Course Structure&Syllabus

of

B. Tech. Programme

in

Production Engineering

Academic Year – 2023-24

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, ODISHA

Burla, Sambalpur-768018, Odisha

www.vssut.ac.in

Vision of the Department

To be recognized as a center of excellence in education and research in the field of Production Engineering by producing innovative, creative, and ethical Production Engineering professionals for the socio-economic upliftment of society to meet global challenges.

Mission of the Department

Mission No.	Mission Statements
M1	Maintaining state-of-the-art research facilities to provide a conducive environment to create, analyze, apply, and disseminate knowledge.
M2	Fortifying collaboration with world-class R&D organizations, educational institutions, industry, and alumni for excellence in teaching, research, and consultancy practices to fulfill the Government's 'Make in India' policy and impart social responsibility among the graduates.
M3	Providing the students with an academic environment of excellence, leadership, ethical guidelines, and lifelong learning needed for a long productive career.

Program Educational Objectives (PEOs)

PEO No.	PEO Statements
PEO1	To acquire competency in solving real-life problems and to design/develop sustainable and cost-effective products according to the prevailing socio-economic context.
PEO2	To enable students to excel in their professional career/entrepreneurial skill/research and higher studies.
PEO3	To provide an opportunity to work and communicate effectively in a team and to engage in the process of life-long learning.

Program Specific Outcomes (PSO)

PSO No.	PEO Statements
PSO1	Identify, formulate design, and investigate Production Engineering problems using first principles of mathematics, basic science, and engineering.
PSO2	Establish themselves as practicing professionals in core service or research sectors or entrepreneurial endeavors by solving real-life engineering problems to offer techno-commercially feasible and socially acceptable solutions using contemporary knowledge and tools.
PSO3	Communicate ethically and effectively as well as demonstrate aspiration to learn and the ability to handle problems with a professional attitude.

Program Outcomes (POs)

PO No.	PO Statements
PO1 (Engineering knowledge)	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to solve complex engineering problems.
PO2 (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.
PO3 (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 public health and safety, and cultural, societal, and environmental concerns.
PO4 (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.
PO5 (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.
PO6 (The engineer and society)	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7 (Environment and sustainability)	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8 (Ethics)	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9 (Individual and teamwork)	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10 (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.
PO11 (Project management and finance)	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12 (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.

CURRICULUM FOR B.TECH. IN PRODUCTION ENGINEERING

FIRST YEAR: FIRST SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	MA-1101	Mathematics – I	3-0-0	3
2	CY-1101	Chemistry	3-0-0	3
3	ME-1101	Engineering Mechanics	3-0-0	3
4	ET-1101	Basic Electronics	3-0-0	2
5	CE-1101	Basic Civil Engineering	3-0-0	2
6	EA-1101	Universal Human Values-I	2-0-0	2
SESSIONALS				
1	CY-1181	Chemistry Lab	0-0-3	1.5
2	ME-1181	Workshop and Digital Manufacturing Lab	0-0-3	1.5
3	EC-1181	Electronics Lab	0-0-3	1.5
4	CE-1181	Engineering Graphics & Design Lab (With AutoCAD)	0-0-3	1.5
5	EA-1181	Sports/Yoga/NCC/NSS	0-0-2	1
		TOTAL	**17-0-14**	**22**

FIRST YEAR: SECOND SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	MA-1102	Mathematics – II	3-0-0	3
2	PH-1101	Physics	3-0-0	3
3	CS-1101	C and Data Structures	3-0-0	3
4	EE-1101	Basic Electrical Engineering	3-0-0	2
5	PE-1101	Basic Manufacturing Processes	3-0-0	2
6	HS-1101	English for Technical Writing	2-0-0	2
SESSIONALS				
1	PH-1181	Physics Lab	0-0-3	1.5
2	CS-1181	Programming Lab	0-0-3	1.5
3	EE-1181	Electrical Engineering Lab	0-0-3	1.5
4	CE-1181	Communicative English & Report Writing Lab	0-0-3	1.5
5	EA-1182	Sports/Yoga/NCC/NSS	0-0-2	1
		TOTAL	**17-0-14**	**22**

SECOND YEAR: THIRD SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	MA-1203	Mathematics – III	3-0-0	3
2	PE-1202	Thermal and Fluids Engineering	3-0-0	3
3	PE-1203	Materials Engineering & Metallurgy	3-0-0	3
4	PE-1204	Mechanics of Material	3-0-0	3
5	CS-1202	Programming in Python	3-0-0	2
6	HS-1202	Engineering Economics	3-0-0	2
SESSIONAL				
1	PE-1281	Thermal and Fluid Engineering Lab	0-0-3	1.5
2	PE-1282	Material Testing Lab	0-0-3	1.5
3	PE-1283	Computer Aided Machine Drawing	0-0-3	1.5
4	CS-1281	Machine Learning Using Python Lab	0-0-3	1.5
		TOTAL	**18-0-12**	**22**

SECOND YEAR: FOURTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	PE-1205	Theory of Metal Cutting	3-0-0	3
2	PE-1206	Theory of Machine	3-0-0	3
3	PE-1207	Inspection & Metrology	3-0-0	3
4	PE-1208	Manufacturing Technology-I	3-0-0	3
5	CS-1202	Artificial Intelligence and Machine Learning	3-0-0	2
6	HS-1203	Organizational Behaviour	3-0-0	2
SESSIONAL				
1	PE-1284	Metal Cutting Lab	0-0-3	1.5
2	PE-1285	Machine Dynamics Lab	0-0-3	1.5
3	PE-1286	Metrology Lab	0-0-3	1.5
4	PE-1287	Production Practice Lab-I	0-0-3	1.5
5	Summer Internship and Research Experience (SIRE - I)*			
		TOTAL	**18-0-12**	**22**

***Minimum 4 weeks of Summer Course / Training / Internship / Skill Course / etc. after 4th Semester**

ACC*: Advanced Competency Course

THIRD YEAR: FIFTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	PE-1309	Design of Machine Elements	3-0-0	3
2	PE-1310	CAD/CAM	3-0-0	3
3	PE-1311	Tool Design	3-0-0	3
4	**PE**	**Professional Elective - I**	3-0-0	3
5	HS-1301	Professional Ethics	3-0-0	2
6	MC-1301	Environmental Engineering	3-0-0	2
SESSIONAL				
1	PE-1381	Machine Design Sessional	0-0-3	1.5
2	PE-1382	CAD/CAM Lab.	0-0-3	1.5
3	PE-1383	Tool Design Sessional	0-0-3	1.5
4	PSI	Seminar on SIRE - I	0-0-3	1.5
		TOTAL	**18-0-12**	**22**

Professional Elective-I		
S/N.	Course Code	Subjects
1	PE-1312	Measurement & Instrumentation
2	PE-1313	Advanced Casting & Welding
3	PE-1314	Mechatronics
4	PE-1315	Maintenance Engineering & Management

THIRD YEAR: SIXTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	PE-1316	Theory of Metal Forming	3-0-0	3
2	PE-1317	Production Planning & Control	3-0-0	3
3	**PE**	**Professional Elective – II**	3-0-0	3
4	**PE**	**Professional Elective - III**	3-0-0	3
5	HS-1301	Entrepreneurship Development	3-0-0	2
6	MC-1302	Industrial Safety Engineering	3-0-0	2
SESSIONAL				
1	PSI	Project for Product Development - I	0-0-6	3
2	PE-1384	Metal Forming Lab	0-0-3	1.5
3	PE-1385	Material Characterization Lab	0-0-3	1.5
Summer Internship and Research Experience (SIRE - II) *				
		TOTAL	**18-0-12**	**22**

Professional Elective-II		
S/N.	Course Code	Subjects
1	PE-1318	Fluid Mechanics & Fluid Power Engineering
2	PE-1319	Manufacturing & Design of Composites
3	PE-1320	Industrial Hydraulics
4	PE-1321	Precision Engineering

Professional Elective –III		
S/N.	Course Code	Subjects
1	PE-1322	Statistical Methods and Design of Experiments
2	PE-1323	Finite Element Method in Manufacturing
3	PE-1324	Principles of Machine Tools
4	PE-1325	Advanced Material Science

FOURTH YEAR: SEVENTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	**PE**	**Professional Elective - IV**	3-0-0	3
2.	**OE**	**Open Elective – I**	3-0-0	3
3.	**OE**	**Open Elective – II**	3-0-0	3
4.	PC(ACC-3)	Advanced Competency Course-3	3-0-0	2
SESSIONAL				
1.	PSI-I	Seminar on SIRE - II	0-0-3	1
2.	PSI-II	Project for Product Development – II / Internship Project - I	0-0-6	3
		TOTAL	**12-0-09**	**15**

Professional Elective-**IV**		
S/N.	Course Code	Subjects
1.	PE-1426	Engineering Ergonomics
2.	PE-1427	Surface Engineering Principles &Systems
3.	PE-1428	Additive Manufacturing
4.	PE-1429	Non-Traditional Machining

Open Elective **–I**		
S/N.	Course Code	Subjects
1.	PE-1430	Maintenance Engineering & Management
2.	PE-1431	Logistics & Supply Chain Management
3.	PE-1432	Plant layout and Automated material handling

Open Elective **–II**		
S/N.	Course Code	Subjects
1.	PE-1433	Automotive & System Engineering
2.	PE-1434	Production Operation & Management
3.	PE-1435	Rapid Prototyping & Tooling

FOURTH YEAR: EIGHT SEMESTERS				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	**OE**	**Open Elective – III**	3-0-0	3
2	**OE**	**Open Elective – IV**	3-0-0	3
SESSIONALS				
1	PSI-III	Seminar on Project	0-0-6	3
2	PSI-IV	Project for Product Development – III / Internship Project - II	0-0-12	6
		TOTAL	**6-0-18**	**15**
		GRAND TOTAL	**162 Credits**	

Open Elective-**III**		
S/N.	Course Code	Subjects
1.	PE-1436	Performance Measurement & Benchmarking
2.	PE-1437	Total Quality System and Engineering
3.	PE-1438	Project Management

Open Elective-**IV**		
S/N.	Course Code	Subjects
1.	PE-1439	Advanced Casting & Welding
2.	PE-1440	Entrepreneurship & E-Business
3.	PE-1441	Quality Engineering

DETAILS SYLLABUS

FIRST YEAR

FIRST SEMESTER

Subject Code	**MA-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**3**
Subject Name	**MATHEMATICS - I**		
Course Objective	The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering and also other disciplines.		
Module I	**Basic Calculus**: Applications of definite integrals to evaluate length of curves, areas of surfaces and volumes of surfaces of revolution, Improper integral (Definition and Elementary Examples), Beta and Gamma functions and their properties.		**6 Hours**
Module II	**Single-variable Calculus (Differentiation):** Rolle's Theorem, Mean value theorem (Statement and applications), First derivative test for local extreme values of functions. Power series, Taylor and Maclaurin series.		**6 Hours**
Module III	**Multivariable Calculus (Differentiation):** Partial derivatives. Jacobians, Hessian Matrix. Maxima, Minima and saddle points. Method of Lagrange multipliers.		**6 Hours**
Module IV	**Linear Algebra:** Vector Space, Basis and dimension, Linear Systems of Equations, Gauss elimination, Linear Dependence and Independence, Rank of a Matrix.		**6 Hours**
Module V	**Linear Algebra:** Inverse of a matrix (Gauss-Jordan). Symmetric, skew-symmetric and orthogonal matrices. Eigen values and eigenvectors. Caley-Hamilton Theorem (Statement only)		**6 Hours**
Essential Reading	G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, 2002. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.		
Supplementary Reading	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010. Gilbert Strang, Introduction to Linear Algebra, 5th Edition, 2016. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.		
Course Outcomes	CO1. To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions. CO2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems. CO3. The tool of power series for learning advanced Engineering Mathematics. CO4. To deal with functions of several variables that are essential in most branches of engineering. CO5. Learn how to convert a real-life problem into a matrix system and solve it.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	3	2	1	3	1	1	1
CO2	3	2	1	3	2	3	3	2	3	2	1	1
CO3	2	3	2	2	1	3	2	1	3	1	1	1
CO4	3	3	1	3	1	1	3	1	2	1	1	1
CO5	3	3	2	2	1	3	2	1	3	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	3	2	1	3	1	1	1

Subject Code	**CY-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**3**
Subject Name	**CHEMISTRY**		
Pre-requisites	**None**		
Module I	**Periodic Properties:** Periodic Properties, Effective Nuclear Charge, Penetration of Orbital's, Variations of *s*, *p*, *d* and *f* Orbital Energies of Atoms in the Periodic Table, Electronic Configurations, Atomic and Ionic Sizes, Ionization Energies, Electron Affinity and Electro negativity, Polarizability, Oxidation States.		**6 Hours**
Module II	**Free Energy in Chemical Equilibria**: Concepts of Entropy, Entropy in Physical and Chemical Changes, Free Energy Concepts, Gibbs Helmholtz Equation, Free Energy Change and Criterion of Spontaneity of Chemical Equation and Chemical Equilibrium, Van't Hoff Equation.		**6 Hours**
Module III	**Spectroscopic Techniques and Applications**: Basic Terms and Principles of Spectroscopy Molecular Rotational (Microwave) Spectroscopy: Basic Principle and Application to Diatomic Molecules, Selection Rules. Molecular Vibrational (IR) Spectroscopy: Basic Principle, Types of Vibrations, Vibrational Frequency, Selection Rules. Electronic (UV-Visible) Spectroscopy: Laws of Absorption, Basis Principle, Types of Electronic Transitions, Chromophores and Auxochrome.		**6 Hours**
Module IV	**Stereochemistry**: Structural and Stereoisomer (Geometrical and Optical), Symmetry and Chirality, Enantiomers, Diastereomers, Optical Activity, Configurational and Conformational Analysis, Representations of Three-Dimensional Structures (E, Z and R, S only).		**6 Hours**
Module V	**Organic Reactions and Synthesis**: Introduction to Reaction Intermediates {Carbocation, Carbanion, Free Radial (Formation, structure and stability), Reactions involving Substitution, Addition, Eliminatio (Examples and Mechanisms).		**6 Hours**

Essential Reading	Engineering Chemistry: fundamental to Applications by Shikha Agarwal, Cambridge University Press, Second Edition, 2019. Engineering Chemistry by B. Rama Devi, P. Aparna, and Prasanta Rath, Cengage Learning, First Edition, 2023.
Supplementary Reading	Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, and James Keeler, OxfordUniversity Press, Eleventh Edition, 2018. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma, and Madan S. Pathania,Vishal Publishing, Forty Eighth Edition, 2021. Fundamentals of Molecular Spectroscopy by C.N. Banwell and E.M.MacCash, 5th Edition, McGraw-Hill Education, Fourth Edition, 2017. Concise Inorganic Chemistry by J.D Lee, Oxford University Press; FifthEdition, 2008. Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, and K.C. Kalia, Vishal Publishing, Fifty Fifth Edition, 2020. Stereochemistry: Conformation and Mechanism by P.S. Kalsi, NewAge International, Eighth Edition, 2015.
	Organic Chemistry Concepts and Applications by Jagdamba Singh, Pragati Prakashan,Eighth Edition, 2015. Organic Chemistry byR.T. Morrison andR.N. Boyd, Pearson Education, Seventh Edition,2010. Organic Chemistry: Structure and Function by P. Volhardt and N. Schore, WH Freeman;Eighth Edition, 2018.
Course Outcomes	CO1: To demonstrate and realize the trend in various periodic properties associated with different elements present in different groups and periods of modern periodic table. CO2: To acquire the knowledge of free energy concept for the thermodynamics associated with chemical reactions and equilibriums. CO3: To analyze and implement the concepts of spectroscopic techniques for identification of various organic and inorganic compounds. CO4: To evaluate and visualize the concept of configurations and conformations of various organic compounds. CO5: To assess the generation, reaction and identification of intermediates Involved during organic reactions and their applications in different organic reaction mechanisms.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	3	3	1	3	1	2	1
CO2	3	3	1	1	2	3	3	1	3	1	2	1
CO3	3	3	1	1	2	3	3	1	3	2	2	2
CO4	2	3	1	1	2	1	2	1	1	1	1	1
CO4	3	2	1	1	1	1	3	2	1	1	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	1	2	3	3	1	3	1	2	1

Subject Code	**ME-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**3**
Subject Name	**ENGINEERING MECHANICS**		
Pre-requisites	**None**		
Module I	Concurrent forces on a plane: Composition, resolution and equilibrium of concurrent coplanar forces, method of moment. General case of forces on a plane: Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections.		**8 Hours**
Module II	Friction: Fundamentals and Problems involving friction, Ladder, Wedges. Principle of virtual work.		**4 Hours**
Module III	Parallel forces on a plane: General case of parallel forces, center of parallel forces and center of gravity, Centroid of plane and composite figures, Theorems of Pappus and Guildins. Moment of inertia: Plane figure with respect to an axis in its plane and perpendicular to the plane, Polar moment of inertia, parallel axis theorem.		**6 Hours**
Module IV	Rectilinear translation: Kinematics, Principle of dynamics, D Alembert"s Principle, Principle of work and energy for a particle and a rigid body, Conservation of energy, Principle of impulse and momentum for a particle and a rigid body, Conservation of momentum, System of rigid bodies, Impact, direct and central impact,coefficient of restitution.		**6 Hours**
Module V	Curvilinear translation: Kinematics, Equation of motion, Projectile, D Alembert"s principle of curvilinear motion. Kinematics of rotation of rigid body.		**6 Hours**
Essential Reading	1. Engineering Mechanics: S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati,5th Edition,2017 McGraw Hill		
Supplementary Reading	Engineering Mechanics, Static and Dynamics, J. L. Meriam and L. G. Kraige, 9th Edition,2021, John Wiley & Sons, Inc. Fundamental of Engineering mechanics, S Rajesekharan& G Shankara Subramanium, 3rd Edition, 2017, S. Chand. Engineering mechanics: K. L. Kumar and Veenu Kumar, 4th Edition,2017,Tata MC Graw Hill.		
Course Outcomes	Upon completion of the subject the students will be able to: **CO1**. Ability to analyze objects in static equilibrium including the determination of reactions, forces and moments. **CO2**. Enrich fundamental concept of friction and demonstrate the analytical skills to solve the problems involving friction. **CO3**. Assimilating the knowledge for determination of centroid and second moment of area of sections and their engineering applications. **CO4**. To analyze the work done by forces, the energy transferred from one object to other and apply principle of work and energy conservation for realistic (/Practical) engineering problems. **CO5**. Identify the various parameters in projectile motion. Apply the principle ofdynamics to analyze the curvilinear motion of rigid bodies.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	2	1	1	3	1	2	3
CO2	3	3	2	1	2	2	2	1	3	2	2	3
CO3	3	3	3	2	2	2	1	1	3	1	2	3
CO4	2	3	2	1	3	1	1	1	3	1	3	3
CO5	3	2	2	1	2	1	1	1	2	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	2	1	1	3	1	2	3

Subject Code	**EC-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**2**
Subject Name	**BASIC ELECTRONICS**		
Pre-requisites	**NONE**		
Course Objective	To impart the fundamentals of semiconductor devices and theirapplications to various circuits. To impart the knowledge of fundamentals of digital electronics andIntegrated Circuits (IC). To impart the knowledge of electronic measuring instruments andfundamentals of communication systems.		
Module I	Semiconductor Physics: Properties of semiconductor, current flow in semiconductors, voltage-current characteristic of a p-n junction, Rectifiers. Bipolar junction Transistor (BJT): Device structure, types and modes of operation, static characteristic, BJT as a switch, BJT as an amplifier, concept of biasing of BJT.		**7 Hours**
Module II	JFET: Physical structure, operation and static characteristics. MOSFET: Physical structure, operation and characteristics of D- andE-type MOSFET. Integrated Circuits: Introduction to CMOS technology in VLSI, Introduction to Integrated circuits, Fabrication of monolithic IC, Integration of circuit components, Limitations of VLSI.		**7 Hours**
Module III	Feedback Amplifiers: General feedback structure, properties of negative feedback, four basic types of feedback topologies (Block diagram only). Operational Amplifier (OP-AMP): Ideal OP-AMP, inverting configuration, non-inverting configuration, OP-AMP Applications (Adder, Subtractor only).		**6 Hours**
Module IV	Digital Electronics Fundamentals-Number system (Decimal, Binary, Octal and Hexadecimal), conversion among number systems, signed-binary numbers, binary addition, subtraction, multiplication and division, logic gates, laws of Boolean Algebra, simplification ofexpressions.		**5 Hours**
Module V	Electronic Instruments: Overview of CRO, DSO; principles of operation, waveform reconstruction, Comparison between CRO & DSO, applications of oscilloscope. Principles of Communication Systems: Fundamentals of AM & FM, (Waveforms and general expressions only).		**5 Hours**

Essential Reading	Electronics Fundamentals and Applications, D. Chattopadhyay and P.C. Rakshit, New Age International Publications. (Selected portions from chapters) Electronic Devices & Circuit Theory, R.L. Boylestad and L. Nashelsky, Pearson Education.
Supplementary Reading	Integrated Electronics, Millman and Halkias, TMH Publications. Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford UniversityPress. VLSI Design, Debaprasad Das, Oxford University Press. Electrical & Electronics Measurement and Instrumentation, A.K. Sawhney, Dhanpat Rai & Co (Pvt.) Ltd.
Course Outcomes	After completion of the course, students should be able to CO1. Understand the operation and application of semiconductor devices. CO2. Analyze characteristics of FETs. CO3. Apply the Feedback Amplifiers and Operational Amplifiers. CO4. Remember the fundamentals of different Digital arithmetic operations and Integrated circuits. CO5. Evaluate some important Electronic Instruments and Communicationsystems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	1	1	2	1	1	1
CO2	3	2	3	3	2	2	1	1	2	1	2	1
CO3	3	2	3	3	2	2	1	1	2	1	1	1
CO4	2	3	2	3	2	1	2	1	1	1	2	1
CO5	3	2	3	2	3	1	3	1	1	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	3	2	2	1	1	2	1	1	1

Subject Code	**CE-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**2**
Subject Name	**BASIC CIVIL ENGINEERING**		
Pre-requisites	**NONE**		
Module I	Introduction to Civil Engineering: Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country, interdisciplinary nature of construction projects. Residential Buildings: NBC Classification, Basic Components of a building: Basic requirement. Planning and Design of buildings: fundamental requirements, selection of sites, Introduction to building design: functional and structural design. Foundations: Classification, Bearing Capacity of Soil and related terms (definition only).		**6 Hours**
Module II	Fundamental Properties of Construction Materials: Physical, mechanical and durability properties. Construction materials: stone, bricks, cement, aggregate, mortar, concrete, timber, steel, non-ferrous metals, paint, plastic, glass, adhesive, tiles, composites (Definition, classification and application).		**6 Hours**

Module III	Importance of Transportation, Transportation modes i.e. Highway, railway, airways, water, pipe and conveyor – Basic Characteristics, advantages and disadvantages. Indian road transport system: Types of roads, classification of highway, urban roads: basic requirements and classification. Basic Components of a Road, Rigid and Flexible pavement (comparison only).	**6 Hours**
Module IV	Quantity of water: Sources of water, Per capita demand, drinking water standards, Public Water Supply System: Necessity and Basic lay out. Conventional water treatment process: Screening, Plain Sedimentation, Sedimentation aided with Coagulation, Filtration, and Disinfection (working principles only).	**6 Hours**
Module V	Irrigation: Importance of Irrigation, Classification of Irrigation projects, Irrigation system: Types, Field water distribution, Multipurpose river valley projects, Dams: Purpose, types. Layout of canal Irrigation system: components and definitions.	**6 Hours**
Essential Reading	Basic Civil engineering, Gopi, S., Pearson Publication Basic Civil Engineering, Bhavikatti, S. S., New Age.	
Course Outcomes	**CO1.** Able to understand the basics of civil engineering and fundamental aspectsof building. **CO2.** Able to get the brief overview of general aspect of building material. **CO3.** Able to get brief idea about transportation modes and planning. **CO4.** Able to get brief idea about drinking water standards and water treatment plant. **CO5.** Able to get brief idea about irrigation network system.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	2	1	1	3	2	2	3
CO2	3	2	2	2	1	2	1	1	3	2	2	3
CO3	2	2	2	2	1	2	1	2	3	2	2	3
CO4	3	2	3	2	1	2	2	1	1	2	1	3
CO5	3	3	2	2	1	3	3	1	2	3	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	2	1	2	1	1	3	2	2	3

Subject Code	**BCS2102**	**Total Contact Hour**	**30**
Semester	**1st/2nd**	**Total Credit**	**2**
Subject Name	**Programming for Problem Solving**		
Pre-requisites	**NONE**		
Module I	Introduction to computing- Block architecture of a computer, fundamental units of storage: bit, bytes, nibbles, word size. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts. Level of programming Languages, structure of C program, Compiling and Executing C program		**6 Hours**

Module II	C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operators and Expressions-Operators, Precedence of operators. Decision Control Structure, Loop Control Structure and Case Control Structure.	**6 Hours**
Module III	Functions: Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion.Arrays1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration & Initialization, String Handling Functions.	**6 Hours**
Module IV	Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation. Structure, Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, Union, Array of Union Variables, Union inside Structure, Bit Fields. Storage Class.	**6 Hours**
Module V	Preprocessor Directives- Types, Pragma Directives, Conditional Directives. typedef, Enumerated Data Type. Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations. Advanced Issues in Input & Output – using argc & argv.	**6 Hours**
Essential Reading	Programming in ANSI C, E Balaguruswamy Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.	
Supplementary Reading	Let us C- Y.Kanetkar, BPB Publications. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education C How to Program- Deitel and Deitel, Pearson Education. The C Programming Language- Brian W. Kernighan and Dennis M. Ritchie, PrenticeHall	
Course Outcomes	CO1: Grasp the fundamentals of Computer and problem solving. CO2: Conceptualize fundamentals of C Programming along with control structures. CO3: Implement different problems on functions and arrays. CO4: Apply pointers structures and unions for problem solving. CO5: Gain knowledge of pre-processor directives and file operations.	

