Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(PCC) MDE101: Mathematical Modeling and Design Optimization

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	30 Marks
Tutorials	01 Hrs/Week		ESE	70 Marks
Total Credits	04		TW	25Marks
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To understand the mathematical modeling and simulation techniques.
2. To learn the different Optimization techniques.
3. To practice the Classical Optimization technique, Single variable optimization technique & Multi-variable optimization technique.
4. To realize Taguchi Method.

	Course Contents	**Hours**
Unit 1	**Research Modeling Simulation**: The Reality, the experiment and the model, Concept of modeling, Models as Approximations ,Types of Modeling, Need and Classification of mathematical modeling, Use of Analogy, Data consideration and Testing of Models, Modeling of dynamic systems with differential equations.	(07)
Unit 2	**Simulation:** simulation of data in the form of mathematical equations, Linear-Non-linear equations, determining the Unknowns of Equations using Least Square Criterion, Process of Simulation, Steps and Features of Simulation Experiments and their Validation	(07)
Unit 3	**Optimization Techniques:** **Classical Optimization Techniques**: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions.	(06)
Unit 4	**Single-variable Optimization Techniques:** Linear and Non-Linear behavior, Unrestricted Search, Solution using Graphical Method and Numerical Methods, Interval-halving Method, Golden- section Method, Newton Method, Secant Method	(07)

Unit 5	**Multi-variable Optimization Techniques:**, Non-linear Equations, Steepest Descent Method, Conjugate Gradient Method, Davidson- Fletcher-Powell Method	(06)
Unit 6	**Taguchi Method:** Introduction, Loss Function and Signal –to-noise ratios, Control Factors and Noise Factors, Orthogonal Design, Design of Experiments, steps in carrying out experiment, analysis of variances etc.	(07)

Term Work:
Minimum Six assignments based on above topics

Course Outcomes (CO): At the end of course students will

1. Understand the variety of different types of models and simulations and the different ways in which they are used.
2. To understand the optimization process.
3. Use of different modeling and simulation techniques for the optimization process.
4. Understand Taguchi method for experimentation.

Reference Books

1	Trochim, William M.K. (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN :81-7722-372-0
2	Montgomery, Douglas C., & Tunger, George C. (2007). 3/e, Applied Statistics & Probability for Engineers, (Wiley India).
3	Ross P.J., "Taguchi Techniques for Quality Engineering", TMH,2005.
4	Jeff Wu, "Experiments: Planning, Analysis and Parameter Design", John Wiley,2000.
5	Fox R.L., "Optimization Methods for Engineering Design", Addison Wesley,1971

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(PCC) MDE102: Solid Mechanics

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	01 Hrs/Week		ESE	70 Marks
Total Credits	04		TW	25Marks
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To prepare the students to succeed as designer in industry/technical profession.
2. To provide students with a sound foundation in solid mechanics required to apply in solving industrial problems .
3. To train the students with good design engineering concepts required for safe and efficient design, construction, installation, inspection and testing of structural parts of the mechanical system.

	Course Contents	**Hours**
Unit 1	**Plane stress and plane strain**: Differential equations of equilibrium, Boundary conditions, Compatibility, Stress functions and Bi-harmonic equation	(07)
Unit 2	**Two dimensional problems in Rectangular coordinates**: Applications to polynomials in rectangular coordinates, Saint-Venant's principle idation	(07)
Unit 3	**Two dimensional problems in polar coordinates**: General equations in polar coordinates, Pure bending of curved bars, Strain components in polar coordinates, Rotating discs, stresses in a circular discs.	(06)
Unit 4	**Shear cente:** Shear stress distribution and shear centre for thin walled open sections. Bending of Beams, energy methods, Introduction to elastic stability, plasticity	(07)
Unit 5	**Torsion:** Torsion of bars with elliptical square and rectangular cross section Membrane analogy, Hydro dynamical analogy, Torsion of hollow and thin tubes	(06)
Unit 6	**Membrane stresses in shell and storage vessels,** Shells and vessels of uniform strength. **Contact stresses**: Problem of determining contact stresses, Assumption Expressions for principal stresses, Examples	(07)

Term Work: Minimum Six assignments based on above topics	
Course Outcomes (CO): At the end of course students will	
	1. Solve the problems related to theory of elasticity, plane stress and plane strain with the knowledge of equilibrium equation, compatibility equation, stress function and biharmonic equation.
	2. Analyze two dimensional problems in rectangular co- ordinates and polar co-ordinates.
	3. Find shear centre for thin walled open sections, beam, etc.
	4. Determine membrane stresses in shell and storage vessels.
Reference Books	
1	S. Timoshenko and J.W. Goodier "Theory of Elasticity" MGH book coLtd
2	Sadhu Singh – Theory of Elasticity, Khanna Publisher
3	"Statics and Mechanics of Materials: An Integrated Approach", Riley, Sturges and Morris. Wiley, 2ndEdition.
4	Chakrabarty, "Theory of Plasticity", McGraw-Hill Book Company, New York1990
5	Timo shenko.S. and Young D.H. – "Elements of strength materials Vol. I and Vol. II". T. Van Nostrand Co-Inc Princeton-N.J.1990

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.Tech Mechanical (Design Engineering) Semester- I				
(PE-I) MDE103: Process Equipment Design				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	---		ESE	70 Marks
Total Credits	03		TW	-----
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of process design parameter.
2. To acquire complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.
3. To make students understand and learn about the Piping Design and process equipment design.
4. To acquire knowledge of Process Control, manufacture, inspection and erection of process equipment and Applications of CAD to process Equipment Design

	Course Contents	Hours
Unit 1	**Process Design Parameters**: Basic concepts in process design, block diagrams for flow of processes, material flow balance. Design pressures -–temperatures, design stresses, factory of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria, optimization technique such as Lagrange's multiplier and golden section method, cost and profitability estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515	(07)
Unit 2	**Design of Cylindrical and Spherical Vessels:** Thin and thick walled cylinder analysis, design of end closers, local stresses due to discontinuity or change of shape of vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels	(07)
Unit 3	**Design of Tall Vessels and Large Storage Tanks:** Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column. **Design of Thick Walled High Pressure Vessels:**	(06)

	Design by various theories of failure, construction of these vessels with high strength steel and other special methods.	
Unit 4	**Process Equipment Design:** Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipments and auxiliary services, safety, etc Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverizing equipment, etc. protective coatings, lining of vessels	(07)
Unit 5	**Process Piping Design:** Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports	(06)
Unit 6	**Process Control:** Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes. Applications of CAD to process Equipment Design	(07)

Course Outcomes (CO): At the end of course students will

	1. Knowledge of basics of process equipment design and important parameters of equipment design.
	2. Considerably more in-depth knowledge of the major subject and ability to design internal pressure vessels and external pressure vessels.
	3. Ability to design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads).
	4. Knowledge of Piping Design and process equipment design.
	5. Knowledge of applications of CAD to process Equipment Design

Reference Books

1	Process Equipment Design : By Dr. M.V. Joshi, Mc-Millan
2	Process Equipment Design : By Browell and Young, John Wiley
3	Plant Design and Economics : Max and Timasulaus Kalus – McGraw Hill.
4	Industrial Pipe Work : D.N.W. Kentish, Mc GrawHill
5	Pressure Vessel Design Hand Book : H .Bedna

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Mech. (Mechanical Design) Semester- I

(PE-I) MDE103: Material Handling Equipment Design

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of material handling equipments.
2. To acquire complete knowledge of design of mechanical handling equipments.
3. To make students understand and learn about the design of load lifting attachments.
4. To acquire knowledge of Study of systems and Equipments used for Material Storage equipment and Material Handling / Warehouse Automation and Safety considerations.

