Course Structure &Syllabus

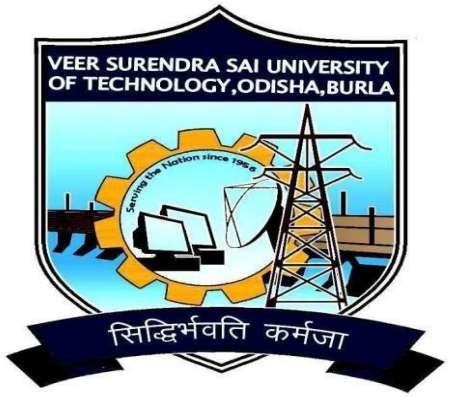
of

B. Tech. Programme

in

Production Engineering

Academic Year – 2019-20



VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, ODISHA

Burla, Sambalpur-768018, Odisha

www.vssut.ac.in

Vision:

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 socio-economic upliftment of society in order to meet the global challenges.

Mission:

Production Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

- Maintaining state of the art research facilities to provide conducive environment to create, analyze, apply and disseminate knowledge.
- Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil 'Make In India' policy of the Government.
- Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PEOs:

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 broaden and deepen their capabilities in analytical and experimental research methods, analysis of data, and drawing relevant conclusions for scholarly writing and presentation.

PEO3: To create awareness of societal impact and professional ethics so as to make the graduates enable to excel in their professional career/entrepreneurial skill/research and higher studies.

PEO4: To create a congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations by applying engineering and management principles.

PEO5: To provide opportunity to work and communicate effectively in a team and to engage in the process of life-long learning.

PSOs:

At the time of graduation, the students will be able to:

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 sector 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 ability to handle problems with professional attitude.

Program Outcomes (POs):

PO1: Ability to apply knowledge of mathematics, science and engineering to solve complex problems in production engineering.

PO2: Ability to identify, formulate, and solve complex production engineering problems using first principle of mathematics, basic science and engineering.

PO3: Ability to design, implement and evaluate production engineering projects to meet societal and environmental needs.

PO4: Ability to design and conduct complex production engineering experiments as well as to analyze and interpret the experimental data.

PO5: Ability to use the techniques, skills, and modern engineering tools necessary for relevant engineering practices.

PO6: Ability to assess impact of contemporary social issues on professional practice.

PO7: Ability to recognize the sustainability and environmental impact of the engineering solutions.

PO8: Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

PO9: Ability to work effectively as an individual and in a team.

PO10: Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

PO11: Ability to understand and apply engineering and management principles in executing projects.

PO12: Ability to 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.

PROPOSED CURRICULUM FOR B.TECH. IN PRODUCTION ENGINEERING

FIRST YEAR: FIRST SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BMA01001	Mathematics-I	3-1-0	4
2.	BCH01001	Chemistry	3-0-0	3
3.	BEC01001	Basic Electronics	3-0-0	3
4.	BIT01001	Programming for Problem Solving	3-0-0	3
5.	BCE01001	Basic Civil Engg.	3-0-0	3
SESSIONALS				
1.	BCH01002	Chemistry Lab	0-0-3	1.5
2.	BEC01002	Basic Electronics Lab	0-0-3	1.5
3.	BIT01002	Programming Lab	0-0-3	1.5
4.	BCE01002	Engineering Graphics & Design	0-0-3	1.5
NON-CREDIT				
1	BNC01001	Induction Programme and Participation in Clubs/Societies	0-0-0	0
		TOTAL	**15-1-12**	**22**

FIRST YEAR: SECOND SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BMA02001	Mathematics - II	3-1-0	4
2.	BPH02001	Physics	3-0-0	3
3.	BEE02001	Basic Electrical Engg.	3-0-0	3
4.	BHU02001	English For Business Communication	3-0-0	3
5.	BME02001	Engineering Mechanics	3-0-0	3
SESSIONALS				
1.	BPH02002	Physics Lab	0-0-3	1.5
2.	BEE02002	Basic Electrical Engg. Lab	0-0-3	1.5
3.	BHU02002	Business Communication Skills Lab	0-0-3	1.5
4.	BME02002	Workshop & Manufacturing Practices	0-0-3	1.5
NON-CREDIT				
1	BNC02001	NSS/NCC/Yoga	0-0-0	0
		TOTAL	**15-1-12**	**22**

SECOND YEAR: THIRD SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1	BMA03001	Math-III	3-1-0	4
2	BPE03001	Thermodynamics	3-0-0	3
3	BPE03002	Material Engineering & Metallurgy	3-0-0	3
4	BPE03003	Basic Manufacturing Processes	3-0-0	3
5	BHU03001	Economics For Engineers	3-0-0	3
SESSIONAL				
1	B….0300..	Instrumentation and Sensor Technology for Engg. Applications	0-0-3	1.5
2	BPE03004	Production Practice- I	0-0-3	1.5
3	BPE03005	Computer Aided Machine Drawing	0-0-3	1.5
4	BPE03006	Thermal & Materials Engineering Lab.	0-0-3	1.5
NON CREDIT				
1	BNC03001	Essence of India Traditional Knowledge/ Environmental Sciences	0-0-0	0
		TOTAL	**15-1-12**	**22**

SECOND YEAR: FOURTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BMA04001	Math IV	3-0-0	3
2.	BPE04001	Theory of Machine	3-1-0	4
3.	BPE04002	Strength of Materials	3-0-0	3
4.	BPE04003	Theory of Metal Cutting	3-0-0	3
5.	BHU04001	Organizational Behavior	3-0-0	3
SESSIONAL				
1.	BPE04004	Production Practice- II	0-0-3	1.5
2.	BPE04005	Metal Cutting Lab.	0-0-3	1.5
3.	BPE04006	Dynamics Lab	0-0-3	1.5
4.	BPE04007	Material Testing Lab.	0-0-3	1.5
NON CREDIT				
1	BNC04001	Environmental Sciences/ Essence of India Traditional Knowledge	0-0-0	0
2	BNC04002	Summer Internship/ Training	0-0-0	0
		TOTAL	**15-1-12**	**22**

THIRD YEAR: FIFTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BPE05001	Design of Machine Elements	3-0-0	3
2.	BPE05002	Inspection and Metrology	3-0-0	3
3.	BPE05003	Tool Design	3-0-0	3
4.		Professional Elective-I	3-0-0	3
5.		Open Elective-I	3-0-0	3
6.		Professional Ethics, Professional Law &Human Values / Financial Management, Costing, Accounting, Balance Sheet & Ratio Analysis	2-0-0	2
SESSIONAL				
1.	BPE05004	Machine Design Sessional	0-0-3	1.5
2.	BPE05005	Metrology Lab.	0-0-3	1.5
3.	BPE05006	Tool Design Sessional	0-0-3	1.5
		TOTAL	**17-0-9**	**21.5**

Professional Elective-I		
Sl.No.	Course Code	Subjects
1.	BPEPE501	Measurement & Instrumentation
2.	BPEPE502	Advanced Casting & Welding
3.	BPEPE503	Production Planning & Control
4.	BPEPE504	Maintenance Engineering & Management

Open Elective-I		
Sl.No.	Course Code	Subjects
1.	BPEOE501	Maintenance Engineering & Management
2.	BPEOE502	Logistics & Supply Chain Management
3.	BPEOE503	Mechatronics

THIRD YEAR: SIXTH SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BPE06001	Theory of Metal Forming	3-0-0	3
2.	BPE06002	Principle of Machine Tools	3-0-0	3
3.		Professional Elective-II	3-0-0	3
4.		Professional Elective-III	3-0-0	3
5.		Open Elective-II	3-0-0	3
6.		Financial Management Costing, Accounting, Balance Sheet & Ratio Analysis/ Professional Ethics, Professional Law &Human Values	2-0-0	2
SESSIONAL				
1.	BPE06003	Metal Forming Lab	0-0-3	1.5
2.	BPE06004	Fluid Dynamics Lab.	0-0-3	1.5
3.	BPE06005	Simulation Lab.	0-0-3	1.5
NON CREDIT				
		Summer Industry Internship/ Training/ Project	0-0-0	0
		TOTAL	**17-0-9**	**21.5**

Professional Elective-II		
Sl.No.	Course Code	Subjects
1.	BPEPE601	Fluid Mechanics & Fluid Power Engineering
2.	BPEPE602	Manufacturing & Design of Composites
3.	BPEPE603	Industrial Hydraulics
4.	BPEPE604	Precision Engineering
Professional Elective -III		
Sl.No.	Course Code	Subjects
1.	BPEPE605	Statistical Methods and Design of Experiments
2.	BPEPE606	Finite Element Method in Manufacturing
3.	BPEPE607	Production and Operation Management
4.	BPEPE608	Advanced Material Science
Open Elective-II		
Sl.No.	Course Code	Subjects
1.	BPEOE601	Automotive & System Engineering
2.	BPEOE602	Production and Operation Management

FOURTH YEAR: SEVEN SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1.	BPE07001	Automation and NC Machine	3-0-0	3
2.	BPE07002	Non Traditional Machining	3-0-0	3
3.		Professional Elective- IV	3-0-0	3
4.		Open Elective-III	3-0-0	3
SESSIONAL				
1.	BPE07003	NTM & FMS Lab.	0-0-3	1.5
2.		Project – I	0-0-6	3
3.		Seminar on internship	0-0-3	1.5
		TOTAL	**12-0-12**	**18**

Professional Elective-**IV**		
Sl.No.	Course Code	Subjects
1.	BPEPE701	Engineering Ergonomics
2.	BPEPE702	Surface Engineering Principles &Systems
3.	BPEPE703	Design for Manufacturing & Assembly
Open Elective **-III**		
Sl.No.	Course Code	Subjects
1.	BPEOE701	Performance Measurement & Benchmarking
2.	BPEOE702	Total Quality System and Engineering
3.	BPEOE703	Project Management

FOURTH YEAR: EIGHT SEMESTER				
THEORY				
S/N	Code	Subject	L-T-P	Credits
1		Professional Elective-V	3-0-0	3
2		Professional Elective-VI	3-0-0	3
3		Open Elective-IV	3-0-0	3
SESSIONALS				
1		Project II	0-0-12	6
2		Seminar on Project	0-0-2	1
		TOTAL	**9-0-14**	**16**

Professional Elective-**V**		
Sl.No.	Course Code	Subjects
1.	BPEPE801	Robotics & Flexible Manufacturing Systems
2.	BPEPE802	Plant layout & Automated Material Handling
3.	BPEPE803	Micro Electro-Mechanical Systems
4.	BPEPE804	Quality Assurance & Reliability

Professional Elective-**VI**		
Sl.No.	Course Code	Subjects
1.	BPEPE805	Rapid Prototyping & Tooling
2.	BPEPE806	Computer Integrated Manufacturing
3.	BPEPE807	Safety Engineering

Open Elective-**IV**		
Sl.No.	Course Code	Subjects
1.	BEPEOE801	Micro Electro-Mechanical Systems
2.	BEPEOE802	Entrepreneurship & E-Business

DETAILS SYLLABI
FIRST SEMESTER

B. Tech.: Mathematics-I (Calculus and Linear Algebra) (BMA01001) [3-1-0]

Module 1: Calculus (8 Lectures)

Rolle's theorem, Mean value theorems (statements only) and applications. Introduction to improper integrals. Beta and Gamma functions and their properties.

Module 2: Calculus (8 Lectures)

Convergence of sequence and series, tests of convergence. Fourier series, arbitrary period, even and odd function, half range series.

Module3: Calculus (8 Lectures)

Limit, continuity and partial derivatives (two variables), maxima and minima. Vector and scalar point functions and fields, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field and applications

Module 4:* Linear Algebra *(8 Lectures)

Linear systems of equations, Gauss elimination, linear independence, rank of a matrix, Gauss-Jordan elimination. Vector Space; basis and dimension'

Module 5:* Linear Algebra *(8 Lectures)

Eigenvalues, eigenvectors, some applications of eigenvalue problems, symmetric, skew-symmetric and orthogonal matrices, diagonalization, quadratic forms, complex matrices and forms.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics (9th Edition), Wiley India Pvt. Ltd
2) S.C. Malik and S. Arora, Mathematical Analysis, New Age International

Reference Books:

1) George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry, Addison Wesley Publishing Company
2) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
3) A. Stroud, Advanced Engineering Mathematics, Industrial Press
4) S.K. Paikray,Text book of Matrix Algebra, Kalyani Publisher

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Recognize basic knowledge of differential calculus, improper integral, Beta and Gamma functions which are useful in various fields of engineering
CO2	Analyse periodic phenomenon and describe Fourier series expansion of periodic function
CO3	Demonstrate functions of several variables that is essential in most of the branches of engineering
CO4	Apply Gauss elimination method and rank of a matrix in solving linear equations
CO5	Implement knowledge of eigenvalues and eigenvectors in a comprehensive manner

Course Articulation Matrix

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

Subject: Chemistry (BCH01001) **Credits: 4 [3-1-0]**

Module–I (9 Hours)

Schrodinger Wave equations (not to be derived), Application to particle in ID box.
Molecular rotational (microwave) spectroscopy: Basic principle and application to diatomic molecules, selection rules.
Molecular vibrational (IR) spectroscopy: Basic principle, types of vibrations and vibrational frequency, application to Harmonic and anharmonic oscillators, selection rules, modes of vibration.
Electronic (UV-Visible) spectroscopy: Basis principle, types of electronic transitions, The Franck - Condon principle, and Jablonski diagram.

Module – II (9 Hours)
Thermodynamics of Chemical Processes:

Concept of Entropy and free energy, Chemical Potential, Equilibrium Conditions.

Phase equilibria:

Phase, Components, Degree of Freedom, Phase Rule Equation.

Phase Diagrams: One Component Systems – Water and Sulphur, Basic idea of (a) Peritectic system, (b) Eutectoid system, (c) Binary phase diagrams of Pb-Ag & Fe-C system.

Module–III (9 Hours)

Electrochemistry:

Electrode Potentials and its Relevance to Oxidation and Reduction, Types of electrodes, Galvanic cell, Measurement of EMF and application of EMF measurements, Types of reference electrodes (Hydrogen, Glass, Quinhydrone Electrodes,) Determination of pH, Electrochemical energy systems its types (Dry Cells, lead acid cell and Fuel Cells: Construction, reaction, advantages and applications).

Corrosion: Concept, types of corrosion, dry or chemical and wet or Galvanic/electrochemical Corrosion, Factors affecting corrosion.

Module–IV (9 Hours)

Kinetics of complex Chemical Reactions: Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain reaction.