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	2	2	3	1	2	3

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	2	2	3	1	2	3
CO2	3	3	3	3	2	1	2	2	3	1	2	3
CO3	3	3	2	3	2	1	2	2	3	1	2	3
CO4	2	2	3	3	2	1	1	1	2	1	1	3
CO5	3	3	2	2	2	2	2	1	1	2	1	3

Subject Code	**EA-1101**	**Total Contact Hour**	
Semester	**1st/2nd**	**Total Credit**	**2**
Subject Name	**UNIVERSAL HUMAN VALUES-I: UNDERSTANDING HARMONY**		
Pre-requisites	**None**		
Course Objective	The objective of the course is fourfold: Development of a holistic perspective based on self-exploration about themselves (human beings), family, society, and nature/existence. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence Strengthening of self-reflection. Development of commitment and courage to act towards full human potential.		
Module I	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** Know each other (Introduction of the faculty and the students), Get to know batch mates. Exploring basic Human Aspirations and concerns. Basic Human Aspirations and their fulfillment Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self- exploration and the basis of right understanding. Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for the fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking. In addition, the video of "The Story of Stuff" can be shown and discussed.		**7 Hours**
Module II	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Resolution of some of the concerns Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease		**5 Hours**
	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship Understanding values in human-human relationship; program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.		**5 Hours**

Module III	Understanding the meaning of Trust; Difference between intention and competence. The videos (two parts) of "Right Now Right Here" can be shown and discussed as practice session. Understanding the meaning of Respect, and the other salient values in relationship. Understanding the harmony in the society (society being an extension of the family): Resolution, Prosperity, fearlessness (trust) and co- existence as comprehensive Human Goals. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives	
Module IV	**Understanding Harmony in the Nature and Existence - Whole Existence as Coexistence** Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self -regulation in nature.The video of "How to grow a forest in your backyard" can be shown and discussed. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space Self-evaluation Include practice sessions to discuss human being as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	**7 Hours**
Module V	**Understanding the harmony in the Nature.** Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature. The video of "How to grow a forest in your backyard" can be shown and discussed. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Self-evaluation include practice sessions to discuss human being as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology, etc	**6 Hours**
Essential Reading	Human Values and Professional Ethics (2nd revised edition) by R R Gaur, R Asthana, G P Bagaria, Excel Books, New Delhi, 2019	**Essential Reading**
Supplementary Reading	1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.	**Supplementary Reading**
Course Outcomes	On completion of the course, a student will be able to: CO1. Have more awareness of themselves and their surroundings (family, society, nature). CO2. Be more responsible in life in handling problems with sustainable solutions CO3. Have better clarity about human relationships and human nature and also become sensitive to their commitment towards what they have understood (human values, human relationships, and human society). CO4. Keep human relationships and human nature in mind. CO5. Apply what they have learned to their real life.	**Course Outcomes**

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	3	3	3	3	2	2
CO2	1	1	1	1	1	3	3	3	3	3	2	3
CO3	1	1	1	1	1	3	3	3	3	2	3	2
CO4	1	1	1	1	1	3	3	3	3	3	2	1
CO4	1	1	1	1	1	3	3	3	3	2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	3	1	1	2	1	3	2	2	2

Subject Code	**CY-1181**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**1.5**
Subject Name	**Chemistry Lab**		
Pre-requisites	**None**		

LIST OF EXPERIMENTS

Any Ten Experiments:

1. Determination of the alkalinity in the given water sample.
2. Determination of the temporary and permanent hardness in the given water sample by complexometric titration using EDTA as standard solution.
3. Determination of amount of available chlorine in bleaching powder.
4. Standardization of potassium permanganate using sodium oxalate.
5. Determination of amount of ferrous iron present in Mohr's salt.
6. Determination of the rate constant of a chemical reaction.
7. Estimation of calcium in Limestone.
8. Determination of dissolved oxygen in water sample.
9. Determination of the partition coefficient of a chemical between two immiscible liquids.
10. Determination of the strength of given HCl solution by titrating it against NaOH solution using pH meter.
11. Conduct metric titration of strong acid and strong base.
12. Determination of viscosity of lubricating oil by Redwood viscometer.
13. Determination of flash point of a given oil by Pensky-Martens flash point apparatus.
14. To find out the concentration of a given potassium permanganate solution spectrophotometric method. Synthesis of Aspirin/Paracetamol.

Essential Reading	Practical Chemistry by D.N. Bajpai, O.P. Pandey and S. Giri, S. Chand Publishing,Revised Edition, 2010. Practical Physical Chemistry by B. Vishwanathan and P.S. Raghavan, Viva Books, First Edition, 2012.
Course Outcomes	CO1: To analyze the alkalinity and hardness value of the water sample. CO2: To analyze the concentration of copper present in the solution. CO3: to analyze kinetics of the reactions. CO4: To gain hands-on experiences of pH meter, conductometer, and spectrophotometer. CO5: To analyze viscosity and flash point of lubricating oils.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	1	2	2	3	1	2	2
CO2	3	2	2	2	1	1	2	1	2	2	2	1
CO3	2	2	2	3	1	1	2	2	3	2	3	2
CO4	3	3	2	3	1	1	2	1	3	3	2	1
CO4	2	2	2	3	1	1	2	1	3	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	3	1	1	2	1	3	2	2	2

Subject Code	**ME-1181**	**Total Contact Hour**	
Semester	**1st/2nd**	**Total Credit**	**1.5**
Subject Name	**WORKSHOP AND DIGITAL MANUFACTURING LABORATORY**		
Pre-requisites	**None**		

LIST OF EXPERIMENTS

1. Preparation of job in fitting section/Study of lathe and turning operation
2. Preparation of job in black smith section/ Study of milling machine and milling operation.
3. Preparation of job in carpentry section/milling operation on CNC milling machine.
4. Study of CNC lathe machine and turning on CNC lathe.
5. Study of Robot (Pick and place and palletizing operation).
6. Study of additive manufacturing using 3D printer and product development.

I. Carpentry Section: Study of different Hand tools, measuring instruments and equipments used in Carpentry work. Safety precautions.

Preparation of Job: Carpentry job involving different types of joint.

Includes the operations: Measuring, Marking, Sawing, Planing, Chiseling, Mortesing, Tenoning, making Half-lap joint, Mortese & Tenon joint and Nail joint.

II. Fitting Section: Study of different Hand tools, measuring instruments and equipments used in Fitting work. Safety precautions. Study of Drilling Machine and Grinding Machine.

Preparation of Job: Paper Wt. / Square or Rectangular joint (male-female joint) (any one)

Includes the operations: Measuring, Marking, Filing, Sawing, Drilling, Tapping, Dieing and Punching.

III. Black Smith Section: Study of different Hand tools, equipment's and Open-hearth furnace used in Blacksmith work. Different types of heat treatment processes. Safety precautions.

Preparation of Job: Weeding hook/ Chisel (any one)

Includes the operations: Measuring, Marking, Cutting, Upsetting, Drawing down, Bending, Fullering and Quenching.

IV. Turning/ Milling Section (Conventional & CNC)

A. Study of Lathe Machine, different parts of Lathe and different applications of Lathe. Study of different measuring & marking instruments.

B. Study of Milling Machine, different parts and applications of Milling Machine. Study of different measuring & marking instruments.

C. (i) Study of CNC Lathe Machine, different parts of CNC Lathe and its operation.

(ii) Part programming for turning operations.

D. (i) Study of CNC Milling Machine, different parts of CNC Milling Machine and its operation.

(ii) Part programming for milling operations.

V. Robotics Lab:

A. Study of Robot.

B. Pick and place operation, demonstration and explanation of code. C. Palletizing operation, demonstration and explanation of code. VI. Additive Lab (Study of 3D Printer and demonstration of its operation).	
Course Outcomes	At the end of the course, the student will be able to: CO1. Acquire knowledge of conventional & CNC (Lathe and Milling Machine). CNC code and part programming for Milling and Turning operations. Different types of hand tool, measuring instruments and machine tools used in Fitting, Carpentry & Smithy work. CO2. Know about different types of operations and joints performed in different shops i.e. in Fitting and Carpentry. CO3. Explore learning about forging temperature of different types of ferrous metals and different types of operation (e.g. upsetting, edging, flattening and bending etc.) carried out on hot metals to prepare jobs. CO4. Acquire knowledge for the preparation of different types of jobs by using conventional/ CNC Lathe and Milling Machines (e.g. facing, step turning, knurling, drilling, boring, taper turning, thread cutting and different methods of indexing for machining gears. CO5. Acquire skills in using different precision measuring and marking instruments. Understand the importance of safety precaution in different shops.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	2	2	3	2	3	2	2	3
CO2	1	1	1	2	2	3	3	2	3	3	2	2
CO3	2	1	2	2	2	2	3	2	3	2	3	3
CO4	3	2	1	1	3	2	3	3	3	3	3	3
CO5	3	1	1	2	2	1	3	2	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	1	1	2	2	2	3	2	3	3	3	3

Subject Code	**EC-1181**	**Total Contact Hour**	
Semester	**1st / 2nd**	**Total Credit**	**1.5**
Subject Name	**ELECTRONICS LAB.**		
Pre-requisites	**None**		
Course Objective	To provide engineering skills for circuit design on breadboard with electronic components. To impart the knowledge on digital fundamentals and digital circuit design. To analyze various electronic circuits such as BJT, FET, OP-AMPs etc.		
LIST OF EXPERIMENTS			
1. Familiarity with electronic components and devices (Testing of semiconductor diode, Transistor, IC Pins connection) Digital Multimeter should be used. 2. Study and use of CRO to view waveforms and measure its Amplitude and Frequency. 3. V-I Characteristics of a Semiconductor Diode			

4. V-I (Output) Characteristics of N-P-N/P-N-P Transistor in CE Configuration
5. Measurement of pinch off voltage and plot transfer characteristics and drain characteristics of JFET.
6. Transfer characteristics and drain characteristics of MOSFET.
7. OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
8. Verification of Truth table of Logic gates (AND, OR, NOT, NAND, NOR, EX-OR)
9. Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
10. Implementation of digital circuit using Universal gates.

SUPPLEMENTARY READING	Integrated Electronics, Millman and Halkias, TMH Publications. 2. Electronic Devices & Circuit Theory, R.L Boylestad and L. Nashelsky, Pearson Education.
Course Outcomes	After completion of the sessional student should be able to CO1. Acquire basic knowledge on electronic devices and components CO2. Design different electronics circuits using semiconductor diodes. CO3. Analyze and develop the characteristics of BJT and FET Circuits CO4. Implement Operational amplifier circuits. CO5. Acquire knowledge on basic digital logic gates.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	1	2	2	3	1	2	2
CO2	3	2	2	2	1	1	2	1	2	2	2	1
CO3	2	2	2	3	1	1	2	2	3	2	3	2
CO4	3	3	2	3	1	1	2	1	3	3	2	1
CO5	2	2	2	3	1	1	2	1	3	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	3	1	1	2	1	3	2	2	2

Subject Code	**CE-1181**	**Total Contact Hour**	
Semester	**1st / 2nd**	**Total Credit**	**1.5**
Subject Name	**ENGINEERING GRAPHICS AND DESIGN LAB (WITH AUTOCAD)**		
Pre-requisites	**None**		

LIST OF EXPERIMENTS

1. Introduction to AutoCAD: Basic commands, Code provision of IS-696 regarding Lines, Lettering, and Dimensioning.
2. Drawing of Scales (Plane Scales, Diagonal Scales, Vernier Scales and Scales of Chords).
3. Construction of simple geometrical figures and Engineering curves.
4. Orthographic Projections:
   Projection of a point situated in various quadrants.
   i) Projections of straight lines.
   ii) Projection of plane figures.
   iii) Projection of simple solids.
   iv) Section of solid and Development of surfaces.
5. Isometric projection and perspective view.

ESSENTIAL READING	1. N. D. Bhatt, *Geometrical Drawing*, Charotar Book Stall, 2002.
SUPPLEMENTARY READING	1. K. Venugopal, *Engineering Drawing and Graphics + AutoCAD*, NewAge International (P) Limited. 4th Reprint: June, 2008. 2. K. L. Narayana and P. Kannaiah, *Engineering Graphics*, Tata McGrawHill Publishing Co. Ltd. 3. J. D. Bethune, *Engineering Graphics with AutoCAD*, Pearson Education.
Course Outcomes:	1. Revise basics of engineering drawings and curves. 2. Use Orthographic projections of Lines, Planes, and Solids. 3. Apply Sectioning of various Solids and their representation. 4. Change Pictorial views to Orthographic Projections 5. Construct Isometric Scale, Isometric Projections and Views.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	3	1	2	3	1	2
CO2	3	2	2	2	2	1	3	1	2	2	2	1
CO3	3	2	3	2	1	1	3	2	2	2	2	2
CO4	3	3	2	2	1	1	2	1	2	2	3	2
CO5	3	2	2	2	2	1	3	1	2	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	2	2	1	1	3	1	2	2	2	2

Subject Code	**EA-1181**	**Total Contact Hour**	
Semester	**1st / 2nd**	**Total Credit**	**0**
Subject Name	Sports/Yoga/NCC/NSS		
Pre-requisites	**None**		
CO1	Develop physical fitness and maintain mental health, acquiring lifelong skills to lead a healthy lifestyle.		
CO2	Cultivate a sense of leadership and the ability to work effectively in teams fostering leadership qualities, discipline, and the ability to take initiative in challenging situations.		
CO3	Equipped with the skills to serve society by addressing community issues and demonstrate civic responsibility and contribute towards nation-building and social welfare.		
CO4	Imbibe the importance of self-discipline, punctuality, and respect for diversity by instilling ethical values, integrity, and the understanding of one's responsibilities towards oneself and society.		
CO5	To communicate effectively with their peers, instructors, and community members, building interpersonal skills that are essential for their professional and personal lives.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	3	3	3	3	1	2
CO2	1	1	1	1	1	3	3	3	3	3	1	1
CO3	1	1	1	1	1	3	3	3	3	3	2	2
CO4	1	1	1	1	1	3	3	3	3	3	2	2
CO5	1	1	1	1	1	3	3	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	1	1	1	1	3	3	3	3	3	2	2

SECOND SEMESTER

Subject Code	**MA-1102**	**Total Contact Hour**	**30**
Semester	**1st /2nd**	**Total Credit**	**3**
Subject Name	**MATHEMATICS-II**		
Pre-requisites	**None**		
Module I	First order ODE Exact ODEs. Integrating factors. Linear first order ODEs. Nonlinear first order ODE and Bernoulli's equations, Applications to Population growth, Newtons law of cooling, RL circuit.		**6 Hours**
Module II	Second order ODE Second order linear differential equations with constant coefficients, Euler-Cauchy equations, method of undetermined coefficients, solution by variation of parameters. Power series solutions of ODE. Legendre's equations (explicit solution only).		**6 Hours**
Module III	Vector Calculus Vector and Scalar Functions and Fields, Derivatives, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field, Line Integrals, Path Independence of Line Integrals, Double Integrals, Green's Theorem in the Plane (Statement and applications).		**6 Hours**
Module IV	Complex Analysis Limit, Continuity, Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and logarithm functions.		**6 Hours**
Module V	Complex Analysis Line Integral in the Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Functions, Laurent series, Residue theorem with simple problems.		**6 Hours**
Essential Reading	1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition,John Wiley & Sons, 2006.		
Supplementary Reading	1. E.M. Stein, Fourier Analysis: An Introduction (Princeton Lectures inAnalysis) 2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008. 3. S. L. Ross, Differential Equations, 3rd Edition, Wiley India, 1984. 4. E. A. Coddington, An Introduction to Ordinary Differential Equations,Prentice Hall India, 1995.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	1	3	1	3	1
CO2	3	3	2	3	2	3	3	1	2	1	3	1
CO3	3	3	3	2	2	3	3	1	3	1	3	1
CO4	3	2	2	2	1	2	1	1	1	1	1	1
CO5	2	3	2	1	1	2	1	1	1	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	2	3	3	1	3	1	3	1

Subject Code	**PH-1101**	**Total Contact Hour**	**30**
Semester	**1st / 2nd**	**Total Credit**	**3**
Subject Name	**PHYSICS**		
Pre-requisites	**None**		
Module I	**Oscillations:** Mechanical and electrical simple harmonic oscillators, damped harmonic oscillator – heavy, critical and light damping,energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, steady state motion of forced damped harmonic oscillator.		**6 Hours**
Module II	**Waves and Optics:** Concept of wave and Wave equation, Superposition of many harmonic waves, Concept of coherent sources(Division of wave front and division of amplitude), Interference in thin parallel film, Newton's ring: Determination of wavelength of light, Refractive index of liquid). Concept of diffraction (Huygen's Principle), Types of diffraction, Franhoffer diffraction due to single slit, diffraction grating (qualitatively).		**7 Hours**
Module III	**Electromagnetism: Vector calculus**: Gradient, Divergence, Curl (Mathematical concept), Gauss divergence theorem and Stoke's theorem (statement only), Derivation of Maxwell's electromagnetic equation in differential form and integral form, Electromagnetic wave equations for **E** and **B** in vacuum and conducting medium, transverse nature of EM waves.		**6 Hours**
Module IV	**Quantum Physics:** Wave particle duality, concept of phase velocity group velocity, relation between them, Matter waves (de Broglie hypothesis), Wave functions, Observables as operators, Eigen function and Eigen values, Normalization, Expectation values, Schrodinger equation (Time dependent and time independent), Particle in a box.		**7 Hours**
Module V	**Lasers:** Introduction to Laser, Characteristics of Lasers, Einstein'scoefficients and relation between them, Lasing action, Population inversion, Three and four level pumping schemes, Ruby Laser, He-NeLaser.		**4 Hours**
Essential Reading/ Supplementary Reading	1. Ian G. Main, Oscillations and waves in physics, Cambridge University Press. 2. H.J. Pain, The physics of vibrations and waves, John Wiley & Sons Ltd. 3. E. Hecht, Optics, Pearson Education Ltd. 4. A. Ghatak, Optics, McGraw Hill Publisher. 5. O. Svelto, Principles of Lasers, Springer.		
Course Outcomes	At the end of this course students will demonstrate the ability to CO1: Demonstrate proficiency and perceptive of the basic concepts in physics. CO2: Utilize the scientific and experimental methods to investigate and verify the concepts related to content knowledge. CO3: Exploring the engineering applications and apply quantum mechanics to engineering Phenomena. CO4: Identifying the relevant formulae and work out engineering problems. CO5: Comprehend principle, concept, working and application of new technology and comparison of results with theoretical calculations.		

Course Articulation Matrix

Table	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	2	2	2	3	3
CO2	3	3	3	3	2	2	1	2	2	2	3	3
CO3	2	3	3	3	3	2	1	2	2	2	3	3
CO4	3	2	3	2	2	1	2	2	1	2	1	2
CO5	2	3	3	3	2	2	1	2	1	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	2	1	2	2	2	3	3

Subject Code	**CS-1101**	**Total Contact Hour**	**30**
Semester	**1st/2nd**	**Total Credit**	**3**
Subject Name	**C and Data Structures**		
Pre-requisites	**Fundamentals of Computers**		
Course Objective	Learn fundamentals of C programming Learn various steps of program development and implementation Learn different Data Structures for structured programming approach Learn relation of memory and memory referencing with the program execution Learn to implant small projects		
Module I	**Fundamentals of C:** Problem-solving processes: Algorithms and Flow Chart. C as a Middle-level language, Structure of C program, Character set Identifiers, Keywords, Data Types, Constant and Variables, Statements, Input and Output statements, Operators and Expressions, Precedence of operators, Control Structures (If, If-else, Switch-case, For loop, While, do-While)		**8 Hours**
Module II	**Function, Array, Structure and Union:** Functions (Built-in, user-defined), Recursive function. Array: 1 – D, 2 – D, Matrix operations, String, Passing Array to Function, Structure, Union.		**7 Hours**
Module III	**Pointer & Dynamic Memory Allocation:** Pointer Arithmetic, Parameter passing using pointers, Call by value vs. Call by reference, Passing parameters, pointer to pointer, pointer to function, Pointer to Structure, Array and pointers, Static vs. Dynamic memory, Pointer variables, Dynamic memory allocation functions [malloc (), calloc (), realloc (), free ()].		**6 Hours**
Module IV	**Data Structures:** Introduction to Data Structure, Linear Linked List: Creation, Insertion, Deletion. Stack, Stack applications (Infix to postfix, postfix evaluation), Queue (linear & circular).		**5 Hours**
Module V	**Tree, Introduction to Sorting & Searching:** Binary Tree, Binary Search Tree, Sorting (Bubble Sort, Quick Sort), Searching (Linear Search, Binary Search).		**4 Hours**
Essential Reading	1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill 2. Programming in C, Pradip Dey, Manas Ghosh, Oxford Publication 3. Data Structures - (Schaum's Outlines), McGraw-Hill Education		

Supplementary Reading	1. Let us C- Yashwant Kanetkar, BPB Publications. 2. Programming with ANSI and Turbo C- Kamthane, A. N. Pearson Education 3. R. S. Salaria, Programming for Problem Solving, Khanna Publishing House 4. The C Programming Language – Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall. 5. Data Structures Using C - Amiya Kumar Rath, Alok Kumar Jagadev, Scitech Publications
Course Outcomes	The students will learn and able to **CO1.** Remember, understand and implement simple algorithms to C programs. **CO2.** Test and execute programs using function, array, structure and union. **CO3.** Analyze the relation of memory and memory referencing with the program execution. **CO4.** Apply different Data Structures for problem solving. **CO5.** Implement different sorting and searching algorithms.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	2	2	1	1	3
CO2	3	2	3	2	2	1	1	2	3	2	1	2
CO3	3	3	2	3	2	2	1	2	3	1	1	3
CO4	3	3	3	3	2	1	1	2	3	1	1	3
CO5	3	2	3	3	2	1	2	2	2	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	2	3	1	1	3

Subject Code	**EE-1101**	**Total Contact Hour**	**30**
Semester	1st / 2nd	**Total Credit**	**2**
Subject Name	**BASIC ELECTRICAL ENGINEERING**		
Pre-requisites	**None**		
Module I	**D.C Networks:** Kirchoff's laws, node voltage and mesh current methods, delta-star and star-delta conversions, superpositionprinciple, Thevenin's and Norton's theorems, Maximum Power Transfer Theorem.		**6 Hours**
Module II	**Single phase and three phase ac circuit:** Average and effective values of sinusoids, solution of R, L, C series circuits, solution ofseries and parallel circuits, series -parallel resonance. Line and phase quantities, Delta and star connections, solution of the balanced three phase circuits, measurement of power in three phase circuits.		**6 Hours**
Module III	**Magnet circuit & principle of electromechanical energy conversion:** Review of fundamental laws of electromagnetic induction, Solution of simple magnetic circuits. DC machine: Construction, types, emf equation of generator, torque equation of motor, speed control of DC motors.		**6 Hours**

Module IV	**AC MACHINES:** Single Phase Transformer: Construction, emf equation, no load and load operation, voltage regulation andefficiency. Three Phase Induction Motor: Construction, principle of working, concept of slip, torque speed relation. Principle of operation of Three Phase alternator.	**6 Hours**
Module V	**Introduction to Power System:** General structure of electrical power systems, Concepts of Generation, Transmission andDistribution, Sources of Electrical Power.	**6 Hours**
Essential Reading	1. G. Rizzoni, Principles and Applications of Electrical Engineering, TMH,2017. Nagrath I.J. and D. P. Kothari, Basic Electrical Engineering, Tata McGraw Hill.	
Supplementary Reading	1. S. Parker Smith, "Problems in Electrical Engineering", Asia Publications,10th Edition. Edward Hughes (revised by Ian McKenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint 2002, 10th Edition.	
Course Outcomes	Upon completion of the subject the students will demonstrate the ability to: **CO1.** Implement principles of DC network, theorems and transients. **CO2.** Analyze the concept of Single phase and three phase AC circuits. **CO3.** Express the concept of magnetic circuit and DC machines. **CO4.** Apply basic principles of AC machines and their working. **CO5.** Demonstrate basic principles of power system	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	1	2	1	1	2	3	1
CO2	3	3	2	1	1	1	2	1	1	3	3	1
CO3	3	2	2	1	1	1	2	1	1	2	3	2
CO4	2	3	2	2	1	2	1	1	2	1	1	1
CO5	3	3	3	1	1	2	2	1	1	2	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	1	2	1	1	2	3	1

Subject Code	**HS-1101**	**Total Contact Hour**	**30**
Semester	1st /2nd	**Total Credit**	**2**
Subject Name	**English For Technical Writing**		
Pre-requisites	**None**		
Module I	**Fundamentals of Communication:** Process of Communication, Types of Communication (Verbal & Non-Verbal), Channels of Business Communication, Barriers to Communication, Plain English, Bias free language, Cross Cultural Communication		**(6 Hours)**
Module II	**Communicative Grammar:** Time and Tense, Aspects (Perfective & Progressive), Verbs of State and Event, Passive and Active Voice, Conditionals		**(6 Hours)**

Module III	**Sounds of English:** The Speech Mechanism and Organs of Speech, Consonant Sounds of English, Vowel Sounds of English, Stress Pattern: Syllable, Stress and Intonation, Problem sounds for Indian Speakers	**(6 Hours)**
Module IV	**Business Writing:** Paragraph writing, Sentence Linker, Business Letters, Report Writing, Proposal writing	**(6 Hours)**
Module V	**Professional Communication for workplace:** Notice, Circular and Memo writing, Agenda & Minute writing, Writing Cover letter, Résumé (CV) Writing	**(6 Hours)**
Essential Reading	1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill) 2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)	
Supplementary Reading	3. Better English Pronunciations by J. D.O Conner (Cambridge University Press) 4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP) 5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)	
Course Outcomes	1. Analyze various components of human communication and to identify key elements and principles of organizational communication. 2. Apply correct usage of English grammar in writing and speaking. 3. Evaluate students' ability to articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly. 4. Compile, plan and structure various forms of business writing in a professional manner. 5. Write various business documents appropriate for different business and employment situations.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	2	2	3	2	3	1	3	1	3
CO2	1	2	1	2	2	3	2	3	1	3	1	3
CO3	1	2	2	2	2	3	3	3	1	3	1	3
CO4	1	1	1	1	2	2	2	2	3	1	2	2
CO5	2	1	1	1	1	2	2	3	2	1	1	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	1	2	1	2	2	3	2	3	1	3	1	3

Subject Code	**PH-1181**	**Total Contact Hour**	
Semester	**1st / 2nd**	**Total Credit**	**1.5**
Subject Name	**PHYSICS LAB.**		
Pre-requisites	**None**		

LIST OF EXPERIMENTS

1. Determination of acceleration due to gravity by using Bar pendulum.
2. Determination of wave length of monochromatic light with the help of Newton's ring apparatus.
3. Determination of grating element of a diffraction grating using spectrometer.
4. Study of resonance using sonometer for unknown frequency.
5. Study of RLC Circuit.
6. Determination of surface tension of water by capillary rise method.
7. To draw the characteristics of a bipolar junction transistor.
8. To determine the rigidity modulus of the material of a wire by using Barton's apparatus.
9. To determine e/m ratio.
10. Magnetic field measurement from Helmholtz coil.

