrication program.
4. To determine the optimal inspection frequency for maximization of profit and minimization of down time and the critical path using CPM and PERT.
5. To explain the NUCREC method of prioritizing maintenance work, Classification of spares, Costs associated with spares inventory, EOQ computation and MUSIC - 3D approach to spares management, to determine the optimal number of spars to satisfy given service level and to apply simulation technique for spares inventory.

Course Content

UNIT- 1

Introduction: Objectives and Functions of maintenance. Factors influencing plant availability, Maintenance control, Maintenance Strategies, Organization for Maintenance. Failure Statistics: Breakdown time distributions, Running-in failures, Time independent failures, Wear-out failures, Failure Probability, Survival Probability and age specific failure rates. .

10 Hours

UNIT- 2

Overhaul and Repair: Meaning and difference, optimal overhaul / Repair / Replace maintenance policy for equipment subject to breakdown. Replacement Decisions: Deterministic and stochastic replacement situations, failure and preventive replacement, Optimal Interval between preventive replacement of equipment subject to breakdown, group replacement.

10 Hours

UNIT- 3

Maintenance Systems: Fixed time maintenance, Condition based Maintenance, Operate to failure, Opportunity Maintenance, Design out maintenance, Total Productive Maintenance. Maintenance Planning: Establishing maintenance plan and schedule, illustrative examples, Preventive Maintenance: Designing a Technically sound preventive maintenance program, failure data, FMECA, Maintenance to prevent failures, lubrication program development.

12 Hours

UNIT- 4

Inspection Decisions: Optimal Inspection frequency (for maximization of profit and minimization of downtime). Shut down planning using CPM & PERT.

10 Hours

UNIT- 5

NUCREC Method of prioritizing maintenance work. Spare Parts Management: Classification of spares, traditional approach to spares inventory, MUSIC-3D Approach to spares inventory, optimum number of spares to satisfy given service level, simulation technique.

10 Hours

Text Books:

1. A KELLY AND M J HARRIS, "Management of Industrial Maintenance", Butterworth's Co, Ltd.

Reference Books:

1. AKS JARDINE "Maintenance, Replacement and Reliability" Pitman publishing Co.
2. A KELLY, "Maintenance planning and control", Butterworth Co, Ltd.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain maintenance objectives and functions, factors influencing Plant Availability, Need for maintenance plan and organization, Functions of maintenance control and determine Failure probability, Survival probability and Age specific failure rates of equipments and components. (Apply)
CO2	Determine the optimal overhaul/repair/replacement maintenance policy for an equipment subject to breakdown and optimal interval between preventive replacements for individual and group replacement of equipments. (Analyse)
CO3	Explain different maintenance systems and the steps involved in establishing a maintenance plan and designing a technically sound preventive maintenance and lubrication program. (Comprehend)
CO4	Determine the optimal inspection frequency for maximization of profit and minimization of down time and the critical path using CPM and PERT. (Analyse)
CO5	Explain the NUCREC method of prioritizing maintenance work, classification of spares and the costs associated with spares inventory, perform EOQ computations, explain MUSIC - 3D approach to spares management, determine the optimal number of spares to satisfy given service level and apply simulation technique for spares inventory. (Analyse)

TRIBOLOGY AND BEARING DESIGN

Subject Code	**MMT120**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To explain various aspects of friction, lubrication classification and hydrodynamic lubrication.
2. To describe with sketches the concept of mechanism of pressure development in an oil film, pad bearings, viscosity and viscosity measuring apparatus and related numerical problems.
3. To analyze oil flow and thermal equilibrium in journal bearing, hydrostatic bearing, derive expression for load carrying capacity and oil flow through bearing, and solve related numerical problems.
4. To analyze the different types of bearing materials, wear, their properties, classify wear and its measurements.
5. To describe Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure, improving design and surface engineering.

Course Content

UNIT – 1

Introduction to Tribology: Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants. **Hydrodynamic Lubrication**: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized full journal bearings.

10 Hours

UNIT – 2

Mechanism of Pressure Development In An Oil Film: Reynold's investigations, Reynold's equation in two dimensions - Partial journal bearings, end leakages in journal bearing, numerical problems. Slider / Pad Bearing with a Fixed and Pivoted Shoe**:** Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, influence of end leakage, numerical examples.

12 Hours

UNIT – 3

Oil Flow and Thermal Equilibrium Of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings, Hydrostatic Lubrication**:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

10 Hours

UNIT – 4

Bearing Materials: Commonly used bearings materials, properties of typical bearing materials, **Wear:** Classification of wear, wear of polymers, wear of ceramic materials, wear measurements, effect of speed, temperature and pressure.

10 Hours

UNIT – 5

Behavior of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.

10 Hours

Text books:

1. Basu S K., Sengupta A N., Ahuja B. B., Fundamentals of Tribiology PHI 2006.
2. Mujumdar B. C., Introduction to Tribiology Bearings, S. Chand company Pvt. Ltd 2008.

Reference books:

1. Fuller, D., Theory and Practice of Lubrication for Engineers, New York Company 1998.
2. Principles and Applications of Tribiology, Moore, Pergamaon press 1998.
3. Srivastava S., Tribiology in Industries, S Chand and Company limited, Delhi 2002.
4. Redzimovskay E I., Lubrication of bearings – Theoretical Principles and Design, Oxford press company 2000.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain various aspects of friction, lubrication classification and hydrodynamic lubrication.
CO2	Describe with sketches the concept of mechanism of pressure development in an oil film, pad bearings, viscosity and viscosity measuring apparatus and related numerical problems
CO3	Analyze oil flow and thermal equilibrium in journal bearing, hydrostatic bearing, derive expression for load carrying capacity and oil flow through bearing, and solve related numerical problems.
CO4	Analyze the different types of bearing materials, wear, their properties, classify wear and its measurements.
CO5	Describe Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure, improving design and surface engineering.

ADVANCED THEORY OF VIBRATIONS

Subject Code	**MMT130**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To apply fundamental concepts of mechanical vibration, analysis and solve related numerical problems.
2. The analyze systems with more than one degree of freedom and solve related numerical problems.
3. To describe various measuring instruments and their application used in vibration analysis.
4. To evaluate Eigen value, transfer matrix and modal analysis problems.
5. To analyze non-linear vibrations using analytical and graphical methods.

UNIT-1

System with single degree of freedom: Review of simple harmonic motion, analysis of free and forced vibration with or without different types of damping, numerical problems related logarithmic decrement, force transmission to foundations, vibration isolation and transmissibility.

10 Hours

UNIT-2

System with More than one degree of freedom: Systems, with two degree of freedom, undamped vibration absorbers, equation of motion using influence Coefficients, generalized co-ordinates and co-ordinates coupling, Orthogonality of natural modes; free and forced vibration of multi-degree of freedom with viscous Damping: Lagrange's equations.

10 Hours

UNIT-3

Vibration Measuring Instruments & Application: Principles of vibration measurement, construction features of accelerometer and vibrometers, steps involved in vibration measurement, Vehicle suspension, Dynamic vibration Absorber, Dynamics of Reciprocating Engines.

10 Hours

UNIT-4

Solution of Eigen-Value problem, Transfer Matrix and Modal Analysis: self-excited vibrations, criterion of stability, effect of friction OIL stability with common examples.

10 Hours

UNIT-5

Non-Linear Vibrations: Introduction of Non-linear vibration, free vibration with Non-linear spring force or non-linear damping, phase plane, energy curves, integral curves lie nard's graphical construction, method of isoclines.

