Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum for

Second Year
Robotics & Automation

(2019 Course)

Savitribai Phule Pune University, Pune

Syllabus for

Second Year Robotics & Automation (2019 Course)

Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
	Theory	Practical / Tutorial*	PBL	Paper		TW	OR	PR	Total	TH	PR/OR/ TW/TU
				Insem	Endsem						
SEM-I											
Engineering Mathematics-III	3	2*		30	70	25			125	3	1
Industrial Electronics and Electrical Technology	3			30	70				100	3	
Strength of Materials	3			30	70				100	3	
Manufacturing Technology	3			30	70				100	3	
Materials Science and Engineering Metallurgy	3			30	70				100	3	
Industrial Electronics and Electrical Technology Lab		2				25			25		1
Strength of Materials Lab		2					25		25		1
Manufacturing Technology Lab		2						50	50		1
Materials Science and Engineering Metallurgy Lab		2					25		25		1
Soft skills		4				50			50		2
Total	15	14	0	150	350	100	50	50	700	15	7
									Total Credits	**22**	

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TU: Tutorial
PR: Practical

Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
	Theory	Practical / Tutorial*	PBL	Paper		TW	OR	PR	Total	TH	PR/OR/ TW/TU
				Insem	Endsem						
SEM-II											
Industrial Engineering and Management	3			30	70				100	3	
Control System Engineering	3			30	70				100	3	
Design of Machine Elements	3			30	70				100	3	
Metrology and Quality Assurance	3			30	70				100	3	
Industrial Engineering and Management Lab		2						50	50		2
Control System Engineering Lab		2				50			50		1
Design of Machine Elements Lab		2					50		50		1
Metrology and Quality Assurance Lab		2						50	50		2
Geometric Dimensioning and Tolerancing Lab		2				25			25		1
C Programming Lab		2				25			25		1
Project Based Learning			4			50			50		2
Total	12	12	4	120	280	150	50	100	700	12	10
									Total Credits =		**22**

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TUT: Tutorial
PR: Practical

Engineering Mathematics III

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks
Tutorials: 2 Hr/week	Tutorial: 01	End-Sem : 70 Marks
		Term work: 25 Marks

Prerequisites: Differential and Integral Calculus, Taylor series and Infinite series, Differential equations of first order and first degree, Fourier series, Measures of central tendency and dispersion, Vector algebra

Course Outcomes:

At the end of this course, students will be able to:

1) Solve higher order linear differential equations and apply to modeling and analyzing mass spring systems.
2) Apply Laplace transform and Fourier transform techniques to solve differential equations involved in Vibration theory, Heat transfer and related engineering applications.
3) Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data and probability theory in testing and quality control.
4) Perform vector differentiation and integration, analyze the vector fields and apply to fluid flow problems.
5) Solve various partial differential equations such as wave equation, one and two dimensional heat flow equations.

Unit I: Linear Differential Equations (LDE) and Applications
LDE of nth order with constant coefficients, Met Legendre‟s DE, simultaneous and symmetric simultaneous DE . Modeling of **m**ass-spring systems, free and forced damped and undamped systems.

Unit II: Transforms
Laplace Transform (LT): LT of standard functions, properties and theorems, Inverse LT, Application of LT to solve LDE.
Fourier Transform (FT): Fourier integral theorem, Fourier transform, Fourier Sine & Cosine transform, Inverse Fourier Transforms.

Unit III: Statistics and Probability
Measure of central tendency, Standard deviation, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Probability, Probability distributions: Binomial, Poisson and Normal distributions, Population and sample, Sampling distributions, t-distribution, Chi-square distribution.

Unit IV: Vector Differential Calculus
Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.

Unit V: Vector Integral Calculus and Applications
Line, Surface and Volume integrals, Work-done, Green‟s Lemma, Gauss‟s D Stoke‟s theorem. LemsApplicationsinFluidMechanics,,Continuityto equations,prob Streamlines, Equations of motion, Bernoulli’s equation.

Unit VI: Applications of Partial Differential Equations (PDE)
Basic concepts, modeling of Vibrating String, Wave equation, one and two dimensional Heat flow equations, method of separation of variables, use of Fourier series. Solution of Heat equation by Fourier Transforms, Two-dimensional wave equation.

Text Books:

1. Advanced Engineering Mathematics, 9e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).

Reference Books:

1. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
2. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
3. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
4. Applied Mathematics (Volumes I and II) by P. N. Wartikar& J. N. Wartikar (Pune Vidyarthi

Industrial Electronics and Electrical Technology

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Basic Electrical Engineering, Basic Electronics Engineering

Course Outcomes:

1. Develop the capability to identify and select suitable DC motor / induction motor /
2. Identify special purpose motor and its speed control method for given industrial application.
3. Program Arduino IDE using conditional statements
4. Interfacing sensors with Arduino IDE
5. Analyze Microcontrollers and embedded systems terminologies and sensors

Unit I: Introduction to Microcontrollers

Introduction to microcontroller and microprocessors, role of embedded systems, open source embedded platforms, Atmega 328P- features, architecture, portstructure, sensors and actuators, data acquisition systems, introduction to Arduino IDE-features, IDE overview, programming concepts: variables, functions, conditional statements.

Unit II: Peripheral Interface-1

Concept of GPIO in Atmega 328P based Arduino board, digital input and output, UART concept, timers, interfacing with LED, LCD and keypad, serial communication using Arduino IDE

Unit III: Peripheral Interface-2

Concept of ADC in Atmega 328P based Arduino board, interfacing with temperature sensor (LM35), LVDT, strain gauge, accelerometer, concept of PWM, DC motor interface using PWM

Unit IV: D. C. Machines

Construction, working principle of D.C. generator, emf equation of D. C. generator (derivation not expected), working principle of D.C. motor, types of D.C. motor, back emf, torque equation for D.C. motor, characteristics of D.C. motor (series and shunt only), three-point starter for D.C shunt motor, methods for speed control of D.C. shunt and series motors, industrial applications.