Course Outcomes	Upon completion of the subject the students will demonstrate the ability to: **CO1.** Express the idea of calculation of acceleration due to gravity at any place using the concept of oscillatory system and simple harmonic motion. **CO2.** Demonstrate the working and operational technique to calculate the mechanical properties of fluid and other materials. **CO3.** Evaluate the voltage, current, power and characteristics behaviour of the electronic devices. **CO4.** Understanding the rigidity concept of solid materials. **CO5.** Analyzing the electrical and magnetic field measurements and their applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	2	1	1	3	2	1	1
CO2	3	2	2	2	3	2	1	1	2	3	2	1
CO3	3	3	2	1	3	2	1	1	3	2	1	2
CO4	2	3	3	1	2	2	1	1	2	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Subject Code	**CS-1181**	**Total Contact Hour**	
Semester	**1st/2nd**	**Total Credit**	**1.5**
Subject Name	**PROGRAMMING LAB.**		
Pre-requisites	**None**		

LIST OF EXPERIMENTS

1	a) Write a program to print your Bio-data. b) Write a program in C to test the arithmetic operators. c) Write a program to find out the simple interest and compound interest with the given input data.
	a) Write a program to test the logical, bitwise, unary and ternary operators with the given

2	input data. b) Write a program to check an inputted year is leap year or not. c) Write a program to calculate the salary of an employee given his basic pay, DA, HRA and TA. Display the output in format of salary statement.
3	a) Write a program to enter the marks of a student in 4 subjects. Then calculate the total, Aggregate %, and display the grades obtained by the student. b) Write a program to enter a number from 1-7 and display the corresponding day of the week using switch case statement. c) Write a program using switch case that read 4 nos. and display a menu thatoffers 4 options: calculate total, calculate average, display the smallest, and the largest number.
4	Write a program to check a given number is palindrome or not. Write a program to generate prime numbers present between two given numbers. Write a program to print the following pyramid star pattern. 
5	a) Write a program that will accept an array, and find the largest number, smallest number, sum of the elements and average of the elements present in the array. b) Write program that will accept an array and sort the array in ascending order. Display both the unsorted and unsorted arrays. c) Write a program that will insert an element at a desired position of an array. Show the array before insertion and after insertion of the new element (Array, element and position will provided by the user)
6	a) Write a program to swap the value of two inputted variable using function. Show the initial value and value after swapping. b) Write a program to print the Fibonacci series using function. c) Write a program that will accept two matrices using function and multiply them using function and show the result using function.
7	a) Write a program to find the GCD among two given number using recursion. b) Write a program to accept student data in a structure and display the structure elements. c) Check a inputted string is palindrome or not using pointer.
8	a) Write a program to read and print an array of n numbers, then find out the smallest number and its position in the array. Perform all these operations using pointer and function. b) Write a program to implement realloc() and free(). c) Declare a pointer; allocate a block of memory to it using Dynamic Memory Allocation. Input a set of integers to the allocated memory block. The display the set of numbers.
9	1. Write a program to implement insertion and deletion of an element using linked list. 2. Write a program to implement Push and Pop operations in Stack. d) Write a program to implement insert and delete operations in Queue.
10	a) Write a program to implement Quick Sort algorithm using C. b) Write a program to search an element using Linear Search algorithm. e) Write a program to search an element using Binary Search algorithm.

Subject Code	EE-1181	Total Contact Hour	
Semester	1st / 2nd	Total Credit	1.5
Subject Name	ELECTRICAL ENGINEERING LAB.		
Pre-requisites	None		

LIST OF EXPERIMENTS

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, to study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules.
2. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
3. Measurement of the armature & field resistance of D.C. Machine by volt-amp method.
4. Starting and speed control of a D.C. shunt motor
5. Study of BH Curve of ferromagnetic core.
6. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excitedat different speeds and different excitation levels.
7. Calibration of a single-phase Energy Meter by direct loading.
8. Measurement of power & power factor of a single-phase circuit
9. Measurement of earth resistance and insulation resistance.
10. Verification of Thevenin's and Norton's theorem.

Course Outcomes	Upon completion of the subject the students will demonstrate the ability to: **CO1.** Express the safety rules as per ISS and symbols of different electrical components and the use of various electrical instruments in the laboratory. **CO2.** Demonstrate the working and operational characteristics of dc motor and dc generator. **CO3.** Evaluate the voltage, current, power and power factor of choke coil and studyBH curve of a ferromagnetic core. **CO4.** Measure armature and field resistance of DC machines, earth resistance and insulation resistance and demonstrate the internal structure of different machines. **CO5.** Analyze the connection and calibration of single phase energy meter.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	3	1	1	3	2	1	1
CO2	3	2	2	2	3	2	1	1	2	3	2	1
CO3	3	3	2	1	2	2	1	1	3	2	1	2
CO4	2	3	3	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	2	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Subject Code	HS-1181	Total Contact Hour	
Semester	1st / 2nd	Total Credit	1.5
Subject Name	COMMUNICATIVE ENGLISH AND REPORT WRITING LAB.		
Pre-requisites	None		
	The purpose of the English lab is to involve students to actively participate in language learning exercises and get more practice than the traditional classroom environment. The		

Course Objective	primary role of the lab is to create an environment where students feel comfortable speaking the language they are learning, and where they can get the help they need in their journey to learn English as a second language. The lab further focuses 1. To provide a platform to the students to develop their language skills. 2. To strengthen their professional skills and to improve fluency in spoken English, to practice correct pronunciation and neutralize their mother tongue influence. 3. To provide hands-on training in Speaking, Listening, reading and writing skills. 4. To improve the fluency of students in spoken English and neutralize their mother tongue influence.
LIST OF EXPERIMENTS	
Assignment I: Self-introduction **Assignment II:** Professional presentation **Assignment III:** Power-point presentation **Assignment IV:** Situational conversational practice/ Role play **Assignment V:** Review of a book/newspaper editorial/movie **Assignment VI:** Cover letter and CV **Assignment VII:** Listening practice **Assignment VIII:** Group discussion **Assignment IX:** Mock interview **Assignment X:** Reading practice	
Course Outcomes	At the end of this course students will demonstrate the ability to **CO1.** To acquire strategic competence to use both spoken and written language in a wide range of communication strategies. **CO2.** To maintain good linguistic competence- through accuracy in grammar, pronunciation and vocabulary. **CO3.** Speak English with proper pronunciation and intonation. **CO4.** Make effective oral presentations by interpreting and analyzing data, pictures and videos and participate in Group Discussion on general topics. **CO5.** Speak with clarity and confidence which in turn enhances their employability skills

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	1	2	3	2	2	2
CO2	1	1	2	1	1	1	1	3	3	3	2	2
CO3	2	1	1	1	1	1	1	2	3	2	1	2
CO4	1	1	1	2	1	1	1	3	3	3	2	2
CO5	1	1	1	1	1	1	1	3	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	1	1	1	1	1	1	1	3	3	3	2	2

Subject Code	EA-1181	Total Contact Hour	
Semester	1st / 2nd	Total Credit	0
Subject Name	Sports/Yoga/NCC/NSS		
Pre-requisites	None		

CO1	Develop physical fitness and maintain mental health, acquiring lifelong skills to lead a healthy lifestyle.
CO2	Cultivate a sense of leadership and the ability to work effectively in teams fostering leadership qualities, discipline, and the ability to take initiative in challenging situations.
CO3	Equipped with the skills to serve society by addressing community issues and demonstrate civic responsibility and contribute towards nation-building and social welfare.
CO4	Imbibe the importance of self-discipline, punctuality, and respect for diversity by instilling ethical values, integrity, and the understanding of one's responsibilities towards oneself and society.
CO5	To communicate effectively with their peers, instructors, and community members, building interpersonal skills that are essential for their professional and personal lives.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	3	3	3	3	1	2
CO2	1	1	1	1	1	3	3	3	3	3	1	1
CO3	1	1	1	1	1	3	3	3	3	3	2	2
CO4	1	1	1	1	1	3	3	3	3	3	2	2
CO5	1	1	1	1	1	3	3	3	3	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	1	1	1	1	3	3	3	3	3	2	2

SECOND YEAR

THIRD SEMESTER

Subject Code	**PE-1202**	**Total Contact Hour**	**30**
Semester	3rd	**Total Credit**	**3**
Subject Name	**Thermal & Fluids Engineering**		
Pre-requisites	**None**		
Course Objective	To obtain knowledge on the basic concepts of thermal and fluids engineering		
Module I	Basic Concepts: Thermodynamic systems and surrounding, state properties, processes and cycles. Thermodynamic equilibrium, heat and work transfer across boundaries, Quasi-static processes. Zeroth &First Law of Thermodynamics: First law for a closed system undergoing a cycle and undergoing a change of state. Internal energy as a system properties. Application of first law to different thermodynamic processes.		**[07]**
Module II	Second Law of Thermodynamics: Reversible and irreversible processes. Refrigerator and heat pump. Equivalence of Kelvin-Plank and Clausis statements, Carnot theorem and its efficiency. Inequality of Clasius and entropy concept. Change of entropy for various thermodynamic processes. Air Standard Cycle: Otto, diesel and dual cycles, Heat transfer – basic of conduction, convection and radiation.Heat transfer concepts & applications.		**[06]**
Module III	Introduction: Physical properties of fluids, Density, Specific weight, Specific volume, Specific gravity, Compressibility, Elasticity, Surface tension, Capillarity, Vapour pressure, Viscosity, Ideal and real fluids, Concept of shear stress, Newtonian and Non Newtonian Fluids.		**[06]**
Module IV	Fluid Statics: Pressure-Density-Height relationship, Manometers, Pressure on plane and curved surface, Centre of pressure, Buoyancy, Stability of immersed and floating bodies, Fluid masses subjected to uniform acceleration, Free and Forced vortex.		**[05]**
Module V	Fluid Dynamics: Basic Equations- equation of continuity, One-dimensional Euler's equations of motion and its integration to obtain Bernoulli's equation and Momentum equation. Dimensional Analysis and Principles of Model Testing: Dimensional homogeneity, Dimensional analysis, Rayleigh's method and Buckingham Theorem. Similarity laws and model studies. Distorted models.		**[06]**
Essential Reading	Engineering Thermodynamics by P. K. Nag, TMH Fluid Mechanics & Hydraulics Machines –By: Modi and Seth, Standard Book House, New Delhi		
Supplementary Reading	Thermodynamics, An Engineering Approach by Cengel and Boles. Publisher: McGrawHill Introduction to Fluid Mechanics by Fox & McDonald, Willey Publisher.		
Course Outcomes: At the end of the course, the student will able to:			
CO1	Demonstrate the basic concepts, zeroth and first law of thermodynamics.		
CO2	Demonstrate the second law of thermodynamics, air standard cycles and basic heat transfer.		
CO3	Identify importance of various fluid properties at rest and in motion and express the principles of continuity, momentum, and energy as applied to fluid motions.		
CO4	Demonstrate fluid statics principles on various surfaces.		
CO5	Apply dimensional analysis and model testing to predict physical parameters that influence the flow in fluid mechanics.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	2	1	2	1	3	1
CO2	3	3	3	3	2	3	2	2	1	2	2	3
CO3	3	3	3	3	1	2	3	2	1	2	1	2
CO4	3	3	3	3	2	3	2	3	2	3	2	3
CO5	3	3	3	3	3	2	2	3	2	1	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	3	2	2	2	2	2	2

Subject Code	**PE-1203**	**Total Contact Hour**	**30**
Semester	3rd	**Total Credit**	**3**
Subject Name	**Material Engineering & Metallurgy**		
Course Objective	To obtain domain knowledge on material characteristics		
Module I	Introduction to materials- Metal and alloys, ceramics, polymers and semiconducting materials—introduction and application as engineering materials. Defects in solids- Point, line and surface defects. Diffusion in solids. Deformation of metals- Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, Bauschinger's effect, work hardening, recovery, recrystallization and grain growth.		**[10]**
Module II	Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Isomorphous alloy system, Types of Nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps – eutectic reactions.		**[08]**
Module III	Transformation in solid state, allotropy, order-disorder transformation, eutectoid, peritectoid reaction and complex phase diagrams, relation between equilibrium diagrams and physical properties of alloys. Study of important binary phase diagrams Fe-Fe3C. Phase transformations in steels pearlitic, martensitic and bainitic transformations cooling curves. Isothermal transformation diagrams, transformations on continuous cooling.		**[12]**
Module IV	Heat treatment- Iron-carbon system. Annealing, normalizing, hardening, critical cooling rate, hardenability, age hardening, surface hardening, tempering.		**[05]**
Module V	High temperature materials, materials for cryogenic application, thermally insulating materials, smart materials, Steels: High Speed Steel, Stainless Steel and Tool Steels.		**[05]**
Essential Reading	Introduction to Physical Metallurgy – S.H. Avner, TMH. Material Science and Engineering- V.Raghavan, PHI.		
Supplementary Reading	Material Science and Engineering: An Introduction- W.D.Callister, Wiley. Physical Metallurgy - V. Raghavan, PHI.		
Course Outcomes: At the end of this course, students will able to			
CO1	Relate the processing-structure-property-performance of various materials.		
CO2	Interpret different equilibrium diagrams with various transformation phases.		
CO3	Make use of iron- carbon equilibrium diagram.		
CO4	Analyze heat treatments techniques and their effects in the engineering materials.		
CO5	Decide materials for various applications and beyond room temperature application.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	3	1	2	1	1	3
CO2	2	2	2	2	2	2	2	1	2	1	2	3
CO3	3	3	2	3	2	2	3	2	2	1	1	3
CO4	2	2	2	3	2	2	2	1	2	1	2	3
CO5	3	2	2	3	2	2	3	1	2	1	1	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	2	3	2	2	3	1	2	1	1	3

Subject Code	**PE-1204**	**Total Contact Hour**	**30**
Semester	3rd	**Total Credit**	**3**
Subject Name	**Mechanics of Materials**		
Pre-requisites	**Engineering Mechanics**		
Course Objective	To provide basic knowledge in mechanics of materials to enable the students to solve real engineering problems and design engineering systemswith some specific materials under different kinds of loadings.		
Module I	Simple Stress and Strain: Stress, strain, elastic constants, and their relationship; temperature stresses, statically indeterminate problems Compound Stress and Strain: Material subjected to biaxial state of stress, Principal Planes, Principal stress, Graphical solution (Mohr's stress circle), Strain measurement and analysis, Principal stresses from principal strains		**[10]**
Module II	Shear force and bending moment: Statically determinate beams, Relationship between bending moment and shear force, shear force and bending moment diagrams for statically determinate beams.		**[05]**
Module III	Simple bending of beams: Theory of simple bending of initially straight beams, Bending of Composite or Flitched Beams, Shearing stress distribution in typical cross-sections of beams, Torsion: Torsion of solid and hollow circular shafts, combined bending, and torsion.		**[06]**
Module IV	Deflection of Beams: Slope and deflection of beams by double integration method and Macaulay's method. Thin cylinders: Cylindrical Vessel with Hemispherical Ends, Longitudinal or axial stress, Circumferential or hoop stress.		**[05]**
Module V	Buckling of columns: Euler's theory for initially straight columns with various end conditions. Theories of failure: Maximum Principal Stress Theory, Maximum Shear Stress Theory, Maximum Principal Strain Theory, Maximum Strain Energy Theory and Maximum Distortion Energy Theory.		**[04]**
Essential Reading	Strength of Materials- G.H.Ryder, Macmillan India Strength of Materials- S.S. Rattan, TMH Publications.		
Supplementary Reading	Mechanics of Materials- R.C. Hibbeler, Pearson. Mechanics of Materials-I- E.J. Hern; Paragaman. Strength of Materials by R. Subramanian, Oxford Univ. Press		
Course Outcomes: At the end of this course, students will demonstrate the ability to			
CO1	Understand and apply the concept of stress and strain tosolveengineering problems analytically and graphically.		

CO2	Construct shear force and bending moment diagrams for statically determinate beams.
CO3	Analyze problems of simple bending in initially straight beams/composite beams and determine the strength of circular solid and hollow shafts under combined bending, and torsion.
CO4	Calculate the slope and deflection of beams by double integration and Macaulay's method and interpret stresses in cylindrical vessel with hemispherical ends.
CO5	Determine the buckling load in columns with various end conditions and apply the concept of theories of elastic failure for structural design under combined conditions of applied stress.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	3	1	2	3
CO2	3	2	3	2	2	1	1	1	1	2	2	2
CO3	3	3	3	3	3	1	2	1	2	1	2	3
CO4	3	3	2	3	2	2	1	2	2	1	3	2
CO5	3	3	3	2	2	1	1	1	2	1	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	1	2	1	2	3

Subject Code:	**CS-1202**	**Total Contact Hour**	**30**
Semester:		**Total Credit**	
Subject Name:	**Programming in Python**		
Course Objectives:	1: Introduction to Python Language and its features. 2: To understand the concept of Python Program using sequence data and Control statements. 3: To be able to understand and create User Defined Function. 4: To understand the concept of OOPs and its implementation. 5: To understand the concept of strings and file handling		
Module I	**Beginning Python Basics** Introduction to Python Features of Python, Application of Python Data Types, Keywords, Identifiers, Literals, Constants. Python Indentation. Operators and expressions. Naming Conventions with examples, Managing Input and Output, Concept of Indentation. Conditional statements, Looping statements, break and continue, pass & return statements, Nesting of loops.		**6**
Module II	**Modules:** Built-in Modules, Import statement, Packages, Date and Time Modules. Array and its operations, Handling Strings and Characters, List: slicing, bound, cloning, nested list, list and methods, Adding Element: append, extend, count, index and insert). Mutability: Sort, reverse, remove, clear and pop. Map, Filter		**8**
Module III	Tuple and methods, Sets and methods, Dictionary: Basic operation, iterator and methods. **Function:** Introduction to Functions, passing arguments, Anonymous functions (Lambda Function), Recursive Functions.		**6**
Module IV	**Object Oriented Programming:** Classes and Objects, Class methods. Encapsulation, Data Abstraction, Constructor, Destructor and Inheritance. **Exception Handling:** Handling Exceptions: try-except, try-finally		**6**

Module V	**Strings and Regular Expressions:**Methods of String Objects, Escape Sequence, Iterating Strings, String Module, String Formatting, Regular Expressions: Re-Module **File Handling:** Introduction to File Handling, File Operations, Directories.	**4**
Essential Reading	1. Python Programming Python Programming for Beginners By By Adam Stewart 2. Python Cookbook By David Beazley and Brian K. Jones	
Supplementary Reading	1. Introduction to Python Programming By Gowrishankar S. Veena A 2.Python Programming: Using Problem Solving Approach, Oxford University Press by Reema Thareja 3.Python Programming University Press by Ch Satyanarayan, M Radhika, B N Jagadesh	
Course Outcomes:	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	2	2	3	1	2	3
CO2	3	3	3	3	2	1	2	2	3	1	2	3
CO3	3	3	2	3	2	1	2	2	3	1	2	3
CO4	2	2	3	3	2	1	1	1	2	1	1	3
CO5	3	3	2	2	2	2	2	1	1	2	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	3	2	1	2	2	3	1	2	3

Subject Code	**HS-1202**	**Total Contact Hour**	**30**
Semester	**3rd**	**Total Credit**	**3**
Subject Name	**Engineering Economics**		

Module-1:

Theory of Demand: Demand and Utility, Demand function and the factors determining demand, Law of Demand, Reasons for downward sloping demand curve, Exceptions to the law of demand. The market forces of Supply and Demand, Elasticity of demand and its application, Utility analysis: cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility

Module-2:

Indifference curve analysis of demand: Concepts, properties, Equilibrium of the consumer, Price Consumption Curve (PCC) and Income Consumption Curve, Decomposition of price effect into income effect and substitution effect, Revealed preference hypothesis, Individual choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann-Morgenstern method of constructing utility index, Friedman-Savage hypothesis, Markowitz hypothesis

Module-3

Production function: short run analysis, Total product, Average product and Marginal product, output elasticity of input, law of variable proportion, Long run production function: Isoquants and concepts of returns to scale, Optimum factor combinations, Homogeneous Production Function, Cobb–Douglas production

function, CES Production function, Cost Analysis: Concepts, Accounting cost, Fixed and variable cost, opportunity cost, Short run and long run cost curves, Relationships between average cost and marginal cost

Module-4

Market and its classifications, Perfect competition: Characteristics, Short run and long run equilibrium of firm under perfect competition. Monopoly market: Price and output determination. Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain's limit pricing model

Module-5

Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, cost effectiveness

Essential Reading	Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London Varian, H. R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York Salvatore, D. (2008). Microeconomics: theory and applications. Oxford University Press
Supplementary Reading	Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi Henderson, J. M. and R. E. Quant (2011). Microeconomic Theory: A Mathematical Approach, Indian Higher Education, New Delhi Intriligator, M. D., R. G. Bodkin and C. Hsiao(1995). Econometric Models, Techniques, and Applications, Pearson India, New Delhi
Course Outcomes	CO1: Utilize economics principles in consumption process CO2: Describe the utility measurement and measure the utility associated with risk CO3: Efficient use of resources in production and take decision regarding optimum output CO4: Describe market mechanism and analyse product market to take proper decisions CO5: Implement economic principles in company related decision making

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	2	2	3	2	3	2
CO2	1	1	1	1	1	2	2	3	2	2	2	2
CO3	1	1	1	1	1	3	2	3	2	3	3	2
CO4	1	1	1	1	1	2	2	3	2	2	3	2
CO5	1	1	1	1	1	3	2	3	2	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	1	1	1	1	3	2	3	2	2	3	2

Subject Code: PE-1281	**Thermal & Fluids Engineering Lab.**
LIST OF EXPERIMENTS	
1	Study of IC engines (cut model)
2	To draw the valve timing diagram of IC Engines.
3	Performance characteristics of multi-cylinder engine (Morse Test)
4	Study of power Transmission system.
5	Determination of metacentric height of a floating object.
6	Determination of flow rate using orifice meter/ Rota meter.