12 Hours

Text Books:

1. L. Meirovitch, "Elements of Vibration Analysis", McGraw Hill.
2. Kelly, Schaum's"Mechanical Vibrations" Outline Series, Mc Graw Hill 1996.

Reference Books:

1. W. T. Thomson, M. D. Dahleh and C. Padmanabhan, "Theory of Vibration with Applications", Pearson Education Inc, 5th edition, 2008.
2. S. Graham Kelly, Schaum's, "Mechanical Vibrations" outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
3. J. S. Rao"Theory and Practice of Mechanical Vibrations".

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Apply fundamental concepts of mechanical vibration, analysis and solve related numerical problems.
CO2	Analyze systems with more than one degree of freedom and solve related numerical problems.
CO3	Describe various measuring instruments and their application used in vibration analysis.
CO4	Evaluate Eigen value, transfer matrix and modal analysis problems.
CO5	Analyze non-linear vibrations using analytical and graphical methods.

QUALITY AND RELIABILITY ENGINEERING

Subject Code	MMT141	No. of Credits	4 - 1 - 0
No. of Lecture Hours / Week	04 + 02 (L+T)	Exam Hours	3
Total No. of Contact Hours	52 + 26 (L+T)	Exam Marks	100

Course Objectives:

1. To explain quality, reliability, quality control and statistical quality control.
2. To explain and apply statistical tools in quality control and solve related numerical problems.
3. To analyze failure data, hazard models, system reliability and solve related numerical problems.
4. To apply reliability improvement and allocation methods to engineering systems.
5. To explain maintainability and availability concepts to improve the system effectiveness.

Course content

UNIT-1

Basic Concepts: Definitions of Quality and Reliability, Parameters and Characteristics, Quality control, Statistical Quality Control, Reliability concepts. **Concepts in Probability and Statistics** Events, Sample Space, Probability rules, Conditional probability, Dependent and Independent Events, Application of Probability concepts in Quality Control, Problems.

10 Hours

UNIT-2

Statistical Aspects and Probability Distributions: Statistical Tools in Quality Control, the Concept of Variation, Graphical Tools for data representation and analysis, Discrete and Continuous Distributions, Normal, Poisson, Binomial, Weibull Distribution, Problems. **Failure Data Analysis:** Introduction, Failure Data, Quantitative measures, MTTF, MTBF, Bath tub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis.

12 Hours

UNIT-3

Hazard Models: Introduction, Constant Hazard, Linearly increasing hazard, the Weibull model, (Derivation not required, emphasis to be on applications). System reliability Series, Parallel and Mixed Configurations, Block Diagram Concept, r-out-of-n structure, solving problems using mathematical models.

10 Hours

UNIT-4

Reliability Improvement and Allocation: Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Elements of a typical reliability program, setting overall reliability goals, Reliability Apportionment, Prediction and Analysis, Problems.

10 Hours

UNIT-5

Maintainability and Availability: Introduction, Formulas, Techniques available to improve maintainability and availability, trade-off among reliability, maintainability and availability, Simple problems.

10 Hours

Text Books:

1. Halpern, Seigmund,"The Assurance Sciences", Prentice Hall International, New Jersey, U.S.A. (1978).
2. Srinath, L.S,"Concepts in Reliability Engineering", Affiliated East-West Press Private Limited, New Delhi, India, (1985).

Reference Books:

1. Juran, J.M. and Gryna, F.M,"Quality Planning and Analysis", Tata McGraw Hill publishing Company Ltd., New Delhi, India. (1982).
2. Blanchard, Benjamin S,"Logistics Engineering and Management", Prentice Hall International, New Jersey, U.S.A. (1986).
3. Kraus, John W, "Maintainability and Reliability", Handbook of Reliability I Engineering and Management, Editors -Ireson. W *.a.* and Coombs, C.F. McGraw Hill, Book Company Inc., U .S.A. (1988).

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain quality, reliability, quality control and statistical quality control.
CO2	Explain and apply statistical tools in quality control and solve related numerical problems.
CO3	Analyze failure data, hazard models and system reliability and solve related numerical problems
CO4	Apply reliability improvement and allocation methods to engineering systems
CO5	Explain maintainability and availability concepts to improve the system effectiveness.

OPERATION AND MAINTENANCE OF HYDRAULIC AND PNEUMATIC SYSTEMS

Subject Code	**MMT142**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course objectives:

1. To apply knowledge of fundamentals of hydraulics to the defined processes, systems and hydraulic circuits.
2. To understand the working of various components and Installation of hydraulics Systems.
3. To understand the operation and maintenance procedures involving preventive maintenance schedules.
4. To describe functions of pneumatic power units and its characteristics.
5. To understand and develop pneumatic circuit symbols using standard practices.

Course Content

UNIT- 1

Fundamentals of Hydraulics: introduction: Hydraulics power, Hydraulics systems- Advantages, Limitations and applications, Pascal's Law, structure of hydraulic control systems, source of hydraulic power, Hydraulic Fluids, Hydraulics systems: Basic industrial systems, system inputs, system outputs, the control of the system, servo systems, Hydraulics, circuits-symbols and diagrams.

10 Hours

UNIT- 2

Hydraulic system components: Reservoir, accumulator pumps motors, hydraulic cylinders, hydraulic values, filters and strainers, pressure gauges, flow meters, pressure switches, hydraulic stools, pipes and fittings. Installation of hydraulics Systems: Hydraulics assemblies, hydraulics on the machine, pipe work, tube fittings, seals and adaptors, flexible hoses and quick action couplings, filling installation check over.

10 Hours

UNIT- 3

Operation and maintenance procedures: Understanding the principles of hydraulics, cause of pressure, pressure loss, energy loss by leakage, power balance of the system, cleanliness, air bleed and points, operate controls, values settings, trouble shooting of hydraulics systems, preventive maintains, starting and stopping, information equipment and facilities, circuit diagrams, components data, preventive maintenance schedules, tool kit modification and repair, pressure gauge connection, sealing methods, charging an accumulator, charging procedure, fault finding.

12 Hours

UNIT- 4

Pneumatic power unit- Introduction-Areas of application of pneumatic power unit- elements of pneumatic power units, classification of pneumatic power units, working principle of pneumatic power units, Advantages and limitations, choice of working medium, characteristics of compressed air, pneumatic control systems, fluid conditioners and FRL units, Applications, rod-less cylinder types, rotary cylinders-construction and applications, symbols.

10 Hours

UNIT- 5

Pneumatic circuit symbols- Introduction to circuit symbols-values symbols-directions control values. Actuation of values- non return values-pressure control values-flow control values-air cylinders-classification and maintains. Circuits- elements-control of simple acting and double acting cylinders- simultaneous control of two cylinders -one cycle operation circuit, Trouble-shooting of pneumatic systems- Documentation- the causes and effects of malfunctions-maintenance.

10 Hours

Text Books:

1. A KELLY AND M J HARRIS, "Management of Industrial Maintenance", Butterworth's Co, Ltd.,1978

Reference Books:

1. AKS JARDINE "Maintenance, Replacement and Reliability" Pitman publishing Co.
2. A KELLY, "Maintenance planning and control", Butterworth Co, Ltd.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Apply knowledge of fundamentals of hydraulics to the defined processes, systems and hydraulic circuits.
CO2	Identify and analyse the working of various components and Installation of hydraulics Systems.
CO3	Analyze the operation and maintenance procedures involving preventive maintenance schedules.
CO4	Acquaint with the functions of pneumatic power units and its characteristics.
CO5	Develop pneumatic circuit symbols using standard procedures and practices.

