ME 5.1 ENGINEERING STATISTICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 5.1	Engineering Statistics	3	1	--	3	100	25	--	--	25	**150**

Course Objectives:

1. To understand the pattern of randomness found in real life situations and the necessity of modeling the situations
2. To study widely used discrete and continuous distribution along with their applications.
3. To estimate the unknown parameters of the population and implement hypothesis testing
4. To understand advanced statistical analysis through goodness of fit, ANOVA and regression.

Course Outcomes:

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

1. Understand the randomness in real life situations and draw meaningful conclusions.
2. Compute point and interval estimates of parameters of population.
3. Perform hypothesis testing on the derived conclusions about population parameters.
4. Perform statistical analysis using goodness of fit, ANOVA and regression.

UNIT-1 (12 hours)

Probability Preliminary: Review of Set theory, Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem.

Random Variable: Introduction, Discrete and Continuous, Characteristics-Mean, Variance and distribution function.

Function of One Dimensional Random Variable: Discrete and continuous case, E and V-operations with approximations. Moment-Generating function.

Discrete Probability distribution: Bernoulli trial, Binomial, Geometric, Poisson, Hyper-Geometric, Uniform. Mean, variance and distribution function, important properties, approximations and applications.

UNIT-2 (12 hours)

Continuous Probability Distribution: Uniform, Exponential, Normal, Lognormal and Weibull distribution. Mean, variance and distribution function, important properties, approximations and applications.

Statistic and Sampling Distribution: Population and the Sample, Statistic, Sampling distributions- Normal, Student's t-distribution, Chi-square and F- distributions.

UNIT-3 (12 hours)

Parameter Estimation: Point Estimation -Definition, unbiased estimator, standard error, method of maximum likelihood and methods of moments. Parameter estimation of standard distributions- Bernoulli, Binomial, Geometric, Exponential and Normal.

Parameter Estimation: Confidence Interval Estimation- Concept, Confidence interval on mean and difference in means of single and two normal population, variance known and unknown, Confidence interval on variance of normal population and on the ratio of variances of two normal distributions, Error and selection of sample size.

Tests of Hypotheses: Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population and equality of two means of two normal populations with variance(s) known and unknown, on variance of single normal population and variances of two normal populations, choice of sample size.

UNIT-4 (12 hours)

Goodness of Fit Test: Chi-square test- Introduction, concept, algorithm for testing discrete and continuous distributions, P-value, Test for Independence.

Analysis of Variance (ANOVA): Concept, one way and two-way classification, statistical analysis on fixed effect model.

Simple Linear Regression: Empirical Models, Simple Linear Regression Concept, Hypothesis Tests: Use of t-test, ANOVA approach to test significance of regression, Model Adequacy: Residual analysis and Lack-of-fit.

Recommended Readings:

1. D. C. Montgomery, C. G. Runger, Applied Statistics and Probability for Engineers, 6th Edition, n Wiley India, 2016.
2. D. C. Montgomery, G. C. Runger, N. F. Hubele; Engineering Statistics, Wiley India; 5th Edition; 2013.
3. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists,9th Edition, Pearson Education India, 2013.
4. R. A. Johnson, Probability and Statistics for Engineers, 8e, Prentice Hall of India, 2011.
5. T. Veerarajan; Probability, Statistics and Random Processes, 3e, Tata McGraw Hill India; 2017.
6. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010.
7. A. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015

Assignments:

At least eight assignments, two on each unit must be submitted by students within stipulated time.

ME 5.2 MACHINE DESIGN – I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 5.2	Machine Design – I	3	--	2	3	100	25	25	--	--	**150**

Course Objectives:

1. The student will achieve an understanding of the design process in mechanical engineering and will be able to correlate design with manufacturing
2. The student shall learn to select the materials for various applications depending on factors like loading, service conditions, cost etc.
3. The student shall appreciate the various modes of failure in a machine component and use the appropriate theories of failure to carry out the stress analysis and design the components.
4. The student shall understand and be able to design the various types of components such as fasteners, shafts, couplings etc.
5. The student shall be able to decide and design the temporary and permanent joints used in joining machine components.

Course Outcomes:

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

1. Analyze the stresses and strains in mechanical components and be able to understand and identify the failure modes in machine components.
2. Design machine elements and components for static as well as fatigue-loading.
3. Prepare the production drawings of the components designed for shop floor use.
4. Choose the parameters that will optimize the design for mechanical systems.

UNIT - 1 (12 Hours)

Introduction to Design Process: Process of Machine Design, Design considerations in machine parts, Use of standard codes, Factor of Safety, Preferred Numbers and Preferred Series.

Static Considerations in Design: Design of simple parts subjected to direct and combined stresses. Design of cotter joint and knuckle joint.

Design of curved members- Rectangular, circular, trapezoidal and I-Cross sections.

Design of levers- Hand/foot lever, bell crank lever and lever for safety valve.

UNIT - 2 (12 Hours)

Flexible Power Drives: Classification and comparison of flexible drives.
Belt Drives- Flat belt and V belt drives, open and crossed belt drives, length of open and crossed belt drive, stresses in flat and V-belts, selection of flat and V-belts for industrial applications using Data Book/manufacturer's catalogue.
Design for Fatigue: Stress concentration, reasons, effects and methods to reduce stress concentration, fluctuating stresses, failure due to fatigue, S-N curve, endurance limit, endurance strength modifying factors, Design for finite and infinite life, Miner's equation, Soderberg, Goodman, Gerber criteria in designing for alternating stresses. Modified Goodman diagram. Design of components for fatigue under combined stresses.

UNIT - 3 (14 Hours)

Design of Joints: Threaded connections- Screw fastener classification, Terminology of ISO Metric threads, Bolted joint in tension, Eccentrically loaded threaded joints, Eccentric load on circular base, Threaded joints subjected to fatigue loading.
Welded Joints- Stresses in fillet and Butt welds. Strength of Parallel and Transverse fillet weld, Eccentrically loaded welded joints. Weld joints subjected to bending and twisting moments, Welded joints subjected to fatigue.
Design of Shafts: Design of shaft based on strength, torsional rigidity and lateral rigidity. Design of shaft based on A.S.M.E. code.
Design of Keys: Classification of keys, Design of Parallel, Taper Sunk keys, Woodruff key and Splines.
Design of Couplings: Classification and objectives of couplings, Design of Flanged Coupling and Flexible Bushed Pin Coupling.

UNIT - 4 (10 Hours)

Springs: Types, application and material for springs, Design equations for Helical Compression springs, Styles of ends, Design of Helical Compression and Tension Springs, Concentric Helical Springs, Helical Torsion Springs, surge in springs.
Multi-Leaf springs: Design equations for leaf springs, nipping of leaf springs, Design of Multi Leaf springs.

