VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019
(Autonomous Institute affiliated to the University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Second Year
of
Four Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.) Degree in Production Engineering

Implemented from the batch admitted in first year, 2023-24

Vision and Mission of the Institute

Vision

To establish global leadership in the field of Technology and develop competent human resources for providing service to society.

Mission

- To provide students with comprehensive knowledge of principles of engineering with a multi-disciplinary approach that is challenging
- To create an intellectually stimulating environment for research, scholarship, creativity, innovation, and professional activity.
- To foster relationships with other leading institutes of learning and research, alumni and industries to contribute to National and International development.

Vision and Mission of the Department

Vision

To develop technically competent and disciplined production engineers with creativity, comprehension and managerial skills to serve as a preferred provider of Manufacturing and Industrial Engineering students and services that satisfy the changing needs of all customer segments.

Mission

- Inculcate and develop the students who will be able to design and manufacture innovative, environmentally friendly, ergonomic and cost-effective quality products and services.
- Enhance the technical quality of the students to fulfil the challenges, competitions and opportunities in Production/ Industrial Engineering.
- Prepare the students to solve community-related engineering problems and other complex problems by means of inculcating technical managerial skills.
- Strive continuously to pursue excellence in all the areas of Manufacturing/ Industrial and enhance the department-industry/research centre interaction by means of training, internship and student projects to solve industrial problems.

Program Educational Objectives (PEO)

- To prepare the Graduates with a sound foundation in the mathematical, scientific and engineering fundamentals and equip them with modern tools so as to analyze, formulate, and solve real-life manufacturing and industrial engineering problems.
- To prepare graduates to become product and process design professionals for sustainable manufacturing.
- To prepare the graduates for a successful career in Indian and Multinational organizations and to excel in their Postgraduate studies.
- To encourage and motivate graduates in the art of self-learning.
- To inculcate a professional and ethical attitude, good leadership qualities, and commitment to social responsibilities in the graduates' thought process.

Program Outcomes (PO)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO):

- Identify, formulate, and analyze complex engineering problems to solve real-life problems in the areas of mechanical design, tool design, advanced manufacturing methods, quality assurance, and industrial Engineering.
- Graduates would provide middle-level managerial leadership-based study and practice of industrial management imparted during the program while working in design and manufacturing industries.
- To employ modern industrial engineering/ management techniques to improve the value of the product by improving the quality and reducing the cost of manufacturing.

Credit Framework for UG Programme in Production Engineering (Level 5.0 – UG Diploma): Semester - III

S. No	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	R5MA2004T	Applied Probability and Statistics	3	0	0	3	3	20	30	50
2	R5PE2001T	Basic Thermodynamics	3	0	0	3	3	20	30	50
3	R5PE2002T	Metal Casting and Welding Technology	3	0	0	3	3	20	30	50
4	R5PE2002L	Metal Casting and Welding Technology Laboratory	0	0	2	2	1	ISCE: 60		40
5	R5SE2005T	Strength of Materials	3	0	0	3	3	20	30	50
6	R5ET2010T	Basic Electronics Engineering	3	0	0	3	3	20	30	50
7	R5ET2010L	Basic Electronics Engineering Laboratory	0	0	2	2	1	ISCE: 60		40
8	R5PE2003T	Industrial Management	2	0	0	2	2	20	30	50
9	*	Multi-Disciplinary Minor – I	2	0	0	2	2	20	30	50
10	R5CH2401O	Environmental Science	2	0	0	2	2	ISCE: 60		40
		Total	**21**	**0**	**4**	**25**	**23**			

Abbreviations:
L: Lecture, **T**: Tutorial, **P**: Practical, **Cr:** Credit **TA**: Teacher Assessment, **MST**: Mid-Semester Test, **ESE**: End Semester Examination, **ISCE:** In Sem Continuous Evaluation
***:** course code of respective Multi-Disciplinary Minor (MDM) course

Credit Framework for UG Programme in Production Engineering
(Level 5.0 – UG Diploma): Semester - IV

S. No	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	R5PE2004T	Fluids and Thermal Engineering	3	0	0	3	3	20	30	50
2	R5PE2004L	Fluids and Thermal Engineering Laboratory	0	0	2	2	1	ISCE: 60		40
3	R5PE2005T	Theory of Machines	3	0	0	3	3	20	30	50
4	R5PE2006T	Metrology and Quality Control	3	0	0	3	3	20	30	50
5	R5PE2006L	Metrology and Quality Control Laboratory	0	0	2	2	1	ISCE: 60		40
6	R5PE2007L	Computer Aided Machine Drawing	1	0	2	3	2	ISCE: 60		40
7	R5PE2008T	Managerial Economics, Finance and Costing	2	0	0	2	2	20	30	50
8	*	Multi-disciplinary Minor – II	2	0	0	2	2	20	30	50
9	R5HS2402O	Universal Human Values	2	0	0	2	2	ISCE: 60		40
10	#	Modern Indian Language	2	0	0	2	2	ISCE: 60		40
11	R5PE2601P	Community Engagement Project/ Field Project	0	0	4	4	2	ISCE: 60		40
		Total	**18**	**0**	**10**	**28**	**23**			

Abbreviations:
L: Lecture, **T**: Tutorial, **P**: Practical, **Cr:** Credit **TA**: Teacher Assessment, **MST**: Mid-Semester Test, **ESE**: End Semester Examination, **ISCE:** In Sem Continuous Evaluation
***:** course code of respective Multi-Disciplinary Minor (MDM) course
#: course code of respective language course

Course Codes for Multi-Disciplinary Minors (MDM)

S. No.	Course Code	Name of the MDM Course in Semester III	Name of the MDM
1	R5CE2201T	Understanding Incubation and Entrepreneurship	Innovation and Entrepreneurship
2	R5CE2202T	Legal Framework for Construction	Contract Law, Arbitration, and Valuation
3	R5CE2203T	Principles of Sustainability	Sustainable Environment
4	R5IT2201T	Introduction to Artificial Intelligence & Machine Learning	Artificial Intelligence & Machine Learning (AIML)
5	R5CO2201T	Introduction to Data Science.	Data Science
6	R5EL2201T	Foundations of Cyber security	Cyber Security
7	R5EL2202T	Introduction to IoT Systems	Internet of Things (IOT)
8	R5EL2203T	Signals and Systems	Signal and Image Processing
9	R5EE2201T	Electro-mechanical Energy Conversion	Electrical Vehicles
10	R5ME2201T	Introduction to Robotics	Robotics
11	R5ME2202T	Warfare Platforms & Systems	Defence Technology
12	R5ME2203T	Introduction to Aerospace Engineering	Aerospace Technology
13	R5IL2201T	Orientation Programme in Entrepreneurship	Entrepreneurship and Start-up

Course Codes for Languages

S. No.	Course Code	Name of the Language course in Semester IV
1	R5HS2501O	Marathi
2	R5HS2502O	Hindi
3	R5HS2503O	Sanskrit
4	R5HS2504O	Kannada
5	R5HS2505O	Gujarati
6	R5HS2506O	Punjabi

Semester III

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5MA2004T	
Course Title	Applied Probability and Statistics	
Prerequisites	Applied Mathematics I & II	

Course outcomes: On the completion of this course, the learner will able to

1. Apply the discrete and continuous probability distributions to find probabilities and expected value of a random variable
2. Find the relationship between two variables with the help of curve fitting and correlation-regression analysis
3. Write the suitable hypothesis and apply appropriate testing procedure using critical values to draw a conclusion
4. Estimate population parameters from sample values and check whether the estimator is unbiased
5. Apply statistical methods to real-world problems using statistical software like Excel, Matlab, and SPSS

Syllabus

1. **Probability distributions**

Review of probability (Sample space, random experiment and events), Conditional probability, dependent and independent events, Bayes theorem, Random variables - discrete and continuous, probability density function, cumulative distribution function, Moment generating function, Expectation, variance, Joint probability, marginal and conditional p.m.f.s, Conditional expectation, Special discrete distributions- Binomial, Poisson, Geometric and Negative Binomial distribution.