ADVANCED TOPICS IN METAL JOINING

Subject Code	MMT143	No. of Credits	4 - 1 - 0
No. of Lecture Hours / Week	04 + 02 (L+T)	Exam Hours	3
Total No. of Contact Hours	52 + 26 (L+T)	Exam Marks	100

Course objectives:

1. To understand distortion and methods of distortion and understand the effects of distortion,.
2. To classify different types of welding processes, learn the concepts, sketch and explain the principles of operations in welding
3. To learn different methods of welding of dissimilar metals and its metallurgical problems
4. To outline the stages of inspection and evaluate types of defects based on the tests and techniques adopted in inspection of welds
5. To understand the importance of symbols used in welding and learn principles of welding design

Course Content

UNIT I

Distortion, Types of distortion and methods to control distortion. Residual Stresses in welds, definition, concept types causes and effects, Residual stress measurement. Metal Spraying, classification of thermal spraying process equipments

10 Hours

UNIT II

Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding concepts, principle of operation, equipments, advantages, disadvantages and applications of the above processes, Welding electrodes -Types, selection of electrodes, Applications of coated electrodes.

10 Hours

UNIT III

Welding of dissimilar metals, concepts, metallurgical problems, Plastic welding processes, fusion welding processes, advantages and disadvantages of each processes, advanced soldering and Brazing processes, different types of soldering and brazing processes

10 Hours

UNIT IV

Inspection of Welds: Stages, Destructive techniques like Tensile, Bend, and Nick break, Impact & Hardness tests. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection. Weld quality, factors to be considered, Discontinuities in welds, their causes and remedies, Quality conflicts.

10 Hours

UNIT V

Welding Symbols- Need for representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples. Welding Design - Introduction, Principles of sound welding design, Welding joint design, Welding positions, Allowable strengths of welds, under steady loads, welding cost estimation, main components, factors, basic costing procedure.

12 Hours

Text Books:

1. Welding Technology by O.P.Khanna. Dhanpat Rai & Sons, 1993
2. **W**elding Engineering by Rossi

Reference Books:

1. Advanced Welding Processes-Nikolacv .G.O.L Shansky MIR Publications.1997
2. Welding for engines by Udin, Funk & Wulf
3. Welding and welding technology-R.L.Little

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Define distortion, residual stresses, metal and thermal spraying, understand the concept of distortion during welding process, describe the methods to control distortion, illustrate the stresses developed in welds, predict the causes and effects of distortion, explain the methods of residual stress measurement, metal and thermal spraying techniques.
CO2	Classify different types of welding processes, learn the concepts, sketch and explain the principle of operation in detail and the electrodes used in welding.
CO3	Learn the different methods of welding dissimilar metals and its metallurgical problems, welding processes for plastics, Various types of soldering and brazing processes.
CO4	Outline the stages of inspection, Judge the type of defects that could be traced using various techniques adopted in inspection of welds.
CO5	Write the symbols used in welding, understand the principles of welding design, welding positions, welding cost estimation.

NON DESTRUCTIVE TESTING

Subject Code	**MMT151**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To explain basic principles of various NDT methods with appropriate sketches and to identify advantages and limitations of them.
2. To explain basic principles of various NDT methods with appropriate sketches and to identify advantages and limitations of them.
3. To explain with sketches basic equipments, types of waves, methods and equipments, standard reference blocks of ultrasonic inspection in casting, extrusions, rolled products, weld sets.
4. To explain with sketches various radiation sources, equipment characteristics of radiography and thermal inspection, to identify applications.
5. To describe Basics of Holography and Acoustical Holography, recording, reconstruction, procedures of inspection, typical applications, to explain systems, techniques and applications. Current Literature.

Course Content

UNIT- 1

Introduction to Non Destructive Testing methods (NDT): Selection of Non Destructive Testing methods (NDT), visual inspection, leak testing, liquid dye penetrant inspection, its advantages and limitations.

10 Hours

UNIT- 2

Eddy current, Magnetic Particle and microwave inspections: principles, operation variables, procedure, inspection coils, Methods of generating magnetic field, types of magnetic particles, suspension liquids, steps in inspection, applications and limitations microwave principles and detectable defects by this method.

10 Hours

UNIT- 3

Ultrasonic inspection: Basic equipment, characteristics of ultrasonic waves, variables, inspection methods; pulse echo, A,B,C scans transmission, resonance techniques, transducer elements ,couplets, search units, contact types and immersion types inspection standards: standard reference blocks, inspection of products like casting, extrusions, rolled products, weld sets.

12 Hours

UNIT- 4

Radiography Inspection: Principles, radiation sources: X-Ray and gamma ray tubes, radiographic films, and filters, image intensifiers and techniques, charts, industrial radiography, image quality, radiography sensitivity, Electron and Neural radiology, application of ICT, Thermal inspection principles, equipment inspection methods, applications.

10 Hours

UNIT- 5

Optical Holography: Basics of Holography, recording and reconstruction, procedures of inspection, typical applications. Acoustical Holography: systems, techniques and applications.

10 Hours

Text Books:

1. Non destructive Evolution and quality control volume l~ of metals hand book 9th Edition Asia international 1989.

Reference Books:

1. Mc Gonnagle, JJGarden and Reach**,** "Non Destructive testing", New York.
2. Davis H.E Troxel G .E wiskovil C.T**,** "Testing instruction of Engineering materials"**,** Mc Graw Hill.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Understand various NDT methods and suggest methods for various applications, explain with sketches, visual inspection, leaks testing, and liquid penetration inspection, identify advantages and limitations of them.
CO2	Explain with sketches principles of eddy current, magnetic particle and microwave inspections, describe with sketches operation variables, procedure, inspection coils, methods of generating magnetic field, list types of magnetic particles, and suspension liquids and steps in inspection.
CO3	Explain with sketches equipment, characteristics of ultrasonic waves, variables, compare and contrast between inspection methods like pulse echo, A, B, C scans, transmission, resonance techniques, transducer elements, couplets, contact types and immersion type inspection
CO4	Describe with sketches X-Ray and gamma ray tubes, radio graphic films, and filters, image intensifiers and techniques, describe industrial radiography, image quality and radiography sensitivity, thermal inspection principles, equipment inspection methods, compare and contrast between electron and neural radiology.
CO5	Explain with sketches holography principle, recording and reconstruction, procedures of inspection and list typical applications; explain with sketches acoustical holography systems, techniques and applications. Prepare write-ups on advanced topics

SURFACE TREATMENT AND FINISHING

Subject Code	**MMT152**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course objectives:

1. To understand the principles of operations, tests to evaluate mechanical and tribological properties.
2. To understand the principles of failure analysis and examination of failed components.
3. To understand the strain rate testing, test machine requirements and specimens measurements.
4. To understand and describe the different types of coating and working principles.
5. To learn and understand different heat treatment processes and their effect on finishing.

Course Content

UNIT- 1

Testing machines and sensors: types of Universal Testing machines and principles of operations, Machine stiffness, load and strain measurement. Calibration and verification of UTM, Friction, wear and surface testing: Testing of sliding contact, damage, abrasive wear, adhesive wear, erosive wear, Testing and determination of surface characteristics of solid materials.(Surface roughness measurements) Importance of calibration of Testing Instruments: Calibration methods and standards Tests / experiments based on methods with active reference to various codes and standard for each test.