Module-V (9 Hours)

Chemistry of engineering materials:

Nanomaterials: Applications of nanomaterials.

Organometallics: Application of organometallics

Books Recommended:

1) P. W. Atkins, Elements of Physical Chemistry, 4th Edition, Oxford University Press
2) C. N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy, 5th Edition,
3) P. K. Kar, S. Dash and B. Mishra, B.Tech. Chemistry Vol. I, Kalyani Publications

Course Outcomes:

CO1: Apply the basic concept of classical mechanics and quantum chemistry to real life applications & to understand the basic concept of electromagnetic radiation, spectroscopic techniques and their applications.

CO2: Should perceive the spontaneity/feasibility of a process applying thermodynamics concepts and to keep up with the idea of phase equilibria, phase rule and its application to one and two component system.

CO3: Define the application of electrochemistry to commercial electrochemical cell and corrosion.

CO4: Able to apply the basic concept of kinetics of a reaction to complex reactions.

CO5: To demonstrate the properties and applications of organometallics and nanomaterials.

Course Articulation Matrix

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

Program Articulation Matrix

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

BASIC ELECTRONICS (BEC01001)

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Electronics: - Signals, Frequency Spectrum of Signals, Analog and DigitalSignals, Linear Wave Shaping Circuits: - RC LPF, Integrator, RC HPF, Differentiator. Properties of Semiconductors: - Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors, Diodes: - p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode.	**12**
MODULE 2	Bipolar junction Transistor (BJTs):- Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch. Introduction to Power Amplifiers: - A,B and Ctypes. JFET:- Physical Structure, Operation and Characteristics	**10**
MODULE 3	Feedback Amplifiers: - General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Practical feedback circuit. Operational Amplifiers (OP-AMPs): - The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).	**08**
MODULE 4	Digital Fundamentals:- Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip Flop	**06**
MODULE 5	Introduction to Electronic Instruments: - CRO: CRT, Waveform Display, Applications of CRO, Electronic Multimeter, Audio Signal Generator: - Block diagram, Front Panel Controls. Principles of Communication:- Fundamentals of AM & FM, Block diagram of Transmitters	**06**
TEXT BOOK	**1.** Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford UniversityPress. Selected portions from chapters 1 to 3, 5, 8,13. **2.** Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, New Age International Publications. Selected portions fromchapters 4 to 12, 14, 16 to 18,20,21.	
REFERENCE BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad and L.Nashelsky, PearsonEducation.	

COURSE OUTCOME: After completion of course student should be able to

1. Understand different types of signals and its application to semiconductor devices andcircuits.
2. Understand different BJTs and itsoperation.
3. Understand the Feedback Amplifiers and Operational Amplifiers.
4. Understand fundamentals of different Digital arithmetic operations and Digitalcircuits.
5. Understand some important Electronic Instruments and Communicationsystems.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement different types of signals and its application to semiconductor devices and circuits.
CO2	Analyze the concept of different BJTs and its operation.
CO3	Express the concept of the Feedback Amplifiers and Operational Amplifiers.
CO4	Apply fundamentals of different Digital arithmetic operations and Digital circuits.
CO5	Demonstrate basic principles of important Electronic Instruments and Communication systems.

Relationship of Course Outcomes (CO) to Program Outcomes (PO)

1 – Low 2 – Moderate 3 – High

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

Program Articulation Matrix row for this Course

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

PROGRAMMING FOR PROBLEM SOLVING (BIT01001)

L-T-P: 3-0-0 **Cr.-3**

Module I: **(8 Lectures)**

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

Module II: **(8 Lectures)**

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.

Module III: **(8 Lectures)**

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.

Module IV: **(8 Lectures)**

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.

Module V: **(8 Lectures)**

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.

Text Books:

1. Programming in ANSI C, E Balaguruswamy
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.

Reference Books:

1. Let us C- Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
3. C How to Program- Deitel and Deitel, Pearson Education.
4. The C Programming Language- Brian W. Kernighan and Dennis M. Ritchie, PrenticeHall.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

1. grasp the fundamentals of Computer and problem solving.
2. conceptualize fundamentals of C Programming along with control structures.
3. Implement different problems on functions and arrays.
4. Apply pointers structures and unions for problem solving.
5. Gain knowledge of pre-processor directives and file operations.

Course Articulation Matrix

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

Basic of Civil Engineering (BCE01001)

Module-II

Introduction to Civil Engineering – Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country.

Introduction to types of buildings as per NBC, Selection of site for buildings, Components of a residential building and their functions, Introduction to Industrial buildings and types.

Building Planning – Basic requirements, elements, introduction to various building area terms, computation of plinth area, carpet area.

Module-II

Surveying – Principle and objectives, Instruments used, Horizontal measurements, Ranging (direct ranging only), Instruments used for ranging, Leveling – Definition, Principles, Instruments, Preparation of level book, problems on leveling, Modern surveying instruments – EDM, Total station, GPS (Brief discussion)

Building Materials – Bricks, properties and specifications, Cement – Types, properties, grades, other types of cement and uses, Cement mortar – Constituents, Preparation, Concrete – PCC and RCC, Grades, Steel – Use of steel in buildings, types.

Module-III

Building Construction – Foundations, Classification, Bearing Capacity of Soil and related terms (definition only), Masonry Works – classifications, definition of different technical terms, Brick masonry – types, bonds, general principle, Roofs – functional requirements, basic technical terms, roof covering material, Floors – function, types, flooring materials(brief discussion), Plastering and Painting – objectives, types, preparation and procedure of application.

Module-IV

Basic Infrastructure services – air conditioning & purpose, fire protection & materials, Ventilation, necessity & functional requirements, Lifts, Escalators.

Introduction to planning and design aspects of transportation engineering, Transportation modes, Highway engineering – historical development, highway planning, classification of highway, Railway Engineering – cross section of rail track, basic terminology, geometric design parameter(brief discussion only).

Module-V

Airport engineering – development, types, definition, characteristics of aircraft, basic terminology, Traffic engineering – traffic characteristics, traffic studies, traffic operations (signals, signs, markings), Urban engineering – classification of urban road.

Irrigation & Water Supply Engineering – Introduction, Types of Irrigation, different types of hydraulic structures, dam and weirs, types of dam, purpose and functions.

Text Books:

- Basic Civil engineering, Gopi, S., Pearson Publication
- Basic Civil Engineering, Bhavikatti, S. S., New Age.

Reference Books:

- Construction Technology, Chudley, R., Longman Group, England
- Basic Civil and Environmental Engineering, C.P. Kausik, New Age.
- American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application

Course Outcomes:

- Analyze the fundamental aspect of building planning.
- Summarize general aspect of building material and surveying.
- Explain about building constructions.
- Judge transportation modes and planning.
- Describe about Airport & Irrigation Structures.

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

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

SESSIONAL

B Tech Chemistry Lab: BCH01002

List of Experiments to be done (Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Standardization of KMnO4 using sodium oxalate.
5. Determination of ferrous iron in Mohr's salt by potassium permanganate.
6. Determination of Rate constant of acid catalyzed hydrolysis of ester.
7. Determination of dissolved oxygen in a sample of water.
8. Conductometric titration of strong acid and strong base
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pensky Marten's Flash Point Apparatus.
11. Determination of available chlorine in bleaching powder.
12. Preparation of acidic and basic buffer solution and measurement of PH using PH meter

Book Recommended:

B. Tech Practical Chemistry- .

Course Outcomes:

CO1: Develop knowledge of concepts and applications of chemistry, important laboratory analytical techniques, and instrumentation.

CO2: Apply fundamental principles for environmental analytical methods.
CO3: Identify suitable analytical techniques for analysing a specific compound in a sample and ensure quality control.
CO4: Implement suitable techniques for sampling and handling of environmental and chemical samples.
CO5: Hands on training on using different laboratory apparatus and equipments including data analysis and conclusions.

Course Articulation Matrix

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

Program Articulation Matrix

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

BASIC ELECTRONICS LAB (BEC01002)

Experiment No.	CONTENT
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	Frequency response of LPF and HPF.
4	V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
5	Clipper Circuit.
6	Clamper Circuit.
7	Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
8	V-I (Output) Characteristics of N-P-N/P-N-P Transistor in CE Configuration.
9	OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
10	Verification of Truth table of Logic gates (AND, OR,NOT, NAND, NOR, EX-OR)
SUPPLEMENTARY BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad andL. Nashelsky, PearsonEducation.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement Acquire basic knowledge on electronic devices and components
CO2	Analyze different electronics circuits using semiconductor diodes.
CO3	Analyze and develop the characteristics of BJT and FET Circuits.
CO4	Apply fundamentals Operational amplifier circuits.
CO5	Implement knowledge on basic digital logic gates

Relationship of Course Outcomes (CO) to Program Outcomes (PO)

1 – Low 2 – Moderate 3 – High

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

Program Articulation Matrix row for this Course

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

PROGRAMMING FOR PROBLEM SOLVING LAB (BHU01002)

L-T-P: 0-0-3 **Cr.-1.5**

Topics to be covered:

1. Programs using Input – Output functions.
2. Programs on variable declaration, assignments, operators and typecasting.
3. Program on selection & iterative constructs.
4. Programs on functions.
5. Programs on arrays.
6. Programs on string manipulation.
7. Programs on pointers.
8. Programs on structure & union.
9. Programs on file handling.
10. A mini-project to be designed by students using features of C.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1: Implement the basicsof C programming.

CO 2: Exercise conditional and iterative statements to develop programs.

CO 3: Exercise user defined functions to solve real time problems.

CO 4: Demonstrate the concept of pointers to access arrays, strings and functions.

CO 5: Create C programs on file manipulations.

Course Articulation Matrix

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

Engineering Graphics & Design (BCE01002)

Course Content

Module-I

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning.

Scales: Plain, Diagonal and Vernier Scales.

Module-II

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Module-III

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids. Sections of solids; Development of surfaces

Module-IV

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simpleand compound Solids.

Module-V

Introduction to Auto-Cad:

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute

Reference Books:

1 Engineering drawing by N.D. Bhatt and V.M Panchal, Charotar Publishing House, Anand.

Engineering Drawing by Venugopal, New Age publisher.

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.

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

	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**

SECOND SEMESTER

Mathematics-II (Differential Equations and Complex Variables) (BMA02001) [3-1-0]

Module 1: **Differential Equations** ***(8 Lectures)***

Exact ODEs, integrating factors, linear ODEs, Bernoulli equation, homogeneous linear odes of second order, homogeneous linear ODEs with constant coefficients, Euler-Cauchy equations, non-homogeneous ODEs, Applications of ODEs to electric circuits

Module 2: **Power Series Solution of Differential Equations** ***(8 Lectures)***

Series solution of differential equation (excluding Frobenius method), Legendre's equation, Legendre polynomials. Bessel's Equation, properties of Bessel's functions, Bessel Functions of the first and Second Kind.

Module 3: **Complex Variables** ***(8 Lectures)***

Complex valued function, differentiation, analytic function, Cauchy-Riemann equations, harmonic and conjugate harmonic functions, exponential function, trigonometric and hyperbolic functions, logarithm, general power

Module 4: **Complex Variables** ***(8 Lectures)***

Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, power series, radius of convergence, Taylor and Maclaurin series, singularities and zeros, Laurent series, Cauchy residue theorem (statement only) and applications.

Module 5: **Elementary Numerical Methods** ***(8 Lectures)***

Solution of algebraic and transcendental equations by Newton-Raphson and secant method.

Interpolation: Lagrange's method, divided difference method, Newton's forward and backward method. Numerical Integration: Trapezoidal and Simpson's Rule. Numerical solutions of differential equations: Euler's method and improved Euler's method.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition.

Reference Books:

1) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press
2) Milton Abramowitz and Irene A. Stegun, *Handbook of Mathematical Functions*, National Bureau of Standards, Applied Mathematics Series - 55
3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
4) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of the effective mathematical tools for the solutions of differential equations that models various physical processes
CO2	Describe power series solution of differential equations
CO3	Demonstrate analytic functions and applications of Cauchy-Riemann equations
CO4	Evaluate integration of complex valued functions, and apply Taylor and Laurent series expansions of functions in various fields of engineering problems
CO5	Compute roots of algebraic and transcendental equations, and also evaluate the integrals by Trapezoidal and Simson's rules

Course Articulation Matrix

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

ENGLISH FOR BUSINESS COMMUNICATION (BHU02001)

Course Description

The course is designed to give students a comprehensive view of communication, its scope and importance in business, and to build the proficiency needed to succeed in today's technologically enhanced workplace. Effective communication is an integral part of life. This course focuses on improving the LSRW skills, i.e. listening, speaking, reading and writing of the students. Students will learn how to communicate effectively though the prescribed syllabus followed by an intensive practice in the language lab. This integrated approach of theory and language lab sessions will help students to communicate clearly with an impact, by improving their verbal and non-verbal communication style, as well as enhancing their competency in grammar and pronunciation. This course further tries to conversant students with the correct practices and strategies in drafting effective business correspondence.

Syllabus

Module 1: Fundamentals of Communication (6 Hours)

- Process of Communication, Types of Communication (Verbal & Non Verbal)
- Channels of Business Communication
- Barriers to Communication.
- Plain English
- Bias free language
- Cross Cultural Communication

Module 2: Communicative Grammar (6 Hours)

- Time and Tense
- Aspects (Perfective & Progressive)
- Verbs of State and Event
- Passive and Active Voice
- Conditionals

Module 3: Sounds of English (06 Hours)

- 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

Module 4: Business Writing (06 Hours)

- Paragraph writing
- Sentence Linker
- Business Letters
- Report Writing
- Proposal writing

Module 5: Professional Writing (06 Hours)

- Notice, Circular and Memo writing
- Agenda & Minute writing
- Writing Cover letter
- Résumé (CV) Writing

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
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)

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of 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 the public health and safety, and the cultural, societal, and environmental considerations.
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: 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 own 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.

Course Outcomes

Upon completion of the course the students will demonstrate the ability to:

CO1	Analyse various components of human communication and to identify key elements and principles of organizational communication.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Evaluate students' ability to articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Write various business documents appropriate for different business and employment situations.

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

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

ENGINEERING PHYSICS (BPH02001)

Module-I PROPERTIES OF MATTEER

Ideas of Elastic Constants (Y, K, η and σ), relation between elastic constants, torsion pendulum, determination of η, cantilever at one end.

Module-II OSCILLATION AND WAVES

Review of Simple Harmonic Oscillation and application to Compound pendulum, Damped Harmonic Oscillation, Forced Oscillation, Resonance, (Amplitude Resonance, Velocity Resonance, and Sharpness of Resonance).