Special continuous distributions - Normal distribution, Exponential distribution, additive properties of variables, Central limit theorem.

2. **Estimation and sampling theory**

Difference between parameter and statistic, Sampling distribution of sample mean and sample proportion, standard error, Point estimation, Unbiased estimator, Consistency and efficiency of estimators, Maximum likelihood estimator, Interval estimation (confidence intervals).

3. **Testing of Hypothesis**

Concepts of Statistical hypothesis, Null and Alternate hypothesis, Critical region, two types of errors, Level of significance, Tests of significance based on Large sample theory, Student's t

	test for single mean, Difference of means and Paired t-test (small sample theory), F test for Population variances and Chi-square test for Goodness of fit and test for Independence of attributes.
4.	**Correlation & Regression Analysis** Correlation analysis, Karl Pearson's correlation coefficient and Rank correlation, Regression analysis- curve fitting, method of least squares.
5.	**Applications of Probability and Statistics** Applications to weather forecasting, Statistical process control, Acceptance sampling, Reliability of an equipment, Decision making under uncertainty. Statistical softwares: Problem solving in Statistical softwares- excel, MATlAB, SPSS.
	Text Books
1.	Richard Levin and David Rubin: Statistics for Management, Pearson India.
2.	S. Gupta and V. Kapoor: Fundamentals of Mathematical Statistics, S. Chand and Co.
3.	Sheldon Ross: Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
4.	Ronald Walpole, Raymond Myers, Myers and Keying: Probability and Statistics for Engineers and Scientists.
5.	Montgomery and George Runger: Applied statistics & probability for engineers, Wiley publisher.
	References
1.	V. K. Kapoor and S. C. Gupta: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2020.
2.	Rorald Walpole: Probability and Statistics for Engineers and Statistics, 9^{th} edition, Pearson India.
3.	T. Veerarajan: Probability, Statistics and Random Processes, Tata McGraw-Hill Education (2008).

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5PE2001T	
Course Title	Basic Thermodynamics	
Prerequisites	Engineering Physics and Chemistry	

Course outcomes: On the completion of this course, the students will able to

1. Understand and apply the fundamental concepts and laws of thermodynamics to various systems
2. Analyze the second law of thermodynamics, entropy, and their applications in engineering cycles
3. Evaluate the performance of air standard and gas power cycles, including deviations from ideal cycles
4. Analyze vapor and combined power cycles to improve efficiency using thermodynamic principles
5. Understand and apply the principles of heat transfer, including conduction and convection, to engineering problems.

Syllabus

1. **Fundamental Concepts and First Law**

Definition and scope, Basic concepts and terminology (system, surroundings, boundaries, states, properties, processes, cycles), properties of system, thermodynamic equilibrium, Reversible and irreversible process, Zeroth law of thermodynamics, First Law, Application to Closed and Open System, Steady flow Energy Equation and its Application.

2. **Second Law of Thermodynamics and Entropy**

Introduction to second law statement, Thermal Reservoir, Reversible and irreversible processes of second law, Heat Engine, Refrigerator, Heat pump, Kelvin Planck and Clausius Statement, Equivalence of two statements, Perpetual Motion Machines, second law to cycle and Cyclic device, Carnot cycle, Carnot Principle, Ideal Carnot Heat Engine, Refrigerator and Heat Pump, Thermal Efficiency, COP. Entropy as parameter to quantify second law effects, increase of entropy principle, Calculation of Entropy change during processes, Isentropic process and property relation, reversible steady flow relation, entropy balance to various system.

3. **Air Standard and Gas Power Cycle**

Basic Consideration in Power Cycles, Carnot cycle and its Engineering Value, Air Standard

	Assumption, Overview of Reciprocating Engine, Otto Cycle for SI Engine, Diesel Cycle for CI Engine, Dual/ Brayton Cycle, Striling and Ericsson Cycle, Development of Gas Turbine, Deviation of actual with ideal, Brayton with Intercooling and Reheating, Introduction and working of Turbojet Engines, Second law for gas power cycle.
4.	**Vapour and Combined Power Cycles** Carnot Vapor Cycle, Rankine Cycle, Deviation from actual vapor power cycles, Increasing Efficiency of Rankine Cycle: Lowering Condenser Pressure, Superheating, Increasing the boiler Pressure, Ideal Reheat Rankine Cycle, Ideal Regenerative Rankine Cycle, Combined Gas-Vapor Power Cycle, Steam Tables and Mollier Charts, Law of Interpolation
5.	**Introduction to Heat Transfer** Introduction to different modes of Heat Transfer, Thermal Conductivity, Thermal Diffusivity. Conduction: Simultaneous Heat Transfer, Steady and Transient 1-D Heat Conduction, Heat Generation, Fourier law, One Dimensional Heat Conduction for plane wall, Cylinder and Sphere. Composite Cylinder and Multiplane Wall. Convection: Fundamental of Convection, Continuity, Momentum and Energy Equation, Free and Forced Convection, Internal Forced Convection, Flow in a Close Conduit, External Forced Convection over a flat plate and cylinder
	Text Books
1.	Nag, P. K., Basic Thermodynamics. Tata McGraw Hill, 2006.
2.	Rathore, Mahesh M. Thermal engineering. Tata McGraw-Hill Education, 2010.
	References
1.	Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. *Thermodynamics: an engineering approach*. Vol. 5. New York: McGraw-hill, 2011.
2.	Cengel, Yunus, John Cimbala, and Robert Turner. *EBOOK: Fundamentals of Thermal-Fluid Sciences (SI units)*. McGraw Hill, 2012.
3.	Cengel, Yunus A., and Afshin J. Ghajar. "Heat and mass transfer." *Penerbit McGraw-Hill Education, New York* (2015).
4.	Rathakrishnan, Ethirajan. *Fundamentals of engineering thermodynamics*. PHI Learning Pvt. Ltd., 2005.
5.	Bejan, Adrian. *Advanced engineering thermodynamics*. John Wiley & Sons, 2016.

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5PE2002T	
Course Title	Metal Casting and Welding Technology	
Prerequisites	Basic Manufacturing Technology	

Course outcomes: On the completion of this course, the learner will able to:

1. Understand various casting methods and their applications
2. Design gating system for metal casting processes
3. Learn and control the factors controlling casting defects
4. Understand the processing of plastics, ceramics and glasses
5. Understand the fundamental and advanced welding processes

Syllabus

1. **Introduction**

Principle of casting. Overview and classification of Casting process.

Sand Casting: Basics, types and processes. Capability of sand-casting processes.

Moulding sand and mould making - Composition, characteristics and testing including mulling index; moldability index; compactability; deformability. Moulding methods and testing of moulds.

Pattern -Types, materials and making/ machining of patterns for different applications.

Core sand; characteristics and constituents, core making, baking and handling techniques; moulding and core making machines.

2. **Gating and Risering Design**

Progressive and directional solidification; rate of solidification; Chvorinov's Rule, electrical analog of solidification problem.