10 Hours

UNIT- 2

Failure Analysis: Principles and Approaches of Failure analysis, objectives, scope, planning, preparation, Failure Analysis procedures, examination of damages and materials evaluation, Tools and Techniques in FA – An overview. Appearances of fracture in common conditions like unit axial loads, tensional and shear loads, fatigue and creep loading. Microscopy, Optical microscope, scanning electron microscope, preparation of Specimens for microscopic study, Speed & Control of Testing Background, Developments in testing Machine Technology, Effects of testing rates on properties ,Results before servo control ,Results from servo controlled machines.

12 Hours

UNIT- 3

Strain Rate Testing, test machine requirements, Specimens Measurements, General Definitions Strength Hardening Constitutive Relations to Model Material Strain Rate Dependency. Lubrication & Determination of characteristics of lubricants: Introduction, Types of lubricants, characteristics of lubricants Methods of lubrication, four ball testing.

10 Hours

UNIT- 4

Fundamentals of Electroplating, galvanizing, Hot dip metal coating, thin coating, thin coating, chromium plating, Nickel plating, Vacuum coating, FVD & CVD metal spraying - Methods, surface preparation, mechanical, Properties of sprayed metals: Various types and plasma coating. Plastic coating of metal-PVC coating Spherodising process details, phosphate coating mechanism of formation, testing of surface coating- Various methods used.

10 Hours

UNIT- 5

Heat treatment methods, annealing, normalizing, tempering, case hardening methods, flame hardening, sub-zero treatment, heat treatment methods for gears, spindles, cutting tools, advanced coating technologies, hard facing, electrode position technique, Nano coatings, coating characterization

10 Hours

Text Books:

1. Principles of metal surface treatment and protection-Pergamon Press Gabe, David Russell Description,Oxford;NewYork-2ded.,1978.

Reference Books:

1. Surface preparations & finishes for Metals-James A Murphy-Mc Graw Hill.

2. Handbook of metal treatment and testing-John Wiley& sons.

3. Heat Treatment of Metals–Zakrov-MlR Publications.

COMPUTERS IN MAINTENANCE ENGINEERING

Subject Code	**MMT153**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives

1. To understand the importance of computer hardware and software in machinery maintenance engineering applications
2. To understand the need and importance of general and real time Management Information Systems
3. To learn and develop computer based maintenance management Information system CMMS
4. To develop Applications in CBM and development principles of Condition based Maintenance information Systems
5. To understand the importance of AI and expert Systems in maintenance engineering

Course Content

UNIT- 1

Introduction: Introduction to computers, Hardware and Software - Recent developments. History & Generation of Computer– Applications of Computer – Advantages of Computer for database development, networking and computational requirements, use of desktops and laptops for industrial hardware controls – Terms related to Computer – Characteristics of Computer: Speed, Storage, Versatility and Diligence – Hardware & Software. Types of Computer: On the Basis of Working Main frame, Mini Computer, Super Computer, Work station, Micro Computer, Desktop Computer, Laptop Computer, Palmtop Computer; use of primary and secondary memory for maintenance applications, applications of serial, parallel and USB ports

10 Hours

UNIT- 2

Computers in Maintenance: Role of Computers in Maintenance Management, Justification for use of Computers in Maintenance. M**aintenance Management Information Systems:** Operating characteristics of a good computerized maintenance management system. Adaptation of operating systems for applications general purpose maintenance and real time maintenance systems, Windows, Linux, Unix and real time operating systems for real time maintenance systems, development of databases, use of databases for charting, trend charting and three dimension plots, use of Microsoft tools for information system development, computer networking, computer up gradation, selection of microprocessors for applications.

10 Hours

UNIT- 3

Need for computer based maintenance management Information system (CMMS), Importance of Aims and objectives of CMMS, Features of a good CMMS modules, **CMMS Modules:** Equipment: Specification and Information about the equipment, equipment history failure analysis, Equipment inquiry, drawings, labour and material cost etc., Use of various tool boxes for Preventive Maintenance Scheduling, PM procedures, maintenance inventory activities transactions, ABC, FNS, XYZ analysis, inventory adjustments for spares.

10 Hours

UNIT- 4

Preventive Maintenance Systems: P.M. work orders, P.M. work program, P.M. scheduling, P.M. work load fore cast, P.M. reports, description of tasks. Input and Output / report formats for various models of PM/CMMS, Applications in CBM and development principles of Condition based Maintenance information Systems, Computerized Vibration signature analysis, Computerized Noise signals and analysis. Trend monitoring, waterfall diagrams using graphics packages, development of database Management System**:** Database, data structures, data base management system (DBMS), Data base models-Hierarchical, Network and relations, use of decision support systems

12 Hours

UNIT- 5

Artificial Intelligence and Expert Systems: Introduction to AI and expert Systems, Functions and Structure Expert Systems, importance in designed maintenance and Applications. Use of data mining for maintenance chart development, trouble shooting work applicable to standard machine systems of mechanical and electrical engineering – engines, motors, generators, Prediction of failures using neural network applications, applications in consumer durables and industrial machinery.

10 Hours

Text Book:

1. Kishan Bagadia, "Micro Computer Aided Maintenance Management"

Reference Books:

1. Lindley. R. Higgins "Maintenance Engineering Hand Book",
2. L.C. Marrow "Maintenance Engineering Hand Book".
3. Current Literatures in Conference and Journals

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Identify appropriate computer hardware and software in machinery maintenance engineering applications.
CO2	Design and develop general and real time Management Information Systems.
CO3	Design and develop computer based maintenance management Information systems.
CO4	Explain the applications in CBM and development principles of Condition based Maintenance information Systems.
CO5	List the features of AI and expert Systems in machinery maintenance and monitoring

NON DESTRUCTIVE TESTING (NDT) LABAROTARY

Subject Code	**MMT16L**	**No. of Credits**	**0 - 0 – 1.5**
No. of Lecture Hours / Week	**3**	**Exam Hours**	**-**
Total No. of Contact Hours	**42**	**Exam Marks**	**-**

Course Objectives:

1. To explain basic principles of various NDT methods and explain with sketches Operation variable and parts like Visual Inspection, Leak Testing, Magnetic Particle and liquid penetration testing, Ultrasonic and Eddy current testing and to identify test standards for them.
2. To conduct visual inspection on castings, welding and gear blocks and to determine location, and extent of surface and sub surface defects using the above mentioned Techniques.

Course content

Set of Experiment – 1

Conduct experiments to detect defects causing leakage in fluid containers.

Set of Experiment – 2

Conduct experiments to detect surface defects using magnetic particle and liquid penetration testing.

Set of Experiment – 3

Conduct experiments to detect surface and sub surface defects, their location and extend using Ultrasonic and Eddy current testing.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain the various components, methods, standards and techniques associated with Visual Inspection, Leak Testing, Magnetic Particle and liquid penetration testing, Ultrasonic and Eddy current testing.
CO2	Apply the above mentioned knowledge of Testing and standards in these techniques and detect the extent and their location of defects and analyze the test results, make inferences and suggest the best technique.

FAILURE MECHANISM AND ANALYSIS

Subject Code	**MMT210**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To explain types, fundamental causes and objectives of failure analysis.
2. To describe different forms of corrosion and failure mechanisms.
3. To explain with sketches different types of wear and failure mechanisms.
4. To analyze the failure mechanisms of mechanical components.
5. To describe with sketches the different tools and techniques used for failure analysis.