Unit V: Three Phase Induction Motors

Constructional feature, working principle of three phase induction motors, types; torque equation, torqueslip characteristics; power stages; efficiency, starters (auto transformer starter, star delta starter); methods of speed control and industrial applications.

Unit VI: Special Purpose Motors

Construction, working principle, characteristic and applications of stepper motors, A.C. and D.C servomotors, universal motors, industrial applications, brushless DC motors, linear induction motors, single phase induction motors,(types, construction, working principle of split phase and shaded pole type induction motors), descriptive treatment for AC series motor (difference between AC series and DC series motor, construction and working).

Text Books

1. Edward Hughes “Electrical Technology”, ELBS, Pearson Education.
2. Ashfaq Husain, “Electrical Machines”, Dhanpat Rai & Sons
3. S. K. Bhattacharya, “Electrical Machine”, Tata Mc Graw Hill publishing Co. Ltd,2nd Edition
4. Nagrath & Kothari, “Electrical Machines”, Tata Mc Graw
5. Ajay Deshmukh, ‘Microcontrollers Theory and Applications’, TATA McGraw Hill
6. Arduino microcontroller processing for everyone-Steven F Barret,Morgan and Claypool Publisher.
7. C programming with ardino-Warwick Smith Elektor Publication.

Reference

1. Electrical Machines, Lowe, Nelson Publications.
2. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, “Electrical Machines”, TataMcGraw Hill Publication Ltd. Fifth Edition.
3. Permanent Magnet Synchronous and Brushless DC Motor Drives, R. Krishnan, CRC press
4. Smarajit Ghosh, “Electrical Machines”, Pearson Education, New Delhi.[R5]Kenneth J. Ayala, ‘The 8051 Microcontroller’, Cengage Learning
5. Started with Arduino by Massimo Banzi and Michael Shiloh Published by Maker Media, Inc

Strength of Material

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Engineering Mechanics, Physics

Course Outcomes:

1. Explain stress and strain at a point as well as the stress-strain relationship for homogeneous, isotropic materials.
2. Construct shear force and bending moment diagram.
3. Detect Shear stress and bending stress in a various cross sections of beams.
4. Design the shaft subjected to torsion
5. Design and analyze the thick and thin cylinders used for industrial applications.
6. Detect the slope and deflection of beam.
7. Explain and detect the buckling of columns.

Unit I: Simple stresses and strains

Basic Concept of stress and strain (linear, lateral. shear and volumetric), Hooke's law, Poisson's ratio, modulus of elasticity, modulus of rigidity, stress strain diagrams for ductile and brittle materials, factor; of safety, working stress, generalized Hooke's law, concept of 3-D stress state, bulk modulus, interrelation between elastic constants**.**

Unit II: Axially Loaded Components

Axial force diagram, stresses, strains, strains & deformations in determinate and indeterminate, homogenous and composite bars under concentrated loads, self-weight and temperature changes.

Transversely Loaded Components

Shear Force and Bending Moment in Determinate Beams due to Concentrated Loads, Uniformly Distributed Loads. Relation between SF and BM Diagrams for Cantilevers, Simple and Compound Beams, Bends Defining Critical and Maximum Values and Positions of Points of Contra Flexure- Construction of Loading Diagram and BMD from SFD and Construction of Loading Diagram and SFD from BMD.

Unit III: Bending and Shear Stresses

Bending stresses

Theory of simple bending, assumptions, derivation of flexure formula, second moment of area of common cross sections with respect to centroidal and parallel axes. bending stress

Shear stresses:

Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress, shear connection between flange and web.

Unit IV: Transformation of Stresses and Strains

Normal and shear stresses on any oblique plane. Concept of principal planes. Derivation of expressions for principal stresses and maximum shear stress, position of principal planes and planes of maximum shear, graphical solution using Mohr's circle of stresses.

Strain energy and impact

Concept of strain energy, derivation and use of expressions for deformations of axially loaded members under gradual impact loads. Strain energy due to self-weight.

Unit V: Torsion of circular shafts

Stresses, strains and deformations in determinate and indeterminate shafts of solid and hollow homogeneous and composite circular cross section subjected to twisting moment. Derivation of torsion equation. Stresses due to combined torsion, bending and axial force on shafts.

Unit VI: Slope and deflection of Beams:

Relation between BM and slope, slope and deflection of determinate beams, Double Integration Method (Macaulay's Method).Derivation of Formulae for Slope and Deflection for Standard Cases.

Buckling

Concept of buckling of columns. Derivation of Euler's formula for buckling load for column with hinged ends. Concept of equivalent length for various end conditions. Limitations of Euler's formula. Rankin's formula. Johnson's formula, safe load on columns.

Reference Books

1. Ramamrutham S. and Narayanan R., Strength of Materials, Dhanapat Rai and sons
2. Rao Prakash "Strength Of Materials- A Practical Approach", Vol I, Universities Press India Limited, ISBN: 8173711259
3. Rattan S. S., Strength of Materials, Tata McGraw-Hill Education, 2016, ISBN: 007107256X
4. Rajput R. K., Strength of Materials, S. Chand Publication. ISBN-10 : 8188458104
5. Khurmi R. S., Strength of Materials, S. Chand Publication., ISBN:8121928222
6. Beer F. P., Johnston E. R and Dewolf J. T., Mechanics of Materials, McGraw Hill Higher Education, 5th edition, 2004, ISBN: 978-007 3529 387.
7. Popov E. P., Engineering Mechanics of Solids, Prentice Hall of India LTD, New Delhi, 2008.ISBN-10 :0137261594

Manufacturing Technology

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures:3 hours / week	Theory:03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites: Systems of Mechanical Engineering, Physics, Engineering Metallurgy, Strength of material

Course Outcomes:

Students should be able to

1. Describe and classify metal casting processes
2. Classify and analyze various forming processes
3. Understand special casting and forming processes
4. Classify and describe different types of welding and joining processes
5. Understand various non conventional machining process.
6. Understand various applications of robots in manufacturing

Unit I: Casting

Sand casting process: Introduction of sand casting. Patterns, Pattern materials, pattern allowances and design. Core prints and core seats. Mould strength, Ingredients of moulding materials and their effect on mould strength, testing of moulding sand. Melting: types of melting furnace (Cupola, electric arc furnace, Induction furnace- Construction, operations and zones), Casting Design consideration, Metal pouring, Gating system, Principles of gating, design of gating system, solidification time, riser design, cleaning, finishing of casting. Defects and respective remedies in casting. Special Casting Process.

