Autonomous Program Structure of
Third Year B. Tech. Fifth Semester
(Mechanical Engineering)
Academic Year: 2022-2023 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem	End Sem	Practical	Oral		
20ME501	Computer Aided Engineering (CAE)	3	0	0	50	50	0	0	100	3
20ME502	Heat Transfer (HT)	3	1	0	50	50	0	0	100	4
20ME503	Power Train Design (PTD)	2	1	0	50	50	0	0	100	3
20ME504	Industrial Inspection & Quality Control (IIQC)	2	0	0	50	50	0	0	100	2
20ME505	Numerical Methods (NM)	2	1	0	50	50	0	0	100	3
20OEHS501	Open Elective I (Humanities)	3	0	0	25	0	0	25	50	3
20ME501L	Computer Aided Engineering (CAE) Lab	0	0	2	25	0	25	0	50	1
20ME504L	Industrial Inspection & Quality Control (IIQC) Lab	0	0	2	25	0	0	25	50	1
20ME505L	Numerical Methods (NM) Lab	0	0	2	25	0	25	0	50	1
20ME506L	Thermal Lab (ET & HT)	0	0	2	25	0	0	25	50	1
20ME507L	Design Lab- II (MD & PTD)	0	0	2	25	0	0	25	50	1
20AC501	Audit Course (AC)	0	0	2	0	0	0	0	0	-
	Total	**15**	**3**	**10**	**400**	**250**	**50**	**100**	**800**	**23**
	Grand Total	**28**			**650**		**150**			

Open Elective I (Humanities)

Sr. No.	Course Code	Course Title
1	20OEHS501A	Entrepreneurship Development
2	20OEHS501B	Intellectual Property Rights
3	20OEHS501C	Introduction to Digital Marketing
4	20OEHS501D	Law for Engineers
5	20OEHS501E	Organizational Behaviour
6	20OEHS501F	Project Management

T. Y. B. Tech. -- Semester-I

Course Code	Computer Aided Engineering (CAE)	L	T	P
20ME501		3	-	-
Pre-requisite	Engineering Graphics, Engineering Mathematics, Computer Aided Machine Drawing, Strength of Materials			

Course Objectives:

To make students

1. To apply the homogeneous transformation of geometric 2D/3D CAD entities
2. To model the curves and surfaces geometry
3. To compute stresses, strains, and deflection in the given problem under static loading
4. To compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods for solving 2D structural problems
5. To understand generalized FEM procedure along with the type of analysis and meshing technique

Course Outcomes:

Students will be able to

After successful completion of the course, students will be able to

1. Apply homogeneous transformation matrix for geometrical transformations of 2D & 3D CAD entities for basic geometric transformations
2. Model the curves and surfaces geometry
3. Apply finite element methods to solve 1D structural problems
4. Compute stresses, strains, and deflection in the given problem under static loading by applying finite element methods to solve 2D structural problems
5. Understand generalized FEM procedure along with the type of analysis and meshing technique

Unit/Module: 1	Computer Graphics	8 hours	CO: 1

Transformations (2D & 3D): Introduction, Formulation, Translation, Shear, Rotation, Scaling and reflection, Homogeneous representation, Concatenated transformation, Mapping of geometric models, Inverse transformations, Introduction to 3D transformation