Recommended Readings:

1. V. B. Bhandari; Design of Machine Elements; Tata McGraw-Hill Education; 2010.
2. J. E. Shigley; Mechanical Engineering Design; Metric Edition; McGraw-Hill Publication; 1986.
3. A. S. Hall, A. R. Holowenko, H. G. Laughlin; Theory and Problems of Machine Design; Schaum's Outline Series; 1981.
4. C. S. Sharma, K. Purohit; Design of Machine Elements; PHI Learning Pvt. Ltd; 2009.
5. D. K. Aggarwal, P. C. Sharma; Machine Design; S. K. Kataria and Sons; 2013.
6. M. F. Spotts, T. E. Shoup; Design of Machine Elements, Prentice Hall International; 1998.
7. P. Childs; Mechanical Design Engineering Handbook; Butterworth-Heinemann; 1e; 2013.
8. R. L. Norton; Machine Design: An Integrated Approach, Pearson India; 2e; 2006.

Recommended Data Books for learning and examination:

1. PSG College Coimbatore - Kalaikathir Achchagam; Design Data Book; 2012.

2. K. Mahadevan, K. Balveera Reddy; Design Data Handbook for Mechanical Engineers, 4e, CBS Publishers; 2015.

Term Work shall consist of the following:

1. Design of Cotter joint and preparing assembly and production drawings.
2. Design of Knuckle Joint with assembly and production drawings.
3. Design of shaft transmitting power through belt drives, gears, mounted with flywheel, etc.
4. Design of coupling and preparing assembly and production drawings.

ME 5.3 ENERGY CONVERSION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 5.3	Energy Conversion	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. Study of air standard and actual engine cycles.
2. Study of SI and CI engine components and processes involved
3. Study and analysis of engine performance characteristics and engine emissions
4. Study alternate fuels for IC Engine.

Course Outcomes:

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

1. Distinguish SI and CI engines
2. Identify and explain working of engines components/systems
3. Analyze engine performance characteristic
4. Perform exhaust gas analysis and comment on adverse implications on environment

UNIT-1 **(12 hours)**

Engine Construction and Operation: Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines and their comparative study.

Fuel Air Cycles and their Analysis : Introduction, Fuel Air Cycles & their significance, Variable Specific heat, Dissociation, Effect of no. of moles, Comparison of Air Standard & Fuel Air Cycles, Effect of operating Variables.

Actual Cycles and their Analysis: Introduction, Comparison of thermodynamic & Actual Cycles, various losses.

Fuels: Important qualities of the Engine fuels - SI and CI engines, Alternate fuels (SI & CI engines) - Liquid fuels, gaseous fuels.

UNIT-2 **(12 hours)**

Spark Ignition Engines: Theory of Carburetion, Types of carburetors, Multi-Point fuel injection system, GDI concept, Combustion in spark Ignition engines, stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, Phenomenon of Detonation in SI engines, effect of engine variables on Detonation. Combustion chambers. Rating of fuels in SI engines, Additives.

Compression Ignition Engines: Fuel supply system, types of fuel pump, injector and distribution system, CRDI, Combustion in compression ignition engines, stages of combustion, factors affecting combustion, Phenomenon of knocking in CI engine. Effect of knocking, Types of combustion chambers, rating of fuels in CI engines. Dopes & Additives, Comparison of knocking in SI & CI engines.

UNIT-3 **(12 hours)**

Super Charging/Turbo-charging: Introduction, Objectives, Effect on power output and efficiency, Supercharging Systems, Turbo-charging, Characteristics of Supercharged Engines, Method of Super Charging, and Limits of Supercharging. Types of supercharging and turbo charging, relative merits, matching of turbocharger.

Engine Testing and Performance: Introduction to Indian Standards for testing of I.C. Engine, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance.

UNIT-4 (12 hours)

Cooling and Lubrication System: Need for cooling system. Types of cooling system, Liquid cooled system, Thermo-syphon system and Pressure cooling system. Lubrication system, Mist lubrication system, Wet sump and dry sump lubrication. Properties of lubricants. Properties of coolants.

Emissions of I. C. Engines: Air pollution due to IC engine, Engine emissions, Hydrocarbon emissions and PPM & Carbon monoxide emissions (CO), oxides of Nitrogen (NOx) Euro norms, Bharat stage norms, Introduction to EDC and IDC, Introduction to carbon credit, Emission control methods for SI and CI engines, Electronic Control Unit, Catalytic converter, Exhaust Gas Recirculation, Diesel Particulate Filter.

Alternative Potential Engines: VCR engine, Dual fuel engines, Multifuel engines, Heterogeneous Charge Compression Ignition, Modern Trends in I. C. Engines.

Recommended Readings:

1. W. W. Pulkrabek; Internal Combustion Engines; Pearson Education; 2004.
2. S. Agrawal; Internal Combustion Engines; New Age International, 2e; 2006.
3. M. L. Mathur, R. P. Sharma; Internal Combustion Engine; Dhanpat Rai Publication; 2010.
4. R. K. Mohanty; Internal Combustion Engines; Standard Book House; 2007.
5. P. W. Gills, J.H. Smith; Internal Combustion Engine, Oxford and IBH Pub. Ltd.; 1959.
6. J. B. Heywood; Internal Combustion Engines Fundamentals; McGraw Hill Education, 1st edition; 2017.
7. H. N. Gupta; Internal Combustion Engines; 2nded, Prentice Hall of India; 2013.
8. V. Ganesan; Internal Combustion Engine; Tata McGraw Hill, 4th edition; 2017.
9. R. Stone; Internal Combustion Engines; Palgrave Publication; 2012.

List of Experiments:

(At least eight experiments should be conducted from the list of experiments)

1. Study of I.C. Engines-2 Stroke and 4 Stroke Engines, Carburetor, Ignition system and Fuel injection system.
2. Morse Test on multi-cylinder petrol engine.
3. Speed Test on petrol engine.
4. Speed Test on diesel engine
5. Load Test on petrol engine.
6. Load Test on diesel engine.
7. Heat Balance test on petrol engine.
8. Heat Balance test on diesel engine.

9. Exhaust Gas analysis of S.I./ C.I. engines.
10. Smoke analysis of C.I. engines.
11. Effect of Supercharging on Performance Characteristics of an engine.
12. Willan's Line method to calculate frictional power.
13. Motoring test on IC Engine.

ME 5.4 MANUFACTURING TECHNOLOGY II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 5.4	Manufacturing Technology II	3	--	2	3	100	25	--	25	--	**150**

Course Objectives:

1. To understand the fundamentals of metal cutting.
2. To study the cutting tool geometry, tool material requirement and commonly used tool materials.
3. To understand different operations on the basic workshop machines.
4. To understand use of dynamometers and economics involved in a machining workshop.
5. To study gear manufacturing and unconventional machining processes.

Course Outcomes:

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

1. Understand the basic theory of metal cutting.
2. Understand the significance of Merchant theory.
3. Understand tool wear mechanisms and able to determine tool life.
4. Analyze single point cutting tool geometry.
5. Understand cutting forces in machining operation.
6. Analyze the economics involved in machining operation.
7. Understand gear manufacturing processes and other unconventional machining processes.