7	Validation of Bernoulli's Theorem.
8	Study of a hydraulic test rig.

COURSE OUTCOMESS: At the end of this course, students will demonstrate the ability to	
CO1	Show wear characteristics of various materials.
CO2	Interpret different principles and operations of IC engine.
CO3	Make use of power transmission system.
CO4	Analyze the methods to enhance the properties of the material from heat treatment process.
CO5	Test the structure-property relationships of various materials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	2	2	1	2	1	3	1	2	3
CO2	1	3	3	3	2	1	1	1	2	1	3	2
CO3	2	2	2	3	3	2	2	1	3	1	2	3
CO4	1	2	3	2	2	1	2	2	3	2	2	2
CO5	1	2	3	3	2	1	1	1	3	1	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	1	2	3	3	2	1	2	1	3	1	2	3

Subject Code: PE-1282	**Material Testing Lab.**
LIST OF EXPERIMENTS	
1	Determination of the tensile properties of a given sample.
2	Determination of the compressive strength of a given specimen.
3	To perform three point bend test on a given sample.
4	Ericson cupping test for three different specimens.
5	Effect of work hardening on tensile properties of metal.
6	Determination of hardness of the given specimen.
7	Fatigue test of a given specimen
8	Impact test on the given sample.

COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to

CO1 Evaluate the tensile properties of mild steel specimen.
CO2 Evaluate the flexural strength and modulus of a given material.
CO3 Evaluate the hardness and compressive strength of a given material.
CO4 Evaluate the fatigue strength of a given material
CO5 Evaluate the impact strength of a given material.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	3	1	1	2	2
CO2	3	3	3	3	2	1	1	3	1	2	2	2
CO3	3	3	2	3	2	1	1	2	2	1	2	1
CO4	2	3	3	3	2	1	1	3	1	1	3	2
CO5	3	3	2	3	1	1	1	3	1	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	3	1	1	2	2

Subject Code: PE-1283	Computer Aided Machine Drawing
LIST OF EXPERIMENTS	
1	Introduction to CAD
2	Interactive graphics for Generation of polyhedron, cylinder, sphere, cone etc.
3	3D viewing and transformation, hidden surface removal.
4	Generation of curves and surfaces; Geometric modelling
5	Preparation of product assembly details.
6	Aggregation for assembly.
COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to	
CO1 Describe the fundamentals of Computer Aided Design. CO2 Use interactive graphic for generation of basic features. CO3 Generate geometric modelling, curves and surfaces using the CAD software. CO4 Create Assemblies for different product. CO5 Apply Computer Aided Design to solve engineering problems.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	2	2	2	2	2
CO2	3	2	2	3	2	1	1	3	2	1	2	2
CO3	2	3	3	3	3	2	1	2	3	2	2	3
CO4	3	3	2	2	3	1	1	2	2	2	3	2
CO5	3	3	3	3	3	1	1	3	2	3	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	1	1	2	2	2	2	2

Subject Code: PE-1283		Computer Aided Machine Drawing
Experiment Details		
Sl. No.		
1	Program on basics of python Programming Language.	
2	Program on basic Data Structures in Python.	
3	Program on Conversion from on data type to another.	
4	Program on Functions in Python.	
5	Program using Object Oriented Programming in Python.	
6	Program using Inheritance in Python.	
7	Program using String in Python.	
8	Program using Regular expression in Python.	
9	Program using File Handling in Python.	
10	Program using basics of Pandas and Matplotlib module in Python.	
Course Outcomes:	CO1: Understand the Python Language and its features. CO2: Apply sequence data and control statements to solve problem CO3: Able to create user defined functions to solve problems. CO4: Analyze the concept of OOPs and its implementation. CO5: Create the python program using strings and files.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	2	2	2	2	2
CO2	3	2	2	3	2	1	1	3	2	1	2	2
CO3	2	3	3	3	3	2	1	2	3	2	2	3
CO4	3	3	2	2	3	1	1	2	2	2	3	2
CO5	3	3	3	3	3	1	1	3	2	3	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	1	1	2	2	2	2	2

FOURTH SEMESTER

Subject Code	**PE-1205**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Theory of Metal Cutting**		
Pre-requisites	**Materials Engineering & Metallurgy**		
Course Objective	To obtain domain knowledge on basic shapes of machine tools, mechanism of chip formation, force analysis in turning, thermodynamics of chip formation and tool wear criteria.		
Module I	Basic shapes of machine tools, Geometry of cutting tools: Classification of cutting tools, Wedge action, Function of different angles of cutting tools, tool point reference systems, tool nomenclatures in ASA, ORS systems, tool signature, Geometry of twist drill & slab milling cutter. Tool materials and their applications: Characteristics of tool materials, developments cutting tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, CBN, recommended cutting speeds for the above tools.		**[06]**
Module II	Orthogonal and oblique cutting, Mechanism of chip formation: Mode of failure under stress- fracture & yielding mechanism. Types of chips, Factors involved in chip formation, shear plane, determination of shear plane angle, Kronenberg's shear angle relation, effect of cutting variable on chip reduction coefficient, Chip formation in drilling and milling.		**[05]**
Module III	Mechanics of metal cutting: Forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Velocity relationship, Stress & shear strain in conventional shear plane, Power & Energy consumption in cutting process, Ernst & Merchant angle relationship, Lee & Shaffer principle. **Measurement of Cutting Forces:** Reasons for measuring cutting forces, **Dynamometers for Machine Tools**, Classification of cutting force dynamometers, Dynamometers for turning, drilling, and milling.		**[07]**
Module IV	Thermodynamics of chip formation: The shear plane temperature-interface temperature from dimensional analysis-Experimental determination of chip tool interface temperature. Cutting fluids: Theory of cutting fluid action at the chip tool interface, techniques for application of cutting fluids, types of cutting fluids, properties of cutting fluids, selection of cutting fluids, application of cutting fluids. Tool wear & Tool life: Mechanisms of tool wear, crater wear, flank wear, causes and mechanism of tool failure, Taylor's tool life equation, Machinability & machinability index, effect of process parameters on tool life and machinability. Vibration and chatter in machining**, Economics of Machining.**		**[06]**
Module V	Machine tools – Definition and classifications, Generation and machining principles. Setting and operations on machines (including major units and specifications) Lathe, Milling, Shaping, Slotting, Planing, Drilling, Boring, Broaching, Grinding (cylindrical, Surface, Centreless).		**[06]**
Essential Reading	Metal cutting Theory & Practice- A. Bhattacharya, C.B. Publisher Textbook of Production Engineering by Jain and Chitale. PHI Publication A course in workshop technology" Vol-II (Machine Tool)- B.S. Raghuwanshi. Dhanpat Rai & Co.		

Supplementary Reading	Fundamentals of Metals machining & machine Tools- Boothroyd-InternationalEdition Theory of Metal cutting- M.C. Shaw
Course Outcomes	At the end of the course, the student will able to:
CO1	Analyze and demonstrate the basics of metal cutting and machine tool operations.
CO2	Develop the theoretical derivation of equations for temperature, strain, force in metal cutting.
CO3	Summarize the theory of metal cutting and compute cutting forces involved from Merchant's circle.
CO4	Apply the various cooling-lubrication methods for controlling the cutting temperature.
CO5	Demonstrate the application of appropriate machining processes and conditions for different metals.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	2	2	3	2	2	3	3
CO2	3	3	3	2	2	3	2	3	2	2	2	3
CO3	3	3	3	3	2	2	1	2	2	2	3	2
CO4	3	3	2	3	3	2	1	3	2	2	3	3
CO5	3	3	3	3	2	2	2	3	2	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	2	2	3	2	2	3	3

Subject Code	**PE-1206**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Theory of Machines**		
Pre-requisites	**Engineering Mechanics**		
Course Objective	To obtain domain knowledge on various mechanism involved in a machine		
Module I	Mechanism: Basic Kinematic concepts and definitions, mechanism, link, kinematic pair, classification of kinematic pairs, degree of freedom, kinematic chain, binary ternary and quaternary joints and links, degrees of freedom for plane mechanism, Grubler's equation, inversion of mechanism, four bar chains and their inversions, single slider crank chain, double slider crank chain and their inversion.		**[08]**
Module II	Velocity and acceleration Analysis of plane mechanism: Velocity of a point on a link by relative velocity method and instantaneous center method. Acceleration of a point on a link. Acceleration in the slider crank mechanism.		**[05]**
Module III	Friction of a screw and nut, square threaded crew, V-threaded screw, pivot and collar bearings, friction circle, friction axis, friction clutches, transmission of power by single plate, multiple and cone clutches. Gear trains: simple train, compound train, reverted train, epicyclic train and their application.		**[07]**
Module IV	Toothed gears: Theory of shape and action of tooth properties methods of generation of standard Tooth profiles, Standard proportions, Interference and Under-cutting, methods of Eliminating Interference, Minimum numbers of teeth to avoid interference.		**[05]**

Module V	Governors: Centrifugal Governors-Watt and Porter Governors, Spring loaded Governor- Hartnell Governor, sensitiveness, stability, Isochronism, Hunting, Governor effort and power, curves of controlling force.	**[05]**

Essential Reading	Theory of machines – S. S. Ratan, Tata McGraw Hill. Mechanism and Machine Theory- Rao and Dukkipati, Wiley Eastern Ltd
Supplementary Reading	A Textbook of theory of machines (in S.I units) – R.S Khurmi & J.K. Gupta, S Chand Publication. Theory of Machines –Thomas Bevan, TMH.
Course Outcomes	At the end of the course, the student will able to:

CO1	Implement and design various types of linkage mechanisms for obtaining specific motion and analyze them for optimal functioning.
CO2	Analyze the velocity and acceleration of a plane mechanism.
CO3	Evaluate and estimate the power of screw and clutches.
CO4	Analyze and evaluate the speed ratios of gears and gear trains.
CO5	Analyze and evaluate the effort and power of governor.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	2	2	2	3	2	1
CO2	3	3	3	3	2	1	3	2	2	3	2	2
CO3	3	2	3	2	3	1	2	3	2	3	2	2
CO4	2	3	2	3	2	2	3	2	3	2	2	1
CO5	3	3	3	2	3	1	3	2	2	3	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	3	3	3	1	3	2	2	3	2	2

Subject Code	**PC-1207**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Inspection & Metrology**		
Pre-requisites	**None**		
Course Objective	To obtain domain knowledge on basics of metrology, comparators, surface measurements, gear measurement and non-destructive testing.		

Module I	Introduction to metrology: Definition, Need of Inspection, Process of measurement, Precision and accuracy, Errors in Measurement, Line standard, end standard. Limits, fits and tolerances: Limits, Tolerances, Terminology for Limits and Fits, Types of Fits, Allowances, Hole & shaft basis system, Interchangeability, selective assembly, Gauges and Gauge Design; Limit gauges; Snap, plug, ring, Taylor's principle. Wear allowance.	**[07]**
Module II	Comparators: Characteristics, Relative Advantages of various types of comparators; Mechanical, Optical, Pneumatic, Fluid displacement type Linear measurement: Rules, Callipers, Height gauges, Micrometers, Depth gauge, Dial indicator, slip gaugesAngular measurement: Sine bar, Sine center, angle gauges, Autocollimator. Form measurement: straightness, flatness, roundness, runout and cylindricity	**[07]**

Module III	Surface Measurements: Roughness and waviness, Surface texture, cut off length, RMS & CLA values, Surface roughness measurement by contact (using Taylor Hobson's Talysurf) and non-contact methods. Interferometry: Introduction, optical flat, Interferometers Type.	**[06]**
Module IV	Metrology of screw thread: Errors in threads, Measurement of element of threads, 2-wire &3- wire methods, best wire size. Gear Measurement: Gear Terminology, Measurement of error, Tooth Thickness Measurement; Gear tooth Caliper, Base Tangent Comparator, Constant Chord Method, Measurement using Rollers.	**[05]**
Module V	Non-destructive Testing- X-ray examination, radiography, Ultrasonic inspection, magnetic test, machine vision system-principle, application, Laser inspection.	**[05]**

Essential Reading	1. Engineering Metrology- R.K. Jain 2. Production Technology- P.C. Sharma
Supplementary Reading	1. Engineering Dimensional Metrology- Miller, Edward Arnold publications 2. Precision Engineering in Metrology- R.L. Murty, New Age Int.
Course Outcomes	At the end of this course, students will demonstrate the ability to:
CO1	Analyze the fundamental concepts in measurement methods and techniques.
CO2	Apply the uses of various gauges and comparators.
CO3	Implement the application of surface roughness measuring instruments in practical domain.
CO4	Incorporate appropriate method and instruments for inspection of various gear elements and thread elements.
CO5	Apply various non-destructive techniques for inspection.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	1	1	2	3	1	1	2
CO2	3	2	3	3	2	1	2	1	3	1	2	2
CO3	3	3	3	3	3	1	1	2	2	1	1	1
CO4	2	3	2	3	3	2	1	1	3	2	2	2
CO5	3	3	3	3	2	1	1	2	3	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	1	1	2	3	1	2	2

Subject Code	**PE-1208**	**Total Contact Hour**	**30**
Semester	4th	**Total Credit**	**3**
Subject Name	**Manufacturing Technology-I**		
Pre-requisites	**Basic Manufacturing Processes**		
Course Objective	To obtain knowledge on casting, welding, forming, powder metallurgy and coating processes and their applications.		
Module I	Fundamentals of metal casting: Overview of casting; heating & pouring; solidification & cooling. Metal casting processes: sand casting; other expandable mold casting processes; permanent mold casting processes; foundry practice; casting quality; metals for casting; product design consideration.		**[07]**

Module II	Fundamentals of welding: overview of welding technology; weld joint; physics of welding; features of fusion welded joint. Welding Processes: Arc welding; resistance welding; oxyfuel gas welding; fusion welding; solid state welding; weld quality; weldability; design consideration in welding. Brazing; soldering; adhesive bonding.	**[08]**
Module III	Fundamentals of metal forming: Overview of metal forming; material behavior in metal forming; temperature in metal forming; strain rate sensitivity; friction & lubrication in metal forming. Bulk deformation processes in metal working: Rolling; forging; open-die forging; impression-die forging; closed die forging;; Extrusion: types of extrusion; analysis of extrusion; dies and presses for extrusion; defects in extruded products. Wire and Bar drawing: analysis of wire drawing.	**[06]**
Module IV	Sheet metal working: cutting operation; bending operation; other sheet metal forming operation. Powder metallurgy: characterization of engineering powders; conventional pressing and sintering; alternative pressing and sintering techniques; materials and products for powder metallurgy. Shaping processes for polymer matrix composites: materials for PMCs; open mold processes; closed mold processes.	**[06]**
Module V	Coating and deposition processes: plating and related processes; conversion coatings; physical and chemical vapor deposition, organic coatings; proclaim enameling; thermal and mechanical coating processes.	**[03]**
Essential Reading	Fundamentals of modern manufacturing- Mikell P. Groover, Wiley India Ed. Manufacturing Technology (Vol. I)- P.N.Rao,TMH Welding Engineering and Technology- R.S. Parmar, Khanna publisher	
Supplementary Reading	Metallurgy of Welding Technology-D. Seferian, Chapman & Hall Principle of Metal Casting- P.L.Jain,TMH	
Course Outcomes	At the end of the course, the student will able to:	
CO1	Apply the knowledge to demonstrate casting processes and applications.	
CO2	Apply the knowledge to demonstrate welding processes and applications.	
CO3	Apply the knowledge to demonstrate forming processesand applications.	
CO4	Apply the knowledge to demonstrate powder metallurgy process and sheet metal operations.	
CO5	Apply the knowledge to demonstrate coating and deposition processes and applications.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1	1	3	2	2	1	2	2
CO2	3	3	3	3	2	1	2	2	3	1	2	2
CO3	3	3	3	3	1	2	2	2	2	1	2	2
CO4	3	3	3	3	1	1	2	2	2	1	2	2
CO5	3	3	3	3	2	1	1	2	1	1	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	1	2	2	2	1	2	2

Subject Code	CS-1202	Total Contact Hour	30
Semester	4th	Total Credit	3
Subject Name	Artificial Intelligence and Machine Learning		

Module I

Basics Concepts of Machine Learning: Brief Introduction to Machine Learning Concepts, Machine Learning Terminology, Machine Learning vs. Statistics, Types of Machine Learning Algorithms, Supervised Learning vs. Unsupervised Learning, Applications of Machine Learning.

Module II

Supervised Learning: Basic concepts of Supervised Learning, Decision tree induction, Evaluation of classifiers, Rule induction, Classification using association rules, Naïve Bayesian classification, Naïve Bayes for text classification, Support vector machines, Combining Classifiers Ensemble methods: Bagging and Boosting, Applications of Supervised Learning.

Module III

Unsupervised Learning: Clustering - K-means, Representation of clusters, Hierarchical clustering, Distance functions, Gaussian Mixture Model (GMM), Spectral Clustering, Expectation Maximization (EM), Principal Components Analysis (PCA).

Module IV

Introduction to Reinforcement Learning and Deep Learning: Reinforcement Learning Tasks and their types in reinforcement learning, Approaches to Reinforcement Learning and Examples, Machine Learning vs. Deep Learning, Introduction to Deep Learning and its applications.

Module V

Ensemble Methods and Evaluation of Machine Learning Models: Machine Learning for Time-Series Analysis, Ensemble Methods – Bagging, Boosting, Stacking, Evaluating Machine Learning Models - Training, Validation and Testing, K-fold Cross validation, Confusion Matrix, Evaluation Metrics, Hypothesis Testing.

Essential Reading	1. Tom Mitchell, Machine Learning. 2. Christopher Bishop, Pattern Recognition and Machine Learning.
Supplementary Reading	From the web (Online)
Course Outcomes	CO1: Understand the basics of machine learning and applications of machine learning. CO2: Understand a wide variety of supervised learning algorithms. CO3: Understand a wide variety of unsupervised learning algorithms. CO4: Understand the basic concepts of Reinforcement Learning and Deep Learning. CO5: Learn how to apply the machine learning algorithms on a dataset; perform evaluation of the algorithms and model selection.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	2	2	3	3	1
CO2	3	2	2	3	2	1	1	2	3	3	2	1
CO3	3	3	2	3	2	1	2	2	2	3	3	1
CO4	3	3	2	2	3	2	2	2	2	2	3	2
CO5	3	3	2	3	3	1	2	3	2	3	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	3	3	1	2	2	2	3	3	1

Subject Code	HS-1203	Total Contact Hour	30
Semester	4th	Total Credit	3
Subject Name	Organizational Behavior		

Module I (6 hours)

Fundamentals of OB: Learning objectives, Definition, scope and importance of OB, why to study OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), Behavioristic and social cognitive, Models of OB, New Challenges of OB Manager, Limitations of OB

Learning: Nature of learning, Determinant of learning, How learning occurs, Learning and OB

Case Study Analysis

Module II (6 hours)

Personality: Definition and importance of personality for performance, Nature and Determinants of personality, Theories of Personality, Personality Traits, Personality and OB

Perception: Meaning and concept of perception, Perceptual process, Importance of perception in OB

Motivation: Definition & Concept of Motive & Motivation, Theories of Motivation (Herzberg's Two Factor Model Theory, Maslow's Need Hierarchy, Aldefer's ERG theory)

Case Study Analysis

Module III (6 hours)

Communication: Importance, The Communication Process, Types of communication, Barriers to communication, Communication networks, Making communication effective

Groups in organization: Nature, Types of Groups, why do people join groups? Stages of Group Development, Group cohesiveness, Group decision making and managerial implication,

Developing Work Teams, Team Building, Effective team building

Leadership: Concept of Leadership, Styles of Leadership, Theories of leadership (Trait theory, Behavioral theory, Contingency theory), How to be an effective leader, Success stories of today's Global and Indian leaders.

Case Study Analysis

Module IV (6 hours)

Conflict: Nature of conflict, Sources of Conflict, Conflict resolutions, Stages of conflict episode, Conflict management technique

Transactional Analysis (TA): Meaning of TA, Ego states, Types of transactions, Life position

Case Study Analysis

Module V (6 hours)

Organizational Change: Why organizational change? Types of Organizational Change, planned change, Kurt Lewin's-Three step model, Resistance to Change, managing resistance to change. Organizational Culture: Meaning & definition, Types of culture, creating, sustaining and changing a culture, Concept of workplace spirituality.

International OB: Introduction to International business, Individual and group behavior in International organization, how culture influence International OB?

Case Study Analysis

Essential Reading	1. Stephen P. Robbins, Organizational Behaviour, Printice Hall of India, New Delhi, 2013 2. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, Bombay, 2018
Supplementary Reading	3. Nelson, D. L., and Quick, J. C. (2007)., Understanding Organizational Behaviour (3rded.)., Thompson South-Western Publication 4. Pareek, U. (2012), Understanding Organizational Behaviour (3rded.)., Oxford University Press.

Course Outcomes	
CO1	Explain the transition process of management thought from traditional period to modern approaches**.**
CO2	Transfer the different motivational theories and evaluate motivational strategies used in a variety of organizational settings.
CO3	Identify and analyze the factors affecting individual and group behavior and evaluate the appropriateness of various leadership styles.
CO4	Evaluate the appropriateness of various conflict management strategies used in organizations and develop strategies for resolving group conflict.
CO5	Explain how organizational change and culture affect working relationships within organizations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	3	2	3	2	3	1
CO2	1	1	1	1	1	2	3	3	3	2	2	2
CO3	1	1	1	1	2	3	2	3	2	2	3	1
CO4	1	1	1	2	1	3	2	3	3	2	3	2
CO5	1	1	1	1	1	3	3	2	3	2	3	2

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	1	1	1	1	3	3	3	3	2	3	2

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	3	3	2	3	2	3	1
CO2	1	1	1	1	1	2	3	3	3	2	2	2
CO3	1	1	1	1	2	3	2	3	2	2	3	1
CO4	1	1	1	2	1	3	2	3	3	2	3	2
CO5	1	1	1	1	1	3	3	2	3	2	3	2

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	1	1	1	1	3	3	3	3	2	3	2

Subject Code: PE-1284		**Subject Name: Metal Cutting Lab.**	
Pre-Requisite:	Theory of Metal Cutting	**Co-Requisite:**	None
Semester-4th			

LIST OF THE EXPERIMENTS

1	To observe the effect cutting speed, depth of cut and feed on surface finish of the machined component using roughness tester.
2	To study the chip formation mechanism and morphological study of chips in turning of steel at different cutting conditions.
3	Determination of cutting forces in turning using lathe tool dynamometer.
4	Determination of cutting forces in drilling using drilling tool dynamometer.
5	Study on tool wear, vibration and tool chatter during cutting.
6	To determine the cutting ratio and shear angle for metal cutting operation on lathe machine.

COURSE OUTCOMESS:	
CO1	Demonstrate understanding of metal cutting principles and mechanism.
CO2	Express the cutting tool geometry of single point and multipoint cutting tool.
CO3	Evaluate the different cutting forces in turning and drilling operations.
CO4	Analyze the tool vibration and chatter formation on machined surface during cutting operation.
CO5	Analyze the chip formation mechanism in various metal cutting operations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	2	3	2	2	2
CO2	3	2	3	3	3	2	3	2	3	2	3	1
CO3	3	2	3	2	3	2	3	2	2	2	3	2
CO4	3	3	2	3	3	1	2	2	3	2	2	2
CO5	3	2	3	3	3	2	3	2	2	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	2	3	2	3	2	3	2

Subject Code: PE1285	Subject Name: Machine Dynamics Lab

LIST OF EXPERIMENTS	
1.	Determination of gyroscopic couple.
2.	Performance characteristics of spring loaded governor.
3.	Determination of critical speed of rotating shaft.
4.	Experiment on static and dynamic balancing apparatus.
5.	Determination of natural frequency under damped and un-damped vibration.
6.	Study of interference and undercutting for gear.

COURSE OUTCOMES:	
CO1	Evaluate gyroscopic couple and critical speed of rotating shaft.
CO2	Analyze the performance characteristics of spring loaded governor.
CO3	Demonstrate and analyze the critical speed of rotating shaft.
CO4	Demonstrate the static and dynamic balancing apparatus and evaluate natural frequency under damped and un-damped vibration.
CO5	Construct and analyze the interference and undercutting for gear.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	3	2	3	3	2	2
CO2	3	3	3	2	2	2	3	3	3	3	2	2
CO3	3	3	3	3	2	1	3	2	2	2	2	1
CO4	3	2	2	3	1	1	2	2	3	3	2	2
CO5	2	3	3	3	2	1	3	2	2	3	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	3	2	3	3	2	2

Subject Code: PE-1286	Subject Name: Metrology Lab.

LIST OF EXPERIMENTS	
1	Study the TMM and to measure the pitch, depth and angle of the thread of a given specimen.
2	Measurement of Spur gear profile using Profile Projector.
3	Measurement of geometric features of metric thread using optical profile projector.
4	Calibration of slip gauge using sine bar.
5	Measurement of geometrical feature concentricity and flatness using CMM.
6	Comparison of surface roughness of specimens machined by conventional and non-conventional method.
7	Study gauge blocks or slip gauge to measure hole diameter and distance between their centers.

COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to	
CO1	Measure different dimensions of industrial components using various measuring instruments.
CO2	Use Profile Projector to determine geometrical parameters of gear and thread.
CO3	Identify the use of slip gauges and sine bar.
CO4	Comprehend the fundamentals of surface roughness measuring instruments.
CO5	Use CMM for measurement of flatness and parallelism of parts.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	2	1	2	1	1	2	1
CO2	3	1	2	2	1	2	1	1	2	1	1	1
CO3	3	1	2	3	1	2	1	2	2	1	2	1
CO4	3	1	1	3	1	2	1	1	2	1	2	1
CO5	3	1	1	3	1	2	1	2	1	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	1	2	3	1	2	1	2	2	1	2	1

Subject Code: PE-1287	Subject Name: Production Practice-I

LIST OF EXPERIMENTS	
1.	Job on Centre Lathe with taper & thread cutting.
2.	Study of Turret lathe.
3.	Gear cutting using index head on milling machine and Gear hobbing machine.
4.	Job on shaper, planner and slotting machine
5.	Study of surface grinding machine.
6.	Study of drilling machine.

COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to	
CO1	Work on centre lathe for taper & thread cutting.
CO2	Produce gears in milling machine and gear hobbing machine.
CO3	Create a plane surface using planner machine tool.
CO4	Modify surface by using surface grinding machine of a job.
CO5	Develop the confidence to design and produce small component for their project work and also to participate in various national and international technical competitions.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1	2	3	3	3	2	3	2
CO2	3	3	2	3	1	2	2	3	2	2	3	2
CO3	3	3	3	2	1	1	3	3	3	2	3	2
CO4	3	3	3	2	1	2	3	2	3	2	3	2
CO5	3	3	3	3	1	2	3	3	3	2	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	2	3	3	3	2	3	2

THIRD YEAR

FIFTH SEMESTER

Subject Code	**PE-1309**	**Total Contact Hour**	**30**
Semester	5^{TH}	**Total Credit**	**3**
Subject Name	**Design of Machine Elements**		
Pre-requisites	**Strength of Materials**		
Course Objective	To obtain knowledge on design process,design of fastening elements, design of shaft, keys & couplings, design of IC engine components.		
Module I	Morphology of design process, Basic requirements for machine, elements and machines, Design procedures, Engineering Materials, their properties and Manufacturing considerations in design.		**[07]**
Module II	Design of fastening elements: Riveted and welded joint for pressure vessels & structural joints, Design of bolted joint, cotter and knuckle joints.		**[08]**
Module III	Design of shaft, keys and couplings. Design of belt drives and pulleys.		**[06]**
Module IV	Design of springs: closed coil helical springs of circular section. Leaf springs. Theory of failure: Application to practical problems.		**[06]**
Module V	Design of IC engine components: Piston and Connecting rod		**[03]**
Essential Reading	Design of Machine Elements- V.B.Bhandari, TMH Design data hand book by S.Md.Jallaludeen, Anuradha Publications		
Supplementary Reading	Mechanical Engineering Design- Shigley, Mischke, Budnyas, McGraw Hill Machine Design- P.C.Sharma&D.K.Agarwal, S.K.Kataria and Sons Fundamentals of Machine Elements- Bernard Hamrock, CRC Press		
Course Outcomes	At the end of the course, the student will able to:		
CO1	Analyze and apply the domain knowledge in selection of materials, manufacturing consideration in design.		
CO2	Design riveted, welded, bolted, cotter and knuckle joints.		
CO3	Design shafts, keys, couplings, belt drives.		
CO4	Design close coiled helical springs, leaf springs and theories of failure application in machine components.		
CO5	Design cylinder, piston and connecting rod of IC engines.		

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	1	3	2	2	2	2
CO2	3	3	3	2	2	1	1	3	3	2	2	2
CO3	3	3	3	3	2	1	1	3	2	2	3	2
CO4	3	3	3	3	2	1	1	2	2	2	2	2
CO5	3	3	3	2	2	1	1	3	3	3	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	3	3	2	1	1	3	2	2	2	2

Subject Code	**PE-1310**	**Total Contact Hour**	**30**
Semester	5TH	**Total Credit**	**3**
Subject Name	**CAD/CAM**		
Pre-requisites	**Computer Aided Drawing**		
Course Objective	To obtain knowledge on various hardware and software that serve as component of CAD system, plotting, transformation techniques, geometric modelling and applications of computer in manufacturing and quality control.		
Module I	Fundamentals of CAD: Design process, Applications of computer for design, Creating the Manufacturing Database,		**[05]**
Module II	The Design workstation, Graphical Terminal, Operator input, output Devices, Plotters and other devices, Central Processing Unit, Memory types.		**[05]**
Module III	Transformation of geometry, 3D transformations, mathematics of projections, Geometric modelling: wire frame modelling, surface modelling and solid modelling, CSG, boundary representation.		**[07]**
Module IV	Numerical control: NC, NC modes, NC elements, NC machine tools, structure of CNC machine tools, features of Machining center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming.		**[10]**
Module V	Computer Aided Quality Control: Terminology in quality control, the computer in QC, contact inspection methods, noncontact inspection methods-optical, noncontact inspection methods no optical, and computer aided testing, integration of CAQC with CAD/CAM.		**[03]**
Essential Reading	CAD / CAM A Zimmers & P. Groover/PE/PHI CAD / CAM Theory and Practice / Ibrahim Zeid / TMH		
Supplementary Reading	Automation, Production systems & Computer integrated Manufacturing/ Groover/P.E CAD / CAM / CIM / Radhakrishnan and Subramanian / New Age Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson Computer Numerical Control Concepts and programming / Warren S Seames / Thomson		

Course Outcomes	At the end of the course, the student will able to:
CO1	Summarize the concepts and applications of CAD.
CO2	Understand the workstation, graphical terminal, CPU and memory types.
CO3	Elaborate fundamental of computers, transformations techniques, geometric modelling, surface modelling and solid modelling.
CO4	Understand the application of computer in Manufacturing, Differentiate between NC, CNC, DNC
CO5	Understand the computer aided quality control of CAD/CAM.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	1	1	1	1	3	2
CO2	3	2	2	3	2	1	1	1	1	2	2	1
CO3	3	3	2	3	3	1	2	1	1	1	3	2
CO4	3	2	2	3	3	1	1	1	2	1	2	2
CO5	3	3	2	2	3	2	1	1	1	1	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	2	3	3	1	1	1	1	1	3	2

Subject Code	**PE-1311**	**Total Contact Hour**	**30**
Semester	5^{TH}	**Total Credit**	**3**
Subject Name	**Tool Design**		
Pre-requisites	**Theory of metal cutting**		
Course Objective	To obtain knowledge on single point cutting tool, cutting processes, forging, sheet metal work and design of jigs & fixtures.		

Module I	Design of single point cutting tools, tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide tipped tools, High production cutting tools.	**[05]**
Module II	Cutting process in broaching, Geometric elements of broach teeth, Design of internal & external surface broach, Calculation of no. of teeth, Rigidity, Cutting force, Power. Form Tools; Method of determining the profile of circular and flat form tool, analytical and graphical method	**[05]**
Module III	Forging Design-Upset forging, forging allowances, Forging die design, Drop forging dies and auxiliary tools.	**[07]**
Module IV	Design for sheet metal works, Press working shearing action center of pressure, clearance cutting force, die block design, punch design, punch support, stop, pilot stripper, knockout, blanking & piercing die design, progressive & compound die design, drawing dies, metal flow, Blank diameter, Drawing force.	**[10]**
Module V	Jigs & fixture design; Location & clamping, principles of location clamping devices, materials for locating & lamping elements, Design principles, Design of drilling jig, Milling fixture.	**[03]**
Essential Reading	Fundamental of tool Design- ASTME, PHI. Metal cutting theory & cutting tool design- Arshinov. A Text Book of Production Engineering- P.C. Sharma, S. Chand & Co. Tool Engineering and Design by G R Nagpal. Khanna Publishers.	
Supplementary Reading	Tool Design- Donaldson, Le Cain &Goold, TMH. Fundamental of tool Engineering Design- Basu, Mukherjee & Mishra, Oxford & IBH.	

Course Outcomes	At the end of the course, the student will able to:
CO1	Interpret the theory of metal cutting, tool life and geometry of single and multipoint cutting tools
CO2	Construct the principles of locating and clamping devices for designing the jigs and fixtures.
CO3	Demonstrate to design the forging dies.
CO4	Select and design dies for piercing, blanking, bending and forming operations
CO5	Understand how to conduct machining economically

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	2	3	3	3	2	2	3	2	2
CO2	3	2	3	3	3	2	3	1	2	3	3	2
CO3	3	2	3	2	3	3	3	2	2	3	2	1
CO4	3	3	3	2	3	3	2	2	2	3	3	2
CO5	3	2	3	3	3	3	3	2	2	2	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	2	3	2	3	3	3	2	2	3	3	2

Subject Code	**PE-1312**	**Total Contact Hour**	**30**
Semester	5^{TH}	**Total Credit**	**3**
Subject Name	**Measurement & Instrumentation**		
Pre-requisites	**Inspection & Metrology**		
Course Objective	To obtain knowledge on single point cutting tool, cutting processes, forging, sheet metal work and design of jigs & fixtures.		
Module I	Basic detector-transducer elements: Electrical transducer, sliding Contact devices, Variable-inductance transducer elements. The differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducers, Electronic transducer element. Intermediate Modifying system: Electrical intermediate modifying devices, input circuitry. The simple current sensitive circuit, ballast circuit, voltage-dividing potentiometer circuit, voltage balancing potentiometer circuit, Resistance bridges. Terminating Devices and Methods; Introduction, CRO recording techniques.		**[06]**
Module II	Strain Measurement: The electrical resistance strain gauge. The metallic resistance strain gage, selection and installation factors for metallic strain gages, Circuitry, Metallic strain gage, the strain gage ballast circuit, the strain gage bridge circuit, Temperature compensation.		**[06]**
Module III	Measurement of Pressure: Pressure measuring systems, Pressure measuring transducers, Gravitation transducers, Elastic transducers, Elastic diaphragms, Secondary transducers used with diaphragms, Strain gage pressure cells, Measurement of high pressures. Measurement of low pressures, Dynamic characteristic of pressure measuring systems, Various calibration methods.		**[06]**
Module IV	Temperature Measurement: Use of bimetals pressure thermometers. Thermocouples, Pyrometry. Calibration of temperature measuring devices. Vibration and shock: Measurement and test methods – Vibrometers and accelerometers, Elementary vibrometers and vibration detectors, Elementary accelerometers, the seismic instrument.		**[06]**
Module V	Description of open and closed loop control systems and their block diagrams. Use of Block diagrams and signal flow graph to find overall transfer function.1st and 2nd order systems and their response to step and sinusoidal input, Error analysis, static and dynamic error coefficients. Routh's stability criterion, Root-Locus method. Bode plot and Nyquist plot, Gain margin and phase margin.		**[06]**
Essential Reading	Mechanical Measurements- T.G. Beckwith & N. Lewis Buck, Oxford and IBH. Modern Control Engineering- K.K. Ogata, PHI.		
Supplementary Reading	Instrumentation, Measurement and Analysis- B. C. Nakra, TMH. Control Systems Engineering- I. J. Nagrath and M. Gopal, New Age international.		
Course Outcomes	At the end of the course, the student will able to:		
CO1	Demonstrate basic detectors and transducers.		
CO2	Describe various techniques for strain measurement.		
CO3	Illustrate various methods for pressure measurement.		
CO4	Describe various techniques for temperature, vibration and shock measurements.		
CO5	Demonstrate open and closed loop control systems, stability besides gain and phase margins.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	3	3	1	2	2
CO2	3	3	3	3	3	1	1	3	3	2	2	2
CO3	3	3	3	3	3	1	1	3	3	1	2	3
CO4	3	3	3	3	3	2	2	3	3	1	2	2
CO5	3	3	3	3	3	1	1	3	3	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	3	3	3	3	3	2	1	3	3	1	2	2

Subject Code	**PE-1312**	**Total Contact Hour**	**30**
Semester	5^{TH}	**Total Credit**	**3**
Subject Name	**Advanced Casting and Welding**		
Pre-requisites	**Production Technology-I**		
Course Objective	To obtain knowledge on casting processes, welding, solidification, advanced welding processes, casting defects.		
Module I	Casting processes: Classification, Metal mould casting processes, principles of melting practice-fluxing- degasification and inoculation- types of furnaces-Crucibles, Cupola, Oil fired furnaces – Electric arc and induction furnaces – Melting practice of cast iron, SG iron, steel, aluminium and copper alloys.Advanced casting processes, investment casting, Rheocasting, continuous casting process, centrifugal casting process. Evaporative pattern casting-ceramic mould casting –electromagnetic moulding-squeeze casting –-shell moulding		**[06]**
Module II	Physics of welding arc, characteristics of arc, modes of metal transfer, welding fluxes, electrode coating, classification of electrode, characteristics of welding power source, pulsed and inverter type power source, power source for resistance welding, weldability, weldability tests, Weldability of cast iron, Plain carbon steel, Determination of preheating temperature, Stainless steel, use of Scheffler' s diagram. Heat flow in welding, significance, theory of heat flow, cooling rate determination, selection of welding parameters based on heat flow analysis, residual stress and its measurement, types and control of distortion.		**[06]**
Module III	Technology of Selected casting Processes: Clay bonded, synthetic resin bonded, inorganic material bonded mould and core making, sand additives, mould coating, Solidification of pure metals and alloys-shrinkage in cast metals-design of sprue, runner, gate and risers-problems in design and manufacture of thin and unequal sections designing for directional solidification, minimum distortion and for overall economy- design problems of L, T, V, X and Y junctions.		**[06]**
Module IV	Advanced welding processes; PAW-electron beam welding-laser beam welding-friction welding-ultrasonic welding – diffusion welding-high velocity oxy fuel processes. Design of welded components symbolic representation of welds on drawings- welding classes-residual stresses in welds weld distortions-design consideration-strength consideration of welded joints-analysis of statistically loaded welded joints-welded structures subjected to fatigue loads.		**[06]**
Module V	Casting defects, inspection, diagnosis and rectification, Cleaning and inspection		**[06]**

	of castings – Casting defect and remedies – foundry automations-moulding machines-Automation of sand plant, moulding and fettling sections of foundry-Dust and fume control- energy and waste management in foundries, quality assurance in welding, effects of welding fumes on environment.Welding defects – causes and remedies – Non Destructive tests – weldingmechanization and automation in foundries arc welding using robots-weld positioner and manipulators –weld seam tracking-vision system-arc sensing.	
Essential Reading	Principle of Metal Casting- Heine, R.W. Loper ,C. Philip and C.R.Rosenthal, McGraw Hill. Manufacturing Technology- P.N.Rao,TMH Welding Engineering and Technology- R.S. ParmarKhanna publisher	
Supplementary Reading	Metallurgy of Welding Technology-D. Seferian, Chapman & Hall Welding and Welding Technology- R.Little, TMH. Principle of Metal Casting- P.L.Jain,TMH	
Course Outcomes	At the end of the course, the student will able to:	
CO1	Apply the knowledge to demonstrate advanced casting processes with appropriate furnace selection.	
CO2	Analyze the thermal, metallurgical aspects during casting / weld solidification.	
CO3	Design the gating system and riser to achieve sound casting.	
CO4	Evaluate welding process behavior for advanced welding methods.	
CO5	Recognize casting and welding induced defects using NDT techniques.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1	1	3	2	2	1	2	2
CO2	3	3	3	3	2	1	2	2	3	1	2	2
CO3	3	3	3	3	1	2	2	2	2	1	2	2
CO4	3	3	3	3	1	1	2	2	2	1	2	2
CO5	3	3	3	3	2	1	1	2	1	1	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	1	2	2	2	1	2	2

Subject Code	**PE-1314**	**Total Contact Hour**	**30**
Semester	**5th**	**Total Credit**	**3**
Subject Name	**Mechatronics**		
Pre-requisites	Theory of Machine, Manufacturing Science, Basic Electronics, Mathematics		
Course Objective	To obtain knowledge on mechatronics systems design and characteristics of sensors and actuators, application of sensors, microcontroller and PLCs.		
Module I	Introduction: Introduction to Mechatronics: Mechatronic system, measurement systems, Introduction to Mechanical, Electrical, Fluid and Thermal systems, Rotational and Transnational systems, Electro-Mechanical, Hydraulic- Mechanical systems.		**[10]**
Module II	Sensors: Desirable features, Displacement, position and proximity sensors, Velocity, motion and Force sensors, Time of flight sensors, Binary force sensor, temperature and Pressure measurement, Sensor selection.		**[05]**

Module III	Actuation Systems: Actuation Systems, Pneumatic and Hydraulic systems, Directional control valves, Rotary actuator, Mechanical actuation systems- Mechanical Systems, Electrical Actuation Systems- Electrical Systems, Relays and Solenoids, DC brushed motors, DC brushless motors, DC servo motors, Stepper Motors. Drive selection.	**[06]**
Module IV	Microcontrollers: 8051 Microcontroller, Microprocessor structure, Digital Interfacing, Analog Interfacing, Applications Programming- Assembly/ C (LED Blinking, Controlling a stepper motor).	**[05]**
Module V	Interfacing: Interfacing microcontrollers with general purpose three-state transistors, interfacing relays, Interfacing solenoids, Interfacing stepper motor, Interfacing with sensors, Interfacing with RS 232 and RS485.	**[04]**
Essential Reading	Mechatronics- W Bolton, Pearson Education. MEMS and Microsystems Design and Manufacture- Tai, Ran Hsu, TMH.	
Supplementary Reading	Mechatronics Principles and Applications- G.C.Onwubolu, Butterworth-Heinemann Foundations of MEMS- Chang Liu, Pearson International Edition. Fundamentals of Microfabrication- Madou, CRC Press.	
Course Outcomes	At the end of the course, the student will able to:	
CO1	Analyze the mechatronics system design and characteristics of sensors and actuators.	
CO2	Define the applications of Sensors.	
CO3	Recognize the applications of Actuation systems.	
CO4	Design 8051 Microcontroller and Programmable Logic Controllers.	
CO5	Analyze the Mechatronics systems by interfacing transistors, sensors, and motors.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	2	1	2	2	1	1	2	2
CO2	3	2	3	3	3	1	1	3	1	2	3	3
CO3	3	3	3	2	2	2	1	3	1	1	3	2
CO4	3	3	2	3	2	2	2	2	1	1	2	2
CO5	2	3	3	3	3	1	1	3	2	1	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	3	1	1	2	2

Subject Code	**PE-1315**	**Total Contact Hour**	**30**
Semester	5TH	**Total Credit**	**3**
Subject Name	**Maintenance Engineering & Management**		
Pre-requisites			
Course Objective	To obtain knowledge on various maintenance systems, planning and scheduling of maintenance, systems operation and documentation and network techniques.		
Module I	Importance of maintenance, Objectives of maintenance, Types of maintenance, Maintenance systems, Planned and unplanned maintenance, Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance systems, Design-out maintenance, Selection of maintenance systems.		**[06]**

Module II	Maintenance planning and scheduling, establishing a maintenance plan, Safety precautions – Characteristics of items to be maintained, Classification of items, Maintenance procedure, Guidelines for matching procedures to items.	**[06]**
Module III	Maintenance organization, Resource characteristics, Resources structure, Maintenance control, Administrative structure, Training of maintenance personnel.	**[06]**
Module IV	System operations and documentation, documenting maintenance operations, Record keeping, Data collection and analysis, Failure statistics, Planning and scheduling plant shutdowns, Depreciation and Machine Life, Replacement policies, Spares and types of spares, spares planning.	**[06]**
Module V	Network techniques in maintenance activities, Evaluation of maintenance performance, Total productive maintenance – development and scope, Basic systems of TPM, Procedures and steps. Productivity circles as a part of TQM, benefits of TPM.	**[06]**
Essential Reading	Maintenance Planning and Control- A. Kelly, East West Press.	
	Maintenance Engineering and Management-R. C. Mishra, K. Pathak, PHI Learning Pvt. Ltd.	
Supplementary Reading	Managing Maintenance Resources- A. Kelly, Butterworth-Heinemann.	
	Handbook of Maintenance Management- Levitt Joel, Industrial Press.	

Course Outcomes: At the end of the course, the student will able to:

CO1	Express the basic objectives of maintenance and enumerate the selection of maintenance systems for diverse industries.
CO2	Establishing a maintenance plan and define the characteristics of diverse items to be maintained.
CO3	Develop maintenance organizational structure and compile the documentation and record keeping of maintenance operations.
CO4	Organize spare planning and demonstrate the scheduling plant shut downs.
CO5	Evaluate maintenance performance and explain basic systems of TPM.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	1	2	3	2	2	2	2	2	2
CO2	1	1	3	1	2	2	2	2	2	2	2	1
CO3	1	1	3	1	1	3	2	2	1	2	1	2
CO4	3	1	2	1	2	2	2	2	2	2	2	2
CO5	3	1	2	1	2	3	2	2	1	2	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	1	3	1	2	3	2	2	2	2	2	2

Subject Code: PE-1381	**Machine Design Sessional**
Assignments (Any Five)	
	Design of Components with application to theories of failure Design and drawing of riveted joint Design and drawing of cotter joint

	Design and drawing of knuckle joint Design of shafts subjected to combined loading Design and drawing of flange coupling Design of connecting rod Design of piston
TEXT BOOK(S):	
1	Design data hand book by S.Md. Jalaludeen, Anuradha Publications
2	Design Data Hand Book by K. Mahadevan and K. Balaveer Reddy, CBS Publishers
COURSE OUTCOMESS: At the end of this course, students will have ability to	
CO1	Evaluate dimensions of a machine component subjected to complex stresses using Theories of failure
CO2	Design riveted joint for boiler drums and to find diameter of rivet for lozenge joint
CO3	Design for a cotter and knuckle joint subjected to axial load
CO4	Design for shafts and couplings (rigid & flexible) subjected to various loads
CO5	Design for connecting rod and piston of an IC engine

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	3	2	1	2	2
CO2	3	3	3	3	2	1	1	2	3	1	2	2
CO3	3	3	3	2	3	1	1	3	3	1	1	1
CO4	3	3	2	3	2	1	1	3	3	1	2	2
CO5	3	3	3	2	2	1	1	3	3	1	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	3	3	1	2	2

Subject Code: PE-1382	**CAD/CAM LAB.**
LIST OF EXPERIMENTS	
a)	Introduction-design process and role of CAD and CAM
b)	Flange coupling assembly
c)	Universal coupling assembly.
d)	Screw jack assembly
e)	Stuffing box/ Plummer block assembly
f)	Manual part programming for step turning operation in CNC
g)	To study the gauge blocks or slip gauge to measure the diameter of holes and distance between their centers.
h)	Nc code generation for step turning and facing operation
i)	Manual part programming for drilling operation
10.	Nc code generation for drilling operation
COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to	
CO1	Understand and interpret machine manufacturing drawings.
CO2	Develop 2D and 3D models using high end modeling software's.
CO3	Apply engineering drawing standards as per BIS conventions.
CO4	Understand the CNC control in modern manufacturing system.
CO5	Prepare CNC part programming and perform manufacturing.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	1	1	1	1	1	3	2
CO2	3	3	3	1	3	1	1	1	2	1	3	2
CO3	3	2	3	1	2	1	1	2	2	3	1	3
CO4	3	2	3	3	2	1	1	2	2	1	1	3
CO5	3	2	3	3	1	1	2	2	1	1	1	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	2	2	1	1	2	2	2	2	3

Subject Code: PE-1383			**Tool Design Sessional**
Pre-Requisite:	Theory of Metal Cutting	**Co-Requisite:**	Tool Design
LIST OF THE EXPERIMENTS			
1	Determination of tool geometry in ASA, ORS and NRS.		
2	Design of single point cutting tool.		
3	Design of form tool.		
4	Design of internal and surface broach tool.		
5	Design of progressive and compound die for sheet metal.		
6	Design for Jig for 2D and 3D objects.		
COURSE OUTCOMESS:			
CO1	Able to identify and design the cutting tool geometry of single point cutting tool, broach tool and form tool for industrial use.		
CO2	Identify press tool requirements to build concepts pertaining to design of press tools		
CO3	Prepare working drawings and setup for economic production of sheet metal components		
CO4	Demonstrate construction of drill jig and design assembly of jigs and fixtures on simple workpiece		
CO5	Select proper material for the design of the tool and dies and to design of those as per the requirements.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	2	2	1	2	2
CO2	3	3	3	3	3	1	2	2	3	1	2	1
CO3	3	3	3	2	2	1	1	3	3	1	1	2
CO4	3	3	2	3	2	2	1	2	3	1	2	2
CO5	3	3	2	3	2	1	1	2	3	1	1	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	2	3	1	2	2