Projections: Orthographic, Isometric, Perspective projections

Unit/Module: 2	Curve and Surface Modeling	6 hours	CO: 2

Curves – Introduction, Analytical curves (Line, circle, ellipse, parabola, hyperbola), Synthetic curves (Hermite Cubic Spline, Bezier, B-Spline Curve) Surfaces – Introduction, Surface representation, Analytic surfaces, Synthetic Surfaces, Hermite bicubic, Bezier, B-Spline, Coons patch surface, Applications in freeform surfaces			
Unit/Module: 3	**One Dimensional Finite Element Analysis**	**8 hours**	**CO: 3**
One Dimensional Problem: Finite element modeling, coordinate and linear shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, (stepped bar, spring in series and parallel), Temperature Effects, Penalty approach, Trusses: Introduction, 2D Trusses, Element stiffness matrix for truss, Assembly of Global Stiffness Matrix, load vector			
Unit/Module: 4	**Two Dimensional Finite Element Analysis**	**8 hours**	**CO: 4**
Plane Stress/Strain problems in 2D elasticity, constitutive relations, Constant Strain Triangle (CST), Liner Strain Rectangle (LSR), displacement function, Pascal‟s triangle, compatibility, and completeness requirement, geometric isotropy, convergence requirements, strain filed, stress filed. Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations			
Unit/Module: 5	**Practical Finite Element Analysis**	**6 hours**	**CO: 5**
Introduction: Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads and constraints), General FEM procedure, Applications of FEM in various fields, p and h formulation, Advantages and disadvantages of FEM Type of Analysis: Linear static, nonlinear, dynamic, buckling, thermal, fatigue, CFD, Crash Introduction to meshing. Types of the element, meshing Techniques. 1D, 2D, and 3D Meshing, Mesh quality check. Effect of mesh density in the critical region, Effect of biasing in the critical region			
	Total hours:	**36 hours**	

Text Books:

1.	Ibrahim Zeid and R. Sivasubramanian, CAD/CAM - Theory and Practice, Tata McGraw Hill Publishing Co. 2010
2.	Daryl Logan, A First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd., 6th Edition 2017

3.	Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
4.	Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune
Reference Books:	
1.	J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw Hill, 2003
2.	Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India

Course Code	Heat Transfer	L	T	P
20ME502		3	1	-
Pre-requisite	Physics, Calculus, Fluid Mechanics	Syllabus Version		
		V:1.1		

Course Objectives:

Course prepares students to

1. To apply laws of heat transfer to ascertain the heat transfer
2. To formulate heat conduction equation using given boundary conditions
3. To identify the requirement of extended surfaces for heat transfer enhancement
4. To determine heat transfer rate in forced and natural convection
5. To predict the radiation heat transfer with the use of radiation shield for given application
6. To calculate efficiency of heat exchanger

Course Outcomes:

Students will be able to

1. apply laws of heat transfer to ascertain the heat transfer rate in steady and transient state heat conduction in solids
2. formulate the equation for heat conduction with heat generation applying suitable BC"s
3. evaluate the requirement of extended surfaces for heat transfer and calculate the heat transfer enhancement using it.
4. analyse the convective heat transfer rate using appropriate correlations
5. predict the heat transfer rate in radiation mode and with the use of radiation shield
6. calculate the efficiency of heat exchanger for given set of operating conditions

Unit/Module: 1	Steady State Conduction Heat Transfer	10 hours	CO: 1,2,3

Modes of Heat transfer, Fourier's law of heat conduction. Steady heat conduction in 1 – D systems. Heat conduction in composite slab, cylinder and sphere, Heat conduction with internal heat generation. Heat transfer through extended surfaces. Critical radius of insulation and insulating materials

Unit/Module: 2	Transient Heat Conduction Analysis	4 hours	CO: 1

Transient heat conduction in solids using lumped heat capacity analysis

Unit/Module: 3	Convection Heat Transfer	8 hours	CO: 4

	Mechanism of convection heat transfer, Energy Equation, Forced convection over flat plate, cylinder and sphere. Concepts of thermal and velocity boundary layer, Empirical correlations. Forced Convection in a pipe, thermal Entrance region, Empirical correlations, Reynolds and Colburn's analogy. Non dimensional parameters and its significance. Natural convection over vertical flat plate and cylinder. Non dimensional parameters and its significance		
Unit/Module: 4	**Radiation Heat Transfer**	**8 hours**	**CO:5**
	Fundamental concepts and laws of radiation, Black and Gray body radiation analysis, Radiation between two gray surfaces, Radiation shields.		
Unit/Module: 5	**Heat Exchangers**	**8 hours**	**CO: 6**
	Introduction and classification. Overall heat transfer coefficient. Heat exchanger analysis using LMTD and NTU method. Effectiveness of heat exchanger.		
	Total Lecture hours:	**38 hours**	

Text Books:

1.	F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley
2.	Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited.
3.	S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press

Course Code	Powertrain Design	L	T	P
20ME503		2	1	-
Prerequisite	Strength of machine elements, Machine Design	Syllabus Version		
		V:1.1		

Course Objectives:

To make students
1. To apply AGMA equations to design a spur and helical gear pair based on strength.
2. To analyze the forces and strengths for designing bevel and worm gears for the required power transmission.
3. To evaluate the tensions and stresses to design/select a flexible drive.
4. To compute the required dynamic load rating for a given bearing to select it from the manufacturer's catalog.
5. To describe the features of transmission systems used for automotive and industrial applications.
6. To elaborate various configurations and operations of hybrid electric vehicles.