Module-III OPTICS

Concept of Wave and wave equation, Superposition of Many harmonic waves, Interference, Concept of coherent sources (Division of wave front and division of amplitude), Interference in thin parallel film, Newton's ring (Theory, Application, Determination of Wavelength of Light, Refractive index of liquid)

Concept of Diffraction (Huygen's Principle), Types of Diffraction, Fraunhofer Diffraction due to a single slit and diffraction Grating, Determination of Wavelength, Dispersive Power and Resolving Power of a Plane Diffraction Grating, Polarization, Double Refraction, Half wave Plate, Quarter wave Plate.

Module-IV ELECTROMAGNETISM

Vector Calculus, Gradient, Divergence, Curl (Mathematical Concept), Gauss' Divergence Theorem and Stoke's Theorem (Statement Only), Derivation of Maxwell's Electromagnetic Equations in Differential form and Integral form, Electromagnetic Wave equations for $\vec{E}$ and $\vec{B}$ in vacuum and in conducting medium, Transverse nature of EM waves.

Module-V QUANTUM MECHANICS AND PHOTONICS

Wave particle duality, Matter Wave (de-Broglie Hypothesis), Wave Functions, Observables as Operators, Eigen Functions and Eigen Values, Normalization, Expectation Values, Schrodinger equation (Time Dependent and Time Independent), Particle in a box.

Lasers: Introduction and Characteristics of Lasers, Einstein's Coefficients and Relation between them, Lasing Action (Population Inversion, Three and Four level Pumping Schemes), Different types of Lasers (Ruby lasers, He-Ne Lasers).

Text Book:

1. Principle of Engg. Physics: Md. N. Khan and S. Panigrahi
2. Engg. Physics: H.K. Malik and A.K. Singh

Reference Books:

1. Oscillations and Waves: N. Subramanyam and Brij Lal
2. Optics: A. Ghatak
3. Electrodynamics: D.J. Griffith
4. Concept of Modern Physics: A. Beiser
5. Lasers: Theory and Applications: K. Thyagarajan and A.K. Ghatak

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Explain the concepts of Stress, Strain, Elastic Modulus and Elastic Constant, Bending of Beams and identify the importance Elastic properties in Engineering Applications
CO2	Demonstrate simple harmonic Oscillator, Damped Harmonic and Forced Oscillators. Express Quality factor and resonance with applications
CO3	Explain the link between Simple Harmonic Motion and Waves. Understand the principle of superposition, the need of coherent sources, analyze the difference between Interference and Diffraction and their applications. Illustrate the concept of Polarization of light and its applications.
CO4	The basic mathematical concepts related to electromagnetic vector fields, Understand the concepts related to Gauss law, Electric and magnetic Flux, Faraday‘s law, induced emf, Displacement current, Ampere’s Circuital law and Maxwell‘s equations. Expalin the transverse nature of electromagnetic wave
CO5	Identify and understand the kinds of experimental results which are incompatible with classical physics, Interpret the wave function and apply operators to it to obtain information about a particle's physical properties Solve the Schrodinger equation to obtain wave functions for some basic, physically important types of potential in one dimension Describe the requirements for a system to act as a laser. To explain lasing with need of metastable state and population inversion To explain the drawbacks of three level laser system and its solution in four level laser system.

Table	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POP11	PO12
CO1	3	3	2	2	1	-	-	1	-	1	-	1
CO2	3	3	3	2	1	-	-	1	-	1	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	2
CO4	3	3	3	2	1	-	-	1	-	1	-	2
CO5	3	3	2	3	2	-	-	2	-	2	-	2

BASIC ELECTRICAL ENGINEERING (BEE02001)

MODULE-I (8 HOURS)

D.C circuit analysis and network theorems: Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, source transformation, Kirchoff's Law: loop and nodal methods of analysis, star delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem. Transients, in R-L, R-C and R-L-C circuits with DC Excitation.

MODULE-II (8 HOURS)

Single phase and three phase ac circuit: Sinusoidal, square and triangular waveforms-average and effective value, form the peak factors, concept of phasors, phasors representation of sinusoidally varying voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, power factor improvement, resonance in series and parallel circuits, bandwidth and quality factors, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements.

MODULE-III (8 HOURS)

Magnet circuit & principle of electromechanical energy conversion: Analogy between electric and magnetic circuit, magnetic circuits with DC and AC excitation, magnetic leakage, BH curve, hysteresis and eddy current losses, magnetic circuit calculation, mutual coupling. Principles of dc motor & generator, types, emf equation of DC machine, torque equation of motor, Speed control of dc motor. characteristics and applications of DC motors.

MODULE-IV (8 HOURS)

AC MACHINES: Single Phase Transformer: Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, Introduction to auto transformers. Three Phase Induction Motor: Type, principle of operation, slip-torque Characteristics, applications. Single Phase Induction Motor: Principle of operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor, emf equation, voltage regulation, applications.

MODULE-V (7 HOURS)

Measurement Instruments & Introduction to Power System: Types of instruments: construction and working principle of PMMC and MI type voltmeter and ammeters, single phase dynamometer type wattmeter and induction type energy meter, use of shunts and multipliers: general layout of electrical power system and function of its elements, concept of grid, Introduction to power converters.

TEXT BOOKS

[1]. Edward Hughes (revised by Ian McKenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint 2002, 10th Edition.
[2]. D.Kulshreshtha, "Basic Electrical Engineering" TMH, 1st Edition.

REFERENCE BOOKS

[1]. C.L. Wadhwa, "Electrical Engineering", New Age International Publishers, 2nd Edition.
[2]. S. Parker Smith, "Problems in Electrical Engineering", Asia Publications, 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 measuring instruments and power system.

Course Articulation Matrix

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

ENGINEERING MECHANICS (BME02001)

Course Contents

Module - I (8 Hours)

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, plane frame, equilibrium of ideal systems.

Module-II (8 Hours)

Friction: Problems involving dry friction, Ladder, WedgesPrinciple of virtual work.

Module - III (8 Hours)

Parallel forces on a plane: General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves, Theorems of Pappus.

Moments of inertia: Plane figure with respect to an axis in its plane and perpendicular to the plane, Polar moment of inertia, parallel axis theorem

Module – IV (8 Hours)

Rectilinear translation: Kinematics, principle of dynamics, D Alembert's Principle,

Principle of work and energy for a particle and a rigid body in plane motion, Conservation of energy, Principle of impulse and momentum for a particle and a rigid bodies in plane motion, Conservation of momentum, System of rigid bodies, Impact, direct and central impact, coefficient of restitution.

Module – V (8 Hours)

Curvilinear translation: Kinematics, equation of motion, projectile, D Alembert's principle of curvilinear motion. Kinematics of rotation of rigid body.

Text Book:

1. Engineering Mechanics: S Timoshenko & Young; 4th Edition (International edition) McGraw Hill.

Reference Books:

1. Fundamental of Engineering mechanics (2nd Edition): S Rajesekharan& G ShankaraSubramanium; Vikas Pub. House Pvt ltd.
2. Engineering mechanics: K. L. Kumar; Tata MC Graw Hill.

Upon completion of the subject the students will be able to:

CO1	Draw free body diagrams and determine the resultant of forces and/or moments.
CO2	Solve the problems involving dry friction.
CO3	Determine the centroid and second moment of area of sections.
CO4	Apply Newton's laws and conservation laws to elastic collisions and motion of rigid bodies.
CO5	Determine the various parameters in projectile motion.

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

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

PHYSICS LABORATORY (BPH02002)

List of Experiments

1. Determination of acceleration due to gravity by using Bar pendulum
2. Determination of surface tension of water by capillary rise method
3. To draw the characteristics of a bipolar junction transistor
4. To determine the rigidity modulus of the material of a wire by using Barton's apparatus.
5. Determination of wave length of monochromatic light with the help of Newton's ring apparatus.
6. Determination of grating element of a diffraction grating using spectrometer.

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	Analyze the mechanical properties of any material with the idea of elasticity and its various applications.
CO5	Implement the measurement of different characteristic properties and related calculations of optical devices.

Course Articulation Matrix

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

BASIC ELECTRICAL ENGINEERING LABORATORY (BEE02002)

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 as per ISS
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance.
6. Starting of Induction motor and measurement of three phase power & power factor by 2-wattmeter method.
7. Callibration of a single phase Energy Meter by directed loading & Phantom loading.
8. Obtaining the voltage, current, power and power factor of fluorescent lamp.
9. 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.
10. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform

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 laboratory.
CO2	Demonstrate the working and operational characteristics of dc motor and dc generator.
CO3	Evaluate the voltage, current, power and power factor of fluorescent lamp.
CO4	Implement the measurement of earth resistance and insulation resistance and demonstrate the internal structure of different machines.
CO5	Analyze the connection and calibration of single phase energy meter, three phase power and power factor by two wattmeter method and basic idea about converters.

Course Articulation Matrix

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

Business Communication and Presentation Skills Lab (BHU02002)

Course Description

Good communication skills are indispensable for the success of any professional. The English language, in particular, has become essential in the lives of young engineers who aspire to build their careers anywhere in the world. In this regard the language laboratory plays an important role in developing the students' basic proficiency in English. Since a large number of engineering students completed their education from vernacular medium schools, they lack the basic English language proficiency which is a detrimental factor during recruitment drives in engineering colleges. In this context the language laboratory is very helpful in practicing and assessing students' speech in different communication environments. It provides them facilities to learn pronunciation, accent, stress and rudimentary communicative English grammar along with various practice sessions like presentations, group discussions, debates, case studies which are the part and parcel of corporate life.

Syllabus (Assignments)

1. Functional English grammar: Practice and exercises
2. Practice of English phonemes
3. Reading comprehension
4. Drafting business correspondence
5. Understanding the importance of body language
6. Oral presentations (Self Introduction, Extempore, Formal Presentation, power point presentations etc.)
7. Group discussion
8. Preparation for appearing an interview
9. Situational conversation practice

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
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)

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of 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 the public health and safety, and the cultural, societal, and environmental considerations.
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: 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 own 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.

Course Outcomes

Upon completion of the sessional the students will demonstrate the ability to:

CO1	Analyse various components of effective human communication and to apply them during various practice sessions.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Confidently face various recruitment drives and qualify them.

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

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

WORKSHOP & MANUFACTURING PRACTICES (BME02002)

Course content

1. **Carpentry Section**:

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

   Preparation of Job:
   Wooden rack/bench/chair/stool (any one)

   Includes the operations:

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

2. **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.

3. **Black Smith Section**:

   Study of different Hand tools, equipments, Open hearth furnace and Induction furnaces used in Blacksmith work. Different types of heat treatment processes. Safety precautions.

Preparation of Job:

Weeding hook/Hexagonal headed bolt/Chisel (any one)

Includes the operations:

Measuring, Marking, Cutting, Upsetting, Drawing down, Bending, Fullering and Quenching.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring instruments and machine tools are used in Fitting, Carpentry and Smithy work.
CO2	Know about different types of operations and joints performed in different shops i.e. in Fitting and Carpentry.
CO3	Know about the 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 skills for the preparation of different types of jobs Carpentry/fitting/smithy shops by using different types of hand tools and machine tools.
CO5	Understand the importance of safety precaution in different shops.

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

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

THIRD SEMESTER

Mathematics-III (Transforms, Probability and Statistics and Multi variate Analysis) [3-1-0]

(BMA03001)

Module 1: **Laplace Transforms** ***(10 Lectures)***

Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and integrals, solution of ODEs, unit step function, Dirac's delta function, differentiation and integration of transforms, convolution, integral equations.

Module 2: **Fourier Transforms** ***(8 Lectures)***

Basic concept of Fourier integral, Fourier sine and cosine integral, condition of convergence, Fourier transformation, Fourier sine transform, Fourier cosine transform, properties.

Module 3: **Probability** ***(6 Lectures)***

Random variables, probability distributions, mean and variance, Binomial, Poisson and hyper-geometric distributions, Normal distribution.

Module 4: **Statistics** ***(8 Lectures)***

Random sampling, point estimation of parameters, maximum likelihood estimation, confidence intervals, testing of hypotheses for mean and variance, correlation and regression.

Module 5: **Multi-variate Analysis** ***(8 Lectures)***

Line integrals, double integrals, change of order, Green's theorem (statements only), surface integrals, triple integrals, Divergence theorem of Gauss (statements only), Stoke's theorem (statements only) and applications.

Text Book:

Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition

Reference Books:

1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of Laplace and Fourier transforms, and apply this idea to solve differential equations
CO2	Describe unit step function and Dirac's delta function which are useful in engineering problems
CO3	Apply Binomial, Poisson and Normal distributions in probabilistic models
CO4	Demonstrate random sampling and estimation of parameters
CO5	Evaluate multiple integrals and with various applications

Course Articulation Matrix

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

Subject Code: BPE03001	Thermodynamics

Pre-Requisite:		Co-requisite:	

Module -I	[06]
1.Basic Concepts: Thermodynamic systems and surrounding, state properties, processes and cycles. Thermodynamic equilibrium, heat and work transfer across boundaries, Quasi-static processes. 2.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.	

Module -II	[06]
3.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. 4.Air Standard Cycle & Introduction to I.C. Engine: Otto, diesel and dual cycles, description and operation of four and two stroke cycle engine, comparison of SI and CI engines, valve timing diagram, power output and efficiency calculation.	

Module -III	[06]
5.Steam And Steam Generator: Properties of steam, measurement of dryness fraction, use of steam table. T-S and H-S diagrams for representing thermodynamic processes. Boiler, Classification of boiler, comparison between water tube boiler and fire tube boiler. Boiler mountings and accessories. Description of Cochran & Babcock -Wilcox boiler. 6.Steam Nozzles: Types of nozzles, isentropic flow through nozzles, Effect of friction on nozzle efficiency. Critical pressure ratio and maximum discharge, throat and exit area.	

Module -IV	[06]
7.Steam Turbines & Condensers: Turbine type and applications. Impulse turbine, pressure and velocity compounding, velocity diagram, work output, losses and efficiency. Impulse reaction turbine, velocity diagram, degree of reaction, work output, losses and efficiency. Jet and surface condensers. Condenser vacuum and vacuum efficiency.	

Module -V	[06]
8.Heat Transfer: Basic modes of heat transfer, one dimensional steady state, conduction through slab, cylinder and sphere; basic theory of radiant heat transfer, black body & mono chromatic radiation, total emissive power.	