Course Content

UNIT-1

Introduction to Failure Analysis: Definition of failures, Classification of failures, Instantaneous failures, Cumulative failures, Fundamental causes of failures-Deficiencies in design, Deficiencies in selection of materials, Imperfection in materials, Deficiencies in processing techniques, Errors in assembly, Improper service conditions. Objectives of Failure analysis, Step by step procedure for Metallurgical failure analysis, Fracture types, Brittle fractures, Ductile fractures, Fatigue fractures.

10 Hours

UNIT-2

Environment Induced Failures: Corrosion damage, Forms of corrosion-Uniform attack, Two metal corrosion or galvanic corrosion, Crevice corrosion, Pitting corrosion, Inter-granular corrosion, Selective leaching, Erosion corrosion, Corrosion cracking- Stress Corrosion Cracking, Corrosion fatigue, Hydrogen cracking, Hydrogen degradation, Liquid metal embrittlement, High temperature corrosion, corrosion failure mechanisms and Preventive techniques.

10 Hours

UNIT-3

Wear Failures: Definition of wear, Types of wear-adhesive wear, Abrasive wear, Corrosive wear, Erosive wear, fretting wear, Fatigue wear, Wear failure mechanisms and Preventive techniques Failure of fraction surfaces-failure of clutches, Failure of brakes, Failure of seals, Creep failures, Stages of creep, Creep curve, Stress rupture, Failure modes and Preventive techniques of friction surface and Seals.

10 Hours

UNIT-4

Failure mechanisms of important components: Failure modes of Shafts- Fatigue failures, Wear failures, Brittle fracture of failures, Ductile fracture of shafts, Distortion failure of shafts, Corrosion failure of shafts, Prevention technique, Failure modes of Bearings- Failure by wear, Fretting, corrosion, Plastic flow, Brinelling, Rolling contact fatigue, Cavitation Failure modes of gears-failure by fatigue, Impact, Wear, Stress rupture. Failure modes of pressure vessels- failure by

overheating, Stress corrosion cracking, Hydrogen embrittlement, Brittle fractures, Ductile fractures, Creep and Stress rupture.

12 Hours

UNIT-5

Tools for failure analysis: Microscopic examination-Metallurgical Microscope, Scanning Electron Microscope, Transmission Electron Microscope, Physical testing-Tension test, Hardness test, Impact test, Fatigue test Non-Destructive Testing techniques-Magnetic particle inspection, Radiography, Liquid penetrant inspection, Eddy current testing, Ultrasonic testing, Acoustic Emission Testing, Thermography, Chemical analysis- Spectroscopy, Atomic absorption spectroscopy, Atomic emission spectroscopy.

10 Hours

Text Book:

1. Failure Analysis & Prevention American Society of Metal Handbook V 10.11 and 17.

Reference Books:

1. L.F. Pau "Failure Diagnosis and Performance Monitoring".
2. H.P. Garg "Industrial Maintenance".

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain types, fundamental causes and objectives of failure analysis.
CO2	Describe different forms of corrosion and failure mechanisms.
CO3	Explain with sketches different types of wear and failure mechanisms.
CO4	Analyze the failure mechanisms of mechanical components.
CO5	Describe with sketches the different tools and techniques used for failure analysis.

MAINTENANCE OF MACHINERY

Subject Code	**MMT220**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To explain the modes of mechanical failures, and its importance in maintenance.
2. To explain the concept of performance standards, functional failures and failure effects.
3. To describe the entire failure consequences by knowing the failure consequences of hidden, safety and environmental, operational and non-operational consequences.
4. To analyze RCM, its implementation, and its benefits.
5. To classify the machines based on its functions and processes and explain the maintenance procedures and processes.

Course Content

UNIT – 1

Modes of Mechanical Failure: Definition of Failure Mode -Failure modes observed in practice -Different Failure modes and their importance in maintenance.

10 Hours

UNIT – 2

Functions of Failure: Functions and Performance Standards -Functional Failures – Failure Modes -Failure Effects. **Failure Consequences:** Hidden Failure Consequences -Safety and Environmental consequences- Operational Consequences -Non-Operational Consequences.

12 Hours

UNIT – 3

Reliability Centred Maintenance: Introduction -Changing world of maintenance - Maintenance and RCM -The seven Basic Questions –Implementing RCM - Achievements of RCM.

10 Hours

UNIT – 4

Classification of mechanical Equipments and its maintenance : Machine Tools- Utilities- Equipment- working principal – Basic Maintenance needs- Maintenance efforts – trouble shooting- maintenance checklists- Pneumatics and Hydraulics in Maintenance.

10 Hours

UNIT – 5

Maintenance Procedures and Processes: Methods of Stopping Corrosion–Painting, Electroplating and Coating Processes.

10 Hours

Text Books:

1. William T. File- Butterworth and Heinemann, "Cost Effective Maintenance -Design and Implementation".
2. John Moubray -Butterworth and Heinemann, "Reliability Centred Maintenance".

Reference Books:

1. "Lindley Higgings","Maintenance Engineering Handbook".
2. Stainer,"Plant Engineering Handbook" -McGraw Hill.
3. J.A. -John wiley and Sons,"Failure of Materials in Mechanical Designs -Analysis, Prediction and Prevention" - Collins.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Define different failure modes and explain their importance in maintenance.
CO2	Explain functions and Performance Standards, functional failures, failure effects and hidden, safety, environmental, operational and non-operational consequences.
CO3	Analyze changing world of maintenance, maintenance and RCM, the seven basic questions, implementing RCM and achievements of RCM.
CO4	Explain with sketches and classify mechanical equipments machine tools, utilities, working principle, maintenance needs and efforts, Pneumatics and Hydraulics.
CO5	Describe maintenance procedures and processes, and methods of stopping corrosion, like Painting, Electroplating and Coating Processes.

CONDITION BASED MAINTENANCE

Subject Code	**MMT230**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To describe principal types, methods, economics and computer applications in condition monitoring.
2. To explain and apply vibration monitoring methods and analyze machinery signatures.
3. To apply the knowledge of dynamic balancing, alignment of machinery and condition monitoring and analyze them regarding ball and roller bearings.
4. To analyze wear monitoring, lubricant analysis, corrosion monitoring and specialized condition monitoring techniques and arrive at inferences.
5. To describe case studies related to condition monitoring of various manufacturing and process engineering systems.

Course content

UNIT-1

Condition Based Maintenance: Principal types and methods, Economics and application, Computer applications to condition monitoring.

10 Hours

UNIT-2

Vibration Monitoring and analysis: Introduction machinery signature, transducers selection, analysis technique, measurement location, severity criteria, permanent monitoring, rotating machinery signals.

10 Hours

UNIT-3

Dynamic balancing and alignment of machinery: Dynamic balancing of rotors, Field balancing in one plane, two planes and in several planes, Machinery alignment methods. rough alignment method, Face peripheral dial indicator method, reverse indicator method Condition monitoring of ball and roller bearings: Shock pulse method, The Kurtosis method, fiber optics method, Contact resistant method, rolling element bearing activity monitor,(REBAM)

12 Hours

UNIT-4

Mechanical fault diagnosis by wear monitoring and lubricant analysis: Sources of contamination, Wear process monitoring techniques. Performance trend monitoring: Machine performance monitoring, component behaviour monitoring. Corrosion monitoring: Need for Corrosion monitoring, Fields of application, Methods Corrosion monitoring

10 Hours

UNIT-5

Specialized condition monitoring techniques: Thermography, Radiography, Ferrography, Acoustic emission monitoring, Noise monitoring. On line monitoring and diagnostic systems. Condition monitoring in power plants, chemical plants and petrochemical plants.