Course Outcomes:

After successful completion of the course, student will be able to
1. apply AGMA equations to design a spur and helical gear pair based on strength.
2. analyze the forces and strengths for designing bevel and worm gears for the required power transmission.
3. evaluate the tensions and stresses to design/select a flexible drive.
4. compute the required dynamic load rating for a given bearing to select it from the manufacturer's catalog.
5. describe the features of transmission systems used for automotive and industrial applications.
6. elaborate various configurations and operations of hybrid electric vehicles.

Unit/Module: 1	Elements of transmission systems- Rigid Drives	8 hours	CO: 1,2

Rigid drives-I: Classification and selection of rigid drives, conjugate action, standard tooth systems, force analysis, modes of failures, gear design based on AGMA strength equations and for dynamic load, thermal considerations.

Unit/Module: 2	Anti-friction Bearings and Flexible Drives	8 hours	CO: 3

Modes of failures, static and dynamic load ratings, equivalent dynamic load, reliability and survival of bearing, load-life relationship and selection of bearings from manufacturers catalog.
Power rating, tensions, stresses and selection from manufacturers catalog for flexible drives.

Unit/Module: 3	Mechanical Transmission Systems	4 hours	CO: 4

Manual transmission systems (MT), Automatic transmission systems (AT), hydraulic torque converter, epicyclic gear train. Gear boxes for automobiles and industrial use: Constant mesh, sliding mesh, synchromesh, differential and planetary gearbox.

Unit/Module: 4	**Transmission in Electric and Hybrid Vehicles**	**8 hours**	**CO: 5**
Constructional, operational and performance features, transmission configurations, torque-speed characteristics, sizing of motor and components, motors, power splitting concepts and interface within powertrain system, powertrain architecture -parallel, series and combined, types of EVs, vehicle layout and packaging options, energy devices & combinations, duty cycles in Indian cities, performance, sustainability assessment.			
	Total hours:	**28**	

Reference Books:

1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd
2.	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3.	Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4.	Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5.	"Design Data",P.S.G. College of Technology, Coimbatore.
6.	Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7.	Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum‟s Outline Series.
8.	Michael Nikowitz, „Advanced Hybrid and Electric Vehicles, System Optimization and Vehicle Integration‟, Springer International Publishing Switzerland 2016.
9.	Iqbal Husain, „Electric and Hybrid Vehicles, Design Fundamentals‟, CRC PRESS.

Text Books:

1.	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

Course Code	Industrial Inspection & Quality Control (IIQC)	L	T	P
20ME504		2	-	-
Pre-requisite	Manufacturing Process, Machine Drawing	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes:

Students will be able to

1. Interpret/apply GD&T for a part drawing
2. Analyze the given part drawing / inspection requirement to select a suitable instrument / gauge / inspection method.
3. Specify type and dimension of limit gauges
4. Apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problems.
5. Apply Statistical Quality Control tool(s) to analyse and interpret the data.

Unit/Module: 1	Geometric Dimensioning, Tolerancing and Inspection Needs	6 hours	CO: 1

- **GD&T Basics**: Need and Rules, Features and Material Conditions [MMC & LMC] Regardless of Feature's Size & Rule, Functional Gauging,
- **Datums**: Types, Selection & Datums Control, MMB and LMB, Adding GD&T to a Design;
- **Feature Control Frame**: SLOF for Drawings (Size, Location, Orientation & Form)
- **Form Tolerances**: (Surface, Median Line/MMC): Straightness, Flatness, Circularity, Cylindricity **Orientation Tolerances**: (Surface, Axis): Parallelism, Perpendicularity Angularity Profile Tolerances: Profile of a Surface and Line – Basics, Profile (Modifiers)
- **Location Tolerances**: True Position Concentricity, Symmetry: Runout Tolerances, Circular and Total Runout and Real Life Example

Unit/Module: 2	Inspection Gauge and Dedicated Metrology	8 hours	CO: 1,2

- **Design of Gauges:** Tolerances, Limits and Fits [IS 919-1993], Taylor‟s principle, Types of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design (numerical).