Riser design; risering curves; NRL method of riser design; feeding distance; risering of complex casting; risering of alloy other than steel; recent developments e.g. riser design by the application of geometrical programming.

3. **Melting and Solidification**

Selection and control of melting furnaces; melting, refining and pouring. Furnaces: cupola, electric and induction furnaces; comparative study and their suitability; charge calculation, handling of molten metal; ferrous and nonferrous foundry practice. Measurement of fluidity; effects of various parameters on fluidity. Methods of elimination and control of dissolved gases in castings.

Solidification: Solidification of pure metal and alloys, their characteristics; free solidification

	and solidification under force. Fettling and inspection of castings; casting defects, causes and remedies; casting design.
4.	**Inspection and Quality Control** Casting defects and remedies. Review of x-ray and gamma ray radiography; magnetic particle; penetrant and ultrasonic inspections; use of statistical quality control in foundry.
5.	**Processing of Plastics, Ceramics and Glasses** Introduction; Extrusion: Miscellaneous Extrusion Processes, Production of Polymer Reinforcing Fibers; Injection Molding: Reaction-injection Molding; Blow Moulding; Rotational Moulding; Thermoforming; Compression Moulding; Transfer Moulding; Casting; Foam Moulding; Cold Forming and Solid-phase Forming; Processing Elastomers.
6.	**Welding Processes: Fusion Welding Processes** **Gas Welding Processes:** Oxy C_2H_2 gas welding, Flame types, Torch Angle, Flame Density, Factors affecting Torch angle, Gas Welding Techniques, Welding Positions, Filler rod material, Flux Material, Air C2H2 gas welding, Oxy H_2 gas welding, Atomic H_2 welding, **Arc Welding Processes:** Types of arc welding processes: Direct Current Straight Polarity (DCSP), Direct Current Reverse Polarity (DCRP), Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), Submerged Arc Welding (SAW), Electroslag Welding, Plasma Arc Welding (PAW). Numerical Treatment on V–I Characteristics of power source, Design of weld bead, Duty cycle **Thermit Welding**: Process, characteristics and applications **Preheating, Post heating, Weldability, Welding Defects**
7.	**Welding Processes: Non-Fusion and Advanced Welding Processes** **Non-Fusion Welding Processes:** Resistance Welding: Spot welding, seam welding, projection welding, flash and butt welding, Soldering, Brazing, Braze Welding, applications. **Advanced Welding Processes:** Laser beam welding, Electron beam welding, Friction beam welding, Hybrid welding
	Text Books
1.	P.N. Rao: Manufacturing Technology – Foundry, Forming and Welding, Vol - I, TMH.
2.	Ghosh and Mallick: Manufacturing Science, EW Affiliated
3.	A. S. Athalye: Hand book of Plastics Materials and Processing

4.	Larry Jeffus: Welding: Principles and Applications, Cengage Learning
	References
1.	B. Ravi: Metal casting Technology, PHI Publication.
2.	P.K. Jain: Principles of Foundry Technology, Tata McGraw Hill Publications.
3.	R. S. Parmar, Welding Technology, Khanna Publications
4.	V. M. Radhakrishnan: Welding Technology, New Age Publishers
5.	ASM: Handbook Vol. XV

Programme	B. Tech. (Production Engineering)	**Semester** - III
Course Code	R5PE2002L	
Course Title	Metal Casting and Welding Technology Laboratory	
Prerequisites	Basic Manufacturing Technology	

Course outcomes: On the completion of this course, the learner will able to:

1. Develop and design effective gating systems for casting processes, ensuring optimal flow and quality of castings
2. Apply magnetic inspection techniques to detect surface and subsurface defects in materials
3. Utilize ultrasonic testing methods to identify and evaluate internal flaws and material properties
4. Conduct laboratory tests to determine the coefficient of permeability of soil using the constant head method, following IS: 2720 (Part-17) - 1986 standards
5. Apply theoretical knowledge to practical assignments, demonstrating understanding and application of key concepts from the syllabus

	Syllabus
1.	Design of gating system
2.	Nondestructive testing: Magnetic Inspection Testing
3.	Nondestructive testing: Ultrasonic testing
4.	Laboratory determination of coefficient of permeability of soil using constant head methods referring to the IS: 2720 (Part-17) - 1986
5.	Assignment on various topics from theory syllabus
	Text Books
1.	P.N. Rao: Manufacturing Technology – Foundry, Forming and Welding, Vol - I, TMH.
2.	Ghosh and Mallick: Manufacturing Science, EW Affiliated
3.	A. S. Athalye: Hand book of Plastics Materials and Processing
4.	Larry Jeffus: Welding: Principles and Applications, Cengage Learning
	References
1.	B. Ravi: Metal casting Technology, PHI Publication.

2.	P.K. Jain: Principles of Foundry Technology, Tata McGraw Hill Publications.
3.	R. S. Parmar, Welding Technology, Khanna Publications
4.	V. M. Radhakrishnan: Welding Technology, New Age Publishers
5.	ASM: Handbook Vol. XV

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5SE2002T	
Course Title	Strength of Materials	
Prerequisites	Engineering Mechanics	

	Course outcomes: On the completion of this course, the learner will able to 1. Apply the principals of axial, shear and bending action for the analysis of structural elements. 2. Apply the principals of axial, shear and bending action for the design of various structures. 3. Estimate stresses and strains in shaft subjected to torsion and in thin-wall spherical and cylindrical vessel subjected to internal pressure 4. Determine analytically and graphically principal stresses, principal strains and maximum shearing stress.
	Syllabus
1.	**Simple Stress and Strain** Definitions of stress, strain, modulus of elasticity, modulus of rigidity, bulk modulus, yield stress, ultimate stress, factor of safety and shear stress. Poisson ratio, bars of varying sections, stress due to self-weight. Composite sections, temperature stresses.
2.	**Shear Force and Bending Moment** Axial force, shear force and bending moment diagram for statically determinate beams and frames.
3.	**Theory of Pure Bending** Flexure formula for straight beams, moment of inertia, product of inertia and polar moment of inertia of plane areas, principal axes of inertia, moments of inertia about principal axes, transfer theorem, flinched beams. Unsymmetrical bending. Flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.
4.	**Shear Stress in Beams** Distribution of shear stress across plane sections, shear connectors. Shear center of thin walled sections such as angle, tee, channel and I sections
5.	**Simple Theory of Torsion** Torsion of circular solid and hollow shafts, stresses in shaft when transmitting power, close-coiled helical springs under axial load.

6	**Bending Moment Combined with Axial Loads** Application to member's subjected to eccentric loads, core of a section, problems on chimneys, retaining walls etc., involving lateral loads
7	**Thin Cylinder and Spherical Shell** Stresses and strains in thin cylindrical and spherical shells under internal pressure.
8	**Principal Stresses and Strains** General equations for transformation of stress, principal planes and principal stresses, maximum shear stress, determination using Mohr's circle, principal stresses in beams, principal stresses in shafts subjected to torsion, bending and axial thrust, concept of equivalent torsional and bending moments.
	Text Books
1.	Ramamurtham: Strength of Materials, Dhanpat Rai Publications.
2.	Beer and Johnston: Mechanics of Materials, McGraw-Hill.
	References
1.	Bhavikatti: Strength of Materials, Vikas Publishing House.
2.	Ferdinand Singer: Mechanics of solids, Longman.
3.	Junnarkar: Mechanics of Structures Vol I, Charotar Publication house.
4.	James Gere: Mechanics of Materials, Brooks/Cole. Publishing Co.