	Course Contents	**Hours**
Unit 1	**Elements of Material Handling System:** Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipments.	(07)
Unit 2	**Selection of Material Handling Equipments:-** Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.	(06)
Unit 3	**Design of Mechanical Handling Equipments:-** **[A] Design of Hoists: -** Drives for hoisting, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms. **[B] Design of Cranes: -** Hand-propelled and electrically driven E.O.T. overheat Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.	(07)
Unit 4	**Design of load lifting attachments:-** Load chains and types of ropes used in Material Handling System; Forged, Standard and Ramshorn Hooks; Crane Grabs and Clamps; Grab Buckets; Electromagnet; Design consideration for conveyor belts; Application of attachments.	(06)

Unit 5	**Study of systems and Equipments used for Material Storage:-** Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc.	(07)
Unit 6	**Material Handling / Warehouse Automation and Safety considerations:-** **[A]** Storage and warehouse planning and design; computerized warehouse planning; Need Factors and Indicators for consideration in warehouse automation; which function, When and How to automate; Levels and Means of Mechanizations. **[B]** Safety and design; Safety regulations and discipline.	(07)

Course Outcomes (CO): At the end of course students will

1. Knowledge of material handling equipments.
2. Considerably more in-depth knowledge of the major subject and ability to design of mechanical handling equipments.
3. Ability to design load lifting attachments.
4. Knowledge of Equipments used for Material Storage equipment.

Text Books

1	N. Rudenko, 'Material Handling Equipments', Peace Publishers, Moscow.
2	James M. Apple, 'Material Handling System Design', John-Willlwy and Sons Publication, New York.
3	John R. Immer, 'Material Handling' Mc Graw Hill Co. Ltd., New York.

Reference Books

1	Kulwiac R. A., 'Material Handling Hand Book', 2nd edition, John Willy Publication, NewYork.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech. Mech. (Mechanical Design) Semester- I

(PE-I) MDE103: Product Design and Development

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1.To acquire basic understanding of product design & development

2.To acquire complete knowledge of design of Consumer Product.

3.To make students understand and learn about the Economics Considerations.

4.To make students understand and learn about the Economics Considerations.

	Course Contents	**Hours**
Unit 1	**Introduction to product design:** Approach industrial product based on idea generation and innovativeness (and inventiveness) to meet the needs of the developing society. Design and development process of industrial products, various steps such as creative process involved in idea of marketing, The Designer- his role, myth and reality, the industrial design organization, basic design considerations, Role of Aesthetics in product design, Functional design practice. Use of modeling technique, prototype designs, conceptual design.	(07)
Unit 2	**Design for Production:** Producibility Requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical molding, eliminating defects and features to aid handling, Design for machining ease, the role of process Engineer, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts.	(06)
Unit 3	**a) Industrial Product Design:** General design situations, sailing specifications, requirements and ratings, their importance in the design. Study of market requirements and manufacturing aspects of industrial designs. Aspects of ergonomic design of machine tools, testing equipments, instruments, automobiles, process equipments etc. convention of style, form and color of industrial design. **b) Design of Consumer Product:** Design concepts of consumer products, specification requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic considerations, interpretation of information, conversions for style, forms, colors.	(07)
Unit 4	**Economics Considerations:** Selection of material, design for production, use of standardization, value analysis and cost reduction, maintenance aspects of product design. Economic Factors Influencing Design: Product value, Design for safety, reliability and Environmental considerations, Manufacturing	(07)

	operations in relation to design, Economic analysis, profit and competitiveness, break even analysis, Economics of a new product design (Samuel Eilon Model)	
Unit 5	Value Engineering and Product Design: Introduction, Historical perspective, Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, The value Analysis Job Plan, Creativity, Steps to problem solving and value analysis, Value Engg. Idea generation check list, Cost reduction, materials and process selection in value engineering. Introduction to TRIZ methodology.	(07)
Unit 6	Design Organization: Organization structure, designer's position, drawing office procedure, standardization, record keeping, and legal product of design patents.	(06)

Course Outcomes (CO): At the end of course students will be able to

5. Knowledge of product design & development
6. Considerably more in-depth knowledge of the major subject and ability to design of Consumer Product.
7. Knowledge of Economics Considerations.
8. Deeper knowledge of design Organization, Value Engineering and Product Design.

Text Books

1	Product Design and Development by Karl T Ulrich and Steven d. eppinger
2	Product Design and Development by AK Chitale and Gupta
3	Design of Systems and Devices by Middendorf Marcel Dekker

Reference Books

1	Industrial design for engineers – W. H. Mayall, London Ilifle books,Ltd.
2	Engineering of Creativity: Introduction to TRIZ Methodology of Inventive Problem Solving By Semyon Savransky, CRC Press, 394 pages, 2000.
3	Engineering design conceptual stage – M. J. French, Heinman Education Books.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.TechMechanical (Design Engineering) Semester- I				
(PE-II)MDE- 104: Robotics				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	) Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1.To acquire basic understanding of robot Fundamentals.

2.To acquire complete knowledge of Manipulator Kinematics, Robotics Dynamics and Trajectory planning

3.To make students understand and learn about Robot Sensors and controls.

4.To acquire knowledge of robot vision, programming languages and Futuristic topics in Robotics

	Course Contents	Hours
Unit 1	**Robot Fundamentals** Definitions, History of robots, present and future trends in robotics, Robot classifications, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Issues in design and controlling robots Repeatability, Control resolution, spatial resolution, Precision, Accuracy, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Applications of robots. Drives used in robots- Hydraulic, Pneumatic and Electric drives, Comparison of drive systems and their relative merits and demerits.	(6)
Unit 2	**Manipulator Kinematics:-** Matrix Algebra, Inverse of matrices, rotational groups, matrix representations of coordinate transformation, transformation about reference frame and moving frameForward & Inverse Kinematics examples of 2R, 3R & 3P manipulators, Specifying position and orientation of rigid bodies Euler's angle and fixed rotation for specifying position and orientation Homogeneous coordinate transformation and examples D-H representation of kinematics linkages Forward kinematics of 6R manipulators using D-H representations Inverse kinematics of 6R manipulators using D-H representations, Inverse Kinematics geometric and algebraic methods.	(7)
Unit 3	**Trajectory planning:-** Introduction, general considerations in path description and generation, joint space schemes, Cartesian space schemes, path generation in runtime, planning path using dynamic model point to point and continuous trajectory , 4-3-4 & trapezoidal velocity strategy for robots.	(7)
Unit 4	**Robot Sensors:-**	(6)

	Internal and external sensors, position- potentiometric, optical sensors ,encoders - absolute, incremental ,touch and slip sensors velocity and acceleration sensors, proximity sensors, force & torque sensors, laser range finder, camera. Micro-controllers, DSP, centralized controllers, real time operating systems.	
Unit 5	**Robot Controllers:-** Essential components-Drive for Hydraulic and Pneumatic actuators, H-bridge drives for Dc motor Overload over current and stall detection methods, example of a micro-controller/ microprocessor based robot Controller. **Robot Vision:-** Introduction, Image acquisition, Illumination Techniques, Image conversion, Cameras, sensors, Camera and system interface, Frame buffers and Grabbers, Image processing, low level &high level machine vision systems	(7)
Unit 6	**Robot Programming languages:-** Introduction the three level of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages. **Futuristic topics in Robotics:-** Micro-robotics and MEMS (Microelecto mechanical systems), fabrication technology for Micro-robotics, stability issue in legged robots, under-actuated manipulators, telecheirs.	(7)

Course Outcomes (CO): After the completion of course students will be able to

1.Knowledge of basics of robot Fundamentals

2.Considerably more in-depth knowledge of Manipulator Kinematics, Robotics Dynamics and Trajectory planning

3.Knowledge about Robot Sensors and controls.

4.Deeper knowledge of robot vision, programming languages

5.Knowledge of Futuristic topics in Robotics

Reference Books

1	S.R.Deb, "Robotics Technology and Flexible Automation ", Tata Mc Graw Hill1994
2	M.P.Groover, M. Weiss R.N. Nagel, N.G. Odrey " Industrial Robotics (Technology , Programming and application s) , McGraw, Hill1996
3	K.S.Fu, R.C.Gonzalez and C.S.G.Lee, "Robotics: Control, sensors, vision and inintlligence ", MCGraw-Hill.1987.
4	J.J.Craig, introduction to Robotics, Addision-wesely1989.
5	Klafter, Richard D., et al "RoboticsEngineering", PhI, 1996.
6	ZeuchNello,"Applying Machine Vision ", john Wiley and sons, 1988.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.TechMechanical (Design Engineering) Semester- I				
(PE-II)MDE- 104:Machine Tool Design				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of Machine tool design.
2. To acquire complete knowledge design of machine tool structure, guide ways and power screws.
3. To make students understand and learn about spindle and spindle support.
4. To acquire knowledge of dynamics , automation and controls of machine tools.