- **Comparators:** Mechanical, Pneumatic, Optical, Electrical (LVDT)
- **Gear Metrology and Thread Metrology:** Types of errors, dedicated instruments and applications

Unit/Module: 3	**Advances in Industrial Inspection**	**3 hours**	**CO: 1**

- **Coordinate Measuring Machine (CMM):** Fundamental features of CMM – development of CMMs – role of CMMs – types of CMM and Applications, – types of probes
- **Machine Vision Systems:** vision system measurement – Multisensory systems.
- **Interferometer:** Principle, NPL Interferometer
- **Laser Metrology:** Basic concepts, laser types, laser interferometers, and applications
- **Industry 4.0:** Inspection 4.0

Unit/Module: 4	**Quality: Tools, Techniques and System**	**8 hours**	**CO: 3**

Quality: Characteristics & elements, Cost vs Value, Deming‟s cycles & 14 Points, Juran Trilogy
***Quality Tools*:** 7 QC Tools, Quality Function Deployment, FMECA, 5S, Kaizen, Poka yoke, Kanban, Six Sigma: DMAIC - Concept and application
Quality Management System: Introduction to ISO 9001, TS-16949, ISO-14000.

Unit/Module: 5	**Statistical quality control and Acceptance Sampling**	**8 hours**	**CO: 4**

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (**X & R** Chart) & Attribute (**P & C** Chart),
Process Capability Indices: (cp, cpk, ppk), Statistical Process Control (Numerical).
Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)

	Total Lecture hours:	**25 hours**	

Text Books:

4.	Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
5.	I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
6.	Jain R.K., Engineering Metrology, Khanna Publication.
7.	Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
8.	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
9.	Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
10.	Basterfield D. H., Quality control, Pearson Education India, 2004.

11.	Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.
Reference Books:	
1.	ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
2.	Juran J. M., Quality Handbook, McGraw Hill Publications.
3.	Online Education resources: viz. NPTEL web site: **(1)** nptel.ac.in/courses/112106179 **(2)** www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html; **(3)** www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; **(4)** freevideolectures.com › Mechanical › IIT Madras (5) nptel.ac.in/courses/112107143/37.

Course Code	Numerical Methods	L	T	P
20ME505		2	1	-
Pre-requisite	Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

To make students

1. To understand numerical errors and error propagation.
2. To apply numerical methods for finding the root of the equation.
3. To solve simultaneous linear algebraic equations by numerical methods.
4. To use numerical methods for curve fitting and interpolation.
5. To apply numerical methods for integration and differentiation
6. To implement numerical techniques for ordinary and partial differential equations.

Course Outcomes:

Students will be able to

After successful completion of the course, student will be able to

1. Understand errors and error propagation.
2. apply numerical method for finding root of the equation
3. solve simultaneous linear algebraic equations by numerical methods
4. use numerical methods for curve fitting and interpolation
5. apply numerical methods for integration and differentiation
6. Obtain an approximate solution of ordinary and partial differential equations applying numerical techniques.

Unit/Module: 1	Root of Equations and Errors	3 hours	CO: 1, 2
Bisection method, Newton Raphson method, Successive approximation method Types of errors, error propagation			
Unit/Module: 2	**Simultaneous Linear Algebraic Equations**	**4 hours**	**CO: 3**
Gauss elimination method, LU decomposition method, Thomas algorithm for tridiagonal matrix, Gauss Seidel method, Jacobi iterative method			
Unit/Module: 3	**Curve Fitting and Interpolation**	**6 hours**	**CO: 4**

Least square technique- straight line, quadratic equation, power equation, exponential equation Interpolation- Newton‟s forward interpolation, Lagrange‟s Interpolation, Spline interpolation			
Unit/Module: 4	**Numerical Integration and Differentiation**	**4 hours**	**CO: 5**
Numerical Integration: trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Gauss quadrature two point formula and three point formula, double integration Numerical Differentiation:			
Unit/Module: 5	**Ordinary and Partial Differential Equations**	**8 hours**	**CO: 6**
Euler‟s method, Heun‟s method, Runge Kutta fourth order method, Runge Kutta second order method for simultaneous ordinary differential equations. PDE: Finite difference method, Elliptic equation , parabolic equation			
	Total Course hours:	**25 hours**	