12 Hours

Text Books:

1. R.A. Caollactt Chapman and hall, "Mechanical Fault Diagnosis and Condition Monitoring", 1977.

Reference Books:

1. L.F. Pau Marcel Deker, Failure Diagnosis and Performance Monitoring.
2. Condition Monitoring and Condition based Maintenance, Update CEP ISTE New Delhi.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Describe principal types, methods, Economics, applications and computer aided condition monitoring.
CO2	Analyse and apply vibration monitoring methods and machinery signatures.
CO3	Describe dynamic balancing, alignment of machinery and condition monitoring of ball and roller bearings
CO4	Analyze mechanical fault diagnosis by wear, corrosion and performance monitoring and lubricant analysis.
CO5	Describe case studies related to condition monitoring of various manufacturing and process engineering systems

NOISE MEASUREMENT ANALYSIS & CONTROL

Subject Code	**MMT241**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To explain acoustics sound and noise in machineries.
2. To classify sound and noise and explain harmful effects and develop programs for effective measurement of noise.
3. To classify and differentiate between sound and noise, discuss the useful and harmful effects, issues related to machinery acoustics.
4. To describe how sound is produced and propagated through various media.
5. To explain how sound is measured using various types of instrumentation systems using various configurations, new technology adaptive noise control techniques.

Course Content

UNIT-1

Understanding Acoustics – Acoustics – science of sound, classification of acoustics, musical, machinery, building, architectural,, production and propagation of sound, sound basics, sound frequency, spectrum, characteristics of sound, propagation of sound , effect of sound due to nature, wind velocity, temperature and moisture effects, Reflection, refraction, transmission, diffraction and absorption of sound, effect of standing wave, transmission of sound in thin and thick barrier, anechoic chamber and reverberation rooms, Sound Fields, Near field, far field, free field, reverberant field, diffused fields, inverse square law, sound directivity index and factor. **SLE:** Propagation of Sound, Effects of Nature, Spectrum, Sound Fields, Standing Wave.

12 Hours

UNIT-2

Noise – Categories of noise, pitched, un-pitched, impact noise features and examples, analogies of sound and noise in power and pressure units, units of sound/noise, Sound pressure level, Sound Power level, Sound intensity level, manipulation of sound, problems on addition and subtraction of sources using analytical and graphical methods, Noise sources, Point, line and Plane sources, characteristic features, Sound/Noise frequency, categorization of frequency, harmful effects of noise on important frequency bands. **SLE:** Sound Levels- Pressure, Power and Intensity, Manipulation of Noise, Solutions – Graphical and Analytical.

10 Hours

UNIT-3

Sound/Noise Measurement – Sound/Procedure for noise measurement – Field visit, development of layout and execution of systematic measurement plan, Instrumentation for noise measurement, types of sound measurement systems, sound noise standards, importance of standards, noise

regulation, block diagram of sound pressure measurement system, sound intensity measurement system, importance of microphones for measurement, types of microphones, types of noise measurement systems, sound analysis, frequency analysis, use of octave filters for measurements. **SLE:** Microphone, Measurement Systems, In Situation and Field Measurement and Analysis.

10 Hours

UNIT-4

Sound / Noise Control- Importance of noise control, Types of controls, Active and passive noise control, control at source, along path and at the receiver end, active noise control principle, use of sound absorbing materials, configurations of noise absorbing materials, acoustic silencers, noise curtains, enclosures, use of composites for effective noise control. Low and high frequency noise absorption, Noise control in buildings, Problems on various design aspects, Reverberation Time, Measurement of Reverberation Time, importance in building acoustics. **SLE:** Passive Control Methods Sound Absorbing Materials, Configurations.

10 Hours

UNIT-5

Noise Regulation – Daytime noise and Night time noise levels, permitted noise levels, how much of sound is too much of sound, Noise Standards in practice, OSHA standard, BIS standard, other noise measurement features, weighted networks, equal loudness contours, Equivalent Sound level, Traffic Noise index, Noise rating curves NRC – Practical measurement in Engine room, around automotive engines, mapping of noise, few case studies and real time problems for discussion and analysis and solutions. **SLE:** Standards and Regulation, NRC, TNI, Real Time Measurement and Analysis, Problems and Case Studies related to buildings and Machinery Acoustics.

10 Hours

Text Books:

1. John E. Foreman Van Nostrand, "Sound Analysis and Noise Control" Reinhold Publication.

Reference Books:

1. Dudley, "Machinery noise control".
2. Edward B. Magrab, “Environmental Noise Control”.
3. Bruel and Kjaer, “Noise-Analysis and Control”–Sound Measurement Review, Denmark.
4. Lawrence Kinsler and Austin Frey, “Fundamentals of Acoustics”.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain acoustics sound and noise in machineries.
CO2	Classify sound and noise and explain harmful effects and develop programs for effective measurement of noise.
CO3	Classify and differentiate between sound and noise, discuss the useful and harmful effects, issues related to machinery acoustics.
CO4	Describe how sound is produced and propagated through various media.
CO5	Explain how sound is measured using various types of instrumentation systems using various configurations, new technology adaptive noise control techniques.

ROTOR DYNAMICS

Subject Code	**MMT242**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To understand the importance of vibrations of rotating systems under various conditions in maintenance engineering applications
2. To study and torsional vibrations of rotating machinery involving various types of systems
3. To learn the importance of critical speed and understand the importance of orbital analysis
4. To study and develop importance of support and support systems and study design configurations of journal bearings.
5. To understand the importance of balancing of rotating systems and develop graphical analysis for rotary systems.

Course Content

UNIT 1

Introduction to Vibration and the Laval-Jeffcott Rotor Model: Vibration of dynamic systems, rotor systems of mechanical and electrical devices, Co-ordinate systems, Steady state rotor motion, Elliptical motion, Single degree of freedom systems, Free and forced vibrations. Two degrees of freedom rotor system, Geared systems, Translational motion, importance of Natural frequencies and Natural modes, Steady state response to unbalance, importance of supports in dynamic systems, types of supports, effect of flexible support.

12 Hours

UNIT 2

Torsional Vibrations of Rotating Machinery: Introduction to torsional vibrations, modelling of rotating machinery shafting, Multi degree of freedom, Systems, Determination of natural frequencies and mode shapes, Branched systems, geared systems, Numerical methods for fundamental frequency, Vibration measurement on rotating machinery, diagrammatic approach in rotating systems, Measurement of torsional vibration.

10 Hours

UNIT 3

Rigid Rotor Dynamics and Critical Speed: Critical Speed in dynamic systems, applications in low and high speed systems, Rigid disk equation - Rigid rotor dynamics, Rigid rotor and flexible rotor, The gyroscopic effect on rotor dynamics, Whirling of an unbalanced simple elastic rotor, Unbalance response, Orbital Analysis and Cascade Plots, Simple shafts with several disks, Effect of axial stiffness, Determination of bending critical speeds, Campbell diagram.

