FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2019-2020)

and

Syllabi

B.E. III and IV Semester

of

Four Year Degree Programme

in

Mechanical Engineering

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Mechanical Engineering) III – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	MC111PO	Indian Constitution	2	-	-	2	30	70	3	-
2	HS201EG	Effective Technical Communication in English	3	-	-	3	30	70	3	3
3	HS202CM	Finance and Accounting	3	-	-	3	30	70	3	3
4	BS205MT	Mathematics-III	3	-	-	3	30	70	3	3
5	ES211CE	Engineering Mechanics	2	1	-	3	30	70	3	3
6	ES214EC	Basic Electronics	3	-	-	2	30	70	3	3
7	PC221ME	Metallurgy and Material Science	3	-	-	3	30	70	3	3
8	PC222ME	Thermodynamics	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
9	PC251ME	Metallurgy and Material Testing Lab	-	-	2	2	25	50	3	1
10	PC252ME	Machine Drawing and Modelling Lab	-	-	2	2	25	50	3	1
			22	**01**	**04**	**27**	**290**	**660**		**23**

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
PO: Political Science EG: English CM: Commerce MT: Mathematics
CE: Civil Engineering EC: Electronics and Communication Engineering
ME: Mechanical Engineering

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

3. All mentioned **Mandatory Courses** for BE (All Branches) should be offered either in I – Semester or II – Semester only **from the academic year 2019-2020**.
4. For those of the students admitted in BE (All Branches) during the academic year 2018-2019 the Mandatory Courses were not offered during the I – Semester or II – Semester may be compulsorily offered either in III – Semester or IV – Semester **for the academic year 2019-2020 only**.

Course Code	Course Title						Core/Elective
MC111PO	**Indian Constitution**						**Mandatory**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To create awareness among students about the Indian Constitution.
- To acquaint the working conditions of union, state, local levels, their powers and functions.
- To create consciousness in the students on democratic values and principles articulated in the constitution.
- To expose the students on the relations between federal and provincial units.
- To divulge the students about the statutory institutions.

Course Outcomes

After completing this course, the student will

1. Know the background of the present constitution of India.
2. Understand the working of the union, state and local levels.
3. Gain consciousness on the fundamental rights and duties.
4. Be able to understand the functioning and distribution of financial resources between the centre and states.
5. Be exposed to the reality of hierarchical Indian social structure and the ways the grievances of the deprived sections can be addressed to raise human dignity in a democratic way.

UNIT-I

Evolution of the Indian Constitution: 1909 Act, 1919 Act and 1935 Act. Constituent Assembly: Composition and Functions; Fundamental features of the Indian Constitution.

UNIT-II

Union Government: Executive-President, Prime Minister, Council of Minister
State Government: Executive: Governor, Chief Minister, Council of Minister
Local Government: Panchayat Raj Institutions, Urban Government

UNIT-III

Rights and Duties: Fundamental Rights, Directive principles, Fundamental Duties

UNIT-IV

Relation between Federal and Provincial units: Union-State relations, Administrative, legislative and Financial, Inter State council, NITI Ayog, Finance Commission of India

UNIT-V

Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Suggested Readings:

1. Abhay Prasad Singh & Krishna Murari, Constitutional Government and Democracy in India, Pearson Education, New Delhi, 2019
2. D.D. Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi
3. Subhash Kashyap, Our Parliament, National Book Trust, New Delhi

4. Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi
5. B.Z. Fadia & Kuldeep Fadia, Indian Government &Politics, Lexis Nexis, New Delhi

Course Code	Course Title						Core/Elective
HS201EG	**Effective Technical Communication in English**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To expose the students to:

- Features of technical communication
- Types of professional correspondence
- Techniques of report writing
- Basics of manual writing
- Aspects of data transfer and presentations.

Course Outcomes

On successful completion of the course, the students would be able to:

1. Handle technical communication effectively
2. Use different types of professional correspondence
3. Use various techniques of report writing
4. Acquire adequate skills of manual writing
5. Enhance their skills of information transfer and presentations

UNIT I

Definition and Features of Technical communication: Definition and features of technical communication (precision, relevance, format, style, use of visual aids), Differences between general writing and technical writing, Types of technical communication (oral and written)

UNIT II

Technical Writing-I (Official correspondence): Emails, IOM, Business letters, Business proposals.

UNIT III

Technical writing-II (Reports): Project report, Feasibility report, Progress report, Evaluation report.

UNIT IV

Technical writing- III (Manuals): Types of manuals, User manual, Product manual, Operations manual.

UNIT V

Information Transfer and Presentations: Non-verbal (bar diagram, flow chart, pie chart, tree diagram) to verbal (writing), Verbal (written) to non-verbal, Important aspects of oral and visual presentations.