Texts and Reference materials:

1.	Steven C Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill
2.	Steven C Chapra, Applied numerical methods with MATLAB for engineers and scientists, Tata McGraw Hill
3.	Dr. B.S. Grewal, Numerical methods in Engineering and science, Khanna Publishers
4.	E. Balagurusamy, Numerical methods, Tata McGraw Hill
5.	Laurene Fausett, Applied Numerical analysis using MATLAB, PHI
6.	P.Kandasamy, K.Thilagavathy, K.Gunavathi, Numerical Methods, S. Chand

Course Code	Computer Aided Engineering (CAE) Lab	L	T	P
20ME501L		-	-	2
Pre-requisite	Strength of material, Computer Aided Machine Drawing			

Course Objectives:

1. To prepare a program in MATLAB/OCTAVE tool for finding transformations of CAD object
2. To formulate 1D FEM problem for static structural analysis
3. To use finite element tool for solve bar, beam, and truss problem of static structural
4. To use finite element tool for static structural of mechanical components

Course Outcomes:

After successful completion of the course, students will be able to

1. Develop program in MATLAB tool for finding transformations of CAD object
2. Write a program to formulate 1D FEM problem for static structural analysis and solve
3. Compute stresses, strains, and deflection in the given 1D and 2D problem under static loading
4. Analyze plane stress/plane strain problem under static loading
5. Compute stresses, strains, and deflection of any mechanical component using 3D elements

Lab Work:

1. Build and execute a computer program on concatenated Transformation
2. Program to formulate a static structural analysis of stepped bar/beams
3. Static structural analysis of stepped bar/beam using FEA tool
4. Program to formulate a static structural analysis of truss
5. Static structural analysis of trusses using FEA tool
6. Static structural analysis of any mechanical element/part/component i.e. plate with a hole, bracket, seat belt hook, etc.
7. Static structural analysis of any mechanical component using 3D elements
8. Static structural analysis of any mechanical assembly

Text Books/References:

1. Nitin S. Gokhale, Practical Finite Element Analysis, Finite to Infinite; First edition
2. ANSYS user guide https://www.ansys.com/academic/learning-resources

Course Name	**Industrial Inspection & Quality Control (IIQC) Lab**	L	T	P
Course Code	**20ME504 L**	-	-	2
Pre-requisite	Manufacturing Process, Machine Drawing	**Syllabus Version**		
		V:1.1		

Course Objectives:

To make students

1. Understand the GD & T symbols and its use w.r.to selection of methods of measurement and measuring instruments.
2. Aware about the concept of IS-919 tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology [viz. CMM, Laser, Machine Vision System] for industrial inspection etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes: Students will be able to

1. Demonstrate the use of different length and angle measuring instruments and comparators.
2. Calibrate the measuring instrument and design the limit gauges
3. Select and apply/use appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
4. Apply Statistical Quality Control tool(s) to analyse and interpret the inspection data.

Part [A] Experiment no. 1 and 6 are mandatory. Perform any three from experiment no. 2 to 5 & any three from experiment no. 7 to 10.

Expt. No.1	Measurement of linear and angular dimensions using standard measuring instruments.	2 hours	CO: 1 and CO: 2
Expt. No.2	Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, MSA (Gauge R & R).	2 hours	
Expt. No.3	Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)	2 hours	
Expt. No.4	Verification of dimensions & geometry of given components using Mechanical comparator.	2 hours	
Expt. No.5	Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.	2 hours	
Expt. No.6	Demonstration of surfaces inspection using optical flat/interferometers.	2 hours	
Expt. No.7	Determination of geometry & dimensions of given composite object / single point tool, using profile projector and tool maker‟s microscope.	2 hours	