	Course Contents	Hours
Unit 1	**Introduction:** Classification of machine Tools, Elements of machine tools, selection of speed and feed, various types of clutch systems, tool drives and mechanism, general requirements of machine tool design process as applied to machine tools, layout of machine tool, various motions introduced in machine tools, parameters defining limits of motions. Requirements of machine, tools drives, mechanical and hydraulics transmission used in machine drives their elements	(7)
Unit 2	**Design of machine tool structure:** Function of machine tool structure and their requirements. Design criteria, materials, Strength and Rigidity consideration, process capability and compliance, static and dynamic stiffness, basic design procedure, design items like beam, column, housing, rams, etc.	(6)
Unit 3	**Design of guide ways and power screws:** Function and types of guide ways, design of slide ways, force analysis of Lathe guide ways, design of antifriction guide ways, design of power screws.	(5)
Unit 4	**Design of Spindle and spindle support:** Function of spindle unit requirement, material of spindles, design calculations design of antifriction bearings, sliding bearing used for spindles	(4)
Unit 5	**Dynamics of machine Tools :** Vibration of machine tools and dynamic rigidity: Effect of vibrations, source of\ vibrations, self excited vibration, single degree of freedom chatter, velocity principle and related models, regenerative principles, chatter in lathe, drilling, milling & grinding, machine tool elastic system, general procedure for assessing Dynamic stability of equivalent elastic system.	(7)

Unit 6	**Automation:** Automation drives for machine tools, Degree of automation, Semi automation, analysis of collect action, design of collect, bar feeding mechanism, tooling layout, single spindle mechanism, analysis, swiss type automatic machine. Loading and unloading. Transfer- devices, Modulator-design concept, in process gauging. **Introduction to machine tool control:** Control system of machine tools: control, mechanical, electrical, hydraulic, numeric and fluidic. Basic principle of control, hydraulic controls, fluid controls, numerical controls, feedback systems, Primary systems programming.	(11)

Course Outcomes (CO): After the completion of course students will be able to

1.Knowledge of basics of Machine tool design

2.Considerably more in-depth knowledge of design of machine tool structure, guide ways and power screws

3.Ability to design spindle and spindle support

4.Knowledge of dynamics, automation.

5.Deeper knowledge of controls of machine tools

Reference Books

1	Machine tool design – N. K. Mehta, 1984, Tata McGraw Hill Publishing Co .Ltd.
2	Principles of Machine tool – G. C. Sen and A. Bhattacharyya, New Central book agency ,Calcutta.
3	Design of machine tool – S. K. Basu, Allied Publishers Bombay.
4	Design principles of metal cutting machine tools – F. KoenigaBerger
5	Machine tools design by Mehta: Tata McGraw-Hill
6	Principles of machine tools by Sen et al Central Book Agency
7	Machine Tool Design by Bassu & Pal: Oxford &IBH
8	Machine tool Design vol. i to iv by Acherken: Mir Publishers
9	Design Principles of Metal cutting machine tools: Koenigsberger:Pergamon

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.TechMechanical (Design Engineering) Semester- I				
(PE-II)MDE- 104: Advanced Design Engineering				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1.To teach some advanced topics in stress analysis such as fatigue and creep

2. To teach analysis of springs used in systems.

3. To teach hazard and reliability analysis.

4.To teach how to modify the design of system such as Cam-follower system, etc.

	Course Contents	Hours
Unit 1	**Engineering Statistics:** Analysis of variance (ANOVA), factorial design and regression analysis, Reliability theory, Design for reliability, Hazard Analysis and fault tree analysis.	(5)
Unit 2	**Fatigue and creep:** Introduction, Fatigue strength, factors affecting fatigue behavior, influence of superimposed static stress , Cumulative fatigue damage , fatigue under complex stresses , fatigue strength after over stresses , true stress and true strength , mechanism of creep of material at high temperature , exponential creep law , Hyperbolic sine creep law , stress relaxation , bending etc.	(7)
Unit 3	**Optimization:** Introduction, multivariable search methods, linear and geometric programming, structural and shape optimization and simplex method.	(6)
Unit 4	**Composite materials:** Composite materials and structures , classical lamination theory , elastic stress analysis of composite material , fatigue strength improvement technique , stresses , stress concentration around cutouts in composite laminate , stability of composite plate and shells , hybrid materials , applications .	(6)
Unit 5	**Design for materials and processes:** Design for brittle fracture, Design for fatigue failure, design for different machining process, assembly and safety etc.	(6)
Unit 6	**Design of Mechanical components:** **a) Gear Design:** Involute Gears, tooth thickness, interference, undercutting, Rack shift, profile modification of spur and helical gears etc. **b) Spring Design:** Vibration and surging of helical springs, helical springs for maximum space efficiency, analysis of Belleville springs, ring springs, volute springs and rubber springs, Design for spring suspension.	(10)

	c) Design for miscellaneous components (To be detailed): Cam shaft with valve opening mechanism, piston, cylinder, connecting rod etc. **d) Cams:** Basic curves, cam size determination, calculating cam profiles, advanced curve, polydyne cams, dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.	

Course Outcomes (CO): After the completion of course students will be able to	
1. Design, cam-follower system for high speeds for any prescribed input motion.	
2. Find stresses in springs used in systems.	
3.Use the Knowledge of fatigue and creep stresses in design of system	
4.Evaluate reliability of components and systems from failure data analysis	
Reference Books	
1	Mechanical Design Analysis – M.F.Spotts
2	Machine Design – Robert Norton
3	Mechanical Metallurgy – G.E. Dieter
4	Engineer Design : A material and processing approach – G.E. Dieter
5	Mechanical Springs – A.M.Wahl.
6	Practical Gear Design – D.W.Dudley.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(PE-III) MDE105: Electric Vehicle

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	---		ESE	70 Marks
Total Credits	03		TW	-----
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of Electric vehical Technology
2. To make the student conversant with power sources of todays and future EV.
3. To prepare the students for a career in the drastically changing automotive industry.
4. To acquaint the student with prerequisite for higher studies in Electric Vehicle
5. To make the students aware with different areas of research in the field of Electric Vehicle

	Course Contents	**Hours**
Unit 1	**Introduction to Electric Vehicles:** Energy crises, Need of future transportation, Introduction and overview of Electric Drive Technologies and Configurations, Traction power requirement for vehicle propulsion under different road and speed condition, EV Indian strategies, policies, R&D and Collaboration, Introduction to Energy Storage	(05)
Unit 2	**Batteries for Electric Vehicles:-** Electrochemical Batteries Reactions and Thermodynamic, Voltage, Specific power and Energy, Working of Pb-Acid batteries, Ni-Fe, Ni- Cd, Ni-MH Batteries, Li- Polymer, Li-ion, Battery selection for Electric Vehicle, Regenerative Braking for battery charging, Effects of Current Density and Heat on Battery Cycle and Life. Battery Storage, Battery Pack Design	(07)
Unit 3	**Battery Charging Technology for Electric Vehicles** Types of battery charging, Normal charging, Opportunity charging, Fast charging, Battery swapping. Battery Charging algorithms, Improve the charging efficiency, Reduce the charging time, enhancing the battery life, Protect the battery, Constant current and constant voltage Charging, Multistage charging (MSC), Pulse Charging, Trickle Charging (TC), Wire and Wireless charging, Charging station infrastructure.	(08)

Unit 4	**Electric Motors in Electric Vehicles:-** Electric Motors used in electric vehicles, DC motors, Induction motors, Permanent Magnet motors, Switched Reluctance motors., Torque speed characteristics of above mentioned motors, Comparison and its layout in EV, Selection of motor for EV, Motor location and drive from motor to wheels.	(07)
Unit 5	**Motor control in Electric Vehicles** Power conversion required in EV. Principle of operation of power electronics devices like: SCR, TRIAC, DIAC, GTO, MOSFET, IGBT and power BJT, Battery to Motor with speed control, Regenerative Braking requirements, Bi-directional and multiple input to single output power conversion in EV. Power conversion required for DC charging and AC charging on board and off boar	(07)
Unit 6	**Safety, Norms and Testing of Electric Vehicles:-** Type approval procedure for electric and hybrid electric vehicles, Government scheme, Electric vehicle conductive AC charging system, DC charging system, V2X technology like V2 home, V2Grid, Self-driving from level 1 to level 5, Autonomous drivin	(06)

Course Outcomes (CO): At the end of course students will

1. To Understand the basic knowledge of electric vehicle technology.
2. To Understand the basic knowledge of electric vehicle technology.
3. To Choose various configurations of an electric vehicle
4. To Configure power transmission system in electric vehicle.