Unit II : Forging and Rolling of Metals

Fundamentals of Material Forming: Introduction of forming processes. Concept of plastic deformation Classification of material forming process, Theory of plasticity, Yield criteria for ductile materials: Von- mises criteria, Tresca criteria.

Forging: Introduction,Classification of forging processes. Forging equipment- Hammers, presses, Upstter etc., construction, working, capacities and selection of equipment. Basic forging

operations such as fullering, edging, drawing, blocking, finishing etc., Types of forging dies, Cleaning and finishing of forgings, Forging defects and the remedies.

Rolling of Metals: Scope and importance of rolling. Types of Rolling Mills - Construction and working. Deformation in rolling and determination forces required. Process variables, Rolling problems: Roll flattening, Roll cambering, Mill spring – its effect on rolling process. Defects in rolling.

Unit III: Wire, Rod and Tube Drawing and Extrusion

Wire, Rod and Tube Drawing: Introduction to rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Analysis of wire drawing operation, Variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing. Multiple drawing, strip drawing. Tube Drawing: Methods, force calculation, lubrication in tube drawing.

ExtrusionTypes: Direct, Indirect, impact, hydrostatic extrusion. Dies for extrusion, stock preparation. Extrusion ratio, Circumscribing circle diameter (CCD), Shape factor. Equipment (with and withoutfriction), Work done in extrusion, Metal flow in extrusion, defects. Role of friction and lubricants.Manufacture of seam-less tubes.

Unit IV: Welding

Introduction & classification of welding processes, Types of Electrodes, coding ofElectrodes,Electrode efficiency, fluxes, welding symbols. **Arc welding processes**- Basic of electric arc welding: DCSP, DCRP & ACHF. Optimum arc setting. Carbon arc, submerged arc, Tungsten inert gas (TIG), Metal Inert gas(MIG), Plasma arc, stud welding-

Theory, comparison on merits, limitations and applications. **Gas welding**: processes and equipment used, type of flames, adjustment of flames, oxyacetylene welding, gas cutting –merits, limitations and applications. **Electric resistance welding**: processes and equipment used, Spot, Seam, Projection welding, Resistance tube welding, - merits, limitations and applications. **Solid state welding:** Ultrasonic, Friction , Explosive, Forge, , Friction stir welding **Special welding processes:** Laser, electron Beam welding, Thermit welding. **Inspection and testing of welding**: visual inspection, destructive & non-destructive testing. Protection and safety in welding.

Unit V: Non-conventional machining process

Detail study with respect to working principle , process parameter, theoretical analysis, experimental results & comparative assessment of Abrasive jet machining, Ultrasonic machining, Chemical machining, Electrochemical machining, Electro discharge machining, Electron beam machining, laser beam machining, Plasma arc machining, Ion Beam machining, wire cut EDM, Numerical based on above processes

Unit VI: Manufacturing through robot applications

Loading and/or unloading of parts in machining operations, hazardous work environment for human: forging, casting, press working , spot and arc welding operations etc., repetitive work cycle operations, assembly operations

References:

1. Rao P.N., “Manufacturing Technology, Foundry, Forming and welding”, Tata McGraw-hill publishing, 2006, ISBN 0-07-463180-2.
2. Dieter, “Mechanical Metallurgy”, Mc-Graw hill, ISBN0071004068.
3. Rowe G.W., “Principles of Industrial Metal Working Process”, Edward Arnold, ISBN8123904282.
4. Dr. R. Narayanswamy, Metal Forming Technology, Ahuja Book Co., ISBN8176190020
5. Kalpakjian Serope and Schmid Steven, “Manufacturing Engineering & Technology”, 2004. ISBN 10: 0131976397 ISBN 13: 9780131976399
6. Little Richard., “Welding & Welding Technology”, Tata Mc-graw hill, 1992, ISBN 0-07-099409-9.
7. Parmar R.S., “Welding Process and Technology”, 2ed.,Khanna Publishers, ISBN-10: 8174091262, ISBN-13: 978-8174091260

Material Science and Engineering Metallurgy

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3hours / week	Theory:03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites: Physics, Chemistry

Course Outcomes: On successful completion of the course students should be able to-

1. Define the mechanical properties of materials and conduct destructive and non destructive tests to evaluate and test the properties of materials
2. Draw and explain equilibrium diagrams for various alloy systems
3. Work with Iron-Iron carbide equilibrium diagram and apply this knowledge for classification of steels from microstructure observations
4. Select proper Heat Treatment, Surface Hardening technique & Isothermal Treatments for the steels considering properties and service requirements
5. Distinguish different Alloy Steels and Cast Irons based on chemical compositions and microstructures
6. Familiarize with different types of non-ferrous alloys and Composites with their need scope and applications

Unit I: Introduction and testing of materials

Introduction to material science and metallurgy, Classification of Engineering Materials; Crystal Structures, indexing of planes and directions, imperfections in crystal, Plastic deformation – slip and twinning mechanisms, deformation of single crystal and polycrystalline materials; strain or work hardening, effect of strain hardening on properties; Cold and Hot working of metals

Material testing : Tensile test – stress-strain curve and evaluation of properties; compression test, fatigue and creep tests, Erichsen cupping test, Hardness tests – Brinell, Rockwell, Vickers, Poldi; Impact tests; Nondestructive tests – Dye penetrant, Magna flux, Ultrasonic, Eddy current tests, Radiography.

Unit II: Equilibrium diagrams

Related terms and definitions, Hume Rothery's rule of solid solubility, Gibb's phase rule, Polymorphism, Solidification, Dendritic growth, Cooling curves, plotting of equilibrium diagrams, Lever rule, Isomorphous system. Coring, Eutectic systems, Partial eutectic systems, Uses of eutectic alloys, Layer type system, other transformation, non-equilibrium cooling and its effects

Unit III: Powder Metallurgy

Process in brief, powder characteristics, powder manufacturing, Advantages and limitations, Production of sintered structural components such as self lubricated bearing, cemented carbide tools, cermets, refractory metals, electrical contact materials, friction materials, Diamond impregnated tools etc.