SIXTH SEMESTER

Subject Code	**PE-1316**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Theory of Metal Forming**		
Pre-requisites	**Materials Engineering & Metallurgy, Strength of Materials**		
Course Objective	To obtain knowledge on casting processes, welding, solidification, advanced welding processes, casting defects.		
Module I	Review of two dimensional stress and strain, state of stress in three dimensions, Stress tensor, Invariants, Mohr's circle for 3-dimensional state of stress, strain at a point- Mohr's circle for strain, Hydrostatic & Deviatory components of stress, Elastic stress-strain relations.		**[06]**
Module II	Elements of theory of plasticity; Flow curve, True stress & true strain, Yield criteria for ductile metals, Von Misses & Teresa yield criteria, combined stress tests. The yield locus, Anisotropy in yielding, Yield surface, levy-Misses, PrandtlReuss Stress-Strain relation.		**[07]**
Module III	Analysis of deformation processes- Method based on homogeneous compression slip line field theory- Geiringer's equation, Haneky's theorem, hodograph for slip line field, Upper bounds and lower bounds, Slab method of analysis.		**[05]**
Module IV	Classification of forming processes variables in metal forming. Hot working, Cold working, Flow stress determination, Strain rate effect, Friction and lubrication, Deformation zone geometry, Workability, Residual stress.		**[06]**
Module V	Analysis of metal forming processes (only limited portion), forging: Load calculation in plane strain forging, rolling: Forces & geometrical relationship in rolling, Rolling load and torque in cold rolling, Von-Karman work equation.		**[06]**
Essential Reading	Mechanical Metallurgy: By- Dieter, McGraw Hill Book Co.		
	Plasticity- Chakraborty- McGraw Hill.		
Supplementary Reading	Engineering Plasticity: BY- Johson& Mellor, Van Nostrand.		
	Metal working –Avitzur, McGraw Hill		

Course Outcomes: At the end of the course, the student will able to:

CO1	Recall the state of stress and strain at a point in 3D, stress tensors and invariants.
CO2	Demonstrate the theory of plasticity such as flow curve, yield criterions etc.
CO3	Select the different methods for the analysis of deformation process.
CO4	Analyze the effects of temperature, strain rate, forces and lubrication on metal forming process.
CO5	Determine the load requirement in forging and cold rolling process.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	1	1	1	1	1	3	3
CO2	3	2	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	1	1	1	1	1	1	2	3
CO4	2	3	3	2	1	1	1	1	1	1	3	2
CO5	3	3	3	3	1	1	1	1	1	1	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	1	1	1	1	1	3	3

Subject Code	PE-1317	Total Contact Hour	30
Semester	6^{TH}	Total Credit	3
Subject Name	Production Planning & Control		
Course Objective	To obtain knowledge on operations research, sensitivity analysis, assignment problems, sequencing problems and project management.		
Module I	Operations Research: Meaning, significance and scope; History of OR, applications of OR; OR Models., Linear Programming Problems (LPP): introduction, problem formulation, graphical solutions. LPP-simplex method, Big M method, unconstrained variables, sensitivity analysis, Duality.		[06]
Module II	Sensitivity Analysis, Transportation Problems: Introduction, transportation model, north west corner method (NWCM), row and column minima (LCET), VAM, optimality test-stepping stone, and Modi method. Traveling Salesperson Problem.		[06]
Module III	Assignment Problems: Introduction, Hungarian method. Typical assignment problems like optimal assignment of crews and travelling salesman problem. Game Theory: Introduction, two persons zero sum games, pure strategies, saddle point, mixed strategies, Dominance Method.		[06]
Module IV	Sequencing Problems: Introduction, processing jobs through two machines, three machines. Replacement Theory, Queuing Theory: concept, waiting line process, single server queuing model (M/M/1) only.		[06]
Module V	Project management: Project management through PERT/CPM. Network construction, CPM, Network Calculation, crashing of project network, project scheduling with limited resources, line of balance.		[06]
Essential Reading	KantiSwarup, P.K Gupta &Manmohan, Operations Research, Sultan Chand, Publications, New Delhi.		
	H. A. Taha – Operations Research, Prentice Hall of India, 2007.		
Supplementary Reading	Operation Research by S D Sharma		
	Operation Research, Phillips, Rabindran and Solberg, John Wiley & Sons		
	Ronald R. Rardin - Optimization in Operations Research, Vol. 166, New Jersey: Prentice Hall, 1998		
Course Outcomes: At the end of the course, the student will able to:			
CO1	Implement different operation research problem formulation techniques to solve engineering problems using LP.		
CO2	Formulate and solve transportation and Traveling Salesperson Problem.		
CO3	Formulate and solve Assignment Problems.		
CO4	Evaluate sequencing and queuing problems.		
CO5	Construct PERT/CPM network and organize project management.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	3	-	2	1	3	2	2
CO2	2	3	2	3	3	3	-	2	1	3	3	2
CO3	2	3	2	3	3	3	-	2	1	3	3	2
CO4	2	3	2	3	3	3	-	2	1	3	3	2
CO5	2	3	2	3	3	3	-	2	1	3	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	2	3	3	3	-	2	1	3	3	2

Subject Code	PE-1318	Total Contact Hour	30
Semester	6^{TH}	Total Credit	3
Subject Name	**Fluid Mechanics & Fluid Power Engineering**		
Course Objective	To obtain knowledge on fluid statistics, dynamics, dimensional analysis, drag & lift, hydraulic turbines, centrifugal pump.		
Module I	Introduction: Physical properties of fluids, Density, Specific weight, Specific volume, Specific gravity, Compressibility, Elasticity, Surface tension, Capillarity, Vapour pressure, Viscosity, Ideal and real fluids, Concept of shear stress, Newtonian and Non Newtonian Fluids. Fluid Statics: Pressure-Density-Height relationship, Manometers, Pressure on plane and curved surface, Centre of pressure, Buoyancy, Stability of immersed and floating bodies, Fluid masses subjected to uniform acceleration, Free and Forced vortex.		**[06]**
Module II	Fluid Dynamics: Basic Equations- equation of continuity, One-dimensional Euler's equations of motion and its integration to obtain Bernoulli's equation and Momentum equation. Dimensional Analysis and Principles of Model Testing: Dimensional homogeneity, Dimensional analysis, Rayleigh's method and Buckingham Theorem. Similarity laws and model studies. Distorted models.		**[06]**
Module III	Drag and lift: Drag and lift coefficient, pressure drag and friction drag on stream lined body and bluff body. Boundary layer separation & its control. Drag over flat plate. Profile drag. Drag characteristics of sphere, cylinder and disc.Circulation and lift on a circular cylinder, Magnus effect. Circulation and lift on an Airfoil.		**[06]**
Module IV	Hydraulic Turbines: Classification of turbines, Different heads and efficiencies of turbines, Study of Pelton, Francis and Kaplan turbines, Specific speed and unit quantities, performance of turbines, Governing of turbines, Cavitation in reaction turbines, Principles of similarity applied to turbines.		**[06]**
Module V	Centrifugal Pump: Principle, classification, pressure changes in a pump.Velocity vector diagrams and work done, minimum speed of pump to deliver liquid, multistage pumps. Similarity Relations and specific speed. Reciprocating pump: Principle of working, slip, work done, effect of acceleration and frictional resistances, separation, air vessels.		**[06]**
Essential Reading	Fluid Mechanics & Hydraulics Machines –By: Modi and Seth, Standard Book House, New Delhi		
	Fluid Mechanics & Hydraulic Machines- By Dr. R. K. BansalLaxmi Pub. (p) Ltd.)		
	Fluid Mechanics & Fluid Machines – By S. K. Som, G. Biswas& S. Chakraborty, TMH		
Supplementary Reading	Introduction to Fluid Mechanics by Fox & McDonald, Willey Publisher.		
	Fluid Mechanics by F.M White, McGraw Hill Publisher		
	Fluid mechanics & hydraulic machines by Subramanya, TMH		

Course Outcomes: At the end of the course, the student will able to:

CO1	Identify importance of various fluid properties at rest and in motion and express the principles of continuity, momentum, and energy as applied to fluid motions.
CO2	Apply dimensional analysis and model testing to predict physical parameters that influence the flow in fluid mechanics.
CO3	Analyze concepts of drag and lift besides details of boundary layer separation.
CO4	Demonstrate working principles of various types of hydraulic turbines, pumps and its applications.
CO5	Evaluate the performance characteristics of hydraulic turbines and pumps.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	1	1	1	2	2
CO2	3	3	2	3	2	1	1	1	1	1	1	2
CO3	3	3	3	3	2	1	1	1	1	1	2	2
CO4	3	3	3	2	2	1	1	1	1	1	1	2
CO5	3	3	2	3	2	1	1	1	1	1	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	1	1	1	2	2

Subject Code	**PE-1319**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Manufacturing & Design of Composites**		
Course Objective	To obtain knowledge on different types of composites, processing of FRP composites, micro & macro-mechanical behavior of composites, analysis of laminated composites.		
Module I	Introduction to composite materials, Matrix material, Reinforcement and interfaces, Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, relative merits and demerits, applications. Hybrid Composites, Nanocomposites, Properties and performance of composites, Applications.		**[06]**
Module II	Processing of FRP Composites: Contact Moulding process, compression moulding processes, Filament winding process		**[05]**
Module III	Micromechanical Analysis of Composite strength and stiffness: volume and weight fractions, longitudinal strength and stiffness, transverse modulus, inplane shear modulus, Poission's ratio		**[07]**
Module IV	Macro-mechanical Behaviour: Stress strain relations of anisotropic materials-Engineering constants for orthotropic and isotropic materials-Plano stress condition-Stress-strain relations for a lamina of arbitrary orientation-strength of an orthotropic lamina		**[07]**
Module V	Analysis of laminated composites: Laminates, stress-strain relations, equilibrium equations, laminate stiffness, classical lamination plate theory.		**[05]**
Essential Reading	Analysis and performance of composite materials by B.D. Agarwal, L.J. Broutman and K. Chandrasekhar, Wiely		
	Mechanics of composite Materials by R.M.Jones, Mc Grew Hill Book Co.		
Supplementary Reading	K.K.Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York		
	Fibre-Reinforedcomposites-Materials, Manufacturing and Design. P.K.Mallick Marcel Dekken, Inc. New York & Basel		
	Engineering mechanics of composite materials by Isaac M.Daniel and OriIshai, Oxford University Press		
Course Outcomes: At the end of the course, the student will able to:			
CO1	Express classification of composite materials, merits and demerits.		
CO2	Demonstrate the processing of FRP composites.		
CO3	Analyze the micro-mechanical behavior of composites.		
CO4	Apply the macro-mechanical behavior of composites.		
CO5	Construct the laminated composites.		

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	2	2	2	1	2	3
CO2	3	2	3	3	2	2	3	1	2	2	3	3
CO3	3	2	3	2	2	2	2	2	2	3	3	3
CO4	3	2	3	3	2	3	2	2	2	2	2	3
CO5	3	2	3	3	2	2	2	1	2	2	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	2	2	2	2	2	2	3	3

Subject Code	**PE-1320**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Industrial Hydraulics**		
Course Objective	To obtain knowledge on hydraulic systems, various types of pumps and motors, flow control methods, various types of valves.		
Module I	Introduction - Pascal's law - Advantages and Disadvantages of hydraulic systems - Requirements of hydraulic oil - Maintenance of hydraulic oils: Heat exchanges, Filters and Strainers etc. – Reservoir design criteria - Principle hydraulic jack - Pipes, Packing and Seals.		**[06]**
Module II	Various types of pumps and motors like Gear type, Piston type, (radial &axial), Vane type (intra vane etc.) - Selection criteria for a specific application like Injection molding machines, Extrusion, Blow molding etc. - Working principles and Performance.		**[06]**
Module III	Types - Classification - Details of flow control; Methods of flow control, Meter in, Meter out, Bleed off, Flow control valves like pressure compensated and non-pressure compensated in detail with applications. Directional control valves; One way (check valves) of various types inline, right angle, restriction, pilot operated etc., two-way valves rotary type, spool type, operating controls, spool central conditions, deceleration valves.		**[06]**
Module IV	Types - Classification - Details of pressure controls - relief valves of types simple and compound, venting and relief valves, unloading valves, sequence valves and its applications, counter balance valve, brake valve, pressure reducing valves like direct acting and pilot operated etc. Principles of operation - Application in molding machines.		**[06]**
Module V	Types like weight loaded, spring loaded, gas charge with and without separator, piston type – with advantages and limitations and applications - intensifiers - its purpose, type like single acting and double acting, applications with various circuits. Introduction - Construction and its mechanism –Various types of valves like Mechanical, Electrohydraulic, single stage/two stage spool type, High performance servo valves with torque motors, Its application in industries.		**[06]**
Essential Reading	Industrial Hydraulics Manual 5e. 2nd Printing- Eaton Hydraulics Training Services (Vickers).		
	Industrial hydraulics- John J. Pippenger, Tyler Gregory Hicks, Gregg Division, McGraw-Hill.		

Supplementary Reading	Essential Hydraulics: Fluid Power Basic, M. Winston, CreateSpace Independent Publishing Platform
	Fluid Power Dynamics, R Mobley, NewnesButterworth-Heinemann Publishing
	Hydraulics and Pneumatics: A Technician's and Engineer's Guide, E. Andrew Parr, Elsevier

Course Outcomes: At the end of the course, the student will able to:	
CO1	Ability to demonstrate properly about hydraulic systems and its design requirements.
CO2	Ability to describe working principles of various types of pumps and motors and its selection criteria.
CO3	Ability to illustrate details of various flow control methods besides flow and directional control valves.
CO4	Ability to describe working principles of various types of pressure control valves and its applications.
CO5	Ability to handle various types of valves like mechanical and electrohydraulic besides Its applications.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	3	1	2	2	1
CO2	3	3	3	3	2	2	1	3	2	1	2	2
CO3	3	3	3	3	1	1	1	3	1	1	2	2
CO4	3	3	3	3	3	1	1	3	2	2	3	2
CO5	3	3	3	3	1	1	2	3	1	1	1	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	3	1	1	2	2

Subject Code	**PE-1321**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Precision Engineering**		
Pre-requisites			
Course Objective	To obtain knowledge on micro-milling and micro-drilling, nanotechnology, nano-measuring systems, measuring equipment and applications of nanotechnology.		
Module I	Precision Engineering: Micromilling and Microdrilling, Micro Electro Mechanical Systems, Microelectronics fabrication methods, Principles of MEMS, mechanical MEMS, Thermal MEMS, Magnetic MEMS.		**[04]**
Module II	Nanotechnology- Carbon nanotubes and Structures, Processing system of nanometre accuracies, mechanism of material processing, Nano Physical processing of atomic bit-units, Nano-chemical and electrochemical atomic-bit processing.		**[05]**
Module III	Nano-Measuring Systems of Sub-Nanometre Accuracy and Resolution: In process or in situ measurement of position of processing point, Post process and on machine measurement of dimensional features and surface, Mechanical measuring systems, Optical measuring systems, Electron beam measuring systems, Pattern recognition and inspection systems		**[07]**
Module IV	Nano-Positioning System of Nanometre Accuracy and Repeatability: Guide systems for moving elements, Servo control systems for tool positioning, Computer		**[07]**

	aided digital ultra-precision position control, Future development of micro actuators.	
Module V	Applications of Nanotechnology: Nano-grating system, Nano lithography, Photolithography, Electron beam lithography, Machining of soft metal mirrors with diamond turning, Mirror grinding of ceramics, Ultraprecision block gauges, balls for rolling bearings, Fabrication CCD's, Optical fibres.	**[07]**

Essential Reading	Nanotechnology- N. Taniguchi, Oxford University Press.
	Micromanufacturing and Nanotechnology- N.P. Mahalik, Elsevier.
Supplementary Reading	Foundation of MEMS- C. Liu, Prentice Hall.
	Introduction to Nanotechnology- C.P. Poole and F.J. Owens, Wiley Interscience

Course Outcomes: At the end of the course, the student will able to:	
CO1	Express the knowledge in micro and nano manufacturing methods.
CO2	Develop MEMS system for industrial use.
CO3	Apply the quality concepts parts, accuracy requirements of machine tools and use of latest machining process such as micro machining and micro fabrication.
CO4	Demonstrate tolerance allocation and analysis for precision machine design and assessment.
CO5	Plan sensibility analysis for precision design optimization and awareness of the needs and benefits of precision engineering

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	2	2	2	2	2	3	1
CO2	3	3	2	3	1	2	3	2	2	2	2	1
CO3	2	3	2	3	2	2	2	2	2	3	3	1
CO4	2	3	1	3	2	2	1	2	2	2	3	1
CO5	3	3	2	3	1	2	2	2	2	2	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	3	2	2	2	2	2	2	3	1

Subject Code	**PE-1322**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Statistical Methods and Design of Experiments**		
Course Objective	To obtain knowledge on hypothesis testing, Chi squares, experiments with single factor, two factor and general factorial design, Taguchi approach to parametric design, multiple factors and their interactions.		
Module I	Sampling Distribution, Types, Random Sampling, Sample Size & Standard Error, Point Estimate, Hypothesis testing, Hypothesis testing of mean with different conditions, differences in mean, Chi squares as test of independence, test of goodness fit.		**[06]**
Module II	Experiments with single factor, Analysis of variance, Fixed effect model, Estimation of model parameters, Comparison of individual treatment means, Orthogonal contrasts, Schaffer method of comparing contrasts, comparing pairs of treatment means. Model adequacy checking, plot of residuals, Choice of sample size, OC curves, Method of CI estimation, Fitting response curves, regression approach orthogonal polynomials.		**[06]**

Module III	Factorial Design, Two factor factorial design, Statistical analysis of fixed effect model, Estimation, Choice of sample size, Random & Mixed model, Fitting response curves and surface. General factorial design.	**[06]**
Module IV	2^k Factorial Design, single replicate, Addition of center points to 2^k design, Yates algorithm for 2^k design, 3^k design, Yates of Algorithm for 2^k design.	**[06]**
Module V	Response surface methods & design, Methods of steepest Ascent, Analysis of 2^{nd}order model. Fitting response surface, evolutionally operation. Taguchi approach to parametric design.	**[06]**

Essential Reading	Design & Analysis of Experiments- D.C. Montgomery, John Wiley & Sons.
	Statistics for Management- Richard I. Levin, PHI.
Supplementary Reading	Design and Analysis of Experiments- J.Antony, Butterworth-Heinemann.
	Statistics for Engineers: An introduction- J.Morrison, WileyBlackwell.
Course Outcomes: At the end of the course, the student will able to:	
CO1	Apply hypothesis testing, Chi squares as test of independence and goodness fit
CO2	Analyze experiments with single factor
CO3	Construct Two factor and general factorial design and analyze fixed effect model.
CO4	Perform Taguchi approach to parametric design.
CO5	Evaluate the effects of multiple factors and their interactions on one or more response variables using Response surface methods & design

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1	2	2	1	3	2
CO2	2	3	3	3	2	2	1	2	3	2	3	2
CO3	2	3	3	3	3	2	1	2	2	2	2	2
CO4	2	3	3	3	2	2	1	2	3	2	3	2
CO5	2	3	3	3	3	2	1	2	2	1	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	3	3	3	2	1	2	2	2	3	2

Subject Code	**PE-1323**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Finite Element Method in Manufacturing**		
Pre-requisites	Mathematics, Design of Machine Elements, Strength of Materials		
Course Objective	To obtain knowledge on various steps of finite element method, shape functions, applications to metal casting problems.		
Module I	Basics of FEM-Initial value and boundary value problems- Galerkin and Raleigh Ritz methods- Steps in FEA-Discretization, Interpolation, derivation of element characteristic matrix, shape function, assembly and imposition of boundary conditions- Solution and post processing for solving One dimensional solid mechanics, plane truss problems.		**[06]**
Module II	Global and Natural co-ordinates- Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element, Isoparametric elements-Jacobian matrices and transformations- Basics of two dimensional axisymmetric analysis.		**[06]**

Module III	FE analysis of metal casting- Special considerations, latent heat incorporation, Gap element-Time stepping procedures-Crank-Nicholson algorithm-Prediction of grain structure.	**[06]**
Module IV	Basic concepts of plasticity- Solid and flow formulation- Small incremental deformation formulation- FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.	**[06]**
Module V	Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics- Solution and post processing- Overview of application packages such as ANSYS and DEFORM-Development of code for one dimensional analysis and validation.	**[06]**
Essential Reading	An Introduction to the Finite Element Method- J.N. Reddy, McGraw-Hill	
	Finite Element Method in Engineering- S.S. Rao, Pergammon Press.	
Supplementary Reading	Metal Forming and the Finite Element Methods- S. Kobayashi, Soo-Ik-Oh and T. Altan, Oxford University Press.	
	The Finite Element Method in Heat Transfer Analysis- R.W. Lewis, K. Morgan, H.R. Thomas and K.N. Seetharaman, John Wiley.	
	Fundamentals of Finite Element Analysis by David V. Hutton, TMH Publications, edition 2005.	

Course Outcomes: At the end of the course, the student will able to:

CO1	Understand the steps of finite element methods and able to solve the simple engineering problems.
CO2	Express the shape functions of different elements for solving linear problems.
CO3	Analyzemetal casting problems using FEM.
CO4	Implement FEM for solving metal cutting problems
CO5	Apply up-to-date interactive modeling and simulation techniques, and commercial software packages for solution of manufacturing problems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	2	2	1	2	3	3	2
CO2	3	2	3	3	3	2	2	1	1	2	3	2
CO3	3	2	3	3	2	2	2	1	2	3	2	2
CO4	3	2	3	2	3	2	2	1	3	3	3	2
CO5	3	2	3	3	3	2	2	1	2	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	2	2	1	2	3	3	2

Subject Code	**PE-1324**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Principles of Machine Tools**		
Course Objective	To obtain knowledge on basic design consideration for general machine tools, stepped and stepless drives, design of guide ways and power screws and machine control systems.		
Module I	General classification of machine tools, working and auxiliary motions, hydraulics transmission and its elements, mechanical transmission and its elements, general requirement of machine tools.		**[04]**

Module II	Kinematics of Machine Tools:- Stepped and stepless drive, basic consideration in the design of drives, variable speed range in machine tools, graphical representation of speed, structure diagram, selection of optimum ray diagram, design of speed and feed gearboxes, stepless regulation of speed and feed rates.	**[07]**
Module III	Machine Tool Structure: Design criteria, materials, static and dynamic stiffness, basic design procedure, design ofbeds and columns, model technique in design of machine structures.	**[07]**
Module IV	Guide ways and Power Screw: Classification of guide ways, material and lubrication, design criteria and calculation of slide ways, design of guides under hydrostatic lubrication, aerostatic sideways, antifriction guide ways, combination guide ways, classification of power screws, design principle of power screw, recirculation power screw assemblies, elimination of backlash.	**[07]**
Module V	Control system in Machine Tools: Classification, control, Changing speeds and feeds, ergonomic considerations applied to design of control members, principle of automatic and adaptive control.	**[05]**
Essential Reading	Machine Tool Design- N.K.Mheta,TMH	
Supplementary Reading	Design of Machine Tools- S.K.Basu and D.K.Pal, Oxford&IBH.	
	Principle of Machine Tools- G.C.Sen and A.Bhattacharya, New Central Book Agency	
Course Outcomes	At the end of the course, the student will able to:	
CO1	Describe the basic design considerations for general Machine Tools.	
CO2	Design stepped and step-less Drives for Machine Tools.	
CO3	Propose suitable designs for Machine Structures.	
CO4	Apply the knowledge for designing guide ways and power screws.	
CO5	Describe the principles of machine control system.	

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2			3			3	2
CO2	3	3	3	3	2			3			1	2
CO3	3	3	3	3	3			3			2	1
CO4	3	3	3	3	2			3			3	2
CO5	3	3	3	3	1			3			1	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2			3			2	2

Subject Code	**PE-1325**	**Total Contact Hour**	**30**
Semester	6^{TH}	**Total Credit**	**3**
Subject Name	**Advanced Material Science**		
Pre-requisites	Material sciences		
Course Objective	To obtain knowledge on internal structure of various materials, material properties of ferrous and non-ferrous materials, mechanical integrity and failure in material structure, recycling issues of different materials.		

Module I	Historical perspective of Materials Science. Properties of materials; Classification of materials. Advanced Materials, Future materials; Atomic structure. Crystal structures, Crystalline and non-crystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers and ceramics. Imperfections in Solids: Point defects, Line defects and dislocations. Interfacial defects. Bulk or volume defects.	**[06]**
Module II	Mechanical Properties of Metals: Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multi-axial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors Failure: Fracture-Ductile and brittle fracture, Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Creep. Stress and temperature effects	**[06]**
Module III	Diffusion: Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Lattice resistance to dislocation motion	**[06]**
Module IV	Phase Diagrams:Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system	**[06]**
Module V	Applications and Processing of Metals and Alloys: Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Economic, Environmental and Social Issues of Material Usage: Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design	**[06]**
Essential Reading	W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.	
	Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.	
Supplementary Reading	V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.	
	U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.	