TEXT BOOK(S):

1.	Engineering Thermodynamics by P. K. Nag, TMH
2.	Fundamentals of Thermodynamics by Sontag,Borgnakke,VanWylen. Willey Publisher.

REFERENCE BOOK(S):

1.	Thermodynamics, An Engineering Approach by Cengel and Boles. Publisher: McGrawhill
2.	Thermodynamics by Moran and Sapiro Publisher: Willey

COURSE OUTCOMESS:

1.	Ability to demonstrate properly about basic concepts and first law of thermodynamics.
2.	Ability to describe second law of thermodynamics and air standard cycles relating to I. C. engines.
3.	Ability to illustrate about details of steam and various types steam generators and steam nozzles.
4.	Ability to describe working principles of various types of steam turbines and condensers.
5.	Ability to illustrate physics of different modes of heat transfer in day-to-day usages of various appliances.

Course Articulation Matrix

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

Subject Code: BPE03002	Material Engineering & Metallurgy

Pre-Requisite:	None	Co-requisite:	None

Module -I **[10]**

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.

Module -II **[08]**

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.

Module -III **[12]**

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.

Module -IV **[05]**

Heat treatment- Iron-carbon system. Annealing, normalizing, hardening, critical cooling rate, hardenability, age hardening, surface hardening, tempering.

Module -V **[05]**

High temperature materials, materials for cryogenic application, thermally insulating materials. Steels: High Speed Steel, Stainless Steel and Tool Steels.

TEXT BOOK(S):

1. Introduction to Physical Metallurgy – S.H. Avner, TMH.
2. Material Science and Engineering- V.Raghavan, PHI.

REFERENCE BOOK(S):

1. Material Science and Engineering: An Introduction- W.D.Callister, Wiley.
2. Physical Metallurgy - V. Raghavan, PHI.

COURSE OUTCOMESS: 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		2	3	3	2		2					3
CO2		2	3	3	2		2					3
CO3		2	3	3	2		2					3
CO4		2	3	3	2		2					3
CO5		2	3	3	2		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		2	3	3	2		2					3

Subject Code:BPE 03003	Basic Manufacturing Processes

Pre-Requisite:		**Co-requisite:**	

Module -I	**[08]**
Manufacturing process: Definition, Classification of manufacturing process, Sand Casting: Pattern-materials, allowances, types, molding types, molding procedure, molding and properties, testing of molding sand, cores, core materials, properties of core making. Melting and founding of cast iron, degasification, design of casting and risering, pouring and feeding of casting, casting defects and Remedies.	

Module -II	**[04]**
Special casting: Shell mould casting, investment casting, permanent mould casting, Die casting, and centrifugal casting.	

Module -III	**[07]**
Fusion welding processes: Introduction, oxy-fuel gas welding, arc welding processes-I (consumable electrode): principle, equipment, power sources, Submerged arc welding, Gas Metal Arc Welding, arc welding processes-II (non-consumable electrode): Gas Tungsten Arc Welding, Plasma Arc Welding, Other welding processes: Thermit welding, Brazing, soldering, Laser beam welding, Gas and Arc cutting,	

Module -IV	**[05]**
Solid state welding process: Introduction, Cold welding, Ultrasonic welding, Friction welding, Resistance welding, Defects in welding.	

Module -V	**[06]**
Metal Forming Process: Introduction, Extrusion: Classification, Advantages, Limitations and applications, Wire Drawing: Classification, Advantages, Limitations and applications, Rolling: Cold and Hot Rolling processes, Classification, Advantages, Limitations and applications,Sheet Metal Working: Deep drawing process.	

TEXT BOOK(S):

3.	Manufacturing Technology (Foundation Forming & Welding)- P.N. Rao, Tata McGraw Hill.
4.	Basic Manufacturing Process- D. Mishra IndiaTech Publisher, New Delhi.
5.	Manufacturing Science- AmitabhaGhosh and A K Mallik, East-West Press Pvt. Lmt

REFERENCE BOOK(S):

3.	Principles of manufacturing materials and processes- J.S.Campbell, Tata McGraw Hill.
4.	Manufacturing Engineering and Technology, 4th Edition- S.Kalpakjian and S.R. Scsimid, Pearson Education.
5.	Materials and processes in manufacturing- DeGarmo, Black and Kohser, Prentice Hall of India.
6.	Principle of Metal Casting- Heine, Loper and Rosenthal, Tata McGraw Hill.

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

CO1	Apply basic manufacturing processes in industry and learn various aspects of casting methods. Also able to design the gating and riser system needed for casting and requirements to achieve defect free casting.
CO2	Implement various advance casting techniques in casting industry.
CO3	Demonstrate the various aspects and types of fusion welding process and their mechanism of working. Also get idea about brazing, soldering.
CO4	Analyze different welding defects and their remedies.
CO5	Implement the basic concept of metal forming process such as rolling, extrusion, wire drawing and sheet metal operation in different automobile and aerospace appliance.

Course Articulation Matrix

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

Economics for Engineers (3-0-0) (BHU03001)

Course Objectives:

- To understand the basic economic principle as a consumer in an economy
- To be able to know the utility measurement in the presence of risk and uncertainty
- To prepare the Engineering students to learn about the production process and analyse the cost/revenue data.
- To provide the foundation for engineers to make good decisions in business environment and learn about the market mechanism.
- To be able to make decision on project alternatives and justify projects on an economic basis

Syllabus:

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

Reference Books:

1. Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London
2. Varian, H. R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York
3. Salvatore, D. (2008). Microeconomics: theory and applications. Oxford University Press
4. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi
5. Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi
6. Henderson, J. M. and R. E. Quant (2011). Microeconomic Theory: A Mathematical Approach, Indian Higher Education, New Delhi
7. Intriligator, M. D., R. G. Bodkin and C. Hsiao(1995). Econometric Models, Techniques, and Applications, Pearson India, New Delhi

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of 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 the public health and safety, and the cultural, societal, and environmental considerations.
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: 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 own 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.

Course Outcomes:

Upon completion of the subject the student will be able to :

CO1	Utilise 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	-	-	-	-	-	2	2	-	-	-	3	3
CO2	-	-	-	-	-	3	2	2	-	-	2	1
CO3	-	-	-	-	-	3	3	-	-	-	3	-
CO4	-	-	-	-	-	2	2	1	1	1	3	-
CO5	-	-	-	-	-	1	2	1	2	-	3	1

Program Articulation Matrix

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

Subject Code: B 03001	**Instrumentation and Sensor Technology for Engg. Applications**

Pre-requisite:	None	**Co-requisite:**	None

COURSE OBJECTIVES: After successful completion of this course, students will able:

1.	
2.	
3.	
4.	
5.	

LIST OF EXPERIMENTS

1.	
2.	
3.	
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9.	
10.	

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

Subject Code:BPE03004			**Production Practice- I**
Pre-requisite:	None	**Co-requisite:**	None

COURSE OBJECTIVES: After successful completion of this course, students will able:	
1.	To introduce different types of material removal processes.
2.	To understand the principles of operations of lathe, milling machine and shaper & planner.

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	
1.	Work on centre lathe for taper & thread cutting.
2.	Produce gears in milling machine and gear hobbing machine.
3.	Create a plane surface using planner machine tool.
4.	Modify surface by using surface grinding machine of a job.
5.	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			3	2	3		3	2
CO2	3	3	3	3			2	3	1		2	3
CO3	3	3	3	3			2	2	2		2	2
CO4	3	3	3	3			2	2	2		2	2
CO5	3	3	3	3			1	1	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	3	3			2	2	2		2	2

Subject Code: BPE03005	**Computer Aided Machine Drawing**

Pre-requisite:	None	**Co-requisite:**	None

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

1 Describe the fundamentals of Computer Aided Design.

2 Use interactive graphic for generation of basic features.

3 Generate geometric modelling, curves and surfaces using the CAD software.

4 Create Assemblies for different product.

5 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						3	3
CO2	3	3	3	3	3						2	3
CO3	3	3	3	3	3						3	2
CO4	3	3	3	3	3						1	2
CO5	3	3	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	3	3	3	3	3						2	2

Subject Code: BPE03006	**Thermal & Materials Engineering Lab.**

Pre-Requisite:	None	**Co-requisite:**	None

LIST OF EXPERIMENTS	
1.	Study of IC engine (cut model)
2.	Study of modern carburetor.
3.	Study of fuel Injection system of diesel engine.
4.	Study of power Transmission system.
5.	To study the wear characteristics of a given sample.
6.	Study of micro-hardness of different materials.
7.	Microstructural Study of different steels.
8.	Heat treatment of different steels.

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		2	3	3	2		2					3
CO2		2	3	3	2		2					3
CO3		2	3	3	2		2					3
CO4		2	3	3	2		2					3
CO5		2	3	3	2		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		2	3	3	2		2					3

FOURTH SEMESTER

MATHEMATICS-IV (Numerical Methods) 4 Credits [3-1-0]

Module I: **Errors and Root Extraction** ***(8 Lectures)***

Definition and sources of error, Propagation of errors, finding roots of algebraic and transcendental equations by Bisection method, Newton's method, Secant method, fixed point iteration method.

Module I: **Interpolation** ***(8 Lectures)***

Interpolation, Lagrange's interpolation, Newton's divided differences, Forward differences, Backward differences, Central differences, Interpolation error.

Module I: **Numerical integration** ***(8 Lectures)***

Numerical integration: Newton-Cotes Integration formula (without derivation), Trapezoidal rule, Simpson's rule, Gaussian quadrature, Errors in Numerical Integration.

Module I: **Numerical Solution of Differentianal Equations** ***(8 Lectures)***

Solution of ODE's: Euler's method, Improved Euler's method, Runge-Kutta Methods of order-2 & 4.

Module I: **Numerical Solution of system of linear equations** ***(8 Lectures)***

Numerical Solution of system of linear equations, Gauss Elimination method, LU decomposition, Gauss-Jordan Elimination method, Gauss Jacobi and Gauss-seidal iteration methods

Text Books:

1. An introduction to numerical analysis, Jain, Iyengar and Jain, New Age International
2. Numerical Analysis, B. S. Grewal, Khanna Publishers

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Compile roots of algebraic and transcendental equations
CO2	Incorporate interpolating polynomial for a given set of data
CO3	Apply numerical integration methods for computing definite integrals
CO4	Describe the solution of ordinary differential equations (IVP) by using numerical methods
CO5	Demonstrate approximate solutions for system of linear equations

Course Articulation Matrix

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

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	2	1	-	-	-	-	1

Subject Code:BPE04001		**Subject name: Theory of Machine**	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I **[06]**

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.

Module -II **[06]**

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.

Module -III **[06]**

Friction of a screw and nut, square threaded crew, V-threaded screw, pivot and collar, 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.

Module -IV **[06]**

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.

Module -V **[06]**

Governors: Centrifugal Governors-watt and Porter Governors, Spring loaded Governor- Hartnell Governor, sensitiveness, stability, Isochronism, Hunting, Governor effort and power, curves of controlling force.

TEXT BOOK(S):

1. Theory of machines – S. S. Ratan, Tata McGraw Hill.
2. A Textbook of theory of machines (in S.I units) – R.K.Bansal, Laxmi Publication.

REFERENCE BOOK(S):

1. Mechanism and Machine Theory- Rao and Dukkipati, Wiley Eastern Ltd.
2. Theory of Machines –Thomas Bevan, TMH.

COURSE OUTCOMES:

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	2		3	3	3	3	2	2
CO2	3	3	3	3	2		3	2	3	3	2	2
CO3	3	3	3	3	2		3	2	3	3	2	2
CO4	3	3	3	3	2		3	2	3	3	2	2
CO5	3	3	3	3	2		3	2	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	3		3	2	3	3	2	2

Subject Code: BPE04002	**Strength of Materials**

Pre-Requisite:	Engineering Mechanics	**Co-requisite:**	None

Module -I	**[12]**
	Analysis of axially loaded members: Composite bars in tension and compression-temperature stresses in composite rods-statically indeterminate problem. 2D Stress system: Principal Planes, Principal stress, Mohr's stress circle, Members in biaxial state of stress: Stresses in thin cylinders. Strain & deformation: Two dimensional state of strain, Principal Strains, Calculation of principal stresses from principal strains, Strain measurement.

Module -II	**[04]**
	Shear force and bending moment diagrams for simple beams: Support reactions for statically determinate beams, relationship between bending moment and shear force, shear force and bending moment diagrams.

Module -III	**[04]**
	Simple bending of beams: Theory of simple bending of initially straight beams, distribution of normal and shear stress, composite beams.

Module -IV	**[06]**
	Torsion in solid and hollow circular shafts, twisting moment, strength of solid and hollow circular shafts. Deflection of Beams: Slope and deflection of beams by integration method and Macaulay's method.

Module -V	**[04]**
	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.

TEXT BOOK(S):	
6.	Strength of Materials- S.S. Rattan, TMH Publications.
7.	Strength of Materials- G.H.Ryder, Macmillan India

REFERENCE BOOK(S):	
7.	Mechanics of Materials- R.C. Hibbeler, Pearson.
8.	Mechanics of Materials-I- E.J. Hern; Paragaman.

COURSE OUTCOMESS: At the end of this course, students will demonstrate the ability to	
CO1	Apply and analyze composite bars in tension and compression, temperature stresses, 2D stress system, principal stresses, Mohr's circle, principal strains, measurement of strains.
CO2	Construct shear force and bending moment diagrams for statically determinate beams.
CO3	Analyze problems of simple bending in initially straight beams and composite beams.
CO4	Solve problems of torsion in solid and hollow shafts and to calculate slope and deflection of beams by integration and Macaulay's method.
CO5	Write buckling load in columns and to evaluate stress in the columns and to calculate dimensions of the component using theories of failure.

Course Articulation Matrix

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

Subject Code: BPE04003		Theory of Metal Cutting	
Pre-Requisite:	None	**Co-Requisite:**	None

Module -I	**[08]**
	Basic shapes of machine tools. Wedge action, function of different angles of cutting tools, tool geometry, and Nomenclatures ASA, ORS systems. Conversion of angles, geometry of twist drill & slab milling cutter, grinding of single point cutting tool. Tool materials.

Module -II	**[08]**
	Mechanism of chip formation: Mode of failure under stress- fracture & yielding mechanism. Types of chips, Factors involved in chip formation, shear plane, effect of cutting variable on chip reduction coefficient, chip formation in drilling and milling.

Module -III	**[08]**
	Force system in turning- Merchant circle diagram, velocity relationship. Stress in conventional shear plane, Energy of cutting process, Ernst & Merchant angle relationship, Forces in drilling and plane slab milling. Measurement of forces- dynamometer for measuring turning & drilling forces.