UNIT - 1 **(12 Hours)**

Theory of Metal Cutting: Wedge shaped tool and its features. Orthogonal and oblique cutting, tool geometry (ASA & ISO). Chip formation and types of chips. built-up-edge. chip thickness ratio. Velocity diagram, shear strain in metal cutting. Concept of feed, speed, depth of cut and cutting forces in turning. milling. drilling and grinding. Effect of various parameters on cutting forces. Effect of different parameters on surface finish. Expression for the height of feed ridges. Ernst Merchants Theory and its modification- Expression for shear plane angle.

UNIT - 2 **(12 Hours)**

Cutting Tool Materials: Basic requirements, selection, study of high carbon steel, high speed steel, cemented carbides, coated tools, ceramics and diamonds.

Tool Life and Tool Wear: Definitions. Symptoms of end of tool life. Tool life equation. Tool wear mechanisms. wear types. Tool life criteria. Effect of built-up-edge and tool angles on tool life.

Single Point Cutting Tool Geometry: Definitions and significance of various angles in plan view and in different sections. Relationship between these angles.

UNIT - 3 **(12 Hours)**

Machining Operations: Basic operations performed on lathe, milling. grinding, broaching, shaping and planning.
Economics of Machining: Introduction, machining time and associated cost criteria for feed choice. Expressions for optimum cutting velocity under different criteria. Restrictions for feed choice.
Machinability: Definition. Different criteria for assessing machinability. Machinability ratings.
Cutting Fluids: Objectives. Requirements, classification, selection of cutting fluids.
Dynamometers: Introduction. Requirements. Dynamometers for turning, milling, drilling and grinding operations.

UNIT - 4 **(12 Hours)**

Unconventional Machining: Introduction and necessity. Ultrasonic Machining. Electric discharge machining. Electrochemical machining. Abrasive jet machining. Laser beam machining. Electron beam machining.
Gear Manufacturing: Gear cutting processes: Gear hobbing. Gear shaping. Gear lapping, Gear grinding and Gear broaching.

Recommended Readings:

1. P. N. Rao; Manufacturing Technology; Vol II; Tata McGraw Hill Education; 2017.
2. G. K. Lal, S. K. Choudhary; Fundamental of Manufacturing Processes; Narosa Publishing House; 2014.
3. A. Ghosh, A. K. Malik ; Manufacturing Science ; East-West Press Pvt. Ltd.; 2010.
4. B. L. Juneja, G. Sekhon., Fundamentals of metal machining and machine tools; Wiley Eastern Ltd; 2015.
5. E. M. Trent; Metal Cutting; Butterworths; 2000.
6. M. C. Shaw; Metal Cutting Principles; CBS Publishers & Distributors; 2002.
7. HMT; Production Technology; Tata McGraw-Hill Education, New Delhi; 2001.
8. E. P. DeGarmo, J .T. Black, R. A. Kohser; Materials and Processes in Manufacturing; Wiley; 2003.
9. P. C. Pandey, C.K. Singh; Production Engineering Sciences ;Standard Publishers Distributors;2006.
10. B. J. Ranganath; Metal Cutting & Tool Design; Vikas Publishing House Pvt. Ltd.; 1999.
11. G. Boothroyd; Fundamentals of Metal Machining & Machine Tools; Tata McGraw Hill; 1975.

List of Experiments:

Following jobs have to be completed during the practical slot:
A. Three machining jobs involving following operations:

1. Plain Turning
2. Facing
3. Step turning,
4. Taper turning,
5. External and internal thread cutting,
6. Knurling
7. Eccentric

8. Forming
9. Drilling

and

B. One job on gear cutting operation.

ME 5.5 DYNAMICS OF MACHINERY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th. Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 5.5	Dynamics of Machinery	3	--	2	3	100	25	--	--	--	**125**

Course Objectives:

1. This course shall help the student to understand the static and dynamic analysis of rigid bodies.
2. This course shall help the student to apply the concept of static and dynamic analysis to mechanisms.
3. To understand and apply the principle of static and dynamic balancing.
4. To understand the working principles and applications of governors, dynamometers and gyroscopes.

Course Outcomes:

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

1. Apply the principles of rigid body dynamics in real life situations.
2. Understand the use of force analysis in analyzing transmission systems.
3. Apply the concepts of dynamics in analyzing balancing of reciprocating and rotating masses.
4. Analyze the effects of dynamic forces in gyroscopes.

UNIT - 1 (12 Hours)

Rigid Body Dynamics: Acceleration of a rigid body, Mass distribution, Angular momentum of a rigid body, Newton's and Euler's Equations for motion. Use of D-Alembert's principle.

Principle of work and energy, Conservation of energy, principle of impulse and momentum, Conservation of angular momentum.

Gyroscopes: Vectorial representation of angular motion. Gyroscopic couple. Effect of gyroscopic couple on Ship, Plane disc, Aeroplane, Stability of two wheelers and four wheelers.

UNIT - 2 (12 Hours)

Static and Dynamic Force Analysis: Four-bar, Reciprocating Engine Mechanism, Spur Gears, Cam and follower Mechanism. Analytical and graphical methods.

Inertia effect of Reciprocating mass and Connecting rod.

Flywheels: Torque analysis, Coefficient of fluctuation of speed and coefficient of fluctuation of energy, Turning moment diagrams, Determination of size of flywheels, Flywheels in Punching Press.

UNIT - 3 (12 Hours)

Balancing of Rotating Masses: Static and dynamic balancing, two plane balancing, field balancing of rotors, balancing machines

Balancing of Reciprocating Masses: Primary and secondary unbalance, balancing of Multi-cylinder in-line Engines, Radial engines, V-engines, W-engines, Opposed piston Engines.

Partial Balancing of Locomotives and its effects: Theoretical aspects on variation in Tractive Force, Swaying Couple and Hammer Blow

UNIT - 4 (12 Hours)

Belt, Rope and Chain Drives: Flat Belts, V-belts, angular velocity, effect of slip, Law of belting, Cone pulleys, crowning, belt tension ratio, effect of belt and centrifugal tension on power transmitted, creep in belt drives, Power transmission using Wire ropes, Ratio of driving tensions for rope drive, Types of chains, Power transmission using Chains.

Dynamometers: Absorption type - Prony brake and Rope brake, Transmission type - Epicyclical train, belt transmission, Torsion dynamometers.

Governors: Types of governors, Force analysis of Porter, Proell, Hartnell and Inertia governors. Controlling force, stability, sensitiveness, Isochronism, effort and power.

Recommended Readings:

1. A. Ambekar; Mechanism and Machine Theory; Prentice Hall of India; 2007.
2. J. S. Rao, R. V. Dukkipati: Mechanism and Machine Theory; New age International; 1989.
3. S. S. Rattan; Theory of Machines and Mechanisms, Tata McGraw Hill; 2017.
4. J. E. Shigley, J. J. Uicker; Theory of Machines and Mechanisms; McGraw Hill; 2010
5. A. Ghosh, A. K. Malik; Theory of Mechanisms and Machines; East west Publishers; 3e. 2006.
6. I. Shames, G. K. M. Rao: Engineering Mechanics: Statics and Dynamics; Pearson Education; 2009.
7. F. P. Beer, E. R. Eisenberg, E. R. Johnston, W. E. Clausen: Vector Mechanics for Engineers; Tata McGraw Hill, 10e; 2013.
8. P. L. Ballaney; Theory of Machines and Mechanisms; Khanna Publication; 2001.