10 Hours

UNIT 4

Influence of Bearings on Rotor Vibrations: Influence of Support stiffness for rotating systems, Importance of supports on critical speeds, Stiffness and damping for low speed and high speed applications in coefficients of journal bearings, Computation and measurements of journal

bearing coefficients, Mechanics of Hydro dynamic Instability, Half frequency whirl and Resonance whip, Design configurations of stable journal bearings. **10 Hours**

UNIT 5

Balancing of Rotors: Introduction to Balancing, balancing of rotating and reciprocating masses, Importance of balancing in dynamic systems, Single plane balancing, Multi-plane balancing, Balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexible rotors, graphical analysis, applications in automotive systems balancing.

10 Hours

Text Book:

1. J. S. Rao, "Rotor Dynamics", New Age International Publishers, New Delhi.

Reference Books:

1. S. Timoshenko, D H. Young and W. Weaver, "Vibration Problems in Engineering", John Wiley.
2. W J Chen and J E Gunter, "Introduction to Dynamics of Rotor – Bearing Systems", Trafford Publishing Ltd.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Describe the importance of vibrations of rotating systems under various conditions in maintenance engineering applications.
CO2	Determine natural frequency and mode shapes of various types of rotor systems.
CO3	Calculate critical speeds and carry out orbital analysis and draw cascade plots.
CO4	Describe the importance of support and support systems and develop design configurations of journal bearings.
CO5	Develop equations for balancing of rotating systems and generate graphical analysis.

MAINTAINABILITY

Subject Code	MMT243	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	4 + 2 (L+T)	Exam Hours	3
Total No. of Contact Hours	52 + 26 (L+T)	Exam Marks	100

Course Objectives:

1. To apply knowledge of fundamentals of maintainability and its relevance in maintenance engineering.
2. To understand tools of maintainability and develop cause and effect diagrams
3. To understand the various human factors in maintenance engineering and develop safety checklists.
4. To understand the concept of reliability centered maintenance and demonstrate models.
5. To understand the importance of maintainability prediction techniques and its relevance in machinery maintenance.

Course Content

UNIT- 1

Maintainability: Purpose and Importance – Terms and definitions – Maintainability Management – Product Life Cycle – Maintainability organizational structures – Program plan – Design reviews. Maintainability measures – Functions and models – System effectiveness – Availability and dependability models.

10 Hours

UNIT- 2

Maintainability tools: Failure Mode, Effects and criticality analysis, Cause and effect diagrams, TQM - Maintainability allocation. Maintainability Design considerations, Standardizations – Interchangeability, Modularization, Simplification, General maintainability and design considerations.

10 Hours

UNIT- 3

Human factor consideration: Auditory and visual warning, Environmental factors – Safety considerations, Electrical, Mechanical and other hazards – Safety checklists. Cost considerations – Costs associated with maintainability - Maintenance cost estimation models.

10 Hours

UNIT- 4

Reliability centered maintenance: The RCM Process – RCM implementation review groups – Methods of monitoring equipment condition – RCM applications. Maintainability, testing, Demonstration and Data Maintenance models and Warranties.

10 Hours

UNIT- 5

Maintainability prediction: Maintainability prediction techniques, integration of maintainability prediction results. Maintainability test and demonstration, system/product test requirements, test planning, admission and control. Formal demonstration phase, evaluation, Data analysis and corrective action

12 Hours

Text Books:

1. A.S. Goldman and T.B. Slattery "Maintainability- A major element of system effectiveness", Robert.E.Krierger publishing company.

Reference Books:

1. Kececioglu D.: Maintainability, Availability and Operational Readiness Engineering, Prentice Hall, New Jercy, 1995.
2. Elsayed E.A.: Reliability Engineering, Addison Western Massachusetts, 1996.
3. Moubray, J.: Reliability – Centered Maintenance, Industrial Press, Inc, New York, 1992.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Apply knowledge of fundamentals of maintainability and its relevance in maintenance engineering.
CO2	Apply tools of maintainability and develop cause and effect diagrams.
CO3	Analyze the various human factors in maintenance engineering and develop safety checklists.
CO4	Apply the concept of reliability centered maintenance and demonstrate models.
CO5	Analyze the importance of maintainability prediction techniques and its relevance in machinery maintenance.

VALUE ENGINEERING

Subject Code	**MMT251**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To understand the concepts of value engineering, identify the advantages, applications.
2. To understand various phases of value engineering. Analyze the function, its approach and evaluation.
3. To learn queuing theory.
4. To evaluate the value engineering operation in maintenance and repair activities.
5. To create the value engineering team and discuss the value engineering case studies.

Course Content

UNIT-I

INTRODUCTION: Value engineering concepts, advantages, applications, problem recognition, and role in productivity, criteria for comparison, element of choice, **ORGANIZATION:** Level of value engineering in the organization, size and skill of VE staff, small plant, VE activity, unique and quantitative evaluation of ideas .

10 Hours

UNIT-II

VALUE ENGINEERING JOB PLAN: Introduction, orientation, information phase, speculation phase, analysis phase. Selection and Evaluation of value engineering Projects, Project selection, methods selection, value standards, application of value engineering methodology, **ANALYSIS FUNCTION:** Anatomy of the function, use esteem and exchange values, basic vs. secondary vs. unnecessary functions. Approach of function, Evaluation of function, determining function, classifying function, evaluation of costs, evaluation of worth, determining worth, evaluation of value

12 Hours

UNIT-III

VALUE ENGINEERING TECHNIQUES: Selecting products and operation for value engineering action, value engineering programmes, determining and evaluating function(s) assigning rupee equivalents, developing alternate means to required functions, decision making for optimum alternative, use of decision matrix, queuing theory and Monte Carlo method make or buy, measuring profits, reporting results, Follow up, Use of advanced technique like Function Analysis System.

10 Hours

UNIT–IV

VERSATILITY OF VALUE ENGINEERING: Value engineering operation in maintenance and repair activities, value engineering in non hardware projects. Initiating a value engineering programme Introduction, training plan, career development for value engineering specialties, **Fast diagramming:** cost models, life cycle costs.

10 Hours

UNIT–V

VALUE ENGINEERING LEVEL OF EFFORT: Value engineering team, co-coordinator, designer, different services, definitions, construction management contracts, value engineering case studies.

10 Hours

Text Books:

1. Anil Kumar Mukhopadhyaya, "Value Engineering: Concepts Techniques and applications", SAGE Publications 2010

Reference Books:

1. Alphonse Dell'Isola, "Value Engineering: Practical Applications for Design, Construction, Maintenance & Operations", R S Means Co., 1997.
2. Richard Park, "Value Engineering: A Plan for Invention", St. Lucie Press, 1999.
3. Del L. Younker, "Value Engineering analysis and methodology", Marcel Dekker Inc, New York, 2004.
4. Miles, L.D., "Techniques of Value Analysis and Engineering", McGraw Hill second Edition, 1989.
5. Khanna, O.P., "Industrial Engineering and Management", Dhanpat Rai & Sons, 1993.

Course Outcomes:

At the end of the course the students shall have the abilities to:

CO1	Describe the concepts of value engineering, identify the advantages, applications.
CO2	List various phases of value engineering. Analyze the function, its approach and evaluation.
CO3	Learn queuing theory.
CO4	Evaluate the value engineering operation in maintenance and repair activities.
CO5	Develop value engineering teams and discuss related case studies.