Module -IV	**[08]**
	Thermodynamics of chip formation: The shear plane temperature-interface temperature from dimensional analysis- Experimental determination of chip tool interface temperature. Coolants- Theory of cutting fluid action at the chip tool interface, Techniques for application of cutting fluids.

Module -V	**[08]**
	Tool wear: Criteria of wear. Machinability and tool life, Flank wear. Taylor's tool life equation, Crater wear, Causes and mechanism of tool failure. Vibration & chatter in machining. Economics of metal machining.

TEXT BOOK(S):

8.	Metal cutting Theory & Practice- A. Bhattacharya, C.B. Publisher
9.	Textbook of Production Engineering by Jain and Chitale. PHI Publication
10.	A course in workshop technology" Vol-II (Machine Tool)- B.S. Raghuwanshi. DhanpatRai& Co.,
11.	Production Technology- P.C Sharma

REFERENCE BOOK(S):

9.	Fundamentals of Metals machining & machine Tools- Boothroyd- International student Edition.
10.	Theory of Metal cutting- M.C. Shaw

COURSE OUTCOMESS:

1.	Analyze and Demonstrate the basics of metal machining.
2.	Develop the theoretical derivation of equations for temperature, strain, force in metal cutting.
3.	Summarize the theory of metal cutting and compute cutting forces involved from Merchant's circle.
4.	Apply the various cooling-lubrication methods to control the heat generation at the cutting zone.
5.	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	2		3			2	3	2	3		3
CO2			3		2	2	2			3	3	2
CO3	3	2		3		2			2		3	3
CO4	3	2	3	3	2	2	2			3	3	3
CO5	3		3	3				3	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	3	2	3	3	3

ORGANIZATIONAL BEHAVIOUR Credit- 3-0-0 Class Hours - 30

Syllabus

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

Reference Books

1. Stephen P. Robbins, Organizational Behaviour, Printice Hall of India, New Delhi, 2013

2. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, Bombay, 2018

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.

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of 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 the public health and safety, and the cultural, societal, and environmental considerations.
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: 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 own 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.

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

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	-	-	-	-	-	**2**	**2**	**2**	**1**	**1**	**3**	**2**
CO2	-	-	-	-	-	**1**	**1**	**1**	**3**	**1**	**-**	
CO3	-	-	-	-	-	**2**	**1**	-	**3**	**3**	**3**	-
CO4	-	-	-	-	-	-	**1**	-	**1**	**2**	**1**	**1**
CO5	-	-	-	-	-	**3**	**1**	1	**2**	**1**	3	**3**

Program Articulation Matrix

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

Subject Code: BPE04004		**Production Practice - II**	
Pre-Requisite:	None	**Co-requisite:**	Basic Manufacturing Processes
LIST OF EXPERIMENTS:			
1. Welding: Study of basic principle of Arc (A.C and D.C) and Gas Welding. A welding joint will be prepared by each student. 2. Study advanced welding technique TIG and MIG. 3. Foundry Shop: Al-sand casting, study of melting furnace. 4. Study of Brazing and Soldering process			
COURSE OUTCOMES:			
1	Apply basic principle of Arc (A.C and D.C) and Gas Welding, Brazing and Soldering.		
2	Define advanced welding technique TIG and MIG.		
3	Demonstrate and Analyze on Al-sand casting and define the working operations of melting furnace.		
4	Construct types of pattern used for making a mold for casting process.		
5	Develop a product using arc welding process.		

Course Articulation Matrix

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

Subject Code: BPE04005			**Metal Cutting Lab.**
Pre-Requisite:	Theory of Metal Cutting	**Co-Requisite:**	None

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:

6.	Demonstrate understanding of metal cutting principles and mechanism.
7.	Express the cutting tool geometry of single point and multipoint cutting tool.
8.	Evaluate the different cutting forces in turning and drilling operations.
9.	Analyze the tool vibration and chatter formation on machined surface during cutting operation.
10.	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			2	3	2			2	3	3	2
CO2	3	2	3			2	3	2				
CO3	3	2			3	2	3	2	2		3	2
CO4	3	2	3			2	3			3	3	2
CO5		2		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	2	3	2	3	2	2	3	3	2

Subject Code: BPE04006		Subject name: Dynamics Lab	
Pre-Requisite:	None	**Co-requisite:**	None

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.
7.	Determination of green compressive strength of moulding sand.
8.	Determination of grain fineness number of moulding sand.
9.	Determination of clay content in moulding sand.
10.	Determination of permeability of moulding sand.

COURSE OUTCOMES:	
CO1	Evaluate gyroscopic couple and critical speed of rotating shaft.
CO2	Analyze the performance characteristics of spring loaded governor.
CO3	Demonstrate the static and dynamic balancing apparatus and evaluate natural frequency under damped and un-damped vibration.
CO4	Construct and analyze the interference and undercutting for gear.
CO5	Demonstrate and analyze molding sand properties such as green compressive strength, grain fineness number, clay content and permeability.

Course Articulation Matrix

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

Subject Code: BPE04007	**Material Testing Lab.**

Pre-requisite:	None	**Co-requisite:**	None

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

1. Evaluate the tensile properties of mild steel specimen.
2. Evaluate the flexural strength and modulus of a given material.
3. Evaluate the hardness and compressive strength of a given material.
4. Evaluate the fatigue strength of a given material
5. 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	3	--	--	3	--	--	3	1
CO2	3	3	3	3	2	--	--	3	--	--	2	3
CO3	3	3	3	3	1	--	--	3	--	--	2	2
CO4	3	3	3	3	2	--	--	3	--	--	2	2
CO5	3	3	3	3	2	--	--	3	--	--	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	--	--	3	--	--	2	2

FIFTH SEMESTER

Subject Code :BPE05001	**Design of Machine Elements**

Pre-requisite:	Strength of Materials	**Co-requisite:**	None

Module -I	**[04]**
Morphology of design process, Basic requirements for machine, elements and machines, Design procedures, Engineering Materials, their properties and Manufacturing considerations in design.	

Module -II	**[08]**
Design of fastening elements: Riveted and welded joint for pressure vessels & structural joints, Design of bolted joint, cotter and knuckle joints.	

Module -III	**[06]**
Design of shaft, keys and couplings. Design of belt drives and pulleys.	

Module -IV	**[08]**
Design of springs: closed coil helical springs of circular section. Leaf springs. Theory of failure: Application to practical problems.	

Module -V	**[04]**
Design of IC engine components: Piston and Connecting rod	

TEXT BOOK(S):

1.	Design of Machine Elements- V.B.Bhandari, TMH
2.	Design data hand book by S.Md.Jallaludeen, Anuradha Publications

REFERENCE BOOK(S):

1.	Mechanical Engineering Design- Shigley, Mischke, Budnyas, McGraw Hill
2.	Machine Design- P.C.Sharma&D.K.Agarwal, S.K.Kataria and Sons
3.	Fundamentals of Machine Elements- Bernard Hamrock, CRC Press

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

1.	Analyze and apply the domain knowledge in selection of materials, manufacturing consideration in design.
2.	Design riveted, welded, bolted, cotter and knuckle joints.
3.	Design shafts, keys, couplings, belt drives.
4.	Design close coiled helical springs, leaf springs and theories of failure application in machine components.
5.	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	3	--	--	3	--	--	3	1
CO2	3	3	3	3	2	--	--	3	--	--	2	3
CO3	3	3	3	3	1	--	--	3	--	--	2	2
CO4	3	3	3	3	2	--	--	3	--	--	2	2
CO5	3	3	3	3	2	--	--	3	--	--	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	--	--	3	--	--	2	2

Subject Code:BPE05002	Inspection and Metrology

Pre-Requisite:		**Co-requisite:**	

Module -I	**[07]**
	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, taper, position gauges, Taylor's principle. Wear allowance, Screw allowance Screw thread gauge, Thread pitch Gauge.

Module -II	**[07]**
	Comparators: Characteristics, Relative Advantages of various types of comparators; Mechanical, Optical, Pneumatic, Fluid displacement type, Measurement of Straightness, Measurement of Circularity, Types of irregularity. Angular measurement: Sine bar, Sine center, angle gauges, Autocollimator, Tapper Measurement.

Module -III	**[06]**
	Surface Measurements: Roughness and waviness, Surface texture, cut off length, RMS & CLA values, Surface roughness measuring instruments, Principle of working. Interferometry: Introduction, optical flat, Interferometers Type.

Module -IV	**[06]**
	Metrology of screw thread: Errors in threads, Measurement of element of threads, 2-wire &3- wire methods. Gear Measurement: Gear Terminology, Measurement of error, Tooth Thickness Measurement; Gear tooth Caliper, Base Tangent Comparator, Constant Chord Method, Measurement using Rollers.

Module -V	**[04]**
	Non-destructive testing- X-ray examination, radiography, Ultrasonic inspection, magnetic test, machine vision system-principle, application, Laser inspection

TEXT BOOK(S):

12.	Engineering Metrology- R.K. Jain
13.	Production Technology- P.C. Sharma

REFERENCE BOOK(S):

11.	Engineering Dimensional Metrology- Miller, Edward Arnold pub.
12.	Precision Engineering in Metrology- R.L. Murty, New Age Int.

COURSE OUTCOMESS: 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	3	3	3			3	3		3	2
CO2	3	3	3	3	3			3	3		2	2
CO3	3	3	3	3	3			3	3		2	3
CO4	3	3	3	3	3			3	3		2	1
CO5	3	3	3	3	3			3	3		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	3			3	3		2	2

Subject Code: BPE05003			Tool Design
Pre-Requisite:	Theory of Metal Cutting	**Co-Requisite:**	None

Module -I	**[06]**
	Design of single point cutting tools, tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide tipped tools, High production cutting tools.

Module -II	**[10]**
	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

Module -III	**[06]**
	Forging Design-Upset forging, forging allowances, Forging die design, Drop forging dies and auxiliary tools.

Module -IV	**[09]**
	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.

Module -V	**[09]**
	Jigs & fixture design; Location & clamping, principles of location clamping devices, materials for locating & lamping elements, Design principles, Design of drilling jig, Milling fixture.

TEXT BOOK(S):

14.	Fundamental of tool Design- ASTME, PHI.
15.	Metal cutting theory & cutting tool design- Arshinov.
16.	A Text Book of Production Engineering- P.C. Sharma, S. Chand & Co.
17.	Tool Engineering and Design by G R Nagpal. Khanna Publishers.

REFERENCE BOOK(S):

13.	Tool Design- Donaldson, Le Cain &Goold, TMH.
14.	Fundamental of tool Engineering Design- Basu, Mukherjee & Mishra, Oxford & IBH.

COURSE OUTCOMES:

11.	Interpret the theory of metal cutting, tool life and geometry of single point and multipoint cutting tools
12.	Construct the principles of locating and clamping devices for designing the jigs and fixtures.
13.	Demonstrate to design the forging dies.
14.	Select and design dies for piercing, blanking, bending and forming operations
15.	Understand how to conduct machining economically

Course Articulation Matrix

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

Subject Code : BPEPE501		Measurement and Instrumentation	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I	**[06]**
	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.

Module -II	**[06]**
	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.

Module -III	**[06]**
	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.

Module -IV	**[06]**
	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.

Module -V	**[06]**
	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.

TEXT BOOK(S):

1	Mechanical Measurements- T.G. Beckwith & N. Lewis Buck, Oxford and IBH.
2	Modern Control Engineering- K.K. Ogata, PHI.

REFERENCE BOOK(S):

1	Instrumentation, Measurement and Analysis- B. C. Nakra, TMH.
2	Control Systems Engineering- I. J. Nagrath and M. Gopal, New Age international.

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

1	Ability to demonstrate basic detectors and transducers.
2	Ability to describe various techniques for strain measurement.
3	Ability to illustrate various methods for pressure measurement.
4	Ability to describe various techniques for temperature, vibration and shock measurements.
5	Ability to 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			3	3		2	2
2CO2	3	3	3	3	3			3	3		2	2
CO3	3	3	3	3	3			3	3		2	3
CO4	3	3	3	3	3			3	3		2	2
CO5	3	3	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
Course	3	3	3	3	3			3	3		2	2

Subject Code:BPEPE502	Advanced Casting and Welding

Pre-Requisite:	Basic Manufacturing Processes	Co-requisite:	Materials Science

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):

18.	Principle of Metal Casting- Heine, R.W. Loper ,C. Philip and C.R.Rosenthal, McGraw Hill.
19.	Manufacturing Technology- P.N.Rao,TMH
20.	Welding Engineering and Technology- R.S. ParmarKhanna publisher

REFERENCE BOOK(S):

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

COURSE OUTCOMESS:*Upon completion of this course students will be able to:*

16.	Apply the knowledge to demonstrate advanced casting processes with appropriate furnace selection.
17.	Analyze the thermal, metallurgical aspects during casting / weld solidification.
18.	Design the gating system and riser to achieve sound casting.
19.	Evaluate welding process behavior for advanced welding methods.
20.	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	2	2	2	1	2	2
CO2	3	3	3	3	1	1	2	2	2	1	2	2
CO3	3	3	3	3	1	1	2	2	2	1	2	2
CO4	3	3	3	3	1	1	2	2	2	1	2	2
CO5	3	3	3	3	1	1	2	2	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
Course	3	3	3	3	1	1	2	2	2	1	2	2

Subject Code:BPEPE503		Production Planning & Control	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I	**[06]**
	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.

Module -II	**[06]**
	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.

Module -III	**[06]**
	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.

Module -IV	**[06]**
	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.

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.

TEXT BOOK(S):

21.	KantiSwarup, P.K Gupta &Manmohan, Operations Research, Sultan Chand, Publications, New Delhi.
22.	H. A. Taha – Operations Research, Prentice Hall of India, 2007.

REFERENCE BOOK(S):

18.	Operation Research by S D Sharma
19.	Operation Research, Phillips, Rabindran and Solberg, John Wiley & Sons
20.	Ronald R. Rardin - Optimization in Operations Research, Vol. 166, New Jersey: Prentice Hall, 1998

COURSE OUTCOMESS:

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:BPEPE504/BPEOE501	Maintenance Engineering & Management

Pre-Requisite:	None	Co-requisite:	None

Module -I **[06]**

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.

Module -II **[06]**

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.

Module -III **[06]**

Maintenance organization, Resource characteristics, Resources structure, Maintenance control, Administrative structure, Training of maintenance personnel.

Module -IV **[06]**

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.

Module -V **[06]**

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.