List of Experiments:

(Following experiments should be conducted from the list of experiments)

1. Static and dynamic balancing of rotating masses.
2. Characteristics of Dead Weight controlled governor.
3. Characteristics of Spring controlled governor.
4. Verification of Gyroscopic Rule.
5. Three Sheets on force Analysis of Mechanisms (Static and Dynamic).
6. Three Sheets on Balancing.

ME 5.6 ENGINEERING MEASUREMENTS AND METROLOGY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th.	S	TW	P	O	Total
ME 5.6	Engineering Measurements and Metrology	3	--	2	3	100	25	--	--	--	**125**

Course Objectives:

1. To inculcate in students the habit of giving importance to metrology and measurement.
2. To read and understand the geometric representations on the drawing.
3. To apply the concepts in measurement of screw threads, gears, etc.
4. To apply measurement concepts in real-world situations.

Course Outcomes:

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

1. Understand use of Tolerance and its notations as appearing on drawing sheets.
2. Measure various dimensions of screw threads and gears.
3. Apply measurement methods for measuring Force, Torque, Pressure and Temperature.
4. Understand working of Nanometrology and its applications.

UNIT-1 (12 hours)

Basic Principles of Engineering Measurement: Introduction to Metrology, Need for Inspection, Accuracy and Precision, Accuracy and Cost, Objectives of Metrology and Measurements, Process Measurement Concepts, Calibration of Measuring Instruments, Errors in Measurements, Systematic and Random Errors, Methods of Measurement.

Standards of Measurement: Introduction, Standards and their Roles, Evolution, Material Standard, Wavelength Standard, Line and End Measurements, Transfer from Line Standard to End Standard, Displacement Method, Calibration of End Bars.

Linear Measurement: Depth gauge, Callipers, Vernier Instruments, Micrometer Instruments, Slip Gauges: Sizes and Grades, Wringing, Manufacture and Calibration.

Angular Measurement: Protractors, Sine Bars, Angle gauges and its calibration, Autocollimator, Angle Dekkor, Clinometer.

UNIT-2 (12 hours)

Comparators: Classification, Types, Advantages, Limitations and Applications: Mechanical, Mechanical-Optical, Optical, Electrical, Electronic, Pneumatic.

Optical Measurement and Interferometry: Introduction, Tool Makers' Microscope, Profile Projector, Optical Interference, Interferometry, NPL flatness Interferometer, Laser Interferometer.

Limits, Fits, and Tolerances: Introduction, Principle of Interchangeability, Tolerances, Fits, System of Limits and Fits, Indian Standard limit fit system, Limit gauging, Taylor's Principle of Gauge Design, Gauge Tolerance, Wear Allowance, Plug and Snap gauges.

Geometric Dimensioning and Tolerancing: Introduction, Standard symbols and terminology, standard drawing, practice, and their interpretation.

UNIT-3 (12 hours)

Metrology of Gears: Errors in Spur Gears, Measurement of Gear elements: Runout, Pitch, Lead, Tooth Thickness, Gear Tooth Calliper, Tooth span micrometers, Parkinson Gear tester

Metrology of Screw Threads: Measurement of Screw Thread elements: Major diameter, Minor diameter, Effective diameter using One-wire method, two-wire method and Three-wire method, Pitch. Thread gauges.

Metrology of Surface Finish: Concepts, Terminology, Analysis of Surface traces, Tomlinson Surface Meter, Taylor-Hobson Talysurf.

Machine Tool Metrology: Straightness, Flatness, Parallelism, Squareness, Roundness, Cylindricity and Runout

Coordinate Measuring Machines: Introduction, Structure, Modes of Operation, Probe, Operation.

Machine Vision: Stages and Applications.

UNIT-4 (12 hours)

Force Measurement: Load cells, Cantilever beams, proving rings.

Torque Measurement: Torsion-bar Dynamometer, Servo-controlled Dynamometer, Prony brake Dynamometer.

Temperature Measurement: Thermocouples, Thermopiles, Thermisters, Pyrometers: Total Radiation pyrometer, Optical pyrometer.

Pressure measurement: Pressure measurement Scales, Industrial U Tube Manometer, Bourdon tube pressure Gauges, McLeod Gauges.

Nanometrology: Nanodimensions, Importance of Nanometrology, Transmission Electron Microscope and Scanning Electron Microscope.

Recommended Readings:

1. N. V. Raghavendra, L. Krishnamurthy; Engineering Metrology and Measurements; Oxford University Press; 2015.
2. A. K. Bewoor, V. A. Kulkarni; Metrology and Measurement; McGraw Hill; 2015.
3. E. Doebelin, D. Manik; Measurement Systems; McGraw Hill; 2011.
4. C. Dotson; Fundamentals of Dimensional Metrology; Cengage Learning; 2012.
5. R. K. Jain; Engineering Metrology; Khanna Publishers; 21e; 2015.

List of Experiments:

(At least twelve experiments should be conducted from the list of experiments)

1. Measurement by Using Vernier Calliper (Dial, Digital and Plain).
2. Measurement of dimensions using Vernier Height Gauge.

3. Measurement of dimensions using Micrometer Screw Guage (Digital and Plain).
4. Measurement of angle using Sine bar/Sine center.
5. Measurement of Angle using Bevel Protractor.
6. Measurement of Angle using Height Gauge.
7. Use of Dial Gauge as Mechanical Comparator.
8. Measurement of straightness and roundness using Dial Gauge.
9. Measurement of Surface Roughness using Surface Roughness Tester.
10. Measurement of various elements of screw thread using Tool Makers Microscope.
11. Measurement of Screw thread parameters using Floating Carriage Micrometer.
12. Measurement of Gear tooth thickness using Gear tooth Vernier caliper and Span Micrometer.
13. Linear and angular measurement using Profile Projector.
14. Measurement using CMM.
15. Process Capability Analysis on measured data.
16. Calibration of Vernier Calliper (Dial, Digital, Plain) by using Slip Gauges.
17. Calibration of Micrometer (Digital, Plain) by using Slip Gauges.
18. Calibration of LVDT.
19. Calibration of Piezo electric transducers.
20. Calibration of Strain Gauge.
21. Calibration of Load cell.
22. Calibration of Pressure cell.

ME 6.1 QUALITY AND RELIABILITY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
						Marks					
		L	T	P	Th Duration (Hrs)	Th	S	TW	P	O	Total
ME 6.1	Quality and Reliability	4	1	--	3	100	25	--	--	25	**150**

Course Objectives:

1. To make the students aware about importance of quality and its effect on bottom line of the organization.
2. To introduce statistical process control and acceptance sampling as methods of online and off line quality improvement tools.
3. To study reliability and its importance with respect to the life of the product.
4. To study various mathematical expression of reliability as well as probabilistic design methodology.