Course Outcomes: At the end of the course, the student will able to:

CO1	Apply the knowledge to identify internal structures for various materials with associated mechanical properties.
CO2	Demonstrate the tailor material properties of ferrous and non-ferrous alloys during different loading conditions.
CO3	Analyze the mechanical integrity with failure in material structure for advanced materials.
CO4	Analyze the phase transformations of iron-carbon system using equilibrium phase diagram.
CO5	Describe the recycling issues using life cycle analysis for different materials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	3	3	1	2	1	1	1	1	3
CO2	1	2	3	3	3	1	2	1	1	1	1	3

CO3	1	2	3	3	3	1	2	1	1	1	1	3
CO4	1	2	3	3	3	1	2	1	1	1	1	3
CO5	1	2	3	3	3	1	2	1	1	1	1	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	1	2	3	3	3	1	2	1	1	1	1	3

Subject Code: HS-1301 **Entrepreneurship Development**

Module -I **[06]**

Entrepreneurship-definition, growth of small scale industry lies in developing countries and their positions vis-a-vis large industries, role of small scale industries in the national economy, characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; Stages in starting a small scale industry.

Module -II **[06]**

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.

Module -III **[06]**

Evaluation of E-Business Infrastructure and Capacity Planning: Quantitative analysis of authentication and payment services, Capacity planning methodologies, Performance models for e-business sites, Modelling web-server workload.

Module -IV **[06]**

Prerequisite: None Managing Business in the Digital World: Introduction, How IT has changed the concepts of traditional MIS with examples and case studies.

Module -V **[06]**

Basic understanding of e-business building blocks, Emerging e-Business models, B2B, B2C, C2C etc., Case-studies on e-auctions, electronic markets, electronic procurement, automated supply chains, e-marketing, e-customer relationship management, e-finance systems, and negotiations support systems.

TEXT BOOK(S):

Scaling for E-Business: Technologies, Models, Performance, and Capacity Planning, Daniel A. Menasc, Virgilio A. F. Almeida, Prentice Hall

Management Information Systems- Managing Information Technology in E Business Enterprises, James A. Brien, TMH

REFERENCE BOOK(S):

"Entrepreneurship" Forbat, John, New Age International.

Auction Theory, Vijay Krishna, Academic Press.

"Essential of Management", Joseph, L. Massod, Prentice Hall of India.

Course Outcomes: At the end of this course, students will

1. Understand Entrepreneurship and analyze the growth of small scale industries and national economy.
2. Implement projects through assessment and field study with accordance to Government policy for small scale industry.
3. Analyze-Business Infrastructure and Capacity Planning.
4. Manage Business in the Digital World.
5. Demonstrate and implement e-business.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	3	3	3	3	2	3	3	3
CO2	3	3	3	1	3	3	3	3	2	3	3	2
CO3	3	3	1	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	3	3	3	2	3	3	3

Subject Code: MC-1302 **Industrial Safety Engineering**

Module -I **[06]**

Concepts and Techniques: History of Safety movement–Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity-productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

Module -II **[06]**

Biological Hazards: Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases.

Module -III **[06]**

Ergonomical Hazards: Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets building design.
Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

Module -IV **[06]**

Hazardous Waste Management: Hazardous waste management in India waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste selection charts for the treatment of different hazardous wastes methods of collection and disposal of solid wastes.

Module -V **[06]**

Safety Education and Training: Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

TEXT BOOK(S):

Rao, C. S, "Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1992.
S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.

REFERENCE BOOK(S):

Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.
Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982.
Encyclopedia of "Occupational Health and Safety", Vol.I and II, published by International Labour Office, Geneva, 1998.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Write failures in machine components and suggest the preventive measures using various techniques for disaster control.
2. Demonstrate the biological hazards and suggest the preventive measures using various techniques for its control
3. Apply the ergonomically hazards and suggest the preventive measures using various techniques forits control.
4. Analyze the hazardous waste and take the preventive measures using waste management.
5. Implement prescribes safety policies and able to do safety campaign.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	3	3	3	3	2	3	3	3
CO2	3	3	3	1	3	3	3	3	2	3	3	2
CO3	3	3	1	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	2	3
CO5	3	3	3	3	3	3	3	3	2	3	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	3	3	3	2	3	2	3

Subject Code: PSI **Project for Product Development - I**

CO1: Apply foundational knowledge of mathematics, science, and engineering to analyze, formulate, and solve complex problems, designing effective and innovative solutions with considerations for public health, safety, and the environment.

CO2: Research and Tool Application: Utilize research methodologies and modern engineering tools to design experiments, interpret data, and model solutions with a clear understanding of the associated limitations.

CO3: Assess the social, cultural, and environmental impacts of engineering solutions, committing to ethical practices and promoting sustainable development.

CO4: Communication and Teamwork: Demonstrate effective communication skills and the ability to work collaboratively in diverse, multidisciplinary teams, while leading and managing projects effectively.

CO5: Professional Growth and Lifelong Learning: Recognize the importance of continuous learning and the need to adapt to technological advancements and changing global contexts.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	3	2	3	3	3	2	2	3
CO2	3	3	2	3	3	2	2	3	2	3	3	2

CO3	3	3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	3	3	3	3	3	3	3

Subject Code: PE-1384 **Metal Forming Lab.**

LIST OF EXPERIMENTS **[08]**

1. To demonstrate the effect of friction and height-to-diameter ratio in the axi-symmetric compression of a solid cylindrical job (Disc Compression Test)
2. To determine the coefficient of interfacial friction during plastic deformation of metals by means of compression of a ring between two compression platens (Ring Compression Test)
3. To learn the forming characteristics of sheet metal specimens with deep drawing operation (Deep Drawing)
4. To extrude a cylindrical cup by forward extrusion and to determine the load variation with the thickness of the bottom of the cup (Forward Extrusion)
5. To extrude a cylindrical cup by forward extrusion and to determine the load variation with the thickness of the bottom of the cup (Backward Extrusion)
6. To find out the flow stress behaviour of sheet metal under equi-biaxial stress condition (Hydraulic Bulge Test)

Course Outcomess: At the end of this course, students will demonstrate the ability to

CO1 Recall different forming process and their relative advantages/ disadvantages with respect to different application.
CO2 Demonstrate different metal forming processes.
CO3 Experiment with various metal using metal forming setups.
CO4 Discover metal formed components for their project work.
CO5 Build industrial products using forming processes.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	3	1	1	2
CO2	3	3	3	3	3	1	1	1	3	1	2	1
CO3	3	3	3	2	2	1	1	1	2	1	2	2
CO4	3	3	2	2	2	1	1	1	3	1	2	1
CO5	3	3	3	3	2	1	1	1	2	1	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	1	3	1	2	2

Subject Code: PE-1385 **Material Characterization Lab**

LIST OF EXPERIMENTS **[08]**

1. Nondestructive evaluation of elastic properties (Young's modulus and Poisson's ratio), resonant frequencies and internal friction or damping using RFDA MF Basic set up in longitudinal mode.
2. Nondestructive evaluation of elastic properties (Young's modulus, torsional modulus and Poisson's ratio), resonant frequencies and internal friction or damping using RFDA MF Basic set up in torsional mode.
3. Measurement of Impedance, admittance, resistance, inductance, capacitance, loss factor, conductivity, and permittivity of a given sample using the High Frequency LCR Meter in ambient condition.
4. Measurement of Impedance, admittance, resistance, inductance, capacitance, loss factor, conductivity, and permittivity of a given sample using the High Frequency LCR Meter with temperature variation.
5. Measurement of microhardness of a given sample using Micro Vickers Hardness Tester.
6. Determine the abrasive resistance of solid materials using Dry Abrasion Tester.
7. Measurement of arithmetical mean roughness (Ra), maximum height (Ry), ten-point mean roughness (Rz) of flat and curved surfaces

Course Outcomess: At the end of this course, students will demonstrate the ability to

CO1 Evaluate the elastic properties of a given material through non-destructive testing.
CO2 Measure the electrical properties of a material in ambient as well as thermal environment.
CO3 Determine the microhardness of a material.
CO4 Obtain the abrasive resistance of a material under dry abrasive environment.
CO5 Quantify various roughness parameter of a material surface.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	3	1	1	2
CO2	3	3	3	3	3	1	1	1	3	1	2	3
CO3	3	3	3	2	2	1	1	1	2	1	2	2
CO4	3	3	2	2	2	1	1	1	3	1	2	3
CO5	3	3	3	3	2	1	1	1	2	1	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	1	1	1	3	1	2	3

FINAL YEAR

SEVENTH SEMESTER

Subject Code : PE-1426 **Engineering Ergonomics**

Module -I **[06]**

Human factors in a production system: characteristics features of man-machine system: quantitative and qualitative visual displays; Human factors associated with speech communication.

Module -II **[06]**

Introduction to kinesiology; Biomechanics and bioengineering aspects of human motor activity; performance analysis of body members in making specific types of movements; and conceptual relationships of stimuli and responses

Module -III **[05]**

Design of control function. Tools and related control devices and control systems. Design of work place and work-components.

Module -IV **[07]**

Applied anthropometry, activity analysis: concepts of productivity and its improvement strategies; Design of individual work place. Human performance under heat, cold, illumination, vibration, noise, pollution. Static and dynamic conditions.

Module -V **[06]**

Application of results from human factors data and analysis in work study; work design; Method study and work measurement techniques; performance rating and time standards.

TEXT BOOK(S):

1 Ergonomics for Beginners: A Quick Reference Guide, Third Edition, Jan Dul, Bernard Weerdmeester, CRC Press.
2 Introduction to Ergonomics, Third Edition, R.S. Bridger, CRC Press.
3 Human Factors in Engineering and Design, Ernest J. McCormick, Mark S. Sanders (Editor) McGraw-Hill Inc., US; 6th Revised edition (1 March 1987).

COURSE OUTCOMESS:

1 Evaluates and analyses the human factors in a production system.
2 Analyze and implement biomechanics and bioengineering aspects of human motor activity.
3 Design the individual work place with control devices.
4 Implement design by considering anthropometry and activity analysis.
5 Analyze the results from human factors data in work study

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	1	3	2	2	2	2	1
CO2	2	3	3	2	3	1	2	2	2	2	2	1
CO3	2	3	2	2	3	1	2	2	1	2	3	1
CO4	2	3	3	3	2	2	2	2	2	1	3	1
CO5	3	3	3	2	3	1	2	1	1	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	3	2	3	1	2	2	2	2	3	1

Subject Code: PE-1427 **Surface Engineering Principles & Systems**

Module -I **[07]**

Mechanisms of Wear and Metal Cleaning: Basic Mechanisms of wear-abrasive, adhesive wear, contact fatigue, Fretting corrosion, Testing of wear resistance, practical diagnosis of wear, general cleaning process for ferrous and non ferrous metals and alloys selection of cleaning processes, alkaline cleaning, emulsion cleaning, ultrasonic cleaning, pickling salt bath descaling, abrasive bath cleaning, polishing and buffing shot peening.

Module -II **[07]**

Thermal Spraying Processes and Electrodeposited Coatings: Thermal spraying materials, characteristics of thermal spray processes, Design for thermally sprayed coatings coating production, spray fused coatings, Principles of electroplating, Technology and control-electroplating systems, Properties and applications of electrodeposits, Non aqueous and electroless deposition, plasma coating.

Module -III **[06]**

Hot Dip Coating and Diffusion Coating: Principles, Surface preparation, Batchcoating and continuous coating process, Coating properties and application, Principles of cementation, Cladding-vacuum deposition, Sprayed metal coating, Structure of diffusion coatings, Chemical vapour deposition (CVD), Physical vapour deposition (PVD).

Module -IV **[05]**

Non-Metallic Coating Oxide and Conversion Coatings: Plating coating, lacquers, rubbers and elastomers, vitreous enamels, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium copper and silver, phosphating primers.

Module -V **[05]**

Quality Assurance, Testing and Selection af Coatings: The quality plan, design, testing and inspection, thickness and porosity measurement, selection of coatings, industrial applications of engineering coatings.

TEXT BOOK(S):

Engineering Coatings-design and application- S. Grainger, Jaico Publishing House.
Principles of Metals surface treatment and protection- D. R. Gabe, Pergamon.

REFERENCE BOOK(S):

Electroplating Handbooks- N.V.Parathasarathy, Prentice Hall.
Advances in surface treatment- Niku-Lavi, Pergamon.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Express the important of surface engineering to industries
2. Develop the application of thermal spray for coating
3. Define the process and mechanism of different diffusion coating process
4. Demonstrate the methods of non metallic coating
5. Express the testing procedure for quality assurance

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	2	3	1	3	2	3	2
CO2	2	2	3	3	2	3	3	1	3	2	2	2
CO3	2	1	3	2	2	2	3	1	2	2	3	1
CO4	3	2	2	3	2	3	3	1	3	2	2	1
CO5	2	2	2	3	2	2	3	2	3	3	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	2	3	3	2	2	3	1	3	2	3	2

Subject Code: PE-1429 **Non-Traditional Machining**

Module -I **[05]**

Introduction: Need for Non-traditional Machining, Classification, process selection. Ultrasonicmachining: Principle, Transducer, Magneto-strictive material, Analysis for Material Removal Rate by Shaw, Effect of process parameters, Application.

Module -II **[05]**

Abrasive Jet Machining: Principle, Application, Advantages and disadvantages, Variables in AJM, Water Jet Machining- Jet Cutting equipment, Principle, advantages, Practical Application.

Module -III **[06]**

Electrochemical Machining: Principle, Faraday's law, Material Removal Rate, Dynamics of ECM process, Tool design, Advantages, Application, Limitation, Electro –chemical grinding, Deburring and Honing.

Module -IV **[07]**

Electro Discharge Machining: mechanism of material removal, Basic EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish, Tool Material, Dielectric fluid, Application limitation.

Laser Beam Machining: Lasing process and principle, population inversion, Principle of Ruby laser, Nd: YAG Laser and CO2 Laser, Power control of laser output, Application.

Module -V **[07]**

Electron Beam Machining: Basic principle, Controlling parameters and focal distance, Application. Ion Beam Machining: Principle and Mechanism, Application.

Plasma Arc Machining: generation of Plasma, Equipments, Torch, Classification, Direct and indirect torches and applications, parameters effecting cutting, Advantages.

TEXT BOOK(S):

Modern machines process- P.C. Pandey and H.S. Shan. TMH

Non-Conventional Machining- P.K. Mishra, Narosa.

REFERENCE BOOK(S):

Manufacturing Processes- Amstead, Ostwald &Begeman, John Wiley & Sons.

Processes and Materials of Manufacturing- Lindberg, PHI.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Express the contribution of non-traditional machining process in micro and precision manufacturing field.

2. Incorporate the selection of appropriate machining process for suitable materials.
3. Define the process parameters, their effect and applications of different non-traditional machining processes.
4. Summarizes the merits and demerits of the non-traditional manufacturing process
5. Analyze the principle of working, mechanism of metal removal in the various unconventional machining process.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	2	3	2	3	3
CO2	3	2	3	2	3	3	3	2	3	2	2	3
CO3	3	2	2	3	2	2	2	2	2	2	1	3
CO4	3	1	2	3	3	2	3	2	2	3	2	2
CO5	3	2	3	2	3	2	3	1	3	2	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	2	3	2	3	2	2	3

Subject Code	**PE-1430**	**Total Contact Hour**	**30**
Semester	7^{TH}	**Total Credit**	**3**
Subject Name	**Maintenance Engineering & Management**		
Course Objective	To obtain knowledge on various maintenance systems, planning and scheduling of maintenance, systems operation and documentation and network techniques.		
Module I	Importance of maintenance, Objectives of maintenance, Types of maintenance, Maintenance systems, Planned and unplanned maintenance, Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance systems, Design-out maintenance, Selection of maintenance systems.		**[06]**
Module II	Maintenance planning and scheduling, establishing a maintenance plan, Safety precautions – Characteristics of items to be maintained, Classification of items, Maintenance procedure, Guidelines for matching procedures to items.		**[06]**
Module III	Maintenance organization, Resource characteristics, Resources structure, Maintenance control, Administrative structure, Training of maintenance personnel.		**[06]**
Module IV	System operations and documentation, documenting maintenance operations, Record keeping, Data collection and analysis, Failure statistics, Planning and scheduling plant shutdowns, Depreciation and Machine Life, Replacement policies, Spares and types of spares, spares planning.		**[06]**
Module V	Network techniques in maintenance activities, Evaluation of maintenance performance, Total productive maintenance – development and scope, Basic systems of TPM, Procedures and steps. Productivity circles as a part of TQM, benefits of TPM.		**[06]**
Essential Reading	Maintenance Planning and Control- A. Kelly, East West Press.		
	Maintenance Engineering and Management-R. C. Mishra, K. Pathak, PHI Learning Pvt. Ltd.		
Supplementary Reading	Managing Maintenance Resources- A. Kelly, Butterworth-Heinemann.		
	Handbook of Maintenance Management- Levitt Joel, Industrial Press.		

Course Outcomes: At the end of the course, the student will able to:	
CO1	Express the basic objectives of maintenance and enumerate the selection of maintenance systems for diverse industries.
CO2	Establishing a maintenance plan and define the characteristics of diverse items to be maintained.
CO3	Develop maintenance organizational structure and compile the documentation and record keeping of maintenance operations.
CO4	Organize spare planning and demonstrate the scheduling plant shut downs.
CO5	Evaluate maintenance performance and explain basic systems of TPM.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	1	3	1	2	3	2	2	2	2	2	2
CO2	1	1	3	1	2	2	2	2	2	2	2	1
CO3	1	1	3	1	1	3	2	2	1	2	1	2
CO4	3	1	2	1	2	2	2	2	2	2	2	2
CO5	3	1	2	1	2	3	2	2	1	2	2	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Course	2	1	3	1	2	3	2	2	2	2	2	2

Subject Code: PE-1431 **Logistics & Supply Chain Management**

Module -I **[06]**

Introduction: Understanding Supply Chain, Historical developments in supply chain management, issues in SCM, linkages within the value supply chain, strategic Supply Chain Management (SCM) decision phases, Scope in supply chain, process view of Logistics, philosophy and concept work of logistics, logistics & competitive strategy supply chain, supply chain flows.

Module -II **[04]**

Supply Chain performance: Customer driven strategies in production & distribution systems, customer focus in SCM, management of supply sources, Drivers & obstacles. Measuring logistics costs &performance. Drivers& Obstacles of Supply Chain Performance: Supply chain performance: Strategic fit and scope; Supply chain drivers, Obstacles to Achieving Strategic fit.

Module -III **[08]**

Planning Demand & Supply in SC: Demand forecasting, Aggregate Planning, Planning & managing inventories in SC,Design the Distribution network designs factors influencing network designs, Network: Designing the distribution networks in practice frame work for network, role of distribution, factors influencing distribution, design decision. option for distribution. Network Design: Network design in uncertain environment the SC, factors influencing network design, models for facility location.

Module -IV **[08]**

Supply Chain Planning: Transportation in SC, Coordinating SC, Integrated production & distribution networks, source decision in SC. Network Design &IT in SC, SCM in the context of JIT, Total Quality Control and product innovation across the supply chain. Metrics for measurement of supply chain performance. Mathematical programming and other models for supply chain decisions. Measuring Logistics costs &performance. Transportation in Supply Chain: Transportation in the supply chain, factors affecting transportation decisions, modes of transportation and their performance.

Module -V **[04]**

IT enabled SC, Best practices & benchmarking for SC, towards Green SC, towards World class SCM, Role of IT in Logistics management. IT application in freight logistics.

Pricing in Supply Chain: Pricing and revenue management in the SC, Sourcing decision in SC, supplier selection, supplier assessment. Coordination in the SC, Lack of coordination and the bullwhip effect, Supply chain information system, E-business and supply chain.

TEXT BOOK(S):

Sunil Chopra, P. Meindl, Supply Chain Management, Pearson Education Asia: Strategy, Planning, and Operation, Chopra Sunil and Meindl Peter, PHI, 5thEdition, 2013.

R.P. Mohanty, S.G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt Ltd.

REFERENCE BOOK(S):

Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing. : Text and Cases, JanatSaha, Pearson Education, First Edition, 2009.

S.K. Bhattacharya, Logistics and Supply Chain Management, Martin Christoper, Pearson PublicationEducation, 1998.

Course Outcomes:

CO1 Analyze the manufacturing operation of a firm

CO2 Evaluate and improve supply chain performance by applying sales, operations planning, MRP and lean manufacturing concepts.

CO3 Apply logistics and purchasing concepts to improve the supply chain operation.

CO4 Demonstrate the implementation of quality management tools for decision making and process improvement.

CO5 Express the best practices and benchmarking for SC as well as the concept of Coordination in the SC

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	3	3	1	2	1	2	3	1
CO2	1	1	3	2	3	3	1	3	1	3	3	3
CO3	3	3	3	2	3	3	2	3	1	2	3	3
CO4	3	3	3	3	3	3	2	3	1	2	3	2
CO5	1	2	3	1	3	3	2	3	1	2	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	2	3	2	3	3	2	3	1	2	3	2

Subject Code: PE-1432 **Plant Layout and Automated Material Handling**

Module -I **[08]**

PLANT LOCATION AND FACILITIES

Factors to be considered – influence of location on plant layout, selection of plant site, Consideration in facilities planning and layout. Equipments required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipments, space requirements, and man power requirements.

Module -II **[08]**

PLANT LAYOUT

Need for layout, types of layout, factors influencing product, process. Fixed and combination layout:

tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models – machine data. Layout planning procedure. Visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines.

Module -III **[10]**

MATERIAL HANDLING

Importance and scope. Principles of material handling. Planning, operating and costing Principles, types of material handling systems, factors influencing their choice.

Module -IV **[12]**

ANALYSIS OF AUTOMATED FLOW LINES

General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines. Assembly system and line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Module -V **[10]**

AUTOMATED MATERIAL HANDLING

Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems. Automated storage systems, automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

TEXT BOOK(S):

Plant Layout and Material Handling, by- James M. Apple, John Wiley & Sons.
Plant Layout and Material Handling, by- B. K. Aggarwal, Jain Brothers.
Plant Layout and Material Handling, by- S. C. Sharma, Jain Brothers.

REFERENCE BOOK(S):

Plant Layout and Material Handling, by- Fred E. Meyers, Prentice Hall.
Facility Layout and Location: An Analytical Approach, by Richard L, Francis, Pearson India.
Materials Handling Handbook, by- Raymond A. Kulwiec, John Wiley & Sons.

Course Outcomes:

1. Identify the role that each department plays in achieving the goals of an organization;
2. Explain the problems in organizing, planning and controlling the use of men, money, materials and machines for industrial production; and
3. Apply industrial engineering principles to solve the problems in organizing, planning and controlling the use of men, money, materials and machines for industrial production.
4. Recommend improvements to existing plant layouts from the standpoint of material handling and product flow
5. Design flexibility into a plant layout to accommodate changes in product volume or product line

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	3	3	2	3	3	1	3	3
CO2	3	3	2	2	3	1	2	1	1	1	3	1
CO3	1	3	2	2	3	3	2	3	3	2	3	3
CO4	3	3	2	2	1	3	2	3	1	2	1	1
CO5	3	1	2	1	3	1	2	3	1	2	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	3	3	2	3	3	2	3	3

Module -I **[06]**

Selection of materials: Criteria of selecting materials for automotive components viz Cylinder block, Cylinder head, Piston, Pistonring, Gudgeon pin, Connecting rod, Crank shaft, Crank case, Cam, Cam shaft, Engine valve, Gear wheel, Clutch plate, Axlebearings, Chassis, Spring, body panel radiator, brake lining etc. Application of non-metallic materials such as composite, ceramicand polymers in automobile.

Module -II **[06]**

Automotive Engine Design: Principles of design of thermal systems, Engine performance characteristics, General Engine Design, Design of Principal Engine Components, Design of Engine Systems: Design of cooling system, radiator, water, pump and fan, Computation of air cooling system Design of fuel system for CIengine, Governor design, Design of carburetor, Design of direct cylinder and port injection system for SI engine, Design of intake and exhaust system Engine friction and wear, Selection of lubricant, lubricating system, pump and filters

Module -III **[06]**

Automotive Chassis, Design of Suspension System, Automotive Steering System, Automotive Brakes, Wheels and Tyres

Module -IV **[06]**

Automotive Lubricants- introduction, properties, standard test methods for automotive lubricants, testing, classification, engine oil performance designations, tests, transmission fluids, gear lubricants, axle lubricants, solid lubricants, automotive engine oils, EP lubricants, Lubricant monitoring, SOAP, Ferro-graphy and other rapid testing methods of lubricant contamination, Hydrostatic and Elasto-hydrodynamic Lubrication.

Module -V **[06]**

Automotive Safety and Regulations: Safety and Crash Testing, Active and passive safety, Tests, Regulatory requirements for crash testing, instrumentation, high speed photography, image analysis; Pedestrian Safety and Ergonomics, Vehicle Safety systems, Automotive Lighting and Light Signalling Devices, Safety regulations: As Issued from time to time by Government of India as per AIS 037 (Automotive Indian Standard).

TEXT BOOK(S):

JullianHappian-Smith ‘An Introduction to Modern Vehicle Design’SAE,
Schwaller, “Motor Automotive Technology” , Delmar Thomson Learning

REFERENCE BOOK(S):

Design of Automotive Engine – A. Kolchin and V. Demidov
Heldt.P.M., Automotive Chassis, Chilton Co., New York
Recent Development in Automotive Safety Technology. SAE, International Publication.