Reference Books

1	James Larmine and John Lowry, Electrical Vehicle Technology Explained,John Wiely and Sons Ltd.,2nd Edition WSE 2015.
2	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamental. CRC Press, 2nd Edition, elibrary 2011
3	C.C. Chan, K.T. Chau, Modern Electric Vehicle Technology, Oxford Publication, New York, 1 st edition 200

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(PE-III) MDE105: Advanced Finite Element Analysis

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	---		ESE	70 Marks
Total Credits	03		TW	-----
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To teach the fundamentals of finite element method with emphasize on the underlying theory, assumption and modeling issues.
2. To make students to study the 1Dand 2D analysis for different field problems.
3. To make students to study the 3D analysis for different field problems.
4. To provide hands on experience using finite element software to model, analyze and design systems of mechanical engineering

	Course Contents	**Hours**
Unit 1	**Introduction to Finite Element Method**: Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods	(05)
Unit 2	**One-Dimensional Elements-Analysis of Bars and Trusses:** Basic Equations and Potential Energy Functional, 1-D Bar Element, trusses, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, 2-D Bar Element, Shape Functions for Higher Order Elements	(07)
Unit 3	**Two-Dimensional Elements-Analysis of Plane Elasticity Problems**: Three-Noded TriangularElement(TRIA3),Four-noded quadrilateral element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD8).	(05)
Unit 4	**Axi-symmetric Solid Elements:** Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements	(07)

Unit 5	**Three-Dimensional Elements and Beam Elements:** Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four- Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements **Beam Elements:** Analysis of Beams and Frames: 1–D Beam Element, 2–D Beam Element, Problems, plate bending and shell elements	(08)
Unit 6	**Heat Transfer and Fluid Flow:** Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media	(08)

Course Outcomes (COs): At the end of course students will

1. Explain the knowledge of Mathematical modeling and FEM.
2. Design Engineering problems by using FEM. Students will develop confidence for self- education and ability for lifelong learning.
3. Formulate and solve Design Engineering problems by using advanced tools. Students will have an ability to carry out research and in the area of Mechanical engineering
4. Design machines, systems, and projects required for industry based on the static analysis of machine components.
5. Use modern tools, software, and equipments to analyze and solve the problems

Reference Books

1	Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier,2006
2	Frank L. Stasa," Applied finite Element Analysis for Engineers", CBS International Edition,1985
3	J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.
4	Bathe K. J. Finite Elements Procedures, PHI. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons,2003
5	Chandrupatla T. R., "Finite Elements in engineering"- 2nd Editions, PHI,2007.2
6	Zeinkovich, "The Finite Element Method for Solid and Structural Mechanics

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(PE-III) MDE105: Reverse Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	---		ESE	70 Marks
Total Credits	03		TW	-----
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of Reverse Engineering.
2. To acquire complete knowledge of tools for Functionality- dimensional- developing technical data - digitizing techniques, etc.
3. To make students understand History of Reverse Engineering – Preserving and preparation for the four stage.
4. To acquire knowledge of data management and integration

	Course Contents	**Hours**
Unit 1	**Introduction** Scope and tasks of RE - Domain analysis- process of duplicating	(04)
Unit 2	**Tools for** Functionality- dimensional- developing technical data - digitizing techniques - construction of surface model - solid-part material- characteristics evaluation - software and application- prototyping - verification	(07)
Unit 3	**Concepts** History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation	(08)
Unit 4	**Data Management** Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software –	(07)
Unit 5	Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces – Reverse Engineering of assembly programs: A model based approach and its logical basics	(06)
Unit 6	**Integration**	(08)

	Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering – Integrating reverse engineering, reuse and specification tool environments to reverse engineering -– coordinate measurement – feature capturing – surface and solid members	

Course Outcomes (CO): At the end of course students will

1. Knowledge of basics of Reverse Engineering.
2. Considerably more in-depth knowledge of tools for Functionality.
3. Knowledge of Preserving and preparation for the four stage
4. Deeper knowledge of data management and integration.

Reference Books

1	Design Recovery for Maintenance and Reuse, T J Bigger staff, IEEE Corpn. July1991
2	White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology,1994
3	Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill,1994.
4	Data Reverse Engineering, Aiken, Peter, McGraw-Hill,1996
5	Reverse Engineering, Linda Wills, Kluiver Academic Publishers,1996
6	Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(LC) MDE106: Design Engineering Lab

Teaching Scheme			**Examination Scheme**	
Lectures	----		ISE	---
Tutorials	---		ESE (Oral)	25
Practical	04Hrs/Week		TW	25
Total Credits	02		Duration of ESE	------.

Course Objectives (CO):

1. To acquire basic understanding of Coordinate Measuring Machine, Turning Center (CNC Lathe) and Vertical Machining Center.
2. To acquire complete knowledge of measurement of vibration parameters, sound parameters.
3. To make students understand and learn about Experimental stress analysis methods.
4. To acquire knowledge Condition monitoring & signature analysis applications

	Course Contents	**Hours**
1	Product Dimension Measurement using Coordinate Measuring Machine	(04)
2	Measurement of vibration parameters using FFT analyzer	(04)
3	Measurement of Sound parameters: a) Sound intensity level b) Sound Power level c) Sound Pressure level	(04)
4	Condition monitoring & signature analysis applications.	(04)
5	Vibration signature analysis of different existing machines such as Lathe, Grinder, Blower	(04)
6	Bonding of strain gauges & Stress Analysis of Machine component by strain gauge technique	(04)
7	Casting of Photoelastic model	(04)
8	Stress Analysis of Machine component using photoelasticity	(04)
9	Programming On Turning Center (CNC Lathe)	(04)
10	Programming On Vertical Machining Center	(04)

Course Outcomes (CO): At the end of course students will	
	1. Knowledge of Product Dimension Measurement using Coordinate Measuring Machine.
	2. Ability to measure vibration parameters, sound parameters.
	3. Ability to programming on Turning Center (CNC Lathe) and Vertical Machining Center
	4. Considerably more in-depth knowledge of the major subject.
	5. Deeper knowledge of Experimental stress analysis methods
	6. Knowledge of Condition monitoring & signature analysis applications
Reference Books	
1	B. C. Nakra & K. K. Choudhary, "Instrumentation, Measurement & Analysis" Tata McGraw Hill Publications Pvt. Ltd., New Delhi
2	Earnest O Doeblin, "Measurement Systems: Applications & Design", McGraw Hill International
3	Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
4	Dally and Riley, "Experimental Stress Analysis" McGraw Hill
5	Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, "Experimental Stress Analysis" Tata McGraw Hill
6	Sadhu Singh "Experimental Stress Analysis" Khanna publisher anics
7	Pabala B.S. " CNC machines"
8	Jha B.K." CNC Programming"

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(SW) MDE107: Seminar – I

Teaching Scheme			**Examination Scheme**	
Lectures	-----		ISE	---
Tutorials	---		ESE (Oral)	---
Practical	02Hrs/Week		TW	50
Total Credits	01		Duration of ESE	------.