Programme	B. Tech. [Production Engineering]	**Semester -** III
Course Code	R5ET2010T	
Course Title	Basic Electronics Engineering	
Prerequisites	None	

Course Outcomes: On the completion of this course, the learner will able to:

1. Analyze electrical circuits using passive components, Kirchhoff's laws, and key theorems.
2. Understand and apply diodes, transistors, and MOSFETs in circuit design
3. Design and analyze analog circuits using operational amplifiers and oscillators
4. Develop and implement digital systems using logic gates, flip-flops, and sequential circuits
5. Apply electronic systems in instrumentation, power supplies, and measurement devices

Syllabus

1. **Basic Circuits Concepts**

Passive components: Resistance, Inductance, Capacitance; series, parallel combinations; Kirchhoff's law: Voltage, Current; Linearity

Understand and apply semiconductor devices like diodes, transistors, and MOSFETs in various circuits

Utilize operational amplifiers in applications like amplifiers, integrators, and oscillators.

Signal sources: Voltage and Current sources; Non-ideal sources; Representation under assumption of Linearity; controlled sources: VCVS, CCVS, VCCS, CCCS; concept of Gain, Transconductance, Transimpedance

Superposition theorem, Thevenin's theorem, Norton's theorem

Introduction to Filter

2. **Diodes**

Semiconductor Diode Characteristics

Modeling the Semiconductor Diode

Diode circuits: Clipper; Clamper circuits

Zener diode, LED, Photodiode, Varacters diode, Tunnel diodes

DC power supply: Rectifier; Half wave, Full wave(center-tapped, bridge), Zener-regulated

	power supply
3.	**Transistor** BJT configuration and biasing, small and large signal model T and μ model Concept of Differential amplifier using BJT BJT switch and Logic circuits Construction and working principle of MOSFET and CMOS MOSFET as logic circuits
4.	**The Operational Amplifier and Oscillator** Basic model; Virtual ground concept; Inverting Amplifier, Non-inverting Amplifier, Integrator, Differentiator,Ssumming Amplifier and their applications Basic feedback theory; positive and negative feedback; concept of stability; Oscillator Waveform generator using Op-Amp for Square Wave, Triangular Wave, Wien Bridge Oscillator for sinusoidal waveform
5.	**Digital Electronics** Number systems, Binary arithmetic Logic gates: OR, NOT, AND, NOR, NAND, XOR, XNOR gate; Truth tables Multiplexers, Demux, Encoder, Decoder Logic Function Representation Latch, flip-flop: S-R flip-flop; JK flip-flop, Master-Slave flip-flop; D-flip flop Sequential circuits: Generic block diagram; Shift registers; Counters
6.	**Application of Electronic System** Instrumentation system: Transducer, Strain Gauge, DMM, Oscilloscope Regulated power supply Remote control, Character Display, Clock, Counter, Measurements, Data Logging, Audio-Video system
	Text Books
1.	David A. Bell, "Electronic Devices and Circuits", Oxford UniversityPress, 5th Edition, 2008.2. D.P. Kothari, I. J. Nagrath, "Basic Electronics"**,** McGraw HillEducation (India) Private Limited, 2014.

2.	David A. Bell, “Electronic Devices and Circuits”, Oxford UniversityPress, 5th Edition, 2008.2. D.P. Kothari, I. J. Nagrath, “Basic Electronics”**,** McGraw HillEducation (India) Private Limited, 2014.
	References
1.	Robert Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” PHI; 8th Edition.200
2.	Thomas L. Floyd, “Electronic Devices” 8th Edition, Pearson Education, Inc., 2007
3.	A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, 6th Edition, Oxford University Press, 2006

Programme	B. Tech. [Production Engineering]	**Semester - III**
Course Code	R5ET2010L	
Course Title	Basic Electronics Engineering Laboratory	
Prerequisites	None	

	Course Outcomes: On the completion of this course, the learner will able to: 1. Apply the Superposition Theorem to analyze linear circuits with multiple sources 2. Understand and measure the characteristics of P-N and Zener diodes, including their behavior in various circuits 3. Design and analyze half-wave, full-wave, and bridge rectifiers for converting AC to DC 4. Analyze the characteristics and behavior of BJT transistors in various configurations 5. Utilize operational amplifiers in various configurations
	Syllabus
1.	Superposition Theorem
2.	P N Diode and Zener diode characteristics
3.	Half wave, Full wave and Bridge rectifier
4.	BJT Transistor characteristics
5.	Logic gates - OR, AND, NOT, NOR, NAND, EXOR
6.	OPAMP - Inverting and Noninverting configuration
7.	OPAMP as an Adder and Subtractor
8.	OPAMP as a scaler or as an Averager
	Text Books
1.	David A. Bell, “Electronic Devices and Circuits”, Oxford UniversityPress, 5th Edition, 2008.2. D.P. Kothari, I. J. Nagrath, “Basic Electronics”**,** McGraw HillEducation (India) Private Limited, 2014.
2.	David A. Bell, “Electronic Devices and Circuits”, Oxford UniversityPress, 5th Edition, 2008.2. D.P. Kothari, I. J. Nagrath, “Basic Electronics”**,** McGraw HillEducation (India) Private Limited, 2014.

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1.	Robert Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” PHI; 8th Edition.200
2.	Thomas L. Floyd, “Electronic Devices” 8th Edition, Pearson Education, Inc., 2007
3.	A.S. Sedra and K.C. Smith, “Microelectronic Circuits”, 6th Edition, Oxford University Press, 2006

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5PE2003T	
Course Title	Industrial Management	
Prerequisites	None	

	Course outcomes: On the completion of this course, the learner will able to 1. Grasp the core functions, principles, and roles of management 2. Develop strategies using models like Porter's Five Forces and BCG Matrix 3. Master HRM practices, including recruitment, training, and labor law 4. Understand intellectual property rights and their legal frameworks 5. Apply business ethics and corporate social responsibility in organizational contexts
	Syllabus
1.	**Basics of Management** Introduction, Definition of management, characteristics of management, functions of management - Planning, Organizing, Staffing, Directing, Co-ordination, Controlling, Motivating, Communication, Decision Making, Principles of management – F.W. Taylor, Henry Fayol, Elton Mayo, Administration and management, Nature of management, levels of management, managerial skills, managerial roles, Forms of Organization- Line , Line –staff etc. Forms of ownerships – Partnership, Proprietorship, Joint stock, Co-operative society, Govt. Sector etc., concept of Globalisation
2.	**Strategic Management** Military origins of strategy – Evolution - Concept and Characteristics of strategic management –Defining strategy – Mintzberg's 5P's of strategy – Corporate, Business and Functional Levels of strategy - Strategic Management Process. Preparing an Environmental Threat and Opportunity Profile (ETOP) – Industry Analysis - Porter's Five Forces Model of competition. BCG Matrix – GE 9 Cell Model -Balanced Scorecard, Generic Competitive Strategies: Low cost, Differentiation, Focus.
3.	**Human Resource Development** Strategic importance HRM; objectives of HRM; challenges to HR professionals; role, Responsibilities and competencies of HR professionals; HR department operations; Human Resource Planning - objectives and process; human resource information system. Talent acquisition; recruitment and selection strategies, career planning and management, training and