TEXT BOOK(S):

23.	Maintenance Planning and Control- A. Kelly, East West Press.
24.	Maintenance Engineering and Management-R. C. Mishra, K. Pathak, PHI Learning Pvt. Ltd.

REFERENCE BOOK(S):

21.	Managing Maintenance Resources- A. Kelly, Butterworth-Heinemann.
22.	Handbook of Maintenance Management- Levitt Joel, Industrial Press.

COURSE OUTCOMESS:

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	-	2	3	3	3	-	2	-	2
CO2	2	3	3	-	2	3	2	-	-	-	-	-
CO3	1	-	3	-	3	3	2	2	-	2	2	2
CO4	-	-	3	-	2	2	1	2	-	2	3	2
CO5	1	3	3	-	2	3	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	1	1	3	-	2	3	2	2	-	2	2	2

Subject Code: BPEOE502	Logistics & Supply Chain Management

Pre-Requisite:	Mathematics - II	Co-requisite:	None

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):

25.	Sunil Chopra, P. Meindl, Supply Chain Management, Pearson Education Asia: Strategy, Planning, and Operation, Chopra Sunil and Meindl Peter, PHI, 5thEdition, 2013.
26.	R.P. Mohanty, S.G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt Ltd.

REFERENCE BOOK(S):

23.	Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing. : Text and Cases, JanatSaha, Pearson Education, First Edition, 2009.
24.	S.K. Bhattacharya ,Logistics and Supply Chain Management, Martin Christoper, Pearson PublicationEducation, 1998.

COURSE OUTCOMESS:

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 : BPEOE503			**Mechatronics**
Pre-requisite:	Theory of Machine, Manufacturing Science, Basic Electronics, Mathematics	**Co-requisite:**	None
Module -I			**[06]**
	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.		
Module -II			**[06]**
	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.		
Module -III			**[06]**
	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.		
Module -IV			**[06]**
	Microcontrollers: 8051 Microcontroller, Microprocessor structure, Digital Interfacing, Analog Interfacing, Applications Programming- Assembly/ C (LED Blinking, Controlling a stepper motor).		
Module -V			**[06]**
	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.		
TEXT BOOK(S):			
1.	Mechatronics- W Bolton, Pearson Education.		
2.	MEMS and Microsystems Design and Manufacture- Tai, Ran Hsu, TMH.		
REFERENCE BOOK(S):			
1.	Mechatronics Principles and Applications- G.C.Onwubolu, Butterworth-Heinemann		
2.	Foundations of MEMS- Chang Liu, Pearson International Edition.		
3.	Fundamentals of Microfabrication- Madou, CRC Press.		
COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to			
1.	Analyze the mechatronics system design and characteristics of sensors and actuators.		
2.	Define the applications of Sensors.		
3.	Recognize the applications of Actuation systems.		
4.	Design 8051 Microcontroller and Programmable Logic Controllers.		
5.	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			2			2	2
CO2	3	2	3	3	3			3			3	3
CO3	3	3	3	2	2			3			3	2
CO4	3	3	2	3	2			2			2	2
CO5	2	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	2			3			2	2

Subject Code: BPE05004	Machine Design Sessional

Assignments (Any Five)

1. Design of Components with application to theories of failure
2. Design and drawing of riveted joint
3. Design and drawing of cotter joint
4. Design and drawing of knuckle joint
5. Design of shafts subjected to combined loading
6. Design and drawing of flange coupling
7. Design of connecting rod
8. 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

1	Evaluate dimensions of a machine component subjected to complex stresses using Theories of failure
2	Design riveted joint for boiler drums and to find diameter of rivet for lozenge joint
3	Design for a cotter and knuckle joint subjected to axial load
4	Design for shafts and couplings (rigid & flexible) subjected to various loads
5	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	--	--	3	--	--	3	1
CO2	3	3	3	3	2	--	--	3	--	--	2	3
CO3	3	3	3	3	1	--	--	3	--	--	2	2
CO4	3	3	3	3	2	--	--	3	--	--	2	2
CO5	3	3	3	3	2	--	--	3	--	--	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	--	--	3	--	--	2	2

Subject Code: BPE05005	**Metrology Lab.**

Pre-requisite:	None	**Co-requisite:**	None

LIST OF EXPERIMENTS

1.	To study the Tool Maker's Microscope 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.	To study the gauge blocks or slip gauge to measure the diameter of holes and distance between their centers.

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

1.	Measure different dimensions of industrial components using various measuring instruments.
2.	Use Profile Projector to determine geometrical parameters of gear and thread.
3.	Identify the use of slip gauges and sine bar.
4.	Comprehend the fundamentals of surface roughness measuring instruments.
5.	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			3	3		3	2				
CO2	3			3	3		2	3				
CO3	3			3	3		2	2				
CO4	3			3	3		2	1				
CO5	3			3	3		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		2	2				

Subject Code: BPE05006		**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:	
1	Able to identify and design the cutting tool geometry of single point cutting tool, broach tool and form tool for industrial use.
2	Identify press tool requirements to build concepts pertaining to design of press tools
3	Prepare working drawings and setup for economic production of sheet metal components
4	Demonstrate construction of drill jig and design assembly of jigs and fixtures on simple workpiece
5	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	1			3			1	3
CO2	3	3	3	3	2			3			2	3
CO3	3	3	3	3	3			3			3	1
CO4	3	3	3	3	2			3			2	1
CO5	3	3	3	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	2			3			2	2

SIXTH SEMESTER

Subject Code :BPE06001	Theory of Metal Forming

Pre-Requisite:	Basic Manufacturing Process, Strength of Materials	Co-requisite:	None

Module -I	[08]
	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.

Module -II	[10]
	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.

Module -III	[10]
	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.

Module -IV	[06]
	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.

Module -V	[06]
	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.

TEXT BOOK(S):

27.	Mechanical Metallurgy: By- Dieter, McGraw Hill Book Co.
28.	Plasticity- Chakraborty- McGraw Hill.

REFERENCE BOOK(S):

25.	Engineering Plasticity: BY- Johson& Mellor, Van Nostrand.
26.	Metal working –Avitzur, McGraw Hill

COURSE OUTCOMESS: At the end of this course, students 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	3	3							2	2
CO2	3	3	3	3							2	2
CO3	3	3	3	3							2	2
CO4	3	3	3	3							2	2
CO5	3	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	2

Subject Code: BPE06002			**Principle of Machine Tools**
Pre-Requisite:	Theory of Metal Cutting	**Co-Requisite:**	None
Module -I			**[4]**
	General classification of machine tools, working and auxiliary motions, hydraulics transmission and its elements, mechanical transmission and its elements, general requirement of machine tools.		
Module -II			**[7]**
	Kinematics of Machine Tools:- Stepped and stepless drive, basic consideration in the design of drives, variablespeed range in machine tools, graphical representation of speed, structure diagram, selection of optimum raydiagram, design of speed and feed gearboxes, stepless regulation of speed and feed rates.		
Module -III			**[7]**
	Machine Tool Structure: Design criteria, materials, static and dynamic stiffness, basic design procedure, design of beds and columns, model technique in design of machine structures.		
Module -IV			**[7]**
	Guide ways and Power Screw: Classification of guide ways, material and lubrication, design criteria andcalculation of slide ways, design of guides under hydrostatic lubrication, aerostatic sideways, antifrictionguide ways, combination guide ways, classification of power screws, design principle of power screw,recirculation power screw assemblies, elimination of backlash.		
Module -V			**[5]**
	Control system in Machine Tools: Classification, control, Changing speeds and feeds, ergonomic considerationsapplied to design of control members, principle of automatic and adaptive control.		
TEXT BOOK(S):			
1.	Machine Tool Design- N.K.Mheta,TMH		
REFERENCE BOOK(S):			
1	Design of Machine Tools- S.K.Basu and D.K.Pal, Oxford&IBH.		
2	Principle of Machine Tools- G.C.Sen and A.Bhattacharya, New Central Book Agency		
COURSE OUTCOMESS:			
1	Describe the basic design considerations for general Machine Tools.		
2	Design stepped and step-less Drives for Machine Tools.		
3	Propose suitable designs for Machine Structures.		
4	Apply the knowledge for designing guide ways and power screws.		
5	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 : BPEPE601	Fluid Mechanics & Fluid Power Engineering

Pre-Requisite:	None	Co-requisite:	None

Module -I	[06]
	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.

Module -II	[06]
	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.

Module -III	[06]
	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.

Module -IV	[06]
	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.

Module -V	[06]
	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.

TEXT BOOK(S):

1.	Fluid Mechanics & Hydraulics Machines –By: Modi and Seth, Standard Book House, New Delhi
2.	Fluid Mechanics & Hydraulic Machines- By Dr. R. K. BansalLaxmi Pub. (p) Ltd.)
3.	Fluid Mechanics & Fluid Machines – By S. K. Som, G. Biswas& S. Chakraborty, TMH

REFERENCE BOOK(S):

1.	Introduction to Fluid Mechanics by Fox & McDonald, Willey Publisher.
2.	Fluid Mechanics by F.M White, McGraw Hill Publisher
3.	Fluid mechanics & hydraulic machines by Subramanya, TMH

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

1.	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.
2.	Apply dimensional analysis and model testing to predict physical parameters that influence the flow in fluid mechanics.
3.	Analyze concepts of drag and lift besides details of boundary layer separation.
4.	Demonstrate working principles of various types of hydraulic turbines, pumps and its applications.
5.	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	3	2			3			2	3
CO2	3	3	3	3	3			3			3	3
CO3	2	3	3	3	1			3			1	1
CO4	3	3	2	3	2			3			2	2
CO5	3	3	3	3	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	H	H	H	H	M			H			M	M

Subject Code: BPEPE602		**Manufacturing & Design of Composites**	
Pre-requisite:	None	**Co-requisite:**	None
Module -I			**[06]**
	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.		
Module -II			**[05]**
	Processing of FRP Composites: Contact Moulding process, compression moulding processes, Filament winding process		
Module -III			**[07]**
	Micromechanical Analysis of Composite strength and stiffness: volume and weight fractions, longitudinal strength and stiffness, transverse modulus, inplane shear modulus, Poission's ratio		
Module -IV			**[07]**
	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		
Module -V			**[05]**
	Analysis of laminated composites: Laminates, stress-strain relations, equilibrium equations, laminate stiffness, classical lamination plate theory.		

TEXT BOOK(S):

1.	Analysis and performance of composite materials by B.D. Agarwal, L.J. Broutman and K. Chandrasekhar, Wiely
2.	Mechanics of composite Materials by R.M.Jones, Mc Grew Hill Book Co.

REFERENCE BOOK(S):

1.	K.K.Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York
2.	Fibre-Reinfored composites-Materials, Manufacturing and Design. P.K.Mallick Marcel Dekken, Inc. New York & Basel
3.	Engineering mechanics of composite materials by Isaac M.Daniel and OriIshai, Oxford University Press

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

1.	Express classification of composite materials, merits and demerits.
2.	Demonstrate the processing of FRP composites.
3.	Analyze the micro-mechanical behavior of composites.
4.	Apply the macro-mechanical behavior of composites.
5.	Construct the laminated composites.

Course Articulation Matrix

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

Subject Code : BPEPE603		Industrial Hydraulics	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I	**[06]**
	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.
Module -II	**[06]**
	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.
Module -III	**[06]**
	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.
Module -IV	**[06]**
	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.
Module -V	**[06]**
	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.

TEXT BOOK(S):

1	Industrial Hydraulics Manual 5e. 2nd Printing- Eaton Hydraulics Training Services (Vickers).
2	Industrial hydraulics- John J. Pippenger, Tyler Gregory Hicks, Gregg Division, McGraw-Hill.

REFERENCE BOOK(S):

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

COURSE OUTCOMESS:

1	Ability to demonstrate properly about hydraulic systems and its design requirements.
2	Ability to describe working principles of various types of pumps and motors and its selection criteria.
3	Ability to illustrate details of various flow control methods besides flow and directional control valves.
4	Ability to describe working principles of various types of pressure control valves and its applications.
5	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			3			2	1
CO2	3	3	3	3	2			3			2	2
CO3	3	3	3	3	1			3			2	2
CO4	3	3	3	3	3			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: BPEPE604		Precision Engineering	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I	**[4]**
	Precision Engineering: Micromilling and Microdrilling, Micro Electro Mechanical Systems, Microelectronics fabrication methods, Principles of MEMS, mechanical MEMS, Thermal MEMS, Magnetic MEMS.

Module -II	**[5]**
	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.

Module -III	**[7]**
	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

Module -IV	**[7]**
	Nano-Positioning System of Nanometre Accuracy and Repeatability: Guide systems for moving elements, Servo control systems for tool positioning, Computer aided digital ultra-precision position control, Future development of micro actuators.

Module -V	**[7]**
	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.

TEXT BOOK(S):	
1	Nanotechnology- N. Taniguchi, Oxford University Press.
2	Micromanufacturing and Nanotechnology- N.P. Mahalik, Elsevier.

REFERENCE BOOK(S):	
1	Foundation of MEMS- C. Liu, Prentice Hall.
2	Introduction to Nanotechnology- C.P. Poole and F.J. Owens, Wiley Interscience

COURSE OUTCOMES:	
1	Express the knowledge in micro and nano manufacturing methods.
2	Develop MEMS system for industrial use.
3	Apply the quality concepts parts, accuracy requirements of machine tools and use of latest machining process such as micro machining and micro fabrication.
4	Demonstrate tolerance allocation and analysis for precision machine design and assessment.
5	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	3	2		2	2	2	2	3		2	2
CO2		3		3	2	2	2	2	3	3	3	2
CO3	3	3		3	2		2	2		3	3	2
CO4	3	3	2		2	2	2	2	3	3	2	2
CO5	3	3	2	3	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	3	2	3	2	2	2	2	3	3	2	2

Subject Code :BPEPE605	Statistical Methods and Design of Experiments

Pre-Requisite:	Mathematics - II	Co-requisite:	

Module -I **[06]**

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.

Module -II **[06]**

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.

Module -III **[06]**

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.

Module -IV **[06]**

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.

Module -V **[06]**

Response surface methods & design, Methods of steepest Ascent, Analysis of 2^{nd}order model. Fitting response surface, evolutionally operation. Taguchi approach to parametric design.

TEXT BOOK(S):

29. Design & Analysis of Experiments- D.C. Montgomery, John Wiley & Sons.
30. Statistics for Management- Richard I. Levin, PHI.

REFERENCE BOOK(S):

27. Design and Analysis of Experiments- J.Antony, Butterworth-Heinemann.
28. Statistics for Engineers: An introduction- J.Morrison, WileyBlackwell.