Course Objectives (CO):

1. To Identify, understand and discuss current, real-world issues.
2. To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). And apply a multidisciplinary strategy to address current, real-world issues.
3. To Improve oral and written communication skills.
4. To Improve presentation skills

	Course Contents	**Hours**
1	Seminar-I should be based on the literature survey on any topic relevant to Design Engineering (should be helpful for selecting a probable title of the dissertation). Each student has to prepare a write up of about 25-30 pages of "A4" size sheets and submit it in IEEE format in duplicate as the term work. The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The concerned faculty should assess the students based on the quality of work carried out, preparation and understanding of the candidates. Some marks should be reserved for the attendance of a student in the seminars of other students.	(--)

Course Outcomes (CO): At the end of course students will

1. Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.
2. Learn and integrate. Through independent learning and collaborative study, attain, use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization and the ability to integrate information across disciplines.
3. Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
4. Communicate. Acquire, articulate, create and convey intended meaning

	using erbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PCC) MDE201: Vibration Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	01 Hrs/Week		ESE	70 Marks
Total Credits	04		TW	25Marks
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To understand the fundamentals of Vibration Theory.
2. To acquire complete knowledge of analysis of Two degree freedom system, Multi degree freedom system and Vibration of Continuous Systems.
3. To make students understand and learn about the Experimental Methods in Vibration Analysis.
4. To acquire knowledge of Analytical Dynamic Analysis, Non-Linear Vibrations and Random Vibration

	Course Contents	**Hours**
Unit 1	**Fundamentals of Vibration:** Review of Single and Two degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and a periodic excitations Impulse response - Transient vibration - Laplace transformation formulation. Fourier transforms- definition, Relation to transfer functions, first order systems, applications. Basic Concepts like Passive, Semi- active and Active Parameters	(07)
Unit 2	**Two Degree Freedom System:** Optimum design of single, two degree of freedom systems, Vibration Absorber and Vibration isolators	(07)
Unit 3	**Multi Degree Freedom System:** Normal mode of vibration - Flexibility matrix and stiffness matrix - Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis - Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of determining natural frequencies. **Vibration of Continuous Systems:** Systems governed by wave equations - Vibration of strings - Vibration of rods - Euler's equation for beams - Effect of Rotary inertia and shear deformation - Vibration of plates. .	(06)

Unit 4	**Experimental Methods in Vibration Analysis**: Vibration instruments - Vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, experimental modal analysis methods, Examples of vibration tests - Industrial case studies	(07)
Unit 5	**Non-Linear Vibrations**: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Limit cycles-van der pol oscillator, Perturbation method, Chaos, Method of iteration, Self-excited oscillations, Lindstedt's Methods	(06)
Unit 6	**Random Vibrations**: Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response	(07)

Term Work:
Minimum Seven assignments based on above topics

Course Outcomes (CO): At the end of course students will

1. Knowledge of fundamentals of Vibrations.
2. Considerably more in-depth knowledge of the major subject and ability to solve problems on Two degree freedom system, Multi degree freedom system.
3. Knowledge of Experimental Methods in Vibration Analysis.
4. Knowledge of Non-Linear Vibrations and Random Vibrations.

Reference Books

1	Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd.,1984
2	Thomson, W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi,1990
3	Den Hartog, J.P., "Mechanical Vibrations", Dover Publications,1990.
4	Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman,1995
5	D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letch worth (Herefordshire, England)(1984)
6	Fundamentals of Mechanical Vibration. - S. Graham Kelly. 2 nd edition McGrawHill
7	Vibration: Fundamental and Practice, Clarence W. de Silva, CRC Press LLC,2000
8	Mechanical Vibrations - S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill,2007

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PCC) MDE202: Smart Materials and Structure

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	01 Hrs/Week		ESE	70 Marks
Total Credits	04		TW	25Marks
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. The course is designed to give an insight into the latest development regarding, Smart materials & their types.
2. To know High –Band width, Low strain smart sensors.
3. To Know smart Actuators.
4. To Understand smart composites
5. To know advances in smart structures and materials

	Course Contents	**Hours**
Unit 1	**Overview of smart materials** Introduction to Smart Materials, Principles of Piezoelectricty, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers,	(06)
Unit 2	**Advanced Materials** Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids	(06)
Unit 3	**High-band width, low strain smart sensors** Piezeoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors	(08)
Unit 4	**Smart actuators** Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect,	(08)

	Wiedemann Effect, Magneto volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Controls	
Unit 5	**Smart composites** Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams	(06)
Unit 6	**Advances in smart structures & materials** Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design	(06)

Term Work:

Minimum Six assignments based on above topics

Course Outcomes (CO): At the end of course students will

1. Ability to design sensors & actuators using smart (piezoelectric, shape memory alloys) materials.
2. Student understands high –Band width, Low strain smart sensors.
3. Ability to understand applications of smart actuators.
4. Ability to interpret emerging technical literature related to smart materials and structures and demonstrates knowledge in a project.

Reference Books

1	Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2	Gauenzi, P., Smart Structures, Wiley, 2009
3	Cady, W. G., Piezoelectricity, Dover Publication.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical Engineering (Design) Semester- II

(PE –IV) MDE- 203 : Experimental Stress Analysis

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1 To acquire basic understanding of Experimental stress analysis methods.

2 To acquire complete knowledge of Photoelasticity

3 To make students understand and learn about the strain gauges

4 To acquire knowledge of coating method, Holography and Moire technique

	Course Contents	**Hours**
Unit 1	**Photo Elasticity :** Arrangement of optical elements in a polar scope, Theory of photoelasticity, Plane & circular polariscope, Isoclinics and isochromatics **Model Materials** : Properties, selection and method of calibration. **Different methods of analysis**: Compensation technique, principle stresses separation technique, calibration methods fringe Multiplication, scaling model to prototype, Application of photo elasticity for two dimensional models..	(07)
Unit 2	**Three Dimensional Photoelasticity**: Stress locking in model materials, slicing technique, shear difference method. Scattered light photoelasticity, Dynamic photoelasticity	(05)
Unit 3	**Strain Gauges:** Electrical Resistance strain gauges: types, gauge factor, sensitivity, applications. Materials ,Bonding of strain gauges : surface preparation ,moisture proofing etc .types of bonds.	(08)

	Testing of gauge installations.Strain measuring circuits, commercial strain indicators.Rosette Analysis. Strain gauge transducers. Cross sensitivity, Temperature compensation.Semi –Conductor strain gauges.	
Unit 4	**Coating Methods for stress analysis** : Coating stresses, Birefringent coatings (Photoelastic & Brittle coatings), coating sensitivity, coating materials, analysis of brittle- coating data.	(07)
Unit 5	**Holography:** Equation for plane waves and spherical waves Intensity – Coherence – Spherical radiator as an object (record process) Hurter – Driffeld curve reconstruction process General case. Holographic setup	(06)
Unit 6	**Moire technique**: Geometrical approach – sensitivity of Moire data - data reduction in plane and out plane Moire methods – Moire photography – Moire grid production.	(07)

Course Outcomes (CO): At the end of course , students will be able to acquire

1. Knowledge of basics of Experimental stress analysis methods
2. Considerably more in-depth knowledge of the major subject and photoelasticity
3. Deeper Knowledge of Strain gauge technique.
4. knowledge of coating method
5. Knowledge of Holography and Moire technique
6. Knowledge of basics of Experimental stress analysis methods

Text Books

1	Dally and Riley, “Experimental Stress Analysis”. McGrawHill.
2	Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, “Experimental Stress Analysis”. TataMcGrawHill.
3	Sadhu Singh “Experimental Stress Analysis”. Khanna publisher.

4	Hand Book of Experimental Stress Analysis by Hyteneyi.
Reference Books	
1	M. M. Frocht, “Photo elasticity Vol I and Vol II. John Wiley &sons.
2	Perry and Lissner, “Strain Gauge Primer”.
3	Kuske, Albrecht & Robertson “Photo elastic Stress analysis” John Wiley &Sons.
4	Dave and Adams, “Motion Measurement and Stress Analysis”.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PE –IV) MDE--203 Design For Sustainability And Life Cycle Cost

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of sustainability and design for sustainability.
2. To acquire complete knowledge of Integrated Sustainable Life Cycle Design and Life Cycle Costing
3. To make students understand and learn about Life Cycle Cost Models, Maintenance and Repair Costs
4. To acquire knowledge of Product Disposal Costs and Activity Based Life Cycle Costing

	Course Contents	**Hours**
Unit 1	**Introduction:** History, definition, concept of product life cycle and life cycle cost (LCC), design for sustainability, product life cycle costing in the changing industrial scenario, the traditional approach to product/system selection, LCC approach to product system selection, introduction to reliability, maintainability, availability and life cycle cost.	05
Unit 2	**Product Design for Sustainability:** Sustainability and product design, types of sustainability, environmental sustainability, and sustainment dominated products, technology sustainment activities, technology obsolescence, technology insertion, technology monitoring and forecasting.	05
Unit 3	**Integrated Sustainable Life Cycle Design:** Concept of product life cycle design, design for X (DFX), life cycle design methodologies, design for manufacturing (DFM), design for assembly (DFA), design for reliability and maintainability (DFRM), design for serviceability	06