	development, investment in training programme; executive development. Labour laws. Trade union and conflict resolution.
4	**Intellectual Property Rights** Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR, Copyrights, Trademark, Industrial Design. International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act. Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.
5.	**Business Ethics and CSR** Business Ethics – Concept, Characteristics, Importance and Need. Indian Ethos, Ethics and Values, Work Ethos. Ethics in Marketing and Advertising, HR, Finance and Accounting, Production, IT. Corporate Governance: Concept, Importance, Evolution. Principles of Corporate Governance, Regulatory Framework of Corporate Governance in India, SEBI Guidelines, Role of Independent Directors, Protection of Stake Holders, Changing roles of corporate Boards. Elements of Good Corporate Governance, Failure of Corporate Governance and its consequences. Corporate Social Responsibility: Concept, Scope & Relevance and Importance. Corporate philanthropy, Models and drivers CSR. CSR and Indian Corporations. Role of NGO's and International Agencies in CSR, Integrating CSR into Business
	Text Books
1.	Tripathi and Reddy: Principles of Management, Tata McGraw Hill, New Delhi.
2.	L.C. Jhamb and Savitri Jhamb: Industrial Management – I, Everest Publishing House.
	References
1.	Ashwathppa: Human Resource Management, Tata McGraw Hill, New Delhi
2.	Kenneth Laudon and Jane Laudon: Management Information Systems, Pearson Education.
3.	Ravi Kishore: Project Management, Tata McGraw Hill, New Delhi.
4.	M. Khan and P. Jain: Financial Management, Tata McGraw Hill, New Delhi.
5.	Dinesh Seth and Subhash Rastogi: Global Management Solutions, Cengage Learning, USA.

Programme	B. Tech. (Production Engineering)	**Semester -** III
Course Code	R5CH2401O	
Course Title	Environmental Science	
Prerequisites	None	

	Course outcomes: On the completion of this course, the learner will able to 1. Imply the basic knowledge of environmental protection, sustainable development and improvement. 2. Categorize and scrutinize impact of human development on natural resources and its conservation. 3. Interpret the impact of environmental problems on socio economic growth. 4. Apply different Science and Technology (S&T) based sustainability solutions and technological improvement, and methods for the remediation of degraded environment. 5. Familiarize with the legislation, management and protocols existing for environmental protection.
	Syllabus
1.	**Significance of Environment Science** Definition, basic principles and scope of environment science. Need for awareness, Industrialization & Urbanization; Basic Ecological Concepts Ecosystems, nature of environmental threats, Current environmental problems, Importance of clean air.
2.	**Natural Resources Management and Sustainability** Concept of Ecosystem, Conservation of ecosystem: Natural Resources, Renewable and Non-renewable Resources, Natural resources and challenges with the conservation. Forest resources, Water resources, Energy resources Role of an individual in conservation of natural resources. Impact of energy use on Environment. Energy conservation and sustainability
3.	**Environment & Society** Urbanization and environment, social movements, Community participation, JFM, participation by NGOs Impact of energy use on Environment, energy production on environment change, nuclear explosion, impact of dam construction, Energy conservation and sustainability
4.	**Green Technologies** Role of advancements in science and technology in developing environment friendly technologies; 3 R's for Green Technology, Green technology towards sustainable future,

	Reduction of ecological footprint, Concept of Sustainability and Green Chemistry as a tool for sustainable development
5.	**Environmental Legislation, Management & Policies** Aims And Objectives of EnvironmentalImpact Assessment (EIA), Environmental Management Plan (EMP) , Indian forest act, The water act(prevention and control of water pollution), The Air act (prevention & control of air pollution) International efforts for environmental protection and contribution of India for same, National Action Plan on Climate Change; Role of Ministry of Environment, forest and climate; Mitigation measures for climate change, international protocols, Montreal protocol, Kyoto protocol, Carbon credits and carbon trading
	Text Books
1.	De., Environmental Chemistry, 6th Edition, New Age International.
2.	Erach Bharucha, Text Book of Environmental Studies for Undergraduate Courses, Universities Press, Second Edition (UGC Recommended)
3.	P.K.Goel, Water Pollution, Causes, Effects and Control, New Age International
4.	Dr. JagdishKrishnaswamy and Dr. R. J. Ranjit Daniels, Environmental Studies, Wiley India Private Limited, New Delhi, First Edition, 2009.
	References
1.	Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad,
2.	Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., Environmental Encyclopedia, Jaico Publ. House, Mumbai, 2000
3.	Jadhav, H &Bhosale, V.M., Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995
4.	Wanger K.D., Environmental Management. W.B. Saunders Co. Philadelphia, USA, 1998
5.	Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (R)

Semester IV

Programme	B. Tech. (Production Engineering)	**Semester -** IV
Course Code	R5PE2004T	
Course Title	Fluids and Thermal Engineering	
Prerequisites	Basic Thermodynamics	

Course outcomes: On the completion of this course, the learner will able to

1. Understand and calculate the performance and efficiency of compressors and internal combustion engines, including various cycles and systems
2. Analyze steam and gas turbines, including flow through nozzles, turbine classification, and methods to improve efficiency
3. Design and evaluate refrigeration and air-conditioning systems, considering load calculations and system performance
4. Apply fluid mechanics principles, including buoyancy, pressure variation, and flow equations to solve problems in fluid statics and dynamics
5. Understand the operation and efficiency of turbines and pumps, including hydro-electric power plants and centrifugal pumps

Syllabus

1. **Compressors and IC Engine**

Uses of compressed air, classification, single stage reciprocating compressor with and without clearance, work and power calculations, two stage air compressor with & without perfect inter-cooling, FAD and volumetric efficiency. Four and two stroke cycle I.C. engines. S.I. and C.I. engines. Systems requirements of I.C. engines. Ignition system of S.I. engines. Governing of I.C. engines. Valve timing diagrams. Calculation of I.P, F.P. and B.P., determination of indicated and brake thermal efficiency and specific fuel consumption.

2. **Steam and Gas Turbine**

Flow through nozzle: Introduction, steam flow through nozzles, nozzle efficiency, and general relationship between area, velocity and pressure in nozzle flow. Steam turbine: Classification, compounding of turbine, Impulse turbine velocity diagram. Condition for max efficiency. Reaction turbine - velocity diagram, degree of reaction, Parson's

turbine. Condition for maximum efficiency. Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration. Effect of operating variable on thermal efficiency and work ratio.

3. **Refrigeration and Air-Conditioning**

	Methods of refrigeration vapour compression refrigeration system, Outside & inside design consideration, factors forming the load on refrigeration & air conditioning systems, cooling & heating load calculations, load calculations for automobiles, effect of air conditioning load on engine performance.
4.	**Introduction to Fluids, Buoyancy and Flotation** Definition of Fluids and its properties, Newtonian and non-Newtonian fluid, Newton's law of Viscosity, Fluid statics, pressure, variation of pressure with depth center of pressure, forces on immersed body, Buoyancy, Metacenter, Meta center height, equilibrium conditions of floating and submerge bodies, Continuity, Momentum and Energy equation, Different types of flow, Euler's and Bernoulli equation. Laminar and turbulent flow in pipes, Darcy's equation, Laminar flow over a flat plate and between the two plates, moving flat plate, minor and major losses, bends.
5.	**Turbines and Pumps** Hydro-electric power plant, Introduction to impact of jet on different geometry of turbine, Pelton wheel, Francis Turbine, Kaplan Turbine, Calculation of Power output and efficiencies. Centrifugal Pump, specific speed, equation for energy transfer, reciprocating pumps.
	Text Books
1.	Rathore, Mahesh M., and R. Kapuno. *Engineering heat transfer*. Jones & Bartlett Publishers, 2010.
2.	Modi and Seth, Fluid Mechanics and Hydraulic Machines, Standard Publication.
	References
1.	Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. *Thermodynamics: an engineering approach*. Vol. 5. New York: McGraw-hill, 2011.
2.	White, Frank M., and Joseph Majdalani. *Viscous fluid flow*. Vol. 3. New York: McGraw-Hill, 2006.
3.	Bergman, Theodore L., Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt. *Introduction to heat transfer*. John Wiley & Sons, 2011.
4.	R Bansal; Fluid Mechanics and Hydralic Machine, Dhanpat Rai Publication
5.	Cengel, Yunus, John Cimbala, and Robert Turner. *EBOOK: Fundamentals of Thermal-Fluid Sciences (SI units)*. McGraw Hill, 2012.