COURSE OUTCOMESS:

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	1	3	3	3	2	1	1	1	3	1
CO2	1	2	3	3	3	3	2	1	2	1	2	2
CO3	2	2	3	3	3	3	1	2	2	2	3	3
CO4	3	3	3	3	3	2	1	2	2	2	3	3
CO5	3	3	3	3	3	2	1	2	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	2	3	3	3	3	3	1	2	2	2	3	2

Subject Code: BPEPE606		**Finite Element Method in Manufacturing**	
Pre-requisite:	Mathematics, Design of Machine Elements, Strength of Materials, Casting and Metal Cutting,	**Co-requisite:**	None
Module -I			**[06]**
	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.		
Module -II			**[06]**
	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.		
Module -III			**[06]**
	FE analysis of metal casting- Special considerations, latent heat incorporation, Gap element-Time stepping procedures-Crank-Nicholson algorithm-Prediction of grain structure.		
Module -IV			**[06]**
	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.		
Module -V			**[06]**
	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.		
TEXT BOOK(S):			
1.	An Introduction to the Finite Element Method- J.N. Reddy, McGraw-Hill		
2.	Finite Element Method in Engineering- S.S. Rao, Pergammon Press.		
REFERENCE BOOK(S):			
1.	Metal Forming and the Finite Element Methods- S. Kobayashi, Soo-Ik-Oh and T. Altan, Oxford University Press.		
2.	The Finite Element Method in Heat Transfer Analysis- R.W. Lewis, K. Morgan, H.R. Thomas and K.N. Seetharaman, John Wiley.		
3.	Fundamentals of Finite Element Analysis by David V. Hutton, TMH Publications, edition 2005.		
COURSE OUTCOMES: At the end of this course, students will:			
1.	Understand the steps of finite element methods and able to solve the simple engineering problems.		
2.	Express the shape functions of different elements for solving linear problems.		
3.	Analyzemetal casting problems using FEM.		
4.	Implement FEM for solving metal cutting problems		
5.	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	3		3	3	3	3	3	2	3		3
CO2	3	3	3		3	3	3	3	2	3		2
CO3	3	3		3	3	3	3	3	2	3		3
CO4	3	3	3	3	3	3	3	3	2	3		3
CO5	3	3	3	3	3	3	3	3	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	3	3	3	3	2	3	0	3

Subject Code : BPEPE607/BPEOE602	Production and Operation Management

Pre-requisite:	None	Co-requisite:	None

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):

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

REFERENCE BOOK(S):

1.	Production and Operation Management- E.E.Adam and R.J.Ebert, PHI.
2.	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	2	2	2	3			3	2	3	2	3	3
CO2	3	2	2	3			2	3	3	3	3	3
CO3	3	2	2	2			2	3	2	2	3	3
CO4	3	3	2	3			2	2	3	3	3	3
CO5	2	2	3	3			3	2	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	2	3			2	3	3	3	3	3

Subject Code BPEPE608	**Advanced Material Science**

Pre-Requisite:	Material Science	**Co-requisite:**	

Module -I	**[06]**
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.	

Module -II	**[06]**
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	

Module -III	**[06]**
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	

Module -IV	**[06]**
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	

Module -V	**[06]**
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	

TEXT BOOK(S):

31.	W. D. Callister, 2006, “Materials Science and Engineering-An Introduction”, 6th Edition, Wiley India.
32.	Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.

REFERENCE BOOK(S):

29.	V. Raghavan, “Material Science and Engineering’, Prentice Hall of India Private Limited, 1999.
30.	U. C. Jindal, “Engineering Materials and Metallurgy”, Pearson, 2011.

COURSE OUTCOMES:*Upon completion of this course students will be able to:*

21.	Apply the knowledge to identify internal structures for various materials with associated mechanical properties.
22.	Demonstrate the tailor material properties of ferrous and non-ferrous alloys during different loading conditions.
23.	Analyze the mechanical integrity with failure in material structure for advanced materials.
24.	Analyze the phase transformations of iron-carbon system using equilibrium phase diagram.
25.	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:BPEOE601	Automotive & System Engineering

Pre-Requisite:	None	Co-requisite:	None

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 portinjection system for SI engine, Design of intake and exhaust system Enginefriction 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):

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

REFERENCE BOOK(S):

31.	Design of Automotive Engine – A. Kolchin and V. Demidov
32.	Heldt.P.M., Automotive Chassis, Chilton Co., New York
33.	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	-	2	-	-	2	2	3	-	-	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	-	2	1	1
CO5	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 :BPE06003	**Metal Forming Lab.**

Pre-Requisite:	None	**Co-requisite:**	None

LIST OF EXPERIMENTS	**[08]**

1.	Ring Compression Test.
2.	Disc Compression Test
3.	Deep Drawing.
4.	Forward Extrusion
5.	Backward Extrusion.
6.	Hydraulic Bulging

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	2
CO2	3	3	3	3							2	2
CO3	3	3	3	3							2	2
CO4	3	3	3	3							2	2
CO5	3	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	2

Subject Code: BPE06004		**Fluid Dynamics Lab.**	
Pre-Requisite:	None	**Co-requisite:**	Fluid Mechanics
List of experiments			

1. Verification of Bernoulli's equation
2. Determination of metacentric height of a pantoon
3. Determination of coefficients of a circular orifice (Cd, Cc, Cv)
4. Determination of discharge coefficient (Cd) of venturimeter
5. Determination of discharge coefficient (Cd) of orifice meter
6. Determination of characteristics curves of a centrifugal pump
7. Determination of characteristics curves of a reciprocating pump
8. Determination of characteristics curves of an impulse turbine
9. Determination of characteristics curves of a reaction turbine
10. Determination of drag coefficient of sphere by Stokes law

TEXT BOOK(S):	
1	Fluid Mechanics & Hydraulics Machines –By: Modi and Seth, Standard Book House, New Delhi
2	Fluid Mechanics & Hydraulic Machines- By Dr. R. K. BansalLaxmi Pub. (p) Ltd.)
3	Fluid Mechanics & Fluid Machines – By S. K. Som, G. Biswas& S. Chakraborty, TMH

REFERENCE BOOK(S):	
1	Introduction to Fluid Mechanics by Fox & McDonald, Willey Publisher.
2	Fluid Mechanics by F.M White, McGraw Hill Publisher
3	Fluid mechanics & hydraulic machines by Subramanya, TMH

COURSE OUTCOMESS:	
1	Ability to demonstrate experiments on verification of Bernoulli's equation and metacentric height of a pantoon.
2	Ability to describe various coefficients of circular orifice and discharge coefficient of venturimeter.
3	Ability to illustrate discharge coefficient of orifice meter and characteristics curves of centrifugal pumps.
4	Ability to describe characteristics curves of reciprocating pumps and impulse turbines.
5	Ability to describe characteristics curves of reaction turbines and drag coefficient of sphere by Stokes law.

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

Subject Code: BPE06005			**Simulation Lab.**
Pre-requisite:	None	**Co-requisite:**	Statistical Methods & Design of Experiment

LIST OF EXPERIMENTS	
1.	Generation of Pseudo-random numbers using excel add ins.
2.	Performance of Chi-square test on a given sample as test of independence.
3.	Performance of Chi-square test on Goodness of fit.
4.	Performance of ANOVA test on given sample using excel add ins.
5.	Performance of t-distribution test using excel add ins on a given sample.
6.	Performance of 2k factorial ANOVA test on a given set of samples using excel add ins.
7.	Performance of two factor ANOVA test without replication on a given set of samples using excel add ins.
8.	Performance of two factor ANOVA test with replication on a given set of samples using excel add ins.
9.	Design an Experiment using DoE Tool.

COURSE OUTCOMES: At the end of this course, students will demonstrate the ability to	
1.	Design and conduct statistical tests.
2.	Conduct Chi-square tests.
3.	Implement factorial design.
4.	Conduct ANOVA tests.
5.	Apply Design of Experiment (DoE) tools in industrial sectors.

Course Articulation Matrix

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

Subject Code		Summer Industry Internship/ Training/ Project	
Pre-requisite:	None	**Co-requisite:**	None

SEVENTH SEMESTER

Subject Code :BPE07001		**Automation and NC Machine**	
Pre-Requisite:	Mathematics - II	**Co-requisite:**	

Module -I	[06]
	Introduction: Automation, types, Reasons for automation, Types of production, Functions in manufacturing, Automation Strategies, Costs in manufacturing. Flow Lines: Automated Flow lines, transfer mechanisms, Automation for machining operations, Line balancing- basic concepts, general procedure, rank positional weight method. Computer aided line balancing (CALB), Manual & Flexible assembly line, Automated assembly systems- Types, Part feeding device.
Module -II	[06]
	Fundamentals of CAD: The design process, Application of computer for design, automated drafting, creating manufacturing data base, benefits of CAD, Design workstation – graphic terminal, operator input and output devices, Software of graphic system- graphic package, Data Base Structure, Wireframe Model and Solid Model, Graphics standards.
Module -III	[08]
	Numerical Control: Components of NC system, NC procedure, NC co-ordinate system, motion control, applications, NC part programming-manual part programming, computer assisted part programming, ATP language-macro statements, programming with interactive graphics, NC part programming using CAD/CAM. Writing simple part programme. Computer control in NC: Problems with conventional NC. Controller technology, CNC, DNC Adaptive Control.
Module -IV	[04]
	Automated material handling: Type of equipment, Principles of material handling, Conveyor system.
Module -V	[06]
	Group Technology cell formation: Part classification & coding, Rank order clustering method for machine component assignment. Computer Aided Process Planning (CAPP) - Retrieval & Generative type process planning system.

TEXT BOOK(S):

35.	Automation, Production System and CIM- M.P. Groover, PHI.
36.	CAD/CAM- Groover&Zimmers, PHI.

REFERENCE BOOK(S):

34.	CAD/CAM/CIM- Radhakrishnan&Subramanyan, Wiley Eastern.
35.	CAD/CAM Theory and Practice- I. Zeid, TMH.

COURSE OUTCOMESS:

CO1	Design and analyze graphics systems (Packages and Modelling).
CO2	Design and analysis of manufacturing automation process.
CO3	Solve practical problems using NC part programing.
CO4	Analyze automated material handling system in a manufacturing industry.
CO5	Apply group technology concept in production environment.

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	2
CO2	2	3	3	2	3	3	1	1	1	2	3	2
CO3	2	1	3	1	3	3	1	1	1	3	3	3
CO4	1	2	3	1	3	3	3	3	1	1	2	2
CO5	1	1	2	1	2	3	2	3	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	2	2	3	1	3	3	2	2	1	3	3	2

Subject Code: BPE07002	**Non Traditional Machining**

Pre-requisite:	Theory of Metal Cutting	**Co-requisite:**	NA

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):

1.	Modern machines process- P.C. Pandey and H.S. Shan. TMH
2.	Non-Conventional Machining- P.K. Mishra, Narosa.

REFERENCE BOOK(S):

1.	Manufacturing Processes- Amstead, Ostwald &Begeman, John Wiley & Sons.
2.	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	2	2			3	3	2	2
CO2	3	2	3	3	3	2	3	3	3	3		2
CO3		2	3	3	3	2	3	3			2	2
CO4	3	2	3	3	3		3	3	3	3	2	2
CO5	3		3	3			3	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	2	3	3	3	2	3	3	3	3	2	3

Subject Code : BPEPE701			**Engineering Ergonomics**
Pre-Requisite:	None	**Co-requisite:**	None
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	2	3		3	2	3		3	2	3	3
CO2	2	3	3	2	3	2	3					3
CO3	2	3	3	2	3	2	3	2	3		3	3
CO4	2			2	3							3
CO5	2	3		2	3	2	3	2	3	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	2	3	3	2	3	2	3	2	3	2	3	3

Subject Code: BPEPE702		Surface Engineering Principles & Systems	
Pre-requisite:	None	**Co-requisite:**	None

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):

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

REFERENCE BOOK(S):

1.	Electroplating Handbooks- N.V.Parathasarathy, Prentice Hall.
2.	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		3		2	2	3		3	2	3	2
CO2	2	2		3	2							2
CO3	2		3	3		2		2	3	2	3	
CO4			3	3				2		2	3	2
CO5	2	2		3	2		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	2	2	3	3	2	2	3	2	3	2	3	2

Subject Code:BPEPE703		Design for Manufacturing & Assembly	
Pre-Requisite:	None	**Co-requisite:**	None

Module -I	**[04]**
	General design principles for manufacturability: strength and mechanical factors, mechanisms selection, evaluation method, Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.

Module -II	**[04]**
	Factors Influencing form Design: Working principle, Material, Manufacture, Design- Possible solutions, Materials choice, Influence of materials on form design, form design of Welded members, forgings and castings.

Module -III	**[08]**
	Component Design-I: Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly.

Module -IV	**[06]**
	Component Design-II: Casting Consideration: Redesign of castings based on parting line considerations, minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA.

Module -V	**[08]**
	Design for the Environment: Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Lifecycle assessment, Basic method, environmentally responsible product assessment, Weighted sum assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

TEXT BOOK(S):

37.	Kevien Otto and Kristin Wood, Product Design. Pearson Publication
38.	K.T. Ulrich and S.D. Eppinger, Product design and development, Tata McGraw Hill

REFERENCE BOOK(S):

36.	Boothroyd, G, Design for Assembly Automation and Product Design. Marcel Dekker.
37.	Bralla, Design for Manufacture handbook, McGraw Hill.
38.	Fixel, J. Design for the Environment McGraw Hill.

COURSE OUTCOMESS:

CO1	Apply design principles for manufacturability mechanisms selection and assembly limits.
CO2	Plan form design of welded members, forgings and castings.
CO3	Design for machinability, economy, clampability, accessibility and assembly.
CO4	Implement casting consideration and concept of group technology while design.
CO5	Incorporate environment consideration, regulations and standards while designing and remanufacturing.

Course Articulation Matrix

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

Subject Code:BPEOE701	Performance Measurement and Benchmarking

Pre-Requisite:	None	Co-requisite:	None

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):

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

REFERENCE BOOK(S):

39.	Performance Management: A business process benchmarking approach, Bjorn Andersen and AsbjornRolstadas, Springer Netherlands.
40.	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
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 BPEOE702	Total Quality System and Engineering

Pre-Requisite:		Co-requisite:	

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):

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

REFERENCE BOOK(S):

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

COURSE OUTCOMESS:*Upon completion of this course students will be able to:*

26.	Demonstrate the product quality cost along with quality monitoring.
27.	Organize the concept of leadership in an organization to achieve the benchmark.
28.	Evaluate for the selection of the best quality improvement technique.
29.	Apply different statistical analysis tools for process control.
30.	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: BPEOE703	**Subject name** : Project Management

Pre-Requisite:	Production and Operation Management	**Co-requisite:**	None

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: BPE07003		Subject name: NTM & FMS Lab.	
Pre-Requisite:	Non-Traditional Machining ,Robotics	**Co-requisite:**	Mechatronics

Part-I (Any three)	**[09]**
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.