COURSE OUTCOMESS:

CO1 Demonstrate proper selection of materials for automotive components.
CO2 Design principal automotive engine and engine components.
CO3 Design suitable suspension, steering and braking system for automobile.
CO4 Express diverse methods for automotive lubrication, testing and monitoring.
CO5 Develop knowledge on automotive safety and regulations as issued by Govt. of India.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	1	1	2	2	3	1	1	1	2
CO2	2	1	3	2	2	3	3	3	2	2	2	2
CO3	2	1	3	2	2	3	3	3	2	2	2	2
CO4	1	1	2	2	3	3	3	3	1	2	1	1
CO5	1	2	1	1	3	3	3	3	1	2	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	1	1	2	1	2	3	3	3	1	2	2	2

Subject Code: PE-1434 **Production Operation & Management**

Module -I **[06]**

Operations function in an organization, Manufacturing vs. Service operation. Design in products, services & processes, new product design, Product life cycle, Process technology: project, job shop, batch, assembly line, continuous manufacturing, Process technology life cycle, Process technology trends, FMS, CIM, CAD, CAM, GT, Design for services, Services process technology. Value Engineering, Standardization, Make or buy Decision.

Module -II **[06]**

Forecasting: Principles & methods, moving average, double moving average exponential smoothing, double exponential smoothing, Forecasting error analysis.

Job Design & work Measurement, Method study: Techniques of analysis, recording, improvement & standardization. Work measurement: work measurement principles using stop watch time study, predetermined motion time standard & work sampling, standard time estimation.

Module -III **[06]**

Manufacturing planning & control: Aggregate planning, Master production scheduling, Rough- cut capacity planning, Material requirement planning, Capacity requirement planning, Loading, scheduling & dispatching function, progress monitoring, & control.

Sequencing and scheduling: Single machine scheduling: Basics and performance evaluation criteria, methods for minimizing mean flow time, parallel machines: minimization of makespan, flowshop sequencing: 2 and 3 machine cases: Johnson's rule and CDS heuristic. Jobshop scheduling: priority dispatching rules.

Module -IV **[06]**

Facility location: Factor influencing plant & warehouse location, impact of location on cost & revenue. Facility location procedure & models; qualitative models, Breakeven analysis, Single facility location model, Multi facility location model, Minimax location, Total & partial covering model. Layout planning: layout types; Process layout, Product layout, Fixed position layout, Systematic layout planning, CRAFT

Module -V **[06]**

Project management: Project management through PERT/CPM. Network construction, CPM, Network Calculation, crashing of project network, project scheduling with limited resources, line of balance.

Modern trends in manufacturing: Just in Time (JIT) system, shop floor control by Kanbans, Total Quality management, Total Productive Maintenance, ISO 9000, Quality Circle, Kaizen, Poka Yoke, Supply Chain Management.

TEXT BOOK(S):

Production systems: planning analysis and control- J.L.Riggs, John Wiley.
Production and Operations Management- R.Panneerselvam, PHI.

REFERENCE BOOK(S):

Production and Operation Management- E.E.Adam and R.J.Ebert, PHI.
Production and Operations Management- S.N.Chary, Tata McGraw Hill.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Analyze different manufacturing systems with associated improvement tools.
2. Apply demand forecasting tools to reduce associated costs and method study for job improvement.
3. Evaluate material requirement planning and sequencing techniques for material management.
4. Design plant layout for optimal plant location.
5. Construct specific projects using project management tools.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	1	2	3	1	2	3	1
CO2	3	3	2	3	1	1	2	2	2	3	3	2
CO3	3	2	3	3	1	2	2	3	2	2	2	2
CO4	3	2	2	3	1	1	2	3	2	3	2	2
CO5	3	2	3	3	1	1	2	2	2	3	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	2	3	1	1	2	3	2	3	3	2

Subject Code: PE-1435 **Rapid Prototyping & Tooling**

Module -I **[06]**

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, Survey of applications, Growth of RP industry, Classification of RP systems. Stereolithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application.

Module -II **[06]**

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications, Aminated Object Manufacturing: Principle, of operation,
LOM materials, process details, application.

Module -III **[06]**

Concepts Modelers: Principle, Thermal jet printer, 3-D printer, GenisysXsprinter HP system 5, Object Quadra systems, Laser Engineering Net Shaping (LENS).

Module -IV **[06]**

Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3D keltool,
Direct Rapid Tooling- Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, Soft Tooling vs. Hard tooling.

Module -V **[06]**

Software for RP: STL files, Overview of Solid view, magics, mimics, magic communicator, etc. Internet based software, Collaboration tools, Rapid Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Surface digitizing, surface generation from point cloud, surface modification- data transfer to solid models.

TEXT BOOK(S):

Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY.

Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling- D.T. Flham and S.S.Dimov, Springer Verlag.

REFERENCE BOOK(S):

Rapid Prototyping: Principles and Applications in Manufacturing- Kai and Fai, World Scientific.

Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.

COURSE OUTCOMES:

Express the fundamentals of rapid prototype and their classifications.

Implement the Selective Laser Sintering techniques.

Analyze the Modelers printer techniques.

Develop knowledge of Rapid tooling and implement in rapid manufacturing.

Write the software aspects of rapid manufacturing and product modeling.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	2	3	2	2	2	2	2
CO2	2	3	3	3	2	3	2	2	2	2	3	2
CO3	2	3	2	3	3	2	3	2	3	2	2	1
CO4	3	2	2	2	2	2	3	2	2	2	3	2
CO5	2	3	2	3	2	3	3	2	2	3	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	2	3	2	2	3	2	2	2	3	2

Subject Code: PSI-I **Seminar on SIRE - II**

CO1: Apply fundamental principles of mathematics, science, and engineering to identify, analyze, and solve complex engineering problems, using research-based methods to draw valid conclusions.

CO2: Design effective solutions for engineering problems, keeping in mind public health, safety, environmental, societal, and cultural considerations, and apply modern tools with awareness of their limitations.

CO3: Make informed decisions by assessing the societal, legal, health, and environmental impacts of engineering solutions, adhering to ethical standards, and promoting sustainable development.

CO4: Function efficiently as an individual or in teams across diverse, multidisciplinary settings, while communicating complex engineering ideas effectively through reports, presentations, and clear instructions.

CO5: Apply engineering and management principles to lead and manage projects professionally, while recognizing the importance of lifelong learning in adapting to technological advancements.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	2	3	3	2	2
CO2	3	3	3	3	2	3	3	2	3	2	3	1
CO3	3	3	2	2	2	2	2	2	3	3	3	2
CO4	3	3	3	3	2	2	2	2	2	2	2	2
CO5	3	3	3	3	2	2	1	2	2	3	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	2	2	2	3	3	3	2

Subject Code: BPE2895 **Project for Product Development – II / Internship Project - I**

Apply fundamental principles of mathematics, science, and engineering to identify, analyze, and solve complex engineering problems, using research-based methods to draw valid conclusions.

Design effective solutions for engineering problems, keeping in mind public health, safety, environmental, societal, and cultural considerations, and apply modern tools with awareness of their limitations.

Make informed decisions by assessing the societal, legal, health, and environmental impacts of engineering solutions, adhering to ethical standards, and promoting sustainable development.

Function efficiently as an individual or in teams across diverse, multidisciplinary settings, while communicating complex engineering ideas effectively through reports, presentations, and clear instructions.

Apply engineering and management principles to lead and manage projects professionally, while recognizing the importance of lifelong learning in adapting to technological advancements.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	2	3	3	2	2
CO2	3	3	3	3	2	3	3	2	3	2	3	1
CO3	3	3	2	2	2	2	2	2	3	3	3	2
CO4	3	3	3	3	2	2	2	2	2	2	2	2
CO5	3	3	3	3	2	2	1	2	2	3	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	2	2	2	3	3	3	2

EIGHTH SEMESTER

Subject Code: PE-1436 **Performance Measurement and Benchmarking**

Module -I [06]

Introduction: Traditional Benchmarking, Key Performance Indicators, Ideal Evaluations, Benchmarking Applications. Performance Measures: Setting, Efficient Production and Best Practice, Farrell Efficiency, Directional Efficiency, Efficiency Measures with Prices Dynamic Efficiency, Structural and Network Efficiency, Choice Between Efficiency Measures.

Module -II [06]

Performance Models: Inputs, Outputs, and Context, The Technology Set, Free Disposability of Inputs and Outputs, Convexity, Scaling and Additivity, Performance Analysis: DEA Technologies, DEA as an Activity Analysis, Dual Cost: Benefit Interpretations, The DEA Game, Numerical Examples.

Module -III [06]

Performance Analysis: Stochastic Frontier Analysis: Introduction, Production Functions and Efficiency Measures, Linear Production Functions, Cobb–Douglas Production Functions, Estimating Production Functions, Ordinary Regression Models, Deterministic Frontier Models, Stochastic Frontier Models, Stochastic Cost Function, Stochastic Distance Function Models

Module -IV [06]

Performance Planning: Strategic Planning and Budgeting, Balanced Scorecards, Budget Properties, Comparative Advantage, Scale and Scope, Cost Margins and Marginal Products, Keep, Drop, Accept and Reject, Account for Quality.

Module -V [06]

Performance Restructuring: Importance, Horizontal Mergers, Learning, Harmony and Size Effects, Organizational Restructuring, Controllability, Transferability and Ex Post Efficiency, Disintegration Gains, Numerical Examples and Case Studies.

TEXT BOOK(S):

1. Performance Benchmarking- Measuring and Managing Performance, Peter Bogetoft, Springer.
2. Quantitative Models for Performance Evaluation and Benchmarking, Joe Zhu, Springer.

REFERENCE BOOK(S):

1. Performance Management: A business process benchmarking approach, Bjorn Andersen and AsbjornRolstadas, Springer Netherlands.
2. Managing by Measuring, Mark T. Czarnecki AMACOM American Management Association.

Course Outcomess:

CO1 Express the performance indicators, efficiency and benchmarking for an organization.
CO2 Develop performance models and implement data envelopment analysis.
CO3 Implement stochastic frontier analysis for performance evaluation.
CO4 Plan for strategic planning and budget analysis.
CO5 Plan and implement performance restructuring.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	1	1	1	1	1	1	1
CO2	2	3	3	2	2	3	2	2	1	1	1	2
CO3	3	3	3	2	3	2	2	2	1	1	1	2
CO4	2	3	2	1	2	2	1	2	3	2	3	2
CO5	2	3	2	1	2	2	2	2	3	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	3	2	2	2	1	2	2	1	2	2

Subject Code: PE-1437 **Performance Measurement and Benchmarking**

Module -I [06]

Introduction: Traditional Benchmarking, Key Performance Indicators, Ideal Evaluations, Benchmarking Applications. Performance Measures: Setting, Efficient Production and Best Practice, Farrell Efficiency, Directional Efficiency, Efficiency Measures with Prices Dynamic Efficiency, Structural and Network Efficiency, Choice Between Efficiency Measures.

Module -II [06]

Performance Models: Inputs, Outputs, and Context, The Technology Set, Free Disposability of Inputs and Outputs, Convexity, Scaling and Additivity, Performance Analysis: DEA Technologies, DEA as an Activity Analysis, Dual Cost: Benefit Interpretations, The DEA Game, Numerical Examples.

Module -III [06]

Performance Analysis: Stochastic Frontier Analysis: Introduction, Production Functions and Efficiency Measures, Linear Production Functions, Cobb–Douglas Production Functions, Estimating Production Functions, Ordinary Regression Models, Deterministic Frontier Models, Stochastic Frontier Models, Stochastic Cost Function, Stochastic Distance Function Models

Module -IV [06]

Performance Planning: Strategic Planning and Budgeting, Balanced Scorecards, Budget Properties, Comparative Advantage, Scale and Scope, Cost Margins and Marginal Products, Keep, Drop, Accept and Reject, Account for Quality.

Module -V [06]

Performance Restructuring: Importance, Horizontal Mergers, Learning, Harmony and Size Effects, Organizational Restructuring, Controllability, Transferability and Ex Post Efficiency, Disintegration Gains, Numerical Examples and Case Studies.

TEXT BOOK(S):

Performance Benchmarking- Measuring and Managing Performance, Peter Bogetoft, Springer.

Quantitative Models for Performance Evaluation and Benchmarking, Joe Zhu, Springer.

REFERENCE BOOK(S):

Performance Management: A business process benchmarking approach, Bjorn Andersen and Asbjorn Rolstadas, Springer Netherlands.

Managing by Measuring, Mark T. Czarnecki AMACOM American Management Association.

Course Outcomess:

CO1 Express the performance indicators, efficiency and benchmarking for an organization.

CO2 Develop performance models and implement data envelopment analysis.

CO3 Implement stochastic frontier analysis for performance evaluation.

CO4 Plan for strategic planning and budget analysis.

CO5 Plan and implement performance restructuring.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	1	1	1	1	1	1	1
CO2	2	3	3	2	2	3	2	2	1	1	1	2
CO3	3	3	3	2	3	2	2	2	1	1	1	2
CO4	2	3	2	1	2	2	1	2	3	2	3	2
CO5	2	3	2	1	2	2	2	2	3	2	3	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	3	3	2	2	2	1	2	2	1	2	2

Subject Code: PE-1438 **Subject name: Project Management**

Module -I **[06]**

Project Management: An Overview, Project Selection Project Identification and Screening Project Appraisal: Part I Project Appraisal: Part II Project Selection Project Planning: Development of Project Network, Project Representation, Consistency and Redundancy in Project Networks.

Module -II **[06]**

Project Scheduling: Basic Scheduling with A-O-A Networks, Basic Scheduling with A-O-N Networks, Project Scheduling with Probabilistic Activity Times, Time/Cost Trade-offs in Projects Linear Time Cost Trade-offs in Projects: A Heuristic Approach. Resource Considerations in Projects: Resource Profiles and leveling, Limited Resource Allocation, Project Implementation Project Monitoring and Control with PERT/Cost Team Building and Leadership in Projects, Project Completion, Project Completion, Review and Future Directions.

Module -III **[06]**

Production Management: Introduction to Production Systems and a Generalized Model of Production, Life cycle of a Production System and Major managerial Decisions. Financial Evaluation of Production Related Decisions: Performance Measures of a Production System, Financial Evaluation of Capital Decisions, Decision Trees and evaluation of risk.

Module -IV **[06]**

Designing Products and Services: Introducing New Products and Services, Product Mix Decisions Production Planning Over Medium Term Horizon: Aggregate Production Planning-Basic Concepts, Modeling Approaches capacity requirements planning.

Module -V **[06]**

Operational Decisions over the Short Term: Basic Inventory Principles, Inventory Modeling, Inventory related Decisions, Material Requirements Planning, and Scheduling of Job Shops.

TEXT BOOK(S):

1. Project Management by Nagarajan K
2. Project Management by Panneerselvam R. & Senthilkumar P.

REFERENCE BOOK(S):

1. Elements of Project Management Paperback by K. Nagarajan

COURSE OUTCOMES:

CO1 Define basic concepts and plan project management.
CO2 Create, Analyze and Evaluate schedule projects with and without resource constraints.
CO3 Plan financial evaluation of a project.
CO4 Create design product and services based on aggregate planning.
CO5 Plan inventory decisions related to products or components.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	3	3	3	3	3
CO2	3	2	2	3	2	1	2	3	3	3	3	3
CO3	3	2	2	3	2	1	2	3	3	3	3	3
CO4	2	2	2	3	2	1	2	3	3	3	3	3
CO5	3	2	2	3	2	1	2	3	3	3	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	2	3	2	1	2	3	3	3	3	3

Subject Code: PE-1439 **Advanced Casting and Welding**

Module -I **[06]**

Casting processes: Classification, Metal mould casting processes, principles of melting practice-fluxing- degasification and inoculation- types of furnaces- Crucibles, Cupola, Oil fired furnaces – Electric arc and induction furnaces –Melting practice of cast iron, SG iron, steel, aluminium and copper alloys.

Advanced casting processes, investment casting, Rheocasting, continuous casting process, centrifugal casting process. Evaporative pattern casting-ceramic mould casting –electromagnetic moulding-squeeze casting –-shell moulding

Module -II **[06]**

Physics of welding arc, characteristics of arc, modes of metal transfer, welding fluxes, electrode coating, classification of electrode, characteristics of welding power source, pulsed and inverter type power source, power source for resistance welding, weldability, weldability tests, Weldability of cast iron, Plain carbon steel, Determination of preheating temperature, Stainless steel, use of Scheffler' s diagram.

Heat flow in welding, significance, theory of heat flow, cooling rate determination, selection of welding parameters based on heat flow analysis, residual stress and its measurement, types and control of distortion.

Module -III **[06]**

Technology of Selected casting Processes: Clay bonded, synthetic resin bonded, inorganic material bonded mould and core making, sand additives, mould coating,

Solidification of pure metals and alloys-shrinkage in cast metals-design of sprue, runner, gate and risers-problems in design and manufacture of thin and unequal sections designing for directional solidification, minimum distortion and for overall economy- design problems of L, T, V, X and Y junctions.

Module -IV **[06]**

Advanced welding processes; PAW-electron beam welding-laser beam welding- friction welding-ultrasonic welding – diffusion welding-high velocity oxy fuel processes

Design of welded components symbolic representation of welds on drawings- welding classes-residual stresses in welds weld distortions-design consideration-strength consideration of welded joints-analysis of statistically loaded welded joints-welded structures subjected to fatigue loads.

Module -V **[06]**

Casting defects, inspection, diagnosis and rectification, Cleaning and inspection of castings – Casting defect and remedies – foundry automations-moulding machines-Automation of sand plant, moulding and fettling sections of foundry-Dust and fume control- energy and waste management in foundries, quality assurance in welding, effects of welding fumes on environment

Welding defects – causes and remedies – Non Destructive tests – weldingmechanization and automation in foundries arc welding using robots-weld positioner and manipulators –weld seam tracking-vision system-arc sensing

TEXT BOOK(S):

Principle of Metal Casting- Heine, R.W. Loper ,C. Philip and C.R.Rosenthal, McGraw Hill.

Manufacturing Technology- P.N.Rao,TMH

Welding Engineering and Technology- R.S. ParmarKhanna publisher

REFERENCE BOOK(S):

Metallurgy of Welding Technology-D. Seferian, Chapman & Hall
Welding and Welding Technology- R.Little, TMH.
Principle of Metal Casting- P.L.Jain,TMH

Course Outcomes: Upon completion of this course students will be able to:

1. Apply the knowledge to demonstrate advanced casting processes with appropriate furnace selection.
2. Analyze the thermal, metallurgical aspects during casting / weld solidification.
3. Design the gating system and riser to achieve sound casting.
4. Evaluate welding process behavior for advanced welding methods.
5. Recognize casting and welding induced defects using NDT techniques.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1	1	3	2	2	1	2	2
CO2	3	3	3	3	2	1	2	2	3	1	2	2
CO3	3	3	3	3	1	2	2	2	2	1	2	2
CO4	3	3	3	3	1	1	2	2	2	1	2	2
CO5	3	3	3	3	2	1	1	2	1	1	2	2

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	1	1	2	2	2	1	2	2

Subject Code: PE-1440 **Entrepreneurship & E-Business**

Module -I **[06]**

Entrepreneurship-definition, growth of small scale industry lies in developing countries and their positions vis-a-vis large industries, role of small scale industries in the national economy, characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; Stages in starting a small scale industry.

Module -II **[06]**

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.

Module -III **[06]**

Evaluation of E-Business Infrastructure and Capacity Planning: Quantitative analysis of authentication and payment services, Capacity planning methodologies, Performance models for e-business sites, Modelling web-server workload.

Module -IV **[06]**

Prerequisite: None Managing Business in the Digital World: Introduction, How IT has changed the concepts of traditional MIS with examples and case studies.

Module -V **[06]**

Basic understanding of e-business building blocks, Emerging e-Business models, B2B, B2C, C2C etc., Case-studies on e-auctions, electronic markets, electronic procurement, automated supply chains, e-marketing, e-customer relationship management, e-finance systems, and negotiations support systems.

TEXT BOOK(S):

Scaling for E-Business: Technologies, Models, Performance, and Capacity Planning, Daniel A. Menasc, Virgilio A. F. Almeida, Prentice Hall

Management Information Systems- Managing Information Technology in E Business Enterprises, James A. Brien, TMH

REFERENCE BOOK(S):

"Entrepreneurship" Forbat, John, New Age International.

Auction Theory, Vijay Krishna, Academic Press.

"Essential of Management", Joseph, L. Massod, Prentice Hall of India.

Course Outcomes: At the end of this course, students will

1. Understand Entrepreneurship and analyze the growth of small scale industries and national economy.
2. Implement projects through assessment and field study with accordance to Government policy for small scale industry.
3. Analyze-Business Infrastructure and Capacity Planning.
4. Manage Business in the Digital World.
5. Demonstrate and implement e-business.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	3	3	3	3	2	3	3	3
CO2	3	3	3	1	3	3	3	3	2	3	3	2
CO3	3	3	1	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	2	3	3	3	3	3	3	2	3	3	3

Subject Code PE-1441 **Quality Engineering**

Module -I **[06]**

Principles of Quality Management- Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering, Concurrent Engineering.

Module -II **[06]**

Leadership- Organizational Structure, Team Building, Information Systems and Documentation, Quality Auditing- ISO 9000- QS 9000.

Module -III **[06]**

Single Vendor Concept- JIT, Quality Function deployment, Quality Circles, KAIZEN, SGA, POKA-YOKE, Taguchi Methods.

Module -IV **[06]**

Methods and Philosophy of Statistical Process Control, Control Charts for Variables and Attributes, Cumulative sum and exponentially weighted moving average control charts, Others SPC Techniques- Process Capability Analysis- Six sigma accuracy.

Module -V **[06]**

Acceptance Sampling Problem, Single Sampling Plans for attributes, Double, multiple and sequential sampling, Military standards, The Dodge-Roming sampling plans.

TEXT BOOK(S):

Total Quality Management for Engineers- M. Zairi, Woodhead Publishing.
Introduction to Statistical Quality Control- D.C. Montgomery, John Wiley and Sons.

REFERENCE BOOK(S):

ISO 9000- A Manual for Total Quality Management- S. Dalela and Saurabh, S.Chand and Company Ltd.
Statistical Quality Control- E.L. Grant and Leavensworth, McGraw-Hill.

Course Outcomes: Upon completion of this course students will be able to:

1. Demonstrate the product quality cost along with quality monitoring.
2. Organize the concept of leadership in an organization to achieve the benchmark.
3. Evaluate for the selection of the best quality improvement technique.
4. Apply different statistical analysis tools for process control.
5. Incorporate the best sampling plan for specific quality problems.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	1	1	2	2	1	3	3
CO2	2	2	3	3	3	1	1	2	2	1	3	3
CO3	2	2	3	3	3	1	1	2	2	1	3	3
CO4	2	2	3	3	3	1	1	2	2	1	3	3
CO5	2	2	3	3	3	1	1	2	2	1	3	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	2	2	3	3	3	1	1	2	2	1	3	3

Subject Code: PSI-III **Seminar on Project**

CO1: Apply foundational knowledge of mathematics, science, and engineering to analyze, formulate, and solve complex problems, designing effective and innovative solutions with considerations for public health, safety, and the environment.
CO2: Utilize research methodologies and modern engineering tools to design experiments, interpret data, and model solutions with a clear understanding of the associated limitations.
CO3: Assess the social, cultural, and environmental impacts of engineering solutions, committing to ethical practices and promoting sustainable development.
CO4: Demonstrate effective communication skills and the ability to work collaboratively in diverse, multidisciplinary teams, while leading and managing projects effectively.
CO5: Recognize the importance of continuous learning and the need to adapt to technological advancements and changing global contexts.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	2	3	3	2	2
CO2	3	3	3	3	2	3	3	2	3	2	3	1
CO3	3	3	2	2	2	2	2	2	3	3	3	2
CO4	3	3	3	3	2	2	2	2	2	2	2	2
CO5	3	3	3	3	2	2	1	2	2	3	3	1

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	2	2	2	3	3	3	2

Subject Code: PSI-IV **Project for Product Development – III / Internship Project - II**

CO1: Apply fundamental principles of mathematics, science, and engineering to identify, analyze, and solve complex engineering problems, using research-based methods to draw valid conclusions.
CO2: Design effective solutions for engineering problems, keeping in mind public health, safety, environmental, societal, and cultural considerations, and apply modern tools with awareness of their limitations.
CO3: Make informed decisions by assessing the societal, legal, health, and environmental impacts of engineering solutions, adhering to ethical standards, and promoting sustainable development.
CO4: Function efficiently as an individual or in teams across diverse, multidisciplinary settings, while communicating complex engineering ideas effectively through reports, presentations, and clear instructions.
CO5: Apply engineering and management principles to lead and manage projects professionally, while recognizing the importance of lifelong learning in adapting to technological advancements.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	3	3	3	2	2	3
CO2	3	3	2	3	3	2	2	3	2	3	3	2
CO3	3	3	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	2	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	2	3

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High); "---": No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	3	3	3	3	3	3	3	3