Expt. No.8	Measurement of thread parameters using floating carriage diameter measuring machine.	2 hours	
Expt. No.9	Measurement of spur gear parameters using Gear Tooth Vernier, Span Micrometer/ Gear Rolling Tester.		
Expt. No.10	Determination of given geometry using coordinate measuring machine (CMM).		
Part [B] Statistical Quality Control (SQC) (Any Two assignments) **Note - Use of computational tools [such as Minitab / Matlab / MS Excel] are recommended**			
Assignment1	Note: For completing this assignment.... 1. The templates ('.excel format') for drawing/developing Pareto Chart, Cause and Effect Diagram, FMEA sheet, 5S Sheet & Kaizen Sheet. 2. Make a screenshot and paste it in the '.ppt format' are made available on Google Classroom. Part - I: Select any product / process and complete following steps... i. Identify & enlist its Quality Characteristics, ii. Identified Failure Modes [related to identified Quality Characteristics], iii. Prepare Check Sheet, iv. Draw Pareto Chart to prioritize quality characteristics, v. Draw Cause and Effect Diagram, vi. Develop FMEA Sheet Part - II: Study any reference / case study available with you (in books or downloaded from internet) related to 5S activity & Kaizen activity then use attached formats of 5S & Kaizen Sheets, prepare it accordingly & add it (ie. its screenshot) in the same template file attached in '.ppt format' to complete this assignment... [Note: Any opportunity of implementing 5S & Kaizen activity at any possible work place like, industry, workshops, shops, your home etc... you are most welcome. Only you need to explain it properly in the given format].	Out of the class activity. [As per selected task for completing this assignment]	CO: 3
Assignment2	Q.1. Instructions... for Variable type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Plot Control Charts of Variables 4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ?	Out of the class activity. [As per selected task for completing this assignment]	CO: 4

	Q.2. Instructions... for Attribute type data-set... Refer excel sheet for data one variable & two attribute data sets, 1. Select appropriate type of charts, 2. Calculate three sigma limits for specific charts, 3. Control Charts of Attribute,		
	4. Interpret the meaning, 5. Determine process capability, 6. Comment on what conclusion would you draw about the ability of the process to produce the items within specified limits or not ? Q. 3. Differentiate between single, double & multiple sampling plans.		
	Total Lecture hours:	**25**	

Text Books:

1	Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
2	I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
3	Jain R.K., Engineering Metrology, Khanna Publication.
4	Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
5	IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
6	Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.
7	Basterfield D. H., Quality control, Pearson Education India, 2004.
8	Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.

Reference Books:

1.	ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
2.	Juran J. M., Quality Handbook, McGraw Hill Publications.
3.	Online Education resources: viz. NPTEL web site: (1) nptel.ac.in/courses/112106179 (2) www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html; (3) www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; (4) freevideolectures.com › Mechanical › IIT Madras (5) nptel.ac.in/courses/112107143/37.

Course Code	Numerical Methods Lab	L	T	P
20ME505 L		-	-	2
Prerequisite	Engineering Mathematics	Syllabus Version		
		V:1.1		

Course Objectives:

1. To use numerical methods to solve problems
2. To use mathematical solver.
3. To prepare flowcharts for numerical methods.
4. To write programs for numerical methods

Course Outcomes:

After successful completion of the course, students will be able to

1. Apply numerical methods to solve engineering problems.
2. Employ mathematical solver for numerical methods.
3. Prepare flowcharts for numerical methods.
4. Write programs for numerical methods.

Lab Work:

1. To prepare flowcharts and write programs for finding Root of Equation: i)Newton Raphson method ii) Successive approximation method iii) bisection method
2. To prepare flowcharts and write programs for Simultaneous Linear Algebraic Equations: i) Gauss elimination methods ii) LU decomposition method iii) Tridiagonal matrix algorithm iv) Jacobi iteration method v) Gauss Seidel method
3. To prepare flowcharts and write programs for Curve Fitting : i) straight line ii) quadratic equation iii) power equation iv) exponential equation
4. To prepare flowcharts and write programs for Interpolation : i) Newton‟s forward interpolation ii) Lagrange interpolation iii) Inverse Lagrange Interpolation
5. To prepare flowcharts and write programs for Numerical Integration : i) Newton Cotes methods ii) Gauss quadrature methods iii) double integration
6. To prepare flowcharts and write programs Ordinary Differential Equations: i) Heun‟s methods ii) Runge Kutta method- 4th order iii) RK2 method for simultaneous ODE
7. To prepare flowchart and write program for Partial Differential Equation : parabolic explicit method