Programme	B. Tech. (Production Engineering)	**Semester - IV**
Course Code	R5PE2004L	
Course Title	Fluids and Thermal Engineering Laboratory	
Prerequisites	Basic Thermodynamics	

Course outcomes: On the completion of this course, the learner will able to

1. Conduct performance tests on refrigeration and air-conditioning systems to assess efficiency and functionality
2. Determine thermal conductivity and resistance of materials and analyze heat transfer through convection
3. Calibrate and validate pressure, vacuum, and flow measurement instruments for accurate engineering applications
4. Evaluate fluid dynamics principles, including hydrostatic forces, stability, and Bernoulli's theorem, in practical scenarios
5. Analyze and interpret the performance characteristics of turbines and pumps under various operating conditions

	List of Experiments (Any 8)
1.	Performance Tests (minimum 2) on the Refrigeration Tutor
2.	Performance Tests (minimum 2) on Air-conditioning Tutor
3.	To determine the thermal conductivity of a Metal Rod and Insulating Material.
4.	To determine the thermal conductivity and thermal resistance of a composite slab
5.	To determine the convective heat transfer coefficient -'h' for a. Free convection b. Forced convection
6.	Calibration of Pressure, Vacuum Gauge, Venturi meter and Orifice Meter
7.	Hydrostatic Forces on Plane Surfaces
8.	Stability of a Floating Body
9.	Verification of Bernoulli's Theorem
10.	Impact of Jet
11.	Constant head characteristics of Pelton Turbine and Francis/Kaplan Turbine
12.	Constant speed characteristics of Pelton Turbine and Francis/Kaplan Turbine

13.	Performance Characteristics of Centrifugal Pump with Iso- Efficiency curves and Reciprocating Pump
	Text Books
1.	Rathore, Mahesh M., and R. Kapuno. *Engineering heat transfer*. Jones & Bartlett Publishers, 2010.
2.	Modi and Seth, Fluid Mechanics and Hydraulic Machines, Standard Publication.
	References
1.	Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu. *Thermodynamics: an engineering approach*. Vol. 5. New York: McGraw-hill, 2011.
2.	White, Frank M., and Joseph Majdalani. *Viscous fluid flow*. Vol. 3. New York: McGraw-Hill, 2006.
3.	Bergman, Theodore L., Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt. *Introduction to heat transfer*. John Wiley & Sons, 2011.
4.	R Bansal; Fluid Mechanics and Hydralic Machine, Dhanpat Rai Publication
5.	Cengel, Yunus, John Cimbala, and Robert Turner. *EBOOK: Fundamentals of Thermal-Fluid Sciences (SI units)*. McGraw Hill, 2012.

Programme	B. Tech. (Production Engineering)	**Semester -** IV
Course Code	R5PE2005T	
Course Title	Theory of Machines	
Prerequisites	Applied Mechanics	

Course outcomes: On the completion of this course, the learner will able to

1. Analyze and classify mechanisms, including special mechanisms and their applications, using concepts like degrees of freedom, mobility, and kinematic inversions
2. Perform displacement, velocity, and acceleration analysis using graphical and algebraic methods
3. Design and evaluate cam profiles for various follower motions
4. Understand and apply gear and gear train principles in power transmission systems
5. Perform balancing of mechanical systems and analyze vibrations to ensure stability and performance

Syllabus

1. **Basics of Mechanisms**

Definitions and Basic kinematic concepts, Classification of mechanisms, Degree of freedom,

Mobility, Kutzbach criterion, Gruebler's criterion, Grashof's Law, Kinematic inversions of four-bar chain and slider crank chains, Limit positions, Mechanical advantage, Transmission Angle. Description of some common mechanisms – Quick return mechanisms, Straight line generators, Dwell mechanisms, Ratchets and Escapements, Universal Joint, Basic structures of Robot Manipulators (serial & parallel).

Special Mechanisms: Straight line generating Mechanisms: Exact Straight-Line Generating Mechanisms – Peaucellier's and Hart's Mechanism. Approximate Straight-Line Generating Mechanisms – Watt's, Grasshopper and Tchebicheff's. Offset slider crank mechanisms, Pantograph. Hook joint- single and Double. Steering gear mechanisms – Ackerman, Davis.

2. **Kinematics of Linkage Mechanisms**

Displacement, velocity and acceleration analysis of simple mechanisms. Velocity analysis using instantaneous centers. Graphical method – Velocity and acceleration polygons, Coriolis component of Acceleration. Kinematic analysis by complex algebra methods, Vector approach, Computer applications in the kinematic analysis of simple mechanisms, Coincident points.

3. **Kinematics of Cam Mechanisms**

	Definitions and Terminology, Classification of cams and followers, Displacement diagrams – Uniform velocity, parabolic, simple harmonic, cycloidal and polynomial motions. Derivatives of follower motions, Layout of plate cam profiles, Specified Contour cams, Circular arc and tangent cams, Pressure angle and undercutting, sizing of cams.
4.	**Gear and Gear Trains** Gear- Law of toothed gearing, Involutes and cycloidal tooth profiles, Spur Gear terminology and definitions, Gear tooth action, contact ratio. Interference and undercutting. Non-standard gear teeth – Helical, Bevel, Worm, Rack and Pinion gears [Basics only].Gear Trains– Speed ratio, train value. Parallel axis gear trains, Epicyclic Gear Trains. Differentials Automobile gear box.
5.	**Power transmission systems** Types of power transmission systems, Importance and fundamentals of belt, rope, and chain drives
6	**Balancing and Vibration** Introduction. Rotary masses: several masses in same plane, several masses in different planes. Balancing of reciprocating masses, primary balancing and secondary balancing. Balancing of locomotives- Variation of Tractive force, Swaying couple and Hammer blow.Vibration: Introduction, free vibrations; longitudinal, transverse and torsional vibrations. Dunkerly's equation, critical or whirling speed of shaft. Torsional vibrations of two rotor systemtorsional equivalent shaft. Free torsional vibrations of a geared system. (Damped and forced vibrations are excluded).
7	**Flywheel and Gyroscope** Turning moment diagram, Fluctuation of speed, fluctuation in energy, function of flywheel estimating inertia of flywheel. Gyroscope: Gyroscopic couple, Effect of precision motion on the stability of moving vehicles such as motor car, motor cycle, air plane and ship.
	Text Books
1.	S.S. Rattan: Theory of Machines, McGraw-Hill Education (India) Private Limited.
2.	A.G. Ambekar: Mechanism and Machine Theory, Prentice Hall of India, New Delhi.
	References
1.	Amitabha Ghosh and Asok Mullick: Theory of Mechanisms and Machines, East-West Affiliated.
2.	P.L. Ballaney: Theory of Machines and Mechanisms, Khanna Publications.