	(DFS), design for environment (DFE), design for product retirement (DFPR) and Life cycle assessment (LCA), Integrated sustainable life cycle design.	
Unit 4	**Basics of Life Cycle Costing:** Cost issues in product life cycle design, theory of product life cycle costing, need for product life cycle costing, cost estimating approaches, parametric cost estimation, cost estimation by analogy, detailed cost estimation, and activity based cost estimation, life cycle costing application areas.	06
Unit 5	**Life Cycle Cost Models:** Introduction, classification, types of life cycle cost models and their inputs, general life cycle cost models and specific life cycle cost models, activity based life cycle cost models, applications of these models to typical industrial products, life cycle costing economics, time value of money and present value of life cycle cost.	05
Unit 6	**Modeling Maintenance and Repair Costs:** Factors influencing maintenance cost, types of maintenance costs, preventive and corrective maintenance cost estimation, manpower, maintenance material, spare and repair parts costs, maintenance cost estimation models, and maintenance cost data collection, stochastic point processes for repairable systems, methodology for planning renewal process and minimal repair process approach to model maintenance and repair costs.	06
Unit 7	**Modeling Product Disposal Costs:** Product end-of-life (EOL) strategies, factors influencing end-of- life strategies, product design for recyclability, compatibility analysis of product design for recyclability and reuse, material recycling at product EOL, system recycling cost, design for disassembly, disassembly cost analysis and estimating product disposal costs.	04
Unit 8	**Activity Based Life Cycle Costing:** General principles of activity based costing (ABC), ABC as applied to Life Cycle Costing, Identification life cycle stages, life cycle activities and cost drivers, development of LCC model, estimation of various LCC components, application of activity based costing to analyze LCC of industrial products/machines.	03
Course Outcomes (CO): At the end of course students will acquire		
1. Knowledge of design for sustainability		

2. Considerably more in-depth knowledge of the major subject and Life Cycle Design	
3. Deeper Knowledge of Life Cycle Costing..	
4. knowledge about Life Cycle Cost Models, Maintenance and Repair Costs	
5. Knowledge of Product Disposal Costs and Activity Based Life Cycle Costing	
Reference Books	
1	W.J. Fabrycky, Benjamin S. Blanchard, 1991, "Life-cycle Cost and Economic Analysis", Prentice Hall International Series in Industrial and Systems Engineering
2	B. S. Dhillon, 1989, "Life Cycle Costing: Techniques, Models, and Applications", Gordon and Breach SciencePublishers.
3	Jan Emblemsvag, 2003, "Life-cycle costing: using activity-based costing and Monte Carlo methods to manage future costs and risks", John Wiley and Sons.
4	B. S. Dhillon, 2010, "Life cycle costing for engineers", CRC Press, Taylor and Francis Group.
5	Alphonse J. Dell'Isola, Stephen J. Kirk, 1981, "Life cycle costing for design professionals", McGraw- Hill
6	Guangbin Yang, 2007, "Life cycle reliability engineering", John Wiley and Sons.
7	Fabio Giudice, Guido La Rosa, Antonino Risitano, 2006, "Product design for the environment: a life cycle approach", CRC/Taylor &Francis.
8	Tracy Bhamra, Vicky Lofthouse, 2007, "Design for sustainability: a practical approach", Gower Publishing, Ltd.,2007.
9	Sandborn, P., and Myers, J., 2008, "Designing Engineering Systems for Sustainability" Handbook of Performability Engineering, ed. K., B., Misra, Springer, London, pp.81-103.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PE-IV) MDE- 203 TRIBOLOGY

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	30 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of Tribology.
2. To acquire complete knowledge of friction and wear
3. To make students understand and learn about Bearings, Lubrication and Lubricants
4. To acquire knowledge of lubrication systems.

	Course Contents	**Hours**
Unit 1	**Introduction**: Introduction to Tribology- General Tribology considerations in the design of gears, cams, reciprocating components, etc. Engine Tribology basics- Tribology aspects of engine components such as bearings, piston assembly, valve train and dive train components etc.	(05)
Unit 2	**Friction:** Nature of metal surfaces- surface properties- surface parameters and measurements. Friction-sliding friction-rolling friction characteristics of common metals and nonmetals- friction under extreme environments. Engine friction- Losses and engine design parameters. .	(05)
Unit 3	**Wear:** Economic role of wear-type of wear-wear mechanism-factors affecting wear-selection of materials for different wear situations-measurement of wear-tribometers and Tribometry. Engine wear-mechanisms, wear resistance material and coatings and failure mode analysis	05
Unit 4	**Bearings, Lubrication and Lubricants:** Theory of hydrodynamic lubrication-Generalized Reynolds Equation-Slider bearings-Fixed and pivoted shoe bearings-Hydrodynamic journal bearings-short and finite bearing-Thrust bearings-Sintered Bearing- Non Circular bearings and multi side surface bearings. Lubrication-type of lubricants-Properties and Testing –Service Classification of lubricants-Lubrication of tribological components-Lubrication systems-Lubricant monitoring, SOAP, Ferrography and other rapid testing methods for lubricants contamination.	(10)
Unit 5	**Hydrostatic (externally-pressurized) & Elasto-Hydrodynamic Lubrication:**	(10)

	Hydrostatic bearing-basic concepts, bearing pad coefficient. Restrictors-Capillary, orifice and flow control valve-bearing characteristic number and performance coefficients-Flat, Conical and Spherical pad thrust bearing-Multirecess journal and thrust bearings-Air and gas lubricated bearings. Lubrication of Ball and roller bearings, cams and gears, selection and life estimation, fatigue and diagnostics.	
Unit 6	**Rheodynamic (static) Lubrication:** Non-Newtonian fluids, characteristics, Thixotropic, materials and Bingham solids, grease lubrication and stability. Tribology of components in extreme environments like vacuum, pressure, temperature; tribomonitoring and special applications; Tribology matching and selection, Tribometry, tribo-testing and standards	(05)

Course Outcomes (CO): At the end of course students will

1. Gain knowledge of design for Tribology
2. Have considerably more in-depth knowledge of the major subject and friction and wear
3. Get deeper Knowledge of Bearings, Lubrication.
4. Have knowledge of Hydrostatic (externally-pressurized) & Elasto-Hydrodynamic Lubrication

Reference Books

1. Bowden F.P. & Tabor D., “Friction and Lubrication of solids”, Oxford University Press, 1986. Ernest Rabinoweiez,: “Friction and Wear of materials” Inderscience Publishers,1995.
2. Neale M.J., Tribology-: Hand Book", Butterworth, 1995.
3. Fuller D.D.,: “Theory and practice of Lubrication for Engineers”, John Wiley sons,1984.
4. Gross W. A.: “Gas film lubrication”, Wiley, 1980.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PE-V) MDE- 204 Analysis and synthesis of Mechanisms

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To prepare the students to succeed as designer in industry/technical profession.
2. To provide students with a sound foundation in kinematic and synthesis of machines and mechanisms
3. To train the students to apply complex number, matrices and algebra for analysis of mechanisms
4. To prepare the students to use modern software for kinematic and dynamic analysis of the mechanisms.

	Course Contents	**Hours**
Unit 1	**Basic Concepts:** Definitions and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom. **Kinematic Analysis Of Complex Mechanisms:** velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.	(05)
Unit 2	**Dynamic Analysis of Planar Mechanisms: -** Inertia forces in linkages, kinetostatic Analysis of mechanisms by matrix method. Analysis of elastic mechanisms, beam element, displacement fields for beam element, element mass and stiffness matrices, system matrices, elastic linkage model, equations of motion.	(07)
Unit 3	**Curvature theory**: Fixed and moving centrodes, inflection circle, Euler- Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms.	(05)
Unit 4	**Graphical Synthesis of Planar Mechanisms**: Type, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev Spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, center point and circle point curves, Bermester points,Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation.	(08)
Unit 5	**Analytical synthesis of Planar Mechanisms**:- Analytical synthesis of four-bar and slider- crank mechanism, Freudenstein's equation, synthesis for four accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers. Complex numbers method	(10)

	of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad Method, Robert Chebychev theorem, Cognates	
Unit 6	**Kinematic Analysis of Spatial Mechanisms:** Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms	(05)

Course Outcomes (CO): At the end of course students will

1. Solve the problems related to mechanisms of higher and lower pairs
2. Analyze four bar mechanisms
3. Carry out synthesis of planner mechanisms with two, three and four accuracy points.
4. Synthesize mechanisms using algebra methods
5. Analyze and synthesize mechanisms using complex numbers
6. Apply the knowledge of synthesis of mechanisms to robotics and automatically controlled mechanisms

Reference Books

1	Theory of Machines and Mechanisms, A. Ghosh and A.K.Mallik, Affiliated East-West Press
2	Kinematic Synthesis of Linkages, R. S. Hartenberg and J. Denavit, McGraw-Hill
3	Mechanism Design – Analysis and Synthesis (Vol.1 and 2), A. G. Erdman and G.N. Sandor, Prentice Hall of India
4	Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, 2nd Ed., McGraw-Hill
5	Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw-Hill, 3rdEdition
6	Kinematics and Linkage Design, A.S.Hall, Prentice Hall of India

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar				
First Year M.Tech Mechanical (Design Engineering) Semester- II				
(PE-V) MDE- 204 Vehicle Dynamics				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To understand the fundamentals of Vehicle dynamics.
2. To acquire complete knowledge of suspension, steering system
3. To make students understand and learn about vehicle stability
4. To acquire knowledge of vehicle handling and Aerodynamic Drag of Cars.