Part-II (Any three)	**[09]**
1.	Machining in CNC Lathe by writing part programs
2.	Machining in CNC Milling by writing part programs
3.	Pick and place operation with revolute Robot
4.	Programming of AS/RS

COURSE OUTCOMES:	
CO1	Demonstrate and apply machining in Non-Traditional Machining.
CO2	Demonstrate and apply machining in CNC Lathe by writing part programs.
CO3	Demonstrate and apply machining in CNC milling by writing part programs.
CO4	Apply Pick and place operation with revolute Robot.
CO5	Apply Programming of AS/RS.

Course Articulation Matrix

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

Subject Code		Project – I	
Pre-requisite:	None	**Co-requisite:**	None

Subject Code		Seminar on Internship	
Pre-requisite:	None	**Co-requisite:**	None

EIGHTH SEMESTER

Subject Code :BPEPE801	Robotics & Flexible Manufacturing Systems

Pre-Requisite:	Mathematics - II	Co-requisite:	

Module -I **[08]**

Robot Fundamentals: Definitions, Laws of Robotics, Robot Specification, Anatomy of a Robot, Robot classifications, Function line diagram representation of robot arms, common types of arms, Robot end effectors- Types, Tools as end effectors, Considerations in gripper selection and design, Robot application in Manufacturing- Material Transfer- Material handling, loading and unloading, Processing - spot and continuous arc welding and spray painting, Assembly and Inspection. Manipulator Kinematics: Homogeneous coordinate transformation, matrix representations of coordinate transformation, D-H representation of kinematics linkages, Forward and Inverse Kinematics of manipulators, Euler's angle and fixed rotation for specifying position and orientation.

Module -II **[04]**

Robotics Dynamics: Velocity Kinematics, Acceleration of rigid body, Lagrange-Euler Formulation, Newton–Euler's formulation.

Module -III **[08]**

Robot Actuators and Sensors: Internal and external sensors, Position- potentiometric, Optical sensors, Encoders - absolute, incremental, Touch and slip sensors, Velocity and acceleration sensors, Proximity sensors, Force and torque sensors. Actuators- Hydraulic, Pneumatic and Electrical, Comparison of actuating systems and their relative merits and demerits.

Module -IV **[04]**

Robot Controllers: Open and close loop control, Manipulator control problem, Linear control, PD and PID control schemes, Force and torque control in robotic manipulators. Robot Programming: Methods of robot programming- Textual and Lead through, WAIT, SIGNAL and DELAY commands, Capabilities and limitations of lead through programming, Robot language structure, Motion, sensor and end effectors commands, Programming examples.

Module -V **[06]**

Flexible Manufacturing Systems: Types of production, Characteristics, Applications, Flexibility in Machining systems, Need for FMS, Flexible Automation, Where to apply FMS technology, Components of FMS- FMS layout configurations, Planning the FMS, Workstations, Material Handling systems, Automatic Guided vehicle systems, Automated storage and retrieval systems, FMS Layout configurations, Applications and benefits of FMS, problems in implementing FMS.

TEXT BOOK(S):

43. Industrial Robotics- Groover M P et al, Pearson Edu.
44. Robotics and Control- R.K. Mittal and I.J. Nagrath, TMH.

REFERENCE BOOK(S):

43. Robotics Technology and Flexible Automation- S.R.Deb, TMH.
44. Robotic Engineering- Richard D. Klafter, PHI.
45. Robotics- Fu K S et al., McGraw Hill.

COURSE OUTCOMESS:

CO1	Express about fundamentals of robots, their applications and develop forward and inverse kinematics of manipulators.
CO2	Write diverse formulations for robotics dynamics.
CO3	Select robot actuators and sensors for specific application and demonstrate their relative merits and demerits.
CO4	Analyze various robot controllers' mechanisms and write simple robot programing.
CO5	Implement the concept of FMS and automation to solve practical industrial problems.

Course Articulation Matrix

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

Subject Code : BPEPE802	Plant Layout and Automated Material Handling

Pre-Requisite:	None		None

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):

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

REFERENCE BOOK(S):

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

COURSE OUTCOMESS:

31.	Identify the role that each department plays in achieving the goals of an organization;
32.	Explain the problems in organizing, planning and controlling the use of men, money, materials and machines for industrial production; and
33.	Apply industrial engineering principles to solve the problems in organizing, planning and controlling the use of men, money, materials and machines for industrial production.
34.	Recommend improvements to existing plant layouts from the standpoint of material handling and product flow
35.	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				3	3	2	3	3		3	3
CO2	3	3	2	2	3		2				3	
CO3		3	2	2	3	3	2	3	3	2	3	3
CO4	3	3	2	2		3	2	3		2		
CO5	3		2		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	3	2	2	3	3	2	3	3	2	3	3

Subject Code :BPEPE803/BEPEOE801		Micro Electro-Mechanical Systems	
Pre-Requisite:	Mathematics - II	**Co-requisite:**	

Module -I	[06]
	Introduction to MEMS technology: Introduction to MEMS and motivation, Basic definitions, Scaling in Micro domain: How small is different- some natural examples, Scaling laws in electrostatic, electromagnetic, rigidity of structures, heating & cooling, Fluid viscosity and fluid interfaces, etc. Scaling in overall system performance considering multiple physical domains.
Module -II	[08]
	MEMS Materials: Mechanical and other properties of materials used in MEMS Microfabrication / Micromachining: Overview of microfabrication, Review of microelectronics fabrication processes like photolithography, deposition, doping, etching, structural and sacrificial materials, other lithography methods,. MEMS fabrication methods like surface, bulk, LIGA and wafer bonding methods.
Module -III	[08]
	Transduction Principles: Transduction principles in microdomain. MEMS Modeling: Basic modeling elements in electrical, mechanical, thermal and fluid systems, analogy between 2nd order mechanical and electrical systems. Modeling elastic, electrostatic, electromagnetic systems.
Module -IV	[04]
	Radio Frequency (RF) MEMS: Introduction, Review of RF-based communication systems, RF –MEMS like MEMS inductors, varactors, tuners, filters, resonators, phase shifters, switches. Optical MEMS: Preview, passive optical components like lenses and mirrors, actuators for active optical MEMS.
Module -V	[04]
	Nanotechnology and MEMS: Relation between micro and nanotechnologies. Need and issues in handling nano products with the help of MEMS.

TEXT BOOK(S):	
48.	MEMS and Microsystems Design and Manufacture- Tai, Ran Hsu, TMH.
49.	Foundations of MEMS- Chang Liu, Pearson International Edition.

REFERENCE BOOK(S):	
49.	MEMS- N. P. Mahalik, TMH.
50.	Fundamentals of Microfabrication- Madou, CRC Press.

COURSE OUTCOMESS:	
CO1	Analyze fundamental science behind micro-electro mechanical systems.
CO2	Develop the ability to take decision on selecting material and fabrication technique for MEMS.
CO3	Design and modeling a micro-electro mechanical system.
CO4	Analyze radio frequency and optical MEMS devices.
CO5	Apply fundamental knowledge of nano technology and MEMS.

Course Articulation Matrix

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

Subject Code BPEPE804	Quality Assurance & Reliability

Pre-Requisite:	None	Co-requisite:	None

Module -I **[06]**

Attributes of quality, Evolution of philosophy of Quality Management, Economics of quality and measurement of cost of quality; Quality Control: Causes of variation, standard errors of mean, Process capability analysis, Natural tolerance limits, Specification Limits, Trial and Revised Control limits, Rational Subgroups, Control Charts for variables (X, R, S, CUSUM, EWMA), Control Charts for attributes.(P, np)

Module -II **[06]**

Acceptance sampling: Single, double and multiple sampling plans, Acceptance sampling for variables, Sampling Plans: Design of single sampling plan, double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL, ATI, AFI, ASN

Module -III **[06]**

Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design
Quality Engineering: Taguchi's quadratic loss function, Off line & online quality control, importance of parameter selection design, experimental design principle for product and process design, two-level experimental for full factorial and fractional factorial design

Module -IV **[06]**

Total Quality Control: Components of TQM, TQM Implementation, Quality function deployment, PDCA cycle, Quality Circle: Implementation, Training for QC, Kaizen and Poke Yoke Systems, Quality Cost, Concept of Zero defect, Quality assurance systems- ISO 9000, 14000, 18000.

Module -V **[06]**

Reliability: System effectiveness, Mission reliability, Design adequacy, Operational readiness, serviceability, performance indices, their evaluation, uses and limitation, reliability models of maintained systems, relationship between reliability and maintainability, system with components in series, parallel and standby, Maintainability prediction.Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability

TEXT BOOK(S):

1. Fundamentals Of Quality Control & Improvement- A.Mitra, PHI
2. Introduction to Statistical Quality Control- D.C.Montogomery, John Wiley & Sons.
3. Total Quality Control- A.V.Feigenbaum, TMH.

REFERENCE BOOK(S):

1. Statistical Quality Control- E.L. Grant and R.S. Leavenworth, McGraw Hill.
2. Taguchi techniques for Quality Engineering- P.J.Ross, McGraw Hill.
3. Quality Assurance through ISO 9000- H.D. Gupta, South Asia publication.

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

1. Apply quality control charts for process control.
2. Design the best sampling plan for specific quality related problems.
3. Define Taguchi method to minimize quality loss function.
4. Analyze different quality management tools.
5. Develop reliability models for systems having different components.

Course Articulation Matrix

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

Subject Code: BPEPE805		Rapid Prototyping & Tooling	
Pre-requisite:	None	**Co-requisite:**	None

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):

1.	Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY.
2.	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling- D.T. Flham and S.S.Dimov, Springer Verlag.

REFERENCE BOOK(S):

1.	Rapid Prototyping: Principles and Applications in Manufacturing- Kai and Fai, World Scientific.
2.	Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.

COURSE OUTCOMES:

1.	Express the fundamentals of rapid prototype and their classifications.
2.	Implement the Selective Laser Sintering techniques.
3.	Analyze the Modelers printer techniques.
4.	Develop knowledge of Rapid tooling and implement in rapid manufacturing.
5.	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	2	3		3	2	2	3	2			3	2
CO2		3	2		2		3	2		2	3	
CO3			2		2	2	3	2		2	3	
CO4	2			3		2	3	2	3	2		2
CO5		3	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	2	3	2	2	3	2	3	2	3	2

Subject Code BPEPE806		Computer Integrated Manufacturing	
Pre-Requisite:	Computer aided design and manufacturing	**Co-requisite:**	

Module -I	**[06]**
	Introduction: The meaning and origin of CIM, The changing manufacturing and management scenario, External communication, Islands of automation and software, Dedicated and open systems, Manufacturing automation protocol, Product related activities of a company, Marketing engineering, Production planning, Plant operations, Physical distribution, Business and financial management.

Module -II	**[06]**
	Computer Aided Process planning: Role of process planning in CAD/CAM integration, Approaches to computer aided process planning- Variant approach and Generative approaches, CAPP and CMPP process planning systems.

Module -III	**[06]**
	Shop Floor Control and FMS: Shop floor control-phases, Factory data collection system, Automatic identification methods- Bar code technology, Automated data collection system, FMS-components of FMS - types -FMS workstation, Material handling and storage systems, FMS layout, Computer control systems-application and benefits.

Module -IV	**[06]**
	CIM System: Open System Open systems inter connection, Manufacturing automations protocol and technical office protocol (MAP /TOP). CIM Implementation: CIM and company strategy, System modeling tools-IDEF models, Activity cycle diagram, CIM open system architecture (CIMOSA), Manufacturing enterprise wheel, CIM architecture, Product data management, CIM implementation software.

Module -V	**[06]**
	Data Communication: Communication fundamentals, Local area networks, Topology, LAN implementations, Network management and installations. Database for CIM: Development of databases, Database terminology, Architecture of database systems, Data modeling and data associations, Relational data bases, Database operators, Advantages of data base.

TEXT BOOK(S):

50.	Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.
51.	Computer Integrated Manufacturing System- Y. Koren, McGraw-Hill.

REFERENCE BOOK(S):

51.	CAD/CAM/CIM- P. Radhakrishnan, S. Subramanyan and V. Raju- New Age International.
52.	Computer Integrated Manufacturing- Paul G. Ranky, Prentice Hall International

COURSE OUTCOMESS: Upon completion of this course students will be able to:

36.	Demonstrate the concept of open system in computer integrated manufacturing.
37.	Develop common database for integration in CIM systems.
38.	Apply the knowledge to monitor using shop floor control in flexible manufacturing systems.
39.	Describe the CIM automation protocols and its architecture for specific industries.
40.	Construct database networks for different applications.

Course Articulation Matrix

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

Subject Code: BPEPE807		**Safety Engineering**	
Pre-requisite:	Industrial Engineering & Management, Ergonomics, Environmental Engineering	**Co-requisite:**	None

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):

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

REFERENCE BOOK(S):

1.	Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.
2.	Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982.
3.	Encyclopedia of "Occupational Health and Safety", Vol.I and II, published by International LabourOffice, 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		3	3	3	3	3	2	3	3	3
CO2	3	3	3		3	3	3	3	2	3	3	2
CO3	3	3		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: BPEOE802		**Entrepreneurship & E-Business**	
Pre-requisite:	Industrial Engineering and Management, Engineering Economics	**Co-requisite:**	None

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):

1.	Scaling for E-Business: Technologies, Models, Performance, and Capacity Planning, Daniel A. Menasc, Virgilio A. F. Almeida, Prentice Hall
2.	Management Information Systems- Managing Information Technology in E Business Enterprises, James A. Brien, TMH

REFERENCE BOOK(S):

1.	"Entrepreneurship" Forbat, John, New Age International.
2.	Auction Theory, Vijay Krishna, Academic Press.
3.	"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		3	3	3	3	3	2	3	3	3
CO2	3	3	3		3	3	3	3	2	3	3	2
CO3	3	3		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			Project II
Pre-requisite:	None	**Co-requisite:**	None

Subject Code			Seminar on Project
Pre-requisite:	None	**Co-requisite:**	None