Unit IV: Steels and Cast Irons

Iron-iron carbide equilibrium diagram, Critical temperatures, Classification and applications of steels, Specifications of steels like BIS, EN, AISI, SAE; Alloy Steels -Effects of alloying elements, classification of alloying elements. Stainless Steels, Sensitization of stainless steel, weld decay of stainless steel. Tool steels and tool materials; Cast Irons: Classification, Effects of various parameters on structures and properties of cast irons, Applications

Unit V: Heat treatment of steels

Introduction to heat treatment furnaces and Furnace atmospheres; Transformation products of austenite, Time-temperature- transformation diagrams, Critical cooling rate, Continuous cooling transformation diagrams; Quenching media; Annealing, Normalizing, Hardening, Effects and Elimination of retained austenite, Tempering, Hardenability testing Carburizing, Nitriding, Carbonitriding, Flame hardening and Induction hardening; Isothermal heat treatments such as austempering, patenting, iso-forming, martempering, ausforrning.

Unit VI: Non-ferrous and Modern Engineering Materials

Copper alloys – brasses and bronzes, Aluminum alloys, Solders, Bearing materials and their applications, Precipitation hardening alloys. High Temperature materials such as Nimonics, Super alloys, Ti-alloys etc.; Composites- Types, Characterization, Production techniques &
Applications, Metal -Matrix composites, Particulate & Fibre composites; Biomaterials; Nano
Materials; Sports materials.

Text-books:

1. Kodgire V. D., "Material science and metallurgy for Engineers", Everest Publishing House, Pune,
ISBN 81 86314 00 8.
2. K. G. Bundinski, M. K. Bundinski , “Engineering Materials” Prentice Hall of India Pvt. Ltd., New- Delhi.
3. Higgins "Engineering Metallurgy", Part I Applied Physical Metallurgy, English Language book Society / Edward Arnold.
4. Smith W. F., “Principles of Material Science and Engineering", McGraw- Hill Inc. Book Company
ISBN 0 07 122920 5.

Reference Books:

1. Rollason E. C., "Metallurgy for Engineering", ELBS Publishing.
2. Clark D.S. and Vamey W. R. "Physical Metallurgy for Engineers", East-West PressPvt. Ltd.,
New Delhi.
3. Avner, *"An* introduction to Physical metallurgy", TMH publication.
4. Donald R. Askeland & Pradeep Phule, The science and engineering of materials, Thomson Asia Pvt.LTD,
ISBN 981 243 855 6.

Industrial Electronics and Electrical Technology Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical: 01	Term Work: 25 Marks

List of Practical: (Any 4 out of 1 to 6 and any 4 out of 7 to 12)

Electrical Engineering

1. Speed control of DC shunt motor.
2. Brake test on DC shunt motor.
3. No load and blocked rotor test on 3 phase Induction Motor.
4. Load test on 3 phase Induction Motor.
5. Load test on single phase Induction Motor.
6. Study of starters for AC and DC motors

Electronics Engineering

7. Interfacing of LED to blink after every 1 sec.
8. Display data using serial communication.
9. Interfacing of LCD to display the message and interface with keypad to display the key pressed.
10. Interfacing of temperature sensor (LM35) and show output on LCD/serial terminal.
11. Interfacing of strain gauge sensor and LVDT to measure the parameters.
12. Study of interfacing accelerometer to change the speed of DC Motor

Strength of Material Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical: 02	OR: 25 Marks

List of Practical (Any Eight of the following)

1. Tension test for aluminium alloy and mild steel using extensometer.
2. Tension test for brass using extensometer
3. Shear test of ductile material on Universal Testing Machine.
4. Impact (I & C) test on mild steel, aluminium, brass.
5. Bending test on timber and plywood
6. Shear force and bending moment diagrams with different end conditions.
7. Slope and deflection.
8. Principal stresses through graphical and analytical method

Manufacturing Technology Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical:01	Practical:50 Marks

List of Experiments

1. Permeability testing
2. Green compression test for moulding sand
3. Moisture content of the green sand
4. Assignment on forging and rolling
5. Experiment on Wire drawing operation
6. Tutorial/presentation on special casting and special forming
7. NDT Test [any one]
   (1) Dye Penetrant Test
   (2) Magnetic Particle test
   (3) Ultrasonic Testing
8. Study of non-conventional machining processes

Material Science and Engineering Metallurgy Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical:01	OR: 25 Marks

List of Experiments:

1. Brinell and Poldi hardness test
2. Vickers and Rockwell hardness test
3. Erichsen Cupping test
4. Impact tests
5. Non- destructive testing - magnaflux testing, dye penetrant test, ultrasonic testing, eddy current testing
6. Tensile test on mild steel and aluminium test pieces.
7. Study and drawing of microstructures of various steels and cast irons
8. Study and drawing of microstructures of hardened steel, tempered steel.
9. Jominy hardenability test on steel
10. Hardening and tempering of steel

Soft Skills

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 4 hours / week	Practical:02	Term work: 50 Mark

Overview

Soft skills are a set of skills required for a holistic development of an individual. Through this course, the students of engineering will be trained in the necessary soft skills which are required for them not only to do well academically but also to excel in each significant aspect of life. Effective communication skills in English have become a prerequisite for students to enhance their academic performance as well as earn a good placement. These skills are also essential for their professional growth. Therefore, the necessary soft skills will be taught with a special emphasis on communication skills in English. Today, the employability of a student is defined by not only his command over technical skills but also his sound soft skills. The soft skills improve students‟ confidence and enable them to implement Training in soft skills infuses in students positive attitude and makes them self assured. They can do well in every walk of life and achieve success in their endeavors. Thus, soft skills contribute significantly to the all round development of students and therefore need to be taught effectively with an emphasis on adequate practical exposure.