3.	Thomas Bevan: Theory of Machines, CBS Publishers and Distributors.
4.	Joseph Shigley, G.R Pennock and John Uicker: Theory of Machines, Oxford University Press.
5.	Graham Kelly: Schaum's Outline of Theory and Problems of Mechanical Vibrations, Tata McGrawHill Publication.
6.	John Hannah and Stephens R.C., Mechanics of Machines, Viva Low-Prices Student Edition

Programme	B. Tech. (Production Engineering)	**Semester -** IV
Course Code	R5PE2006T	
Course Title	Metrology and Quality Control	
Prerequisites	Engineering Graphics	

Course outcomes: On the completion of this course, the learner will able to

1. Understand the principles, methods, and standards of inspection and measurement, including calibration and error analysis
2. Apply concepts of limits, fits, tolerances, and selective assembly for interchangeable manufacturing using IS and ISO standards
3. Utilize various comparators, interferometers, and angular measurement tools for precise measurements in engineering applications
4. Conduct accurate measurements of surface texture, screw threads, and gears using specialized instruments and techniques
5. Implement statistical quality control methods, including control charts, process capability analysis, and acceptance sampling, while understanding TQM principles

Syllabus

1. **Introduction**

Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology.

Standards of Measurement - Line, end and wave length standards, primary, secondary and tertiary standards, sub division of standards.

Linear Measurements -Calipers, micro meters, surface plates, angle plates, V - blocks, straight edges, height and depth gauges, inside micrometers, bore gauges, slip gauges, accessories, types of slip gauges use and care of slip gauges.

2. **Limits, Fits and Tolerances**

Requirement of interchangeable manufacture, allowance and tolerance, limits and fits, hole based and shaft-based systems, IS 919: 1963, tolerance grades IT 01 to IT 05, types of fits, geometrical tolerance problem, Newall and ISO systems, general requirements of “GO” & “NO GO” gauging; Taylor’s principle, positional tolerance, selective assembly

3. **Comparators**

Need for comparators, amplifying system; mechanical, mechanical-optical, electrical, electronic and pneumatic comparators; principle, construction and operation of various

	comparators.
4.	**Interferometry** Principles of interference, monochromatic source, concept of flatness, flatness testing, optical flats, interference patterns and their significance, optical interferometer, laser interferometer.
5.	**Angular Measurement** Angle standards, Vernier protractor, clinometers; sine bar, sine table and sine center, spirit level, angle Dekker, optical square, optical dividing head and rotary table. Taper and Radius measurement for internal and external surface using gauges, autocollimator and sine bar.
6.	**Surface Texture Measurement** Profile geometry, roughness and waviness, definition and significance of terms; band width selection, roughness standards specifying surface roughness parameters, R_a, R_z, R_p, etc.; RMS number, surface roughness measuring instruments (Tomlinson's surface meter etc.), surface roughness symbols
7.	**Measurement of Screw Threads and Gears** Types of screw threads, definitions, proportions of ISO metric thread form; measurement of major and pitch diameters, two wire and three wire methods, floating carriage micrometer; measurement of internal threads; tolerance system and design of thread gauge; tools maker's microscope, limit gauges for internal and external threads, thread gauges and their applications. Gear Measurement using Gear caliper, gear tooth comparator and, gear measurement using rollers, master gears and Parkinson tester, tolerance for composite errors.
8.	**Statistical Control Charts** Introduction to SQC and statistical background. System of Chance Causes, Patterns of Variations, Interpretation of Lack of Statistical Control. Interpretation of Patterns of Variation on X & R Charts, Control Charts for Variables and attributes. Process Capability Analysis - Estimation of Process Capability using Process Capability Indices, Viz: Cp, Cpk, Cpm, and Their Interpretation
9.	**Quality Assurance System** Background including normal, poison and binomial distribution. Different sampling plans. Lot-by- lot acceptance using single sampling plan, OC curves, sampling risk, AQL, LTPD, alpha and beta risk, construction of OC curve for given sampling plan and estimation of different parameters. Double sampling plans and Use of Dodge - Romig sampling plans, Total Quality Management (TQM)
	Text Books

1.	I.C. Gupta: Engineering Metrology, Dhanpat Rai Publications
2.	R.K. Jain: Engineering Metrology, Khanna Publications
	References
1.	Kulkarni and Bewoor: Metrology and Measurement, Tata McGraw Hill Publications.
2.	Statistical Quality Control: M. Mahajan, Dhanpat Rai Publication
3.	Total Quality Management: Besterfield Dale and others, Pearson Education

Programme	B. Tech. (Production Engineering)	**Semester - IV**
Course Code	R5PE2006L	
Course Title	Metrology and Quality Control Laboratory	
Prerequisites	Engineering Graphics	

Course outcomes: On the completion of this course, the learner will able to

1. Accurately measure linear dimensions and angles using vernier calipers, micrometers, and sine bars
2. Gain proficiency in using advanced metrology instruments like sigma comparators and surface profilometers
3. Analyze and interpret measurement data for quality control using CMMs and calibration tools
4. Evaluate surface and geometric characteristics, such as straightness and roughness, using precise instruments
5. Apply metrology techniques in practical engineering scenarios to ensure manufacturing quality

	Syllabus
1.	Experiment on linear measurement using vernier caliper and micrometer screw gauge
2.	Experiment on angle measurement using sine bar
3.	Experiment using sigma comparator
4.	Experiment on thread measurement using floating carriage micrometer
5.	Experiment on measurement of gear tooth thickness and pitch using gear tooth vernier
6.	Demonstration of coordinate measuring machine
7.	Calibration using dial gauge
8.	Experiment on measurement of surface waviness and roughness using surface profilometer
9.	Experiment on measurement of straightness using tools like spirit level and autocollimator
	Text Books
1.	I.C. Gupta: Engineering Metrology, Dhanpat Rai Publications
2.	R.K. Jain: Engineering Metrology, Khanna Publications

	References
1.	Kulkarni and Bewoor: Metrology and Measurement, Tata McGraw Hill Publications.
2.	M. Mahajan: Statistical Quality Control, Dhanpat Rai Publication
3.	Besterfield Dale and others: Total Quality Management, Pearson Education

Programme	B. Tech. (Production Engineering)	**Semester - IV**
Course Code	R5PE2007L	
Course Title	Computer Aided Machine Drawing	
Prerequisites	Engineering Graphics	

Course outcomes: On the completion of this course, the learner will able to

1. Understand principles of dimensioning, material specifications, and standard mechanical components in production drawings
2. Represent key machine elements like screws, keys, cotters, and couplings in technical drawings
3. Use CAD software for creating and editing 2-D and 3-D machine part drawings
4. Create detailed assembly and part drawings for machine tools, bearings, and engine components
5. Implement tolerances, fits, and allowances to ensure accurate machine part assemblies

Syllabus

1. **Fundamentals of Machine Drawing**

Principles of Dimensioning, Specification of Materials, Standard Mechanical Components Specifications, Limit, Surface Roughness, Production Drawings and Process Sheets Production Drawings of Mating Parts, Production Drawing of Assemblies Tool Drawings, Jigs and Fixtures Drawings, Inspection and Gauging Tool Drawings

2. **Machine Elements**

Screwed fasteners: Thread nomenclature, forms of screw threads, V threads, Square thread, ACME, Buttress, and Whitworth. Representation of threads, Hexagonal headed bolts and nuts, square headed bolts & nuts, locking devices for nuts. Keys, cotters and pin joints: Keys such as saddle keys, sunk keys, round keys, Cotter joints such as Socket and Spigot joint, Gib and Cotter joint, Cotter and Sleeve Joint. Pin joint (Knuckle joint). Couplings: Rigid couplings, Split, Muff, and Flanged protected type, Flexible bush pin type.