Course Outcomes:

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

1. Understand the importance of Statistical Process Control and its role in variation reduction.
2. Understand use of Acceptance Sampling method in quality improvement.
3. Perform mathematical analysis in Reliability studies.
4. Design mechanical components in probabilistic environment.

UNIT-1 **(16 hours)**

Quality: Introduction and its role in industry, Quality Costs, Quality of conformance, Quality of design, Quality of performance. Quality Philosophies, Role of Quality Assurance department.

Introduction to Six Sigma, Zero Defect and Zero Effect, ISO 9001 quality standards, TQM.

Statistical Quality control: Introduction and methods, Quality tools: Flow Chart, Histogram, Pareto chart, Cause and Effect diagram, Scatter diagram. Statistical Process Control- Introduction, Chance and Assignable causes of Quality Variation, Statistical Basis of the Control Chart.

Variable Control Charts: Introduction, Statistical basis of the Charts, Development and Use of Sample Mean and Range Charts, Development and Use of Sample Mean and Standard Deviation Charts, Charts based on Standard Values, Interpretation, Analysis of pattern, Type I and II errors, Average Run Length (ARL), Average Time to Signal (ATS), Operating-Characteristic (O.C.)Curve, Process Capability studies.

UNIT-2 **(16 hours)**

Control Charts for Attributes: Introduction, Control charts for non-conforming items (p, np charts)- Statistical Basis, Development and Operation, Fixed sample size and Variable sample size, Type I and II errors, O.C. curve and ARL.

Control charts for non-conformities (C, U charts)- Statistical Basis, Development and Operation, Fixed sample size and Variable sample size, Type I and II errors, O. C. curve and ARL.

Acceptance Sampling by Attributes: Introduction, Advantages and Disadvantages of sampling, Single, double and Multiple sampling plans - Calculation of Probability of acceptance, O. C. Curve; Military Standard System- Terminology, referring tables, Designing single, double and multiple sampling plans; Dodge-Romig system- Terminology, referring tables, Designing single and double sampling plans; Use of Cameron table- Designing Single Sampling Plan; Sequential Sampling Plan- design and application.

UNIT-3 (16 hours)

Reliability Engineering: Need for Reliability, definition of reliability and its various measures, reliability analysis- Exponential, Normal, Lognormal and Weibull distribution.

Reliability of Systems - Series, Parallel and Combined Series-Parallel systems, Complex systems, Three-State Devices, Standby Redundant system with Perfect switching, Common-Mode failures, Fault Tree Analysis (FTA).

Reliability Allocation - Equal Apportionment technique, ARINC Apportionment technique, AGREE Allocation method.

Reliability Optimization by Dynamic Programming.

UNIT-4 (16 hours)

Reliability-based Design: Probabilistic Design Methodology. Combination of random variables in design- Transformation of Random variables, Expectation and Variance of a function of Random Variables, Approximation for E-Operator and V-operator of function of random variables, Statistical Tolerancing.

Interference Theory: Computation of reliability with stress and strength following Exponential, Normal, Lognormal.

Reliability-based Design of Mechanical Components: Shaft (Tension and Torsion), I-beam, Connecting Rod, Pressure Vessel, Helical Spring.

Recommended Readings:

1. D. C. Montgomery; Statistical Quality Control: A Modern Introduction; Sixth Edition, Wiley India; 2009.
2. C. E. Ebeling; An Introduction to Reliability and Maintainability Engineering; Tata McGraw Hill; 2000.
3. K. C. Kapur, L. R. Lamberson; Reliability in Engineering Design; Wiley India; 1997.
4. S. S. Rao; Reliability Engineering, Pearson Education; 2016.
5. A. Mitra; Fundamentals of Quality Control and Improvement; Third Edition; Wiley India; 2008.
6. E. L. Grant, R. S. Leavenworth; Statistical Quality Control; Seventh Edition; McGraw Hill India; 2000.
7. R. K. Jain, H. M. Trivedi; Quality Management for Zero Defect and Zero Effect: A Compendium of Case Studies and Best Practices; American Society for Quality India; 2016.

Assignments:

At least eight assignments, two on each unit must be submitted by students within stipulated time.

ME 6.2 MACHINE DESIGN – II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 6.2	Machine Design - II	3	--	2	3	100	25	25	--	--	**150**

Course Objectives:

1. To inculcate the belief that the real life problems in design are not closed bound.
2. To demonstrate the methodology of designing near real life situations through problem solving
3. To enable the student to acquire knowledge about selection of appropriate machine components for given applications.
4. To enable the student to apply engineering tools and techniques to product design.

Course Outcomes:

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

1. Design a clutch and braking system.
2. Select, analyze and design power transmission systems.
3. Select appropriate bearings from manufacturer's catalogue.
4. Design a suitable journal/sliding contact bearing to meet the specifications.

UNIT - 1 (14 Hours)

Clutches: Torque transmitted by single plate, multi-plate, and cone clutch. Design of clutch plate, pressure plate, springs & lever. Design of Centrifugal clutch.

Brakes: Similarity and difference between brake and clutch, energy equations, Classification of brakes, block or shoe brake, band brake, pivoted shoe brake, internal expanding shoe brake, and disc brakes. Thermal considerations in Brakes.

Flywheel: Review of- Torque analysis in Flywheel, Coefficient of fluctuation of speed and coefficient of fluctuation of energy, Stress analysis in solid disc flywheel and rimmed flywheel.

Design of flywheel for I.C. Engines and Punch Press applications.

UNIT - 2 (10 Hours)

Bearings:

Sliding Contact Bearings: Types of lubrication, viscosity, Petroff's law, Stable lubrication, Thick-film lubrication, Bearing Modulus, Introduction to hydrodynamic theory, Reynold's equation and dimensionless numbers, Types of Journal bearings, Full and partial bearings, Heat dissipation of bearings, bearing materials, journal bearing design.

Rolling Contact Bearings: Classification, selection criteria, static load carrying capacity, Stribeck's equation, Dynamic Load carrying capacity, Load - Life relationship, selection of ball and roller bearings from manufacturer's catalogue, Bearing selection for criteria other than L_{10} life, RC bearings subjected to cyclic loads and speeds, Mounting of bearings.

UNIT - 3 (14 Hours)

Gears: Classification of gears, selection of Gears, Law of Gearing.

Spur Gears: Terminology, Interference, Backlash, Force Analysis, Gear Tooth failures, Beam strength, and Wear Strength of Gear Tooth based on Buckingham's approach and Spott's approach, Estimation of module based on beam and wear strength, heat treatment of gears, Gear lubrication.

Helical Gears: Terminology, Force analysis, Formative or virtual teeth, Beam strength and wear strength of helical gears, Estimation of module based on beam and wear strength, Herringbone gears.

Worm Gears: Terminology, proportions of worm Gears, Force Analysis, material selection, Strength and wear rating of worm gears, Thermal considerations in design of worm gears.