Teaching Methodology

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate onlyin English during the session. Specific details about the teaching methodology have been explained in every activity given below.

Practical Activities (Term work)

Following 10 activities are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should give students 10 assignments on the basis of the 10 activities conducted in the practical sessions. Students will submit these 10 assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. Self Assessment: (2 hours)

The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

2. Public Speaking (4 hours)

Any one of the following activities may be conducted :

a. **Prepared speech** (topics are given in advance, students get 10 minutes top repare the speech and 5 minutes to deliver.
b. **Extempore speech (**students deliver speeches spontaneously for 5 minutes each on a given topic)
c. **Story telling (Each student narrates a fictional or real life story for 5 minutes each)**

d. **Oral review** (Each student orally presents a review on a story or a book read by them)

3. Power-point Presentations (4 hours)

Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.

4. Formal Group Discussion (4 hours)

Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback.

5. English Language Proficiency Test (2 hours)

The teacher should conduct a 50 mark English proficiency test in the lab and discuss the answers with explanation and more illustrations.

6. Mock Meetings (2 hours)

In order to enhance students‟ formal oral commun Teacher should give a topic for the meeting and teach students how a notice and agenda for a meeting is prepared. Students will participate in the meeting assuming the roles assigned by the teacher. After the meeting, teacher should guide students on how minutes of meeting are recorded.

7. Letter, Report & Resume writing (4 hours)

Each student will write one formal letter, one report and a resume. The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts.

8. Reading and Listening skills (4 hours)

The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

9. Conflict Management and decision making skills (2 hours)

The teacher should teach students how to make sound and practical decisions by dealing with conflicts. Students should know how to manage internal and external conflicts. The teacher can conduct a case study activity to train students in these skills.

10. Stress management (2 hours)

The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.

Scheme of Evaluation

The teacher should give marks out of 10 for each activity. The total marks for all 10 activities will be 100 marks. At the end of semester, the marks scored by a student out of 100 will be scaled down to marks out of 25. Thus, each student will get marks out of 25 for this subject.

References

1. Rutherford A. J. : Communication skills for Technical Communication, Pearson Education
2. Meenakshi Raman, Sangeeta Sharma : Technical Communication – Principles and practice, Oxford
3. Scot Ober : Contemporary Business Communication (Indian adaptation) Biztantra
4. Dutt et.al. : A course in Communication Skills, Foundation
5. Ibbotson: Cambridge English for Engineering, Cambridge
6. Turk: Effective Speaking, Taylor & Francis
7. Patnaik: Group Discussion and Interview Skills, Foundation
8. Mishra: A companion to communication skills in English, PHI
9. Lynch: listening, Cambridge
10. Sasikumar, Dutt & Rajeevan: A course in Listening & Speaking I & II, Foundation
11. Malcom Goodale: Professional Presentations, Cambridge
12. Ham-Lyons & Heasley: Writing, 2nd Edition, Cambridge
13. ASTD: 10 steps to successful meetings, Cengage Learning
14. E. Suresh Kumar, P. Sreehari, J. Savitri: Communication Skills & Soft Skills An Integrated Approach, Pearson
15. Barun K. Mishra: Personality Development and Group Discussions, Oxford University Press
16. Accenture, Convergys, Dell et.al: NASSCOM - Global Business Foundation
    Skills: A Foundation Books, Cambridge University Press

Industrial Engineering and Management

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Knowledge of machines used in manufacturing organizations

Course Outcomes:

Students will be able to

1. Describe Principles and Types of Management
2. Interpret Theories of Motivations and leadership
3. Develop Entrepreneurship skills
4. Apply various Tools and techniques of Industrial Engineering for Productivity improvement
5. Apply Method study and examine the recorded facts and propose new method
6. Apply Work Measurement techniques to determine standard time

Unit I: Evolution of Management Practices

Characteristics, objectives Functions, Principles and Types of Management., Scientific Management-Contribution of F. W. Taylor, Henry Fayol Gantt, Maynard and Indian contributors to the Management thought.

Organization: Definition, Principles, Function and Types of organization structure, Different forms of Business— Proprietor, Partnership Firm, Private & Public limited company, Cooperative, Private &Public Trusts.

Unit II: Motivation

Human Needs and Types of Motivation, Theories of Motivations-Maslow's theory, McGregor's Theory of X and Theory of Y, Herzberg's Theory of two factor, David C.McCelland's Theory of Achievement, Expectance/valence Theory of Victor Vroom, Porter & Lawler's Model. Group dynamics: Types, characteristics, objectives of Group Dynamics Leadership: Definition, styles & functions of leadership, qualities for good leadership, role of the leader, Theories of leadership, Managerial grid, professional and business ethics.

Unit III: Entrepreneurship development

Characteristics of successful entrepreneurs, communications skill, problem solving skill and process, Basic element of Business plans, Sources of finance, Selection of Business location, Record keeping system, Analysis financial performance, Break even analysis, Technology and Business, Strategies for Business Growth, Concept related to start-up and Intellectual Property Rights (IPR).

Unit IV: Industrial Engineering

History, Development, Definition, Functions & Applications of Industrial Engineering. Tools and techniques of Industrial Engineering, Introduction to work study and work content.

Productivity Engineering Productivity: factor productivity, total productivity; labour Productivity, measurement of Productivity, Productivity improvement techniques. Productivity improvement programme.

Wages and incentives: Concept of wages, factors affecting wages, Job evaluation, merit rating.

Unit V: Method Study

Steps, Tools and Techniques used in the Method Study, outline Process Chart, Flow process Chart, Symbols, Flow Diagrams, Two Handed Chart, String diagram, Multiple Activity Chart, 5W and 1 H,Use of Motion Pictures and its analysis SIMO chart, cyclegraph Chronocylegraph. Developing, Presentation, Installation & Maintenance of new Methods. Principles of motion economy.

Unit VI: Work Measurement Time Study

Aim & Objectives, Terminology & Tools, Use of stopwatch procedure in making Time Study. Time Study Forms, Performance rating, allowances and its types. Calculation of Standard Time.