3. **Assembly and Details Drawings**

Machine tools parts: Machine swivel vice, pipe vice, screw jack, tailstock, tool head of shaper, Simple drill jig & milling fixture, simple press tool assembly. Bearings: Plummer block, foot step bearing, bracket with pedestal bearing. IC Engine parts: I.C. Engine connecting rod, stuffing box joints: Classification of Pulleys, pipe joints, Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys. Pipe joints (any two): Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint, and eccentric. Conventional representation of ball and roller

	bearing. Pedestal bearing, footstep bearing, and Clapper block.
4.	**Tolerances and Fits** Tolerances and Fits: Limits, fits, allowances and tolerances: Selection of tolerances, methods of placing limit dimensions, fits. Calculation of tolerances, limits, allowances and fit.
5.	**CAD** Computer Aided Design and Drafting: CAD packages commands, editing commands, Basic Dimensioning, Creating 2-D and 3-D objects of simple machine parts
	Text Books
1.	K L Narayana, P Kannaiah and K Venkata Reddy: Machine Drawing, New Age International Publishers.
2.	Siddheshwar Sastry: Machine Drawing, Tata McGraw Hill Publishing House.
	References
1.	M.B. Shah and B. C. Rana: Machine Drawing, Pearson Publications.
2.	N.D. Bhatt and V. Panchal: Machine Drawing, Charotar Publishing House.
3.	Solidworks online training module: https://www.solidworks.com/partner-product/solidworks-online-training-and-books

Programme	B. Tech. (Production Engineering)	**Semester -** IV
Course Code	R5PE2008T	
Course Title	Managerial Economics, Finance and Costing	
Prerequisites	None	

Course outcomes: On the completion of this course, the learner will able to

1. Understand and apply key economic principles, including utility, market structures, and government policies
2. Analyze demand, supply, elasticity, and market dynamics across various structures
3. Evaluate financial sources, statements, capital budgeting, and working capital management
4. Apply costing methods, including job and process costing, and cost control techniques
5. Assess the effects of globalization on markets, multinational corporations, and national economic indicators.

Syllabus

1. **Managerial Economics**

Introduction- Economics, basic concepts - utility, wealth, welfare, price, markets, and opportunity cost. Micro - and macro- economics, economics of growth and development.

Demand and supply analysis: Law and elasticity of demand and supply. Demand function. Market structure - competition, monopoly, oligopoly and imperfect competition. Market imperfections and state interventions. Role of government; monetary, fiscal and trade policies, BOP, industrial policy; instruments of government policy; taxation, incentives, budget. National income measures – GDP, NDP, GNP, NNP; Inflation and its indices. Globalization of market and production in multinational corporation.

Theory of firm: Production and Cost analysis for short run and long run. Cost-Output Relationship: Cost Function, Cost-Output relationships in Short Run and Long Run. Revenue Analysis and Pricing Policies.

2. **Finance**

Introduction – Basic business function, sources of finance and their relative importance. Long- and short-term finance. Fund allocation, alternative uses of finance. Time value of money. Analysis of financial statements –Ratio analysis using balance sheet, profit and loss account. Capital budgeting decisions- type, nature and evaluation criteria: NPV, IRR, Payback. Working capital management. Financial markets; money markets, bill market, discount houses, call loan

	market, etc., Capital markets; mutual funds, stock markets, industrial banks, world bank, UTI, IDBI, ICICI, SEBI and state finance corporations.
3.	**Costing** Cost classification: Cost ascertainment; allocation, apportionment, absorption of overheads and non-production cost; overhead analysis, absorption methods, general considerations. Job costing; factory job costing, contract cost. Unit costing; output and operating cost, simple process costing, normal and abnormal losses in process, waste, scrap, bye-and joint products. Marginal costs and breakdown charges. Cost planning and control, standard cost and budgetary control, setting standards, variance analysis. Cost reduction; tools, techniques and productivity. Depreciation; causes and significance, methods of providing for depreciation, book values, taxes and depreciation
	Text Books
1.	Paul Samuelson and William Nordhaus: Economics, Tata McGraw Hill.
2.	Prasanna Chandra: Financial Management, McGraw Hill.
3.	Jawaharlal: Cost Accounting, Tata McGraw Hill (TMH).
	References
1.	Prasanna Chandra: Finance Sense - Text and Cases, Tata McGraw Hill.
2.	Varshney and Maheshwari: Managerial Economics, Sultan Chand and Sons, New Delhi.
3.	Ruddar Datt and Sundaram: Indian Economy, S.Chand Publication.
4.	L.M. Bhole and Jitendra Mahakud (2017): Financial institutions and markets, McGraw Hill Education.
5.	Paul Keat, Philip Young and Sreejata Banerjee: Managerial Economics, Pearson Publication.
6.	Dominick Salvatore: Principles of Economics, Schaum's Outline Series.
7.	Dominick Salvatore: Microeconomics, Schaum’s Outline Series.
8.	Eugene Diulio: Macroeconomics, Schaum's Outline Series.

Programme	B. Tech. [Production Engineering]	**Semester -** IV
Course Code	R5HS2402O	
Course Title	Universal Human Values	
Prerequisites	None	

	Course Outcomes: On the completion of this course, the learner will able to 1. Analyze the significance of value inputs provided in formal education along with skills and develop a broader perspective about life and education 2. Formulate their aspirations and concerns at different levels of living, and the way to fulfill them in a sustainable manner. 3.Evaluate their current state of understanding and living, and model a healthy lifestyle 4. Examine the issues of home sickness, interactions with seniors on the campus, peer pressure with better understanding and feel grateful towards parents, teachers and others 5. Develop more confidence and commitment for value-based living in family, society and nature
	Syllabus
1.	Aspirations and concerns – Understanding basic human aspirations, fixing one's goals, and the need for a holistic perspective in form of Universal Human values Self-management – self-confidence, handling peer pressure, time management, anger, stress, personality development and self-improvement which leads to harmony in the human being.
2.	Understanding Health – Health issues, healthy diet, healthy lifestyle which shall lead to Harmony of the self and body in forms of mental and physical health.
3.	Relationships – Learning to handle home sickness, gratitude towards parents, teachers and others, understanding impact of ragging and interaction, competition and cooperation to achieve harmony in relationships.
4.	Participation in society, participation in nature leading to harmony in the society and nature/existence, Role of education in developing holistic perspective
	Text Books
1.	E.P.G.Gohl, L.D.Vilensky, Textile Science, an Explanation of Fibre Properties, Second Edition, 1987, CBS Publishers & Distributors Pvt. Ltd.
2.	Manufactured Fibre Technology, V.B. Gupta and V.K. Kothari, Springer Science + Business Media, 2003, ISBN 978-94-010-6473-6

	References
1.	Tatsuya Hongu, Glyn O. Phillips, MachikoTakigam, New Millennium Fibers, Woodhead Publishing Ltd., CRC Press LLC, 2005, ISBN 0-8493-2598-6.
2.	H.V.S. Murthy, Introduction to Textile Fibres (Revised edition- 2015), Wood Head Publication, ISBN 9789385059094 .