	Course Contents	Hours
Unit 1	**Introduction:** Classification of vibration, definitions, mechanical, vibrating systems, mechanical vibration and human comfort, 41odeling and simulation studies. Model of an automobile, one degree of freedom, two degree of freedom systems, free, forced and damped vibrations. Magnification and transmissibility. Vibration absorber, multidegree of freedom systems-closed and far coupled systems, Orthogonality of modal shapes, modal analysis.	(06)
Unit 2	**Suspension:** Requirements, spring mass frequency, wheel hop, wheel shimmy, choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and aft directions. Hydraulic dampers and choice of damper characteristics. Independent, compensated, rubber and air suspension systems. Roll axis and vehicle under the action of side forces.	(07)
Unit 3	**Steering systems :** Front axle types, constructional details, front wheel geometry, Condition for True rolling, skidding, steering linkages for conventional & independent suspensions, turning radius, wheel wobble and shimmy, power and power assisted steering. **Tyres:** Types. Relative merits and demerits. Ride characteristics. Behavior while cornering, slip angle, cornering force, power consumed by a tyre. Effect of camber, camber thrust	(08)
Unit 4	**Stability of vehicles:**	(06)

	Load distribution. Stability on a curved track and on a slope. Gyroscopic effects, weight transfer during acceleration and braking, over turning and sliding. Rigid vehicle-stability and equations of motion. Cross wind handling.	
Unit 5	**Vehicle Handling:** Over steer, under steer, steady state cornering. Effect of braking, driving torques on steering, effect of camber, transient effects in cornering. Directional stability of vehicles	(06)
Unit 6	**Aerodynamic Drag of Cars:** Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. Scope, historical developments, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics	(07)

Course Outcomes (CO): At the end of course students will

1. Knowledge of fundamentals of Vehicle dynamic
2. Considerably more in-depth knowledge of suspension, steering system
3. Knowledge of vehicle stability.
4. Deeper knowledge of vehicle handling
5. Knowledge of Aerodynamic Drag of Cars

Reference Books

1	Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA1992
2	Thomson WT 'Theory of Vibration with Applications', CBS Publishers and Distributors, New Delhi. 1990
3	Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York,1978
4	Cole D E, "Elementary Vehicle Dynamics", Ann Arbor, Michigan, USA,1972
5	Maurice Olley, "Chassis Design – Principles andAnalysis",Bentley publishers
6	J. G. Giles, 'Steering Suspension and Tyres, Illiffe Books Ltd.,1968

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(PE-V) MDE- 204 Reliability Engineering

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To acquire basic understanding of Reliability Engineering.
2. To acquire complete knowledge of Failure data analysis and reliability measures
3. To make students understand and learn about reliability models and Reliability Evaluation of Systems
4. To acquire knowledge of Design for Reliability and Maintainability and reliability Testing.

	Course Contents	**Hours**
Unit 1	**Introduction:** Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of failure, typical engineering failures and their causes, theory of probability and reliability, rules of probability, random variables, discrete and continuous probability distributions. **Failure Data Analysis:** Data collection and empirical methods, estimation of performance measures for ungrouped compete data, grouped complete data, analysis of censored data, fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters.	(06)
Unit 2	**Reliability Measures:** Reliability function–R(t), cumulative distribution function (CDF)–F(t), probability density function (PDF) – f(t), hazard rate function-λ(t), Mean time to failure (MTTF) and Mean time between failures (MTBF), median time to failure (tmed), mode (tmode), variance (σ2) and standard deviation (σ), typical forms of hazard rate function, bathtub curve and conditional reliability.	(07)
Unit 3	**Basic Reliability Models:** Constant failure rate (CFR) model, failure modes, renewal and Poisson process, two parameter exponential distribution, redundancy with CFR model, time-dependent failure models, Weibull, Rayleigh, Normal and Lognormal distributions, burn-in screening for Weibull, redundancy, three parameter Weibull, calculation of R(t), F(t), f(t), λ(t), MTTF, tmed, tmode, σ2 and σ for above distributions	(07)
Unit 4	**Reliability Evaluation of Systems:**	(06)

	Reliability block diagram, series configuration, parallel configuration, mixed configurations, redundant systems, high level versus low level redundancy, k- out-of-n redundancy, complex configurations, network reduction and decomposition methods, cut and tie set approach for reliability evaluation.	
Unit 5	**Maintainability and Availability:** Concept of maintainability, measures of maintainability, mean time to repair (MTTR), analysis of downtime, repair time distributions, stochastic point processes, maintenance concept and procedures, availability concepts and definitions, important availability measure	(06)
Unit 6	**Design for Reliability and Maintainability:** Reliability design process and design methods, reliability allocation, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used, maintainability design process, quantifiable measures of maintainability, repair versus replacement. **Reliability Testing**: Product testing, reliability life testing, burn-in testing, acceptance testing, accelerated life testing and reliability growth testing	(08)

Course Outcomes (CO): At the end of course students will

1. Knowledge of Reliability Engineering
2. Considerably more in-depth knowledge of Failure data analysis and reliability measures
3. Knowledge of Failure data analysis and reliability measures.
4. Deeper knowledge of Design for Reliability and Maintainability
5. Knowledge of reliability Testing

Reference Books

1	Charles E. Ebling, 2004, An Introduction to Reliability and Maintainability Engineering, Tata McGraw Hill Education Private Limited, NewDelhi
2	L. S. Srinath, 1991, “Reliability Engineering”, East West Press, NewDelhi
3	Alessandro Birolini, 2010, “Reliability Engineering: Theory and Practice”,Springer
4	Roy Billiton and Ronald Norman Allan, 1992, “Reliability evaluation of engineering systems: concepts and techniques”, Springer
5	B. S. Dhillon, Chanan Singh, 1981, Engineering Reliability – New Techniques and Applications”, John Wiley andSons
6	Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, “Maintenance, Replacement and Reliability: Theory and Applications”, CRC/Taylor andFrancis
7	B. S. Dhillon, 1999, “Engineering Maintainability”, Prentice Hall of India

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(OEC) MDE-205: Cryogenics

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	30 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. Learn about low temperature applications in engineering
2. Learn to the technology of gas liquefaction, separation and purification..
3. Study of measurement system at low temperature
4. Learn to stored Cryogenic fluids, vacuum system,inslations used

	Course Contents	**Hours**
Unit 1	**Introduction and Properties of materials at low temperature:** Meaning & definition of cryogenics, Importance of cryogenics studies, properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials.	(06)
Unit 2	**Liquefaction of Cryogenic Gases:** Ideal cycle, system performance parameters, Joule Thomson effect, adiabatic expansion, liquefaction systems; Simple Linde Hampson system, Precooled Linde Hampson system, Cascade system, Claude system, comparison of above systems. Claude system for liquefaction of hydrogen and neon	(07)
,Unit 3	**Cryocoolers:** Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford McMohan refrigerator, Pulse tube refrigerator.	(07)
Unit 4	**Cryogenic Plants and Equipment's:** Air separation and purification system linde single column and double column system Dewars, classification of Dewar's, Inner vessel design, Suspension system design, Piping Insulations used in Cryogenics, Importance of Vacuum system in Cryogenics, Vacuum System, Vacuum Pumps , Vacuum Valves	(07)