Work Sampling: Introduction to work sampling. Determinations of Standard time using work Sampling.

Synthetic & Standard data Methods: Concepts, Introduction to PMTS, MTM1, WFS, and Basic Motion Time Study. MTM2 & Other second Generation Methods, MOST and other advanced work measurement techniques.

Text Books:

1. M. Telsang, Industrial Engineering and Production Management, S. Chand Publication, ISBN 81 219 1773 5.
2. O. P. Khanna, Work StudyII, Dhanpat Rai Publications, New Delhi.
3. Banga& Sharma, Industrial Organisation& Engg. Economics, Khanna Publishers, 2001, ISBN 81-7409-078-9
4. Chabra T. N., Principles & Practices of Management, Dhanpatlal&compony.
5. Mahajan M., Industrial Engineering and Production ManagementDhanpat Rai and Sons Publishers, 2005, ISBN-81-7700-047-0

Reference Books:

1. H. B. Maynard and others, Industrial Engineering Handbook, IVth edition McGraw Hill Publications, ISBN 0-07-041084-4.
2. Introduction to Work Study, ILO Universal Pub. Co,B'bay,ISBN 81 85027 06
3. Ralph M. Barnes,Motion and Time Study: Design and Measurement of Work J. Wiley & Sons.
4. Koontz Harold and Weihrich Heinz, —Essentials of management, 7ed, Tata McGraw Hill publishing, 2008, ISBN 0-07-0623030-x.
5. Luthans f., Organizational Behaviour, McGraw-Hill Company, 2008, ISBN 81-317-0502
6. Cynthia L. Greene, Entrepreneurship: Ideas in Action, Thomson, ISBN-981-243-257-1.

Control System Engineering

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Algebra, Calculus, Linear algebra, Ordinary differential equations, Signals and systems

Course Outcomes: After completion of this course, the student will be able to:

1. Model a physical system and express its internal dynamics and input-output relationships by means of block diagrams, mathematical model and transfer functions.
2. Understand and explain the relationships between the parameters of a control system and its stability, accuracy, transient behavior.
3. Identify the parameters that the system is sensitive to. Determine the stability of a system and parameter ranges for a desired degree of stability.
4. Plot the Bode, Nyquist, Root Locus diagrams for a given control system and identify the parameters and carry out the stability analysis.
5. Determine the frequency response of a control system and use it to evaluate or adjust the relative stability,
6. Design a P, PD, PI, or PID controller based on the transient and steady state response criteria.

Unit I: Introduction to Control Systems

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.

Unit II: Time Response of feedback control systems

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).

Unit III: Stability analysis

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.

Unit IV: Frequency domain analysis and stability

Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded) Introduction to lead, lag and lead-lag compensating networks (excluding design)

Unit V: Digital Control System and PLC

Introduction to Digital Control System: Introduction, Spectrum Analysis of Sampling process, Signal reconstruction, Difference equations,

Functions of PLC, Advantages, Architecture, working of PLC, Selection of PLC, Networking of PLCs, Ladder Programming, Interfacing Input and Output devices with PLC, PLC based automated systems. High frequency inputs. PLC programming standard IEC61131, Soft PLC techniques

Unit VI: The Design of Feedback Control Systems

The Design of Feedback Control Systems: Approaches to System Design**,** Cascade Compensation Networks, Phase-Lead Design Using the Bode Diagram, Phase-Lead Design Using the Root Locus, System Design Using Integration Networks, Phase-Lag Design Using the Root Locus, Phase-Lag Design Using the Bode Diagram, Design on the Bode Diagram Using Analytical Methods.

References:

1. Katsuhiko Ogata, Modern Control Engineering, Fifth Edition, PHI Learning Private Limited, New Delhi, 2010
2. I.J. Nagrath , M. Gopal, Control Systems Engineering, Fifth Edition, New Age International Publishers, New Delhi, 2007
3. Curtis D Johnson, Process Control Instrumentation Technology, Eighth Edition, PHI Private Limited, New Delhi, 2011
4. Richard C. Drof , Robert N. Bishop, Modern Control Systems, Addison Wesley Publishing Company, 2001
5. B.C.Kuo, Digital Control Systems, Second Edition, Oxford University Press, New York, 2007

Design of Machine Elements

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Basic mechanical Engineering, Engineering Mechanics, Mechanics of Materials,

Course Outcomes:

On successful completion of the course students should be able to-

1. Understand the basic principles and process of machine design
2. Understand the theories of failures and Factor of safety to design mechanical component.
3. Analyze the stress and strain on mechanical components such as shaft, power screws, mechanical springs, gears, and bearings.
4. Understand, identify and quantify failure modes for mechanical parts such as shaft, power screws, mechanical springs, gears, and bearings.
5. Demonstrate knowledge on basic machine elements used in design of machine elements to withstand the loads and deformations for a given practical application.

Unit I: Introduction to Machine Design

Design Process: Machine Design, Traditional design methods, Basic procedure of MachineDesign, Requisites of design engineer, Design of machine elements, Sources of design data, Use of standards in design, Selection of preferred sizes. Design of Simple Machine Parts: Factor of safety, Service factor, Design of simple machine parts, Cotter joint, Knuckle joint and lever.

Unit II: Design of shafts, Keys and couplings

Shafts: Design considerations in Transmission shafts with spur gear and pulley, splined Shafts,Shaft design on strength basis, Shaft design on torsional rigidity basis, ASME code for shaft design. Keys: Classification of keys, Design considerations in parallel and tapered sunk keys, Design ofsquare, flat and Kennedy keys. Couplings: Design considerations, Classification, Design of Rigid, Muff coupling, Flange couplingand Flexible bushed pin coupling.

Unit III: Design of Power Screws

Power Screws: Types of screw threads, multiple threaded screws, Torque analysis with square and trapezoidal threads, Self-locking screw, Collar friction torque, Stresses in power screws, design of screw and nut, design of Screw jack.

Unit IV: Design of Springs

Mechanical Springs: Types, Applications and materials of springs, Stress and deflection equations for helical springs, Types of ends, Design of helical compression and tension springs, Springs in series and parallel, Helical torsion spring, surge in spring.