UNIT - 4 (10 Hours)

I.C. Engine Components: Design of - Connecting Rod, Piston and Cylinder of IC Engines.

Power Screws: Design of Screw and Nut for common engineering applications with Square, Acme and Buttress threads.

Patent and Intellectual Property: Introduction to Intellectual Property, types of Intellectual Property.

Recommended Readings:

1. V. B. Bhandari; Design of Machine Elements; Tata McGraw-Hill Education; 2010.
2. J. E. Shigley; Mechanical Engineering Design; Metric Edition; McGraw-Hill Publication; 1986.
3. A. S. Hall, A.R. Holowenko, H.G Laughlin; Theory and Problems of Machine Design; Schaum's Outline Series; 1981.
4. C. S. Sharma, K. Purohit; Design of Machine Elements; PHI Learning Pvt. Ltd; 2009.
5. D. K. Aggarwal, P. C. Sharma; Machine Design; S.K Kataria and Sons; 2013.
6. M. F. Spotts, T. E. Shoup; Design of Machine Elements, Prentice Hall International; 1998.

Recommended Data Books for learning and examination:

1. PSG College Coimbatore - Kalaikathir Achchagam; Design Data Book; 2012.
2. K. Mahadevan, K. Balveera Reddy; Design Data Handbook for Mechanical Engineers, 4e, CBS Publishers; 2015.

Term Work shall consist of the following:

1. Design of a single plate or multi plate clutch and preparing assembly and production drawings.
2. Design of any one of the following - Screw Jack, Power Press, C Clamp, Lead Screw of a Lathe, etc. and preparing assembly and production drawings.
3. Selection of Rolling Contact bearing for a given application.
4. Design of a Spur or Helical Gear and preparing a drawing of the designed pair of gears in mesh showing at least two pairs of teeth in mesh.

ME 6.3 GAS DYNAMICS AND TURBOMACHINERIES

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
						Marks					
		L	T	P	Th Duration (Hrs)	Th	S	TW	P	O	Total
ME 6.3	Gas Dynamics and Turbomachineries	3	1	2	3	100	25	--	25	--	**150**

Course Objectives:

1. Introduce the fundamental concepts of compressible flow.
2. Understand conceptually Flow with Shock wave.
3. Understand the fundamental concepts of turbo machinery.
4. Understand the fundamental concepts of Hydraulic Turbine, Centrifugal Pump.

Course Outcomes:

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

1. Analyze compressible flow analysis through ducts.
2. Analyze power generating and absorbing turbomachines.
3. Understand the basics of flow with normal Shock waves and heat transfer.
4. Analyze performance of Centrifugal pump.

UNIT-1 (12 hours)

Introduction to Compressible Flow: Thermodynamics of compressible flow, perfect gases, Reynolds transport theorem, integral form of conservation equations: conservation of mass, conservation of momentum and conservation of energy. Sonic velocity and Mach number, wave propagation - mach cone & Mach angle, Regimes of flow, Prandtl velocity ellipse, concept of stagnation and reference/characteristic states, Alternate form of energy equation, Effect of Mach number on compressibility.

1D Steady Isentropic Flow in Variable Area Passages: Governing equations, effect of area change on flow properties, Flow through nozzles: Area - Mach number relations, Impulse function, effects of different pressure ratios across a supersonic nozzle, under expansion & over expansion, mass flow rate in nozzles, Flow through diffusers.

UNIT-2 (12 hours)

Flow with Normal Shock Wave:

Introduction and development of normal shocks, Governing equations, Prandtl relation, Change in Mach number across a shock wave, Change in properties across a shock wave - Static pressure, temperature and density, stagnation pressure and stagnation temperature.

Flows with Heat transfer and Friction: Hugoniot equation and Hugoniot curve, One dimensional flow with heat addition, the Rayleigh Curve, One dimensional flow with friction, the Fano curve.

UNIT-3 (12 hours)

Introduction to Turbomachines: Definition and classification, Application of First law & Second law to turbomachines, Efficiencies of turbomachines, Unit and specific values

Energy Exchange in Turbomachines: Velocity triangles and Euler turbine equation and alternate form, Impulse & reaction, Turbine utilization factor. Enthalpy-Entropy diagrams for power generating and power absorbing turbomachines.

UNIT-4 (12 hours)

Hydraulic Turbines: Introduction and classification of turbines, selection based on specific speed, Pelton turbine: construction, work done & efficiencies, design parameters, Francis turbine: construction, work done and efficiencies, Kaplan turbine: Construction, work done & efficiencies.

Centrifugal Pumps: Construction & classification, Types of heads and efficiencies, Velocity triangles and analysis - effect of blade outlet angle on energy transfer, Characteristic curves, Minimum speed, NPSH and cavitation, Series & parallel arrangement, System resistance curve & operating point.

Recommended Readings:

1. J. Anderson; Modern Compressible Flow; Tata McGraw Hill,3rd edition; 2012.
2. P. Balachandran; Fundamentals of Compressible Flow; Prentice Hall India Learning Private Limited; 2006.
3. S. M. Yahya; Fundamentals of Compressible Flow; New Age International Publishers; 2002.
4. B. U. Pai; Turbomachines; Wiley India; 2014.
5. R. K. Rajput; Fluid Mechanics & Hydraulic Machines; S. Chand & Co.; 2016.
6. B. K. Venkanna; Fundamentals of Turbomachineries; Prentice Hill of India; 2009.
7. P. R. Somasundaram; Gas Dynamics and Jet Propulsions; New Age International Publishers; 1996.
8. V. Babu; Fundamentals of Gas Dynamics; ANE Books India; 2011.
9. H. Cohen; G. F. C. Rogers, H. I. H. Saravanamutto; Gas Turbine Theory; Longman Group Ltd.; 1980.
10. V. Ganesan; Gas Turbines; Tata McGraw Hill Publishers; 2e; 2003.

List of Experiments:

(At least eight experiments should be conducted from the list of experiments)

1. Characterization of a Nozzle.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine..
5. Performance Test on Single Stage Centrifugal Pump
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Performance Test on Single stage Reciprocating Air Compressor test rig.
9. Performance Test on Two stage Reciprocating Air Compressor test rig.
10. Performance Test on Blower test rig.
11. Performance test on Gear pump test rig.

12. Performance test on Vane pump test rig

ME 6.4 MECHANICAL VIBRATIONS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
						Marks					
		L	T	P	Th Duration (Hrs)	Th	S	TW	P	O	Total
ME 6.4	Mechanical Vibrations	3	--	2	3	100	25	--	25	--	**150**

Course Objectives:

1. Understand and appreciate the phenomenon of vibrations.
2. Obtain linear vibratory models of dynamic systems and obtain natural frequencies.
3. Formulate and solve the differential equation of motion of vibratory systems.
4. Analyze the free and forced vibration effects of systems using classical and numerical methods.