Unit 5	**Cryogenic Measurement systems:** Temperature measurements, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements.	(06)
Unit 6	**Applications of Cryogenics:** Superconductive devices: Superconducting bearings, magnets, motors gyroscope and switches, Cryotrons and MRI Manufacturing process application Medical Application: cryosurgery, skin disease treatment Space applications: Missile launching, propellant pressurizing systems, vehicle cooling, cryopropollents, space simulators Electronic applications: MASER, LASER, infrared detectors, photomultipliers	(07)

Course Outcomes (CO): At the end of course students will

	1. Introduce the importance of Cryogenics and its various applications in different areas
	2. Describe various methods to produce low temperature and phenomena's at cryogenic temperature.
	3. Understand the working principle of different cryogenic refrigeration and liquefaction system.
	4.Understand cryogenic equipment's and plants.
	5.Demonstrate the knowledge of cryogenic instrumentation

Text Books

1	Cryogenics, S.S. Thipase, Narosa Book Distributors Pvt Ltd (1 January 2012)
2	Fundamentals of cryogenic engineering, Mamata Mukhopadhyay, Prentice Hall India Learning Private Limited; 4th edition (1 January 2010)
3	Cryogenic Technology and Applications, A.R. Jha, Elsevier Science

Reference Books

1	Barron F. Randall, "Cryogenic Systems" Oxford University Press, New York2. Cryogenic fundamentals-Haselden, Academic press New York
2	Cryogenic engineering, Thomas Flynn, CRC Press; 2nd edition (June 30, 2020)
3	Cryogenic Engineering & Gas Applications, Dr. P.K. Bose,

Useful Websites

1	www.cryogenicsociety.org
2	www. nptel.ac.in
3	

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- I

(OEC) MDE -205: Design for Manufacture and Assembly

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/Week		ISE	0 Marks
Tutorials	--		ESE	70 Marks
Total Credits	03		TW	--
			Duration of ESE	02 Hrs.30 Min.

Course Objectives (CO):

1. To understand how to apply tolerances, limits fits
2. To understand form design of casting, weldments, forging and sheet metal components.
3. To understand component design and how to apply DFMA Tools
4. To reduce production costs by analyzing and eliminating the factors that greatly affect the time, cost, and quality of manufacturing, assembly and service processes
5. To apply design for the environment

	Course Contents	**Hours**
Unit 1	**Introduction to tolerances:** Tolerances: Limits and Fits, tolerance Chains and identification of functionally important dimensions. Dimensional chain analysis-equivalent tolerances method, equivalent standard tolerance grade method, equivalent influence method. Geometric tolerances: applications, geometric tolerancing for manufacture as per Indian Standards and ASME Y 14.5 standard, surface finish, review of relationship between attainable tolerance grades and different machining	(06)
Unit 2	**Form design of castings, weldments`, forging and sheet metal components:** Materials choice - Influences of materials - Space factor - Size - Weight - Surface properties and production method on form design. Redesign of castings based on parting line considerations, Minimizing core requirements, redesigning cast members using Weldments, form design aspects in Forging and sheet metal components. .	(07)
Unit 3	**Component Design:** Machining Considerations Design features to facilitate machining - Drills - Milling cutters - Keyways – Doweling procedures, Counter sunk screws - Reduction of machined area- Simplification by separation - Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Redesign For Manufacture - Design features to facilitate machining: datum features - functional and manufacturing. Component design – machining considerations, redesign for manufacture, examples	(07)
Unit 4	**DFMA TOOLS**	(07)

	Rules and methodologies used to design components for manual, automatic and flexible assembly,traditional design and manufacture Vs concurrent engineering, DFA index, poke- yoke, lean principles, six sigma concepts, DFMA as the tool for concurrent engineering, three DFMA criteria for retaining components for redesign of a product; design for manual assembly; design for automatic assembly; computer-aided design for assembly using software.	
Unit 5	**DESIGN FOR THE ENVIRONMENT** Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible	(07)
Unit 6	**Product assessment** – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for Recyclability – Design for remanufacture –Design for energy efficiency – Design to regulations and standards.	(06)

Course Outcomes (CO): After the completion of course students will be able to

1. Students get knowledge of how to apply tolerances, limits fits.
2. Students get knowledge of form design of casting, weldments, forging and sheet metal components.
3. Students get knowledge of component design and how to apply DFMA Tools.
4. Students get knowledge of design for the environment.

Reference Books

1	A.K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI2007.
2	G.Boothroyd, P.Dewhurst and W.Knight, Product Design for Manufacture andAssembly, Marcell Dekker, 2002.
3	R.Bryan , Fischer, Mechanical Tolerance stackup and analysis, Marcell Dekker,2004.
4	M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc.,1999.
5	J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Publications,2000.
6	G.E. Dieter ,Engineering Design: A Materials and Processing Approach. McGraw-Hill

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M. Tech Mechanical (Design Engineering) Semester- II

(LC) MDE- 206: Computer Aided Analysis Lab-II

Teaching Scheme			**Examination Scheme**	
Lectures	--		ISE	--
Practicals	4 Hours/Week		ESE	--
Total Credits	02		TW	25 Marks
			Duration of ESE	--

Course Objectives (CO):

1. To make students understand and learn about the analysis and simulation of mechanical parts through software and the solving techniques of various engineering problems.

	Laboratory Experiments (ANY FIVE)	**Hours**
1	**Importing Geometry in FEA Software**	(04)
2	**Static Analysis of a Truss**	(04)
3	**Static Analysis of a Beam**	(04)
4	**Torsional Analysis of a Shaft**	(04)
5	**3 dimensional FE Analysis of ONE of the following using FEA software.** a. Gear tooth analysis b. Crane Hook analysis	(04 + 04)
6	At least **one project and a case study** should be carried out based on recent Publications / Research papers / Technical development.	(04)

Course Outcomes (CO): At the end of course, students will

1.Gain knowledge of importing geometry in FEA software

2.Learn ANSYS- Analysis Software/Any analysis software

3.Be able to use the ANSYS software/Any open source analysis software for solving various problems

Reference Books

1. Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier,2006
2. Frank L. Stasa," Applied finite Element Analysis for Engineers", CBS International Edition, 1985.
3. Bathe K. J. Finite Elements Procedures, PHI.
4. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.
5. Zeinkovich, "The Finite Element Method for Solid and Structural Mechanics, 6th Ed., Elsevier2007.
6. Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated Eastwest Press Pvt. Ltd. New Delhi, 2000.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

(SW) MDE107: Seminar – II

Teaching Scheme			**Examination Scheme**	
Lectures	----		ISE	---
Tutorials	---		ESE (Oral)	---
Practical	02Hrs/Week		TW	50
Total Credits	01		Duration of ESE	------.

Course Objectives (CO):

1. To Identify, understand and discuss current, real-world issues.
2. To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). And apply a multidisciplinary strategy to address current, real-world issues.
3. To Improve oral and written communication skills.
4. To Improve presentation skills

	Course Contents	**Hours**
1	Seminar II shall be based on tentative topic of dissertation such as review paper on some specific well defined area/ specialized stream of Mechanical Engineering.Each student has to prepare a write up of about 25-30 pages of "A4" size sheets and submit it in IEEE format in duplicate as the term work. The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The faculty, based on the quality of work, carried out, preparation and understanding of the candidates. Some marks should be reserved for the attendance of a student in the seminars of other students. .	(--)

Course Outcomes (CO): At the end of course students will

1. Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.
2. Learn and integrate. Through independent learning and collaborative study, attain, use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization and the ability to integrate information across disciplines.

	3. Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
	4. Communicate. Acquire, articulate, create and convey intended meaning using erbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

Tatyasaheb Kore Institute of Engineering & Technology, Warananagar

First Year M.Tech Mechanical (Design Engineering) Semester- II

MDE207: Comprehensive Viva

Teaching Scheme			**Examination Scheme**	
Lectures	------		ISE	---
Tutorials	---		ESE (Oral)	25
Total Credits	----		TW	----
			Duration of ESE	------.

Course Objectives (CO):

1. To verify the continuous assessment and performance of students by external examiner and internal examiner.

	Course Contents	**Hours**
1	The students have to prepare on all subjects which they have studied in Ist and IInd semesters The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by institute. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.	(--)

Course Outcomes (CO): At the end of course students will

1. Verify their knowledge based on the subjects they have studied in Semester-I and Semester-II.