Text Books/References:	
1.	Steven C Chapra, Applied Numerical Methods with MATLAB for engineers and Scientists, McGraw Hill Education

Course Code	Thermal Lab	L	T	P
20ME506 L		-	-	2
Pre-requisite	Manufacturing Process, Machine Drawing	Syllabus Version		
		V:1.1		

Course Objectives:

1. To conduct experiments involving steady state heat transfer phenomenon
2. To analyze and process the experimental data/observations to ascertain the heat transfer
3. To illustrate the results in the graphical form
4. To Compare the results with available theoretical/experimental results and deduce the conclusion from it
5. To study the boiler construction and working

Course Outcomes:

After successful completion of the course, students will be able to

1. Conduct experiments involving steady state heat transfer phenomenon
2. Analyze and process the experimental data/observations to ascertain the heat transfer rate
3. Illustrate the results in the graphical form to find the nature of temperature variation over time and length
4. Compare the results with available theoretical/experimental results and deduce the conclusion from it
5. Understand the construction and working of industrial boiler and its accessories

Lab Work:

1. Determination of Thermal Conductivity of insulating powder
2. Determine heat transfer through composite solid
3. Determination of heat transfer coefficient in Natural Convection
4. Determination of heat transfer coefficient in Forced Convection
5. Determination of Emissivity of a Test surface
6. Determination of Stefan Boltzmann Constant
7. Determination of critical heat flux for given wire
8. Determination of temperature distribution along the fin length
9. Trial on parallel and counter flow heat exchanger
10. Visit to the industry for the study of boiler construction and operations

Text Books/References:

1.	R. C. Sachdeva, „Fundamentals of Engineering Heat and Mass Transfer" New Age International Publishers
2.	R. K. Rajout, „Thermal Engineering", Laxmi Publications

Course Code	Design Lab II	L	T	P
20ME507 L		-	-	2
Prerequisite	Strength of machine elements, Machine design, Transmission system design.	Syllabus Version		
		V:1.1		

Course Objectives:

1. To explain the design process, various design considerations and theories of failures.
2. To design/select the required machine elements for the given application.
3. To design the mechanical system (assembly) for the given application.
4. To present the design work in the form of reports and drawings.

Course Outcomes:

After successful completion of the course, students will be able to

1. explain the design process, various design considerations and theories of failures.
2. design/select the required machine elements for the given application.
3. design the mechanical system (assembly) for the given application.
4. present the design work in the form of reports and drawings.

Lab Work: The lab work will begin in semester IV and conclude at the end of semester V.

A. **Assignments** based on,
   i) Design process, design considerations, standards in design.
   ii) Engineering materials, their features, applications and selection.
   iii) Principal stresses and theories of failures.
   iv) Manufacturing and assembly considerations in design.

B. **Case studies** based on any three of the following engineering applications,
   - Design of a mechanical joint for a roof truss/valve mechanism/foundation bolt.
   - Design of a mechanical coupling for a compressor/pump/gear box.
   - Design of turnbuckle for stay rope/jib crane.
   - Select a belt from the manufacturer's catalogue for the given application.
   - Select a bearing from the manufacturer's catalogue for the required application.

C. **Comprehensive Design Project (Project Based Learning):**
   - Comprehensive project to design a transmission system (gear box) for the specified application.
   - The project work is carried out by a group of 3-5 students.
   - The project involves identification of functional requirements, configuration of specifications, selection of mechanisms, preparation of layout, design of individual elements and the overall assembly.
   - Each group will present the design project work by preparing a design report and drawings by using suitable software.

Text Books/References:	
1.	Shigley J.E. and Mischke C.R., "Mechanical Engineering Design",McGraw Hill Publication Co. Ltd.
2	Spotts M.F. and Shoup T.E. ,"Design of Machine Elements", Prentice Hall International.
3	Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
4	P.S.G. Design Data, PSG College of Technology Coimbatore.
5	Bhandari V.B ,"Machine Design Data Book", Tata McGraw Hill Publication Co. Ltd.