Course Outcomes:

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

1. Analyze vibrations in mechanical systems and structures.
2. Model linear vibratory system and synthesize its response.
3. Predict vibratory responses to harmonic, periodic and non-periodic excitation.
4. Relate the experimental determination of vibration parameters for condition monitoring and modal analysis.

UNIT - 1 (12 Hours)

Free & Forced Vibration of Single Degree Freedom System: Periodic motion and related concepts, Model of a single degree freedom (SDOF) system, governing equation for damped and un-damped free vibration, Determination of natural frequency by Newton's method & Energy method. Logarithmic Decrement.

Response to harmonic excitation of SDOF systems with fixed support, system response to support excitation, Rotating and reciprocating unbalance.

UNIT - 2 (12 Hours)

Vibration Control: Vibration Isolation and transmissibility, Isolator design (damped and undamped), Design of dynamic vibration absorbers (damped and undamped).

Transient Vibration: Response to transient excitation for step, ramp, impulse, exponential, sinusoidal and combination inputs using Duhamel integral, Laplace transform and phase plane technique. Shock response spectrum (S.R.M), Drop Test.

UNIT - 3 (12 Hours)

Systems with Multi-Degrees of Freedom (Exact Analysis): Properties of vibrating systems, free vibration, Eigen value problem, use of stiffness and flexibility influence coefficients.

Critical Speed of shafts.

Numerical Methods: Rayleigh's method, Dunkerley's method, Method of Matrix Iteration, Stodola and Holzer's method.

UNIT - 4 (12 Hours)

Experimental Methods in Vibration Analysis: Vibration exciters and measuring Instruments, Signal Analysis Techniques (Time domain, Frequency domain & Cepstrum analysis), Amplitude and Power Spectra, Coherence, Auto and Cross- correlations. Amplitude and Frequency Modulation, Fast Fourier Transform (FFT) Analyzer.

Frequency Response: Sinusoidal Input, Phasors, Frequency Response, Bode Plots, Stability.

Recommended Readings:

1. J. S. Rao, K. Gupta; Theory & Practice Of Mechanical Vibrations; New Age International; 2e; 1999.
2. G. K Grover; Mechanical Vibrations; Nem Chand & Bros; 8e; 2009.
3. A. Ambekar; Mechanical Vibrations and Noise Engineering; Prentice Hall of India Pvt. Ltd.; 2006.
4. S. S. Rao; Mechanical Vibrations; Pearson Inc; 4e; 2004.
5. W.T. Thomson; Mechanical Vibrations; Prentice Hill India; 5e; 2007.
6. L. Meirovitch; Fundamentals of Vibrations; McGraw Hill International; 2001.
7. V. P. Singh; Mechanical Vibrations; Dhanpat Rai S.K. Kataria & Sons; 3e; 2006.

List of Experiments:

(At least eight experiments should be conducted from the list of experiments)

1. Determination of natural frequency of single DOF systems - spring mass system and/or simple pendulum and/or single rotor system.
2. Determination of mass moment of inertia of a given rigid body by suspending it as a compound pendulum, bifilar suspension and trifilar suspension.
3. Determination of natural frequencies of vibration of two DOF system.
4. Determine the damping ratio in a damped single degree of freedom system.
5. Performance characteristics of forced vibration.
6. Condition monitoring using vibration measuring and analyzing instrument.
7. Verification of Dunkerley's rule to determine the natural frequency of multiple degrees of freedom system.
8. To draw response of single degree of freedom system to varying frequency of excitation on non dimensional plane.
9. Experimental Modal Analysis using Data Acquisition System.
10. Determination of natural frequencies of a Multi DOF systems using Holzer's method.
11. Simulation of Multi DOF systems using MATLAB.

ME 6.5 MECHATRONICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	P	O	Total
ME 6.5	Mechatronics	3	--	2	3	100	25	--	--	--	**125**

Course Objectives:

1. To describe key elements of Mechatronics system.
2. To have a basic understanding of Control systems.
3. To understand principles of sensors, signal conditioning & data acquisition.
4. To understand the concept of system modeling and analysis.
5. To understand basics of hydraulic & pneumatic actuation systems.
6. To understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application.
7. To get a brief overview of MEMS.

Course Outcomes:

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

1. Identify key elements of mechatronics system.
2. Compare various Control Modes.
3. Develop basic system models.
4. Outline various signal conditioning devices for mechatronic systems.
5. Construct simple Fluid Power Circuits.
6. Develop PLC ladder programs.
7. Describe various MEMS components.

UNIT - 1 (12 Hours)

Introduction to Mechatronics: Definition, open loop & closed loop control systems, Basic elements of closed loop control system, Application of microprocessor based control system to automatic washing machine.

Concepts of Control Engineering: Review of Laplace transform, Transfer function, First order system with time response specifications subjected to unit step, ramp & impulse inputs, numerical problems on time response of first order systems, concept of second order system with time response specification, basics of proportional, integral, derivative, PI, PD, PID controllers.

UNIT - 2 (12 Hours)

Sensors: Performance terminology of sensors, RTD sensor, Encoders, Capacitive & Inductive proximity sensor, Photoelectric sensor, Selection of Sensors.

System Models: Mathematical models, Electrical system building blocks, Mechanical system building blocks, Electrical & Mechanical analogies, Fluid system building blocks, Thermal system building blocks.

Signal Conditioning: Operational amplifier with pin diagram, only inverting & non inverting amplifier, Filtering-low pass, high pass, band pass, band stop, principle of Analog to digital conversion, principle of Digital to analog conversion, protection, principle of operation of multiplexers.

Data acquisition: Basics of PC based data acquisition, Concept of Virtual Instrument.

UNIT - 3 (12 Hours)

Pneumatic & Hydraulic Actuation Systems: Introduction, basic control valves (direction, pressure, flow), actuators (linear, rotary), basic hydraulic and pneumatic circuits, Process control valve.

Electrical Drives: Relay, Solenoid, PWM, Brief overview of variable frequency drives, Brief overview of stepper motor driver and controller, communication interface standard RS232, basics of CAN & MODBUS.

UNIT - 4 (12 Hours)

Programmable Logic Controllers: Introduction to PLC, block diagram of PLC, PLC architecture, I/O units & I/O processing, Introduction to ladder programming using logic gates, latching, timers, counters, selection of PLC.

Overview of MEMS: Basic concept of MEMS as micro sensor & micro actuator, basic concept of micro gear, micro motor, micro turbine, micro optical components, Intelligent Microsystems.