Unit V: Design of Spur Gears

Spur Gears: Various design consideration, Beam Strength, tangential loading module calculations, width calculations, type of gear tooth failures, Estimation of dynamic load by velocity factors and Spott"s equation.

Unit VI: Design of Bearings

Rolling Contact Bearings: Type, static and dynamic loading capacity, stribeck‟s equation, concept of equivalent load, load life relationship, selection of bearing from manufacturers catalogue, design for variable load and speeds, bearing probability of survival other than 90%, lubrication and mounting of bearing.

Text Books

1. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw- Hill publication Co. Ltd., 1989, ISBN 0-07-049462-2.
2. Spotts M. F. and Shoup T. E., “Design of Machine Elements”, 8ed., Pearson Education pvt. Ltd., 2008, ISBN 81 -7758- 4219.
3. Bhandari V.B., “Design of Machine Elements”, Tata Mcgraw-hill publishing, 2007, ISBN 978-00-70-681798
4. Kannaiah, “Machine Design”, Scitech publications Pvt. Ltd., 2007, ISBN 81- 88429-10-4.
5. RAGHAVENDRA, Design Of Machine Elements I Dme I, CBS Publishers and Distributors, Pvt.Ltd., 2019, ISBN: 978-93-890-1718-2

Reference Books

1. Orthewein and William C. Orthewein, “Machine Component Design”.
2. PSG Design data”, M/S DPV printers, Coimbatore, 2000.
3. Black paulH.and Adams O. Eugene, “Machine Design”, 3ed.,McGraw-hill Book Company, 1999, ISBN 0–07-085037-2.
4. Hall Allens, Holowenko Alfred R., Laughlin Herman G., “Theory & Problems of Machine Design”, McGraw-hill Book Company, 2000, ISBN 48333-7

Metrology and Quality Assurance

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem :70 Marks

Pre-requisites:
Engineering Graphics, Machine Drawing and Manufacturing Technology

Course Outcomes:
After learning this subject, the student will be able to:
1. Describe and work with various linear and angular measuring devices
2. Design limit gauges and work with special measuring devices for gear,screw thread and surface finish measurements
3. Distinguish various comparators and use profile projector
4. Use various control charts and various quality assurance tools
5. Get knowledge of various quality standards and their implementations in industries.
6. Implement TQM and TPM concepts in practice

Unit I: Introduction
Meaning of Metrology, Precision, Accuracy, Errors in Measurement, Calibration,
Linear Measurement: Standards, Classification of Standards, Precision and Non PrecisionMeasuring instrument, Slip Gauges. Manufacturing of slip gauges
Angular Measurement: Sine bar, Sine Center, Uses of sine bars, angle gauges, Auto Collimator, Angle Dekkor.
Inspection of Geometric parameters: Straightness, flatness, Parallelism, Concentricity,Squareness and Circularity. Alignment testing- lathe/milling/ drilling m/c
Comparators: Uses, Types, Advantages and Disadvantages of various Comparators.

Unit II: Limits, Fits and Tolerances
Meaning of Limit, Fits and Tolerance, Cost -Tolerance relationship,concept of Interchangeability, selective assembly, Indian Standard System. Design of limitsGauges: Types, Uses, Taylor's Principle, Design of Limit Gauges, Introduction to auto gaugingsystems. Interferometry: Introduction, Flatness testing by interferometry, NPL Interferometer.

Unit III: Surface Finish Measurement
Surface Texture, methods of evaluation of surface roughness,Grades of Roughness, Specifications, Tomlinson's Surface Recorder, Taylor- Hobson SurfaceMeter and Talysurf for measuring all characteristics of surface texture.
Screw Thread Metrology: External Screw Thread terminology, effective diameter measurementmethods, Pitch and flank Measurement of External Screw Thread, Application of Tool Maker'sMicroscope, Use of Profile Projector.
Gear Metrology: Spur Gear Parameters, Gear tooth thickness measurement: Gear tooth Verniercaliper, Constant chord method, Span Micrometer, Base tangent method.
Recent Trends in Engineering Metrology-Universal measuring machine coordinate measuringmachine, laser interferometer.

Unit IV : Introduction to Quality
Meaning of Quality, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Roleof Quality in Present day environment. Introduction to Statistical Quality Control: Control Charts,X, R, P and C Charts, Sampling inspection, OC Curves and Sampling Plans, Process CapabilityIndex (PCI), Concept, Methods of determining PCI and uses of PCI.

Unit V: Quality Assurance tools and techniques
Total quality management (T.Q.M):- Approaches-Deming's Approach, Juran's Approach,Seven quality tools and new seven quality tools, Q.F.D., Quality Circles, Kaizen, six sigma, T.P.M. Technical Specification (T.S) TS 16949 Standards.

Unit VI: Quality Standards

ISO 9001-2000 Series of Standards- History and Evolution of ISO 9000 Series, importanceand overview of ISO 9000- 1998 Series standards, structure of ISO 9000-2000 Series standards,clauses of ISO 9000 series standards and their interpretation and implementation, quality systemdocumentation and audit.

ISO 14000:- Environmental management concepts, and requirement of ISO 14001, benefit ofEnvironmental Management Systems, Environmental, Health and Safety standards.

Text Books:

1. I.C.Gupta, "A Text book of Engineering Metrology", Dhanpat Rai and Sons.
2. R.K. Jain, "Engineering Metrology", Khanna Publication, 21st Edition.
3. K.W.B.Sharp, "Practical Engineering Metrology", Pitman Publication, ISBN-13: 978-0273439417
4. F. M. Gryna, R. Chua & J. Defco, "Jurans Quality Planning and Analysis for Enterprise Quality", McGraw Hill series. ISBN 0070618488

Reference Books:

1. Dr. N V Raghavendra and Dr. L Krishnamurthy, Engineering Metrology and Measurements, ISBN-13: 978-0198085492
2. K.J.Hume, "Engineering Metrology", Kalyani publication ISBN8170290015
3. Kaoru Ishikawa, "Guide to Quality Control", Asian Productivity Organisation, Series,
4. Juran's Quality Handbook, McGraw-Hill International Editions: Industrial Engineering Series 5th Edition

Industrial Engineering and Management Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Term work:01	Term work: 25 Marks

Term work:
Term work shall consist of any assignments and/or case studies based on each unit of the syllabus: The topic should be from manufacturing or service sector.