PLANT ENGINEERING

Subject Code	MMT252	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	4 + 2 (L+T)	Exam Hours	3
Total No. of Contact Hours	52 + 26 (L+T)	Exam Marks	100

Course Objectives:

1. To define various terms and to explain the scope and mention the importance of facilities design function.
2. To explain with sketches various plant utilities and to list factors, characteristics influencing in selection of them.
3. To explain with sketches distributions and control system of Air conditioning and to calculate air quantity required, heat losses and gains.
4. To explain need for energy conservation, Energy audit and Energy Management, and to explain the factors involving motivation and training in facilities design, and to explain housekeeping scope, standards, materials and tools and supervision.
5. To define various terms and to explain the scope and mention the importance of facilities design function.

Course content

UNIT- 1

Facilities Design Function: Definitions, Scope, importance, objectives, functions and activities, facilities design process, types of layout problems, characteristics of good layout, the layout function, Factors for consideration in facilities designs, facilities design as a co-coordinating function, facilities design procedure.

12 Hours

UNIT- 2

Plant Utilities: Electricity generation: Introduction, generation of electrical power, combined heat and power, factors influencing choice, the selection, plant and installation. Types of Boiler, Applications and solutions, super heaters, economizers, water level control, efficiency, boiler installation, automatic controls on boiler, energy conservation and noise in the boiler house

10 Hours

UNIT- 3

Air Conditioning: The air quantity required, heat losses and gains, air conditioning, distribution and system resistance, Fans, dust control and filtration, humidification. Test procedures for air-conditioning systems heating and ventilation.

10 Hours

UNIT- 4

Energy Conservation: The need for energy conservation, energy audit, energy management, major areas of energy conservation, justification for energy-conservation measures, motivation and training.

10 Hours

UNIT- 5

Water and Effluents: Requirements of water, water chemistry water purification processes and effluents Housekeeping scope, standards, use of materials and tools for good housekeeping and supervision

10 Hours

Text Books:

1. James M. Apple, 'Plant Layout and Material Handling',3rd EdThe Renald press company.

Reference Books:

1. Dennis A. Snsow Butterworth N. Heinemann, "Power Engineer's reference Book",
2. Victor J. Cotz, P.E. et, "Plant Engineer" AIS manual and guide", PHI.
3. Charles H. Becker, "Plant Manager's Handbook", McGraw Hill.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Define various terms, explain scope, mention objectives and importance of facilities design process, Discuss types and characteristics of layout problems, explain factors involved in facilities design and procedure.
CO2	Explain electricity generation, factors influencing it, various plants; with sketches explain different types of boilers and their accessories and controls. Describe energy conservation, noise control in boiler house.
CO3	Describe with sketches different air conditioning systems, explain air conditioning distribution and system resistance, fans, dust control filtration, humidification, calculate air quantity required, losses and gains in heat, list Test procedures for air- conditioning systems heating and ventilation.
CO4	Discuss need for energy conservation, major areas of energy conservation and its audit, energy management, discuss motivation and training in facilities design.
CO5	Discuss requirements of water for plants, explain water chemistry, explain water purification process and comment on effluents. Discuss housekeeping scope and standards; explain use of materials and tools for good housekeeping and supervision.

REPAIR TECHNOLOGY

Subject Code	**MMT253**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**4 + 2 (L+T)**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26 (L+T)**	**Exam Marks**	**100**

Course Objectives:

1. To understand the need for repair and maintenance, types, selection of suitable tools and equipments for the systems.
2. To understand types, objectives, benefits and safety of the material handling.
3. To develop the procedures and mechanisms used for repair and maintenance of machines and transmission systems.
4. To learn the concept and components of hydraulic and pneumatic systems, identification of problems associated with them and their rectification.
5. To understand the selection, operation and maintenance procedures for repair and maintenance of heavy duty machines used in industries.

Course content

UNIT- 1

Repair and maintenance: Introduction to repair and maintenance, tools and equipments used for repairs; extractors, jacks, presses, ropes, rope slings and fittings, stages in repair procedure, Maintenance objectives, Scope of maintenance, Types of maintenance, suitability of adoption of maintenance system, Minimizing downtime, Replacement decisions.

10 Hours

UNIT- 2

Material handling: Objectives and benefits of Material handling, Relationship between layout and Material handling, Principles of material handling, Unit load concept, Classification of material handling equipments, Equipment selection. Safety rules for material handling jobs, Factories Act, Safety regulations & Product safety – case studies.

10 Hours

UNIT- 3

Repair of machines and transmission: Repair of bed housing type parts, equipment repair and acceptance procedures, repair of parts and mechanisms of production equipments, shafts, bearings, couplings, clutches, gears, pulleys, pistons, cylinders, and connecting rods, recovery and strengthening of machine elements, repair of filled joints.

10 Hours

UNIT- 4

Maintenance of hydraulic and pneumatic system: concepts of hydraulics, classification of the accessories used in hydraulic system, problems in various valves and auxiliaries, Rectifying the problems, constructional details of pumps and motors, Identifying the problems, Pump Maintenance & Trouble Shooting, Classification the hydraulic circuits and its development, identify various components of pneumatic system, repair and maintenance of air Compressors: Single Acting and Double Acting, Components of Pneumatic System, air receiver and pressure control. 1**2 Hours**

UNIT- 5

Repair and maintenance of heavy duty machines: Selection, operation and maintenance of Industrial Trucks, Mobile Cranes, Tower crane, Checklist, Competent persons, planning the movement of storage and retrieval of common goods of various shapes and sizes in a general store of a big industry, Problems identification in power press, shear and furnace and their repair.

10 Hours

Text Books:

1. B.Celberg, G.Pekeu, "Repair of Industrial equipment", Mir Publishers, Moscow current lieterature.

Reference Books:

1. H.P.Garg, "Industrial Maintenance", S. Chand Limited, 1987

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain the need for repair and maintenance, types, selection of suitable tools and equipments for the systems.
CO2	Explain types, objectives, benefits and safety of the material handling.
CO3	Explain the procedures and mechanisms used for repair and maintenance of machines and transmission systems
CO4	Explain the concept and components of hydraulic and pneumatic systems, identification of problems associated with them and their rectification.
CO5	Explain the selection, operation and maintenance procedures for repair and maintenance of heavy duty machines used in industries.

DYNAMICS LAB

Subject Code	MMT26L	No. of Credits	0 -0 – 1.5
No. of Lecture Hours / Week	3	Exam Hours	-
Total No. of Contact Hours	42	Exam Marks	-

Course Objectives:

1. To explain the various components, methods, standards and techniques associated with Sound measurement around a surface vibrator, frequency analysis, abrasion, sound pressure level in a reverberating room, transmission and insertion losses.
2. To apply the above mentioned knowledge of testing and standards in these techniques and detect the extent and their location of defects, analyze the test results, make inferences and suggest the best technique and on various equipments and location.

Course content

Set of Experiment – 1

Conduct experiments to measure noise around IC-engines with emphasis on frequency analysis.

Set of Experiment – 2

Conduct experiments to measure various types of losses of sound/noise from a source.

Set of Experiment – 3

Conduct experiments to measure noise around utilities like generator, pumps, blowers etc., with emphasis on frequency analysis.

Course outcomes:

At the end of the course the students shall have the abilities to:

CO1	Explain the various components, methods, standards and techniques associated with Sound measurement around a surface vibrator, frequency analysis, abrasion, sound pressure level in a reverberating room, transmission and insertion losses.
CO2	Apply the above mentioned knowledge of testing and standards in these techniques and detect the extent and their location of defects, analyze the test results, make inferences and suggest the best technique and on various equipments and location.