Recommended Readings:

1. W. Bolton; Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering; Pearson; 3e; 2005.
2. D. Necsulescu; Mechatronics; Pearson; 2002.
3. D. A. Bradley, D. Dawson, N.C. Burd, A. J. loader; Mehatronics: Electronics in Products & Processes; Nelson Thornes Ltd. (India); 2004.
4. C. W. de Silva; Mechatronics: A Foundation Course; CRC Press (Indian edition); 2013.
5. A. Smaili, F. Mrad; Mechatronics: Integrated technologies for Intelligent Machines; Oxford University press; 2009.
6. K. P. Ramachandran, G. K. Vijayaraghavan, M. S. Balasundaram; Mechatronics: Integrated Mechanical Electronic systems; Wiley India; 2015.
7. D. G. Alciatore, M.B. Histand; Introduction to Mechatronics and Measurement Systems; Tata McGraw Hill; 2e; 2003.
8. D. Shetty, R. A. Kolk; Mechatronics System Design; Cengage; 2e; 2012.
9. T. C. Chang, R. Wysk, H. P.Wang; Computer Aided Manufacturing, Pearson; 3e; 2010.
10. J. Prasad, M. N. Jayaswal, V. Priye; Instrumentation & Process Control, I. K. International Publishing House Pvt Ltd; 2012.
11. T. Hsu; MEMS & Microsystem Design & Manufacture; Tata McGraw Hill; 2012.

List of Experiments:

(At least eight experiments should be conducted from the list of experiments)

1. Problems on P, PI, PD, PID controllers in MATLAB/SIMULINK.
2. Basic circuits and cylinder sequencing using Fluid Power software & Hardware.
3. Development of virtual instruments using LABVIEW.
4. Design of interfacing circuits using simulation software.
5. Experiments on Programming PLC.
6. Control valve characteristics.
7. Real time temperature/pressure/flow control using PID control system.
8. P/I & I/P converter.
9. Interfacing of any Sensor with Data Acquisition System.
10. Microcontroller based experiments.

ME 6.6 AUTOMOBILE ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P	Th Duration (Hrs)	Marks					
						Th	S	TW	O	P	Total
ME 6.6	Automobile Engineering	3	1	--	3	100	25	--	--	--	**125**

Course Objectives:

1. Understand the need functioning and purpose of various automotive system.
2. Analyze the vehicle performance utilizing the resistances in various scenarios.
3. Applying the engineering knowledge solutions to pollution norms, safety norms and respond to emergent social needs.

Course Outcomes:

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

1. Identify the different components and systems in automobile engineering.
2. Understand and describe importance and features of different systems like axle, differential, brakes, steering, suspension, wheels and transmission.
3. Explain principle of operation, construction and applications of various systems.
4. Understand the need, requirement and functioning of various sensors.

UNIT - 1 (12 Hours)

Introduction: Automobile history and development, Classification, Basic Frame Structure, Sub-frames, Integral and Chassis-less construction, Body styles, Engine and Drive-Train.

Engine Components: Engine Block, Cylinders, Piston and Rings, Connecting Rod, Crankshaft, Bearings, Camshaft, Valve-Train and Valves, Cylinder Head, Combustion chamber, Intake and Exhaust Manifold construction, Oil pan and sump, Gasket and Sealant.

Friction Clutches: Requirement and Operating Principle of friction clutch**,** Clutch components and construction, Cone clutch, Single plate clutch,. Diaphragm spring clutch, Multi-plate clutch, Semi Centrifugal, Centrifugal and Electro-Magnetic clutches. Fluid Flywheel.

UNIT - 2 (12 Hours)

Vehicle Performance: Power for propulsion, Traction and Tractive effort, Road Performance Curves: Acceleration, Gradiability and Drawbar pull.

Gearbox: Necessity of gear box, Sliding Mesh, Constant mesh, Synchromesh, Torque convertor, Epicyclic gear box, Transfer Caseand Four wheel drive system, Overdrive, Automatic Transmission.

Drive Line: Universal joint, Constant Velocity joint,Propeller Shaft, Slip Joint, Differential gears and mechanism, Rear axles.

Tyres and Wheels: Types of tyre construction, Tyre tread, Aquaplaning,Tyre specification, Types of wheels,Wheel construction, alloy wheels.

UNIT - 3 (12 Hours)

Steering System: Condition for true rolling motion, steering geometry, General arrangement of a Steering System, Basic steering Mechanisms: Ackermann and Davis, Types of Steering Gear boxes: Worm and Worm wheel, Worm and Nut, recirculating ball type and Rack and pinion. Over–Steer and Under–Steer, collapsible steering, Tilt steering, Power assisted Power Steering and Electronic power steering.
Wheel Alignment: Principles, Caster angle, Camber angle, King Pin Inclination, Toe-in and Toe out.
Suspension System: Suspension Components, Leaf Spring and Coil Spring, Torsion bar, Telescopic Damper, Independent suspension types: Double wishbone and MacPherson strut, Rear wheel Suspension System: Torque Tube Drive and Hotchkiss Drive. Independent Rear suspension.
Brakes: Functions and Requirements of Brakes**,** Types of brake systems, Theory of shoe brakes, Weight transfer, Drum brake, Self-Energized brakes, Disc brake, Hydraulic Brakes, Parking brakes, Air brakes, Power brakes, Stopping distance.

UNIT - 4 (12 Hours)

Automotive Electrical Systems: Starting system, Battery, Starting Motor. Charging system, Alternator, Ignitions system, Purpose and Requirement, Battery Ignition and Magneto Ignition. Electronic Ignition system
Electric, Hybrid and Fuel Cell Vehicles: Battery Electric Vehicle and Layout, Basic unit of battery electric vehicle, Hybrid Electric Vehicles and Layout, Fuel Cell Vehicle.
Safety Features: Antilock Braking system, Seat belts, Air bags, Traction Control and Stability Control, Crumple Zone, Hill start assistant control, Intelligence Speed Assist, Lane Assist System, parking assistant. Construction, working & application of sensors: temperature sensors, inductive sensors, Position sensors (rotary, linear). Hot wire and thin film air flow sensors, vortex flow/turbine fluid sensors, Optical sensor, Oxygen sensors, Light sensors, Rain sensors.
Drive/ Steer by Wire Automobiles: Introduction, Types and its working.
Automobile Air Conditioning: Introduction, Construction and working.

Recommended Readings:

1. K. Singh, Automobile Engineering, Vol I & II, Standard Publishers Distributors; 13e; 2012.
2. K. K. Jain, R. B. Asthana; Automobile Engineering; Tata McGraw Hill; 2002.
3. A. S. Rangwala; Trends in Automobile Engineering, New Age International Publishers; 2017.
4. N. K. Giri; Automotive Mechanics; Khanna Publishers, New Delhi; 2005.
5. M. J. Nunney; Light and Heavy Vehicle Technolog; Elsevier Ltd, 2009.
6. W. H. Crouse, Donald L Anglin Author; Automotive Mechanics; Tata McGraw Hill; 2007.
7. Newton Steeds and Garret; Motor Vehicles; Butterworth, London; 13e, 2005.
8. R. K. Rajput; Automobile Engineering; Laxmi Publications Ltd.; 2017.
9. A. Bonnick, D. Newbold; A Practical Approach to Motor Vehicle Engineering and Maintenance; Routledge Publishers; 2013.
10. A.K. Babu, A.P.Singh; Automobile Engineering; S Chand Publications; 2013.
11. T. Denton; Automobile Electrical and Electronic System; Butterworth Heinemann Publication; 2e; 2003.

Assignments:

At least eight assignments, two on each unit must be submitted by students within stipulated time.