1. Study of scientific management , International and National contributors to management thought
2. Leadership styles and Great leaders [student's opinion] and his characteristics
3. National and International successful entrepreneurs [student's opinion]. Success story of his business
4. Application of Productivity improvement techniques
5. Method study: Recording of the existing activity using charts and diagrams and propose new method
6. Calculation of standard time for given activity
7. Case study on Value analysis/ Value engineering

Control Systems Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical: 01	Term Work: 50 Marks

Assignment to be given on the following topics. (Any ten)

1. Find overall transfer function of the system using block diagram algebra.
2. Find determine the stability of a system using Routh Hurwitz Criterion, marginal value of K and frequency of sustained oscillations.
3. Construct the root locus and comment on the stability.
4. Find the time domain specifications of the given system.
5. Find the steady state error and error coefficients of the type 0, 1 and 2 systems for step, ramp and parabolic inputs.
6. Find frequency domain specifications of the system.
7. Draw Bode Plot, find PM and GM and Comment on the stability. Also, find transfer function of the system from given Bode plot.
8. Find stability of the system using Nyquist Criteria.
9. Write State space model of the system and solution.
10. Find State Transition Matrix for given system and verify the properties of the same.
11. Find the Transfer Function of a Digital System.
12. Find the response of first and second order Digital Systems for Step Input.
13. Study the Digital PID Controller with reference to response time, steady state error and offset.

Design of Machine Elements Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical: 01	OR: 50 Marks

Term work shall consist of

1) ONE design project. Design project shall consist of two imperialsize sheets –one involving assembly drawing with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design projects should be in the form of „Design of Mechanical System" comprising of machine elements studied and topics covered in the syllabus. Design data book shall be used wherever necessary to achieve selection of standardized components.
2) Problem based assignment on each unit.

Metrology and Quality Assurance Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical: 02	Practical: 50 Marks

A] Experiments: (Any Eight)

1. Linear Measurement using precision instruments.
2. Measurement of angle by sine bar / Sine center
3. Alignment Test on Lathe/ Drilling/Milling Machine.
4. Measurement of the Surface roughness
5. Measurement of Optical surface using Interferometer.
6. Measurement of Screw thread parameters using Floating Carriage Micrometer.
7. Measurement of Gear tooth thickness using Gear tooth Vernier caliper or Spanmicrometer
8. Study and Experiment on Profile Projector.
9. Study and Experiment on any type Comparator.
10. Study of Limit Gauges and auto gauging systems.

B] Reports based on Industrial Visit

Geometric Dimensioning and Tolerancing Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical:01	Term Work: 25 Marks

Term work based on following topics:

1. Introduction to geometric dimensioning and tolerancing. Terminology and Basic rules
2. Features and Rules of geometric dimensioning and tolerancing, Envelope Principle, Maximum Material Condition, Least Material Condition, Basics of Functional Gauging
3. Datum Control: Introduction to datum, datum reference frames, Maximum material boundary (MMB) and Least material Boundary (LMB)
4. Adding geometric dimensioning and tolerancing, The Feature Control Frame, Size, Location, Orientation and Form (SLOF) for Drawings, Datum section
5. **Form Tolerances**: Straightness (Surface), Straightness (Median Line/MMC), Flatness (Surface), Flatness (Median Plane/MMC), Circularity, Cylindricity
6. **Orientation Tolerances**: Parallelism (Surface), Parallelism (Axis), Perpendicularity (Surface),Perpendicularity (Axis), Angularity (Surface and Axis),
7. Profile, Location and Runout Tolerances

C Programming Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 02 hours / week	Practical:01	Term Work: 25 Marks

1. Introduction to Computer Programming

Program and Programming, Programming Languages, Types of software's, Operating Systems, Dos commands, Basic Linux commands and vi editor, Compiler, Interpreter, Loader and Linker, Variables, Data Types, Declaration of Variable, Assigning Values to Variables, Initialization, Comments, Const Qualifier, Basic Structure of a 'C' program.

2. Operators and Expressions

Dealing with all operators, Arithmetic operators, Increment and decrement operators, Relational operators, Logical operators, The bitwise operators, The assignment operators, The conditional operator, The size of operator, The comma operator, Type casting operator, Other operators, Precedence and order of evaluation.

3. **Control statements**

Conditional Control Statements , if, if-else, nested if-else , else-if ladder, Multiple Branching Control Statement , switch-case , Loop Control Statements, while, do-while, for, Nested Loops, Jump Control statements , break , continue , goto , exit , return.

4. Function

What is function?, Why function?, Advantages of using functions, Function Prototype, Defining a function, Calling a function, Return statement, Types of functions, Recursion, Nested functions, main() function, Library Function, Local and global variables.

5. **Array**

One dimensional arrays, Declaration of 1D arrays, Initialization of 1D arrays, Accessing element of 1D arrays, Reading and displaying elements, Two dimensional arrays, Declaration of 2D arrays, Initialization of 2D arrays, Accessing element of 2D arrays, Reading and displaying elements, Programming Examples.

6. File Handling and Graphics

Using files in C, Buffer and streams, Working with text files and Binary Files, File operations using std. library and system calls, File management I/O functions, Random Access Files, graphics syntaxes, graphics in animation.

Reference Books:

1. Kernighan and Ritchie, The C Programming Language, Prentice Hall of India, 2019
2. Carlo Ghezi, Mehdi Jazayeri, Programming Language Concepts, John Willey and Sons
3. Yashavant Kanetkar, Graphics Under C, BPB Publications, 2010
4. Herbert Schildt, C Complete Reference, Tata McGraw-Hill Education, 2009
5. Al Kelley; Ira Pohl, A Book on C: Programming in C, ISBN 0-201-18399-4, 2010