Suggested Readings:

1. Raman, Meenakshi & Sharma, Sangeeta. (2015). *Technical Communication: Principles and Practice* (3rd ed.). New Delhi.
2. Rizvi, Ashraf, M. (2017). *Effective Technical Communication* (2nd ed.). New Delhi, Tata McGraw Hill Education.
3. Sharma, R. C., & Mohan, Krishna. (2017). *Business Correspondence and Report Writing: A Practical Approach to Business & Technical Communication* (4th ed.). New Delhi, Tata McGraw Hill Education.

4. Tyagi, Kavita & Misra, Padma. (2011). *Advanced Technical Communication*. New Delhi, PHI Learning.
5. Jungk, Dale. (2004). *Applied Writing for Technicians.* New York, McGraw-Hill Higher Education.

Course Code	Course Title						Core/Elective
HS202CM	**Finance and Accounting**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The course will introduce the students

- To provide basic understanding of Financial and Accounting aspects of a business unit
- To provide understanding of the accounting aspects of business
- To provide understanding of financial statements
- To provide the understanding of financial system
- To provide inputs necessary to evaluate the viability of projects
- To provide the skills necessary to analyse the financial statements

Course Outcomes

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

1. Evaluate the financial performance of the business unit.
2. Take decisions on selection of projects.
3. Take decisions on procurement of finances.
4. Analyse the liquidity, solvency and profitability of the business unit.
5. Evaluate the overall financial functioning of an enterprise.

UNIT-I

Basics of Accounting: Financial Accounting–Definition- Accounting Cycle – Journal - Ledger and Trial Balance-Cash Book-Bank Reconciliation Statement (including Problems)

UNIT-II

Final Accounts: Trading Account-Concept of Gross Profit- Profit and Loss Account-Concept of Net Profit-Balance Sheet (including problems with minor adjustments)

UNIT-III

Financial System and Markets: Financial System-Components-Role-Considerations of the investors and issuers- Role of Financial Intermediaries. Financial Markets-Players- Regulators and instruments - Money Markets Credit Market- Capital Market (Basics only)

UNIT-IV

Basics of Capital Budgeting techniques: Time Value of money- Compounding- Discounting- Future Value of single and multiple flows- Present Value of single and multiple Flows- Present Value of annuities-Financial Appraisal of Projects– Payback Period, ARR- NPV, Benefit Cost Ratio, IRR (simple ratios).

UNIT-V

Financial statement Analysis: Financial Statement Analysis- Importance-Users-Ratio Analysis-liquidity, solvency, turnover and profitability ratios.

Suggested Readings:

1. Satyanarayana. S.V. and Satish. D., Finance and Accounting for Engineering, Pearson Education
2. Rajasekharan, Financial Accounting, Pearson Education
3. Sharma.S.K. and Rachan Sareen, Financial Management, Sultan Chand

4. Jonathan Berk, Fundamentals of Corporate Finance, Pearson Education
5. Sharan, Fundamentals of Financial Management, Pearson Education

Course Code	Course Title						Core/Elective
BS205MT	**Mathematics – III**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the solution methodologies for second order Partial Differential Equations with applications in engineering
- To provide an overview of probability and statistics to engineers

Course Outcomes

After completing this course, the student will be able to:

1. Solve field problems in engineering involving PDEs.
2. They can also formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.

UNIT - I

Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method.

UNIT - II

Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, one dimensional diffusion equation and its solution by separation of variables.

UNIT - III

Discrete random variables, expectation of discrete random variables, moments, variance of a sum, continuous random variables & their properties, distribution- functions, and densities.

UNIT - IV

Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis – Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

UNIT - V

Test of significance; Large sample test for single proportion, difference of properties, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances – Chi- square test for goodness of fit and independence of attributes.

Suggested Readings:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2000.
2. Advanced Engineering Mathematics, R.K. Jain & Iyengar, Narosa Publications.
3. Engineering Mathematics, P. Sivaramakrishna Das & C. Vijaya Kumar, Pearson India Education Services Pvt. Ltd.
4. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.

5. E. Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, 2006.
6. P. G. Hoel, S. C. Port and C. J. Stone, “Introduction to Probability Theory”, Universal Book Stall, 2003.
7. S. Ross, “A First Course in Probability”, Pearson Education India, 2002.
8. W. Feller, “An Introduction to Probability Theory and its Applications”, Vol. 1, Wiley, 1968.
9. T. Veerarajan, “Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.
10. Mathematical Statistics, S.C. Gupta & V.K. Kapoor, S. Chand Pub.

Course Code	Course Title						Core/Elective
ES211CE	**Engineering Mechanics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**1**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Resolution of forces, equilibrium of force systems consisting of static loads
- Obtaining centroids and moments of inertia for various regular and irregular areas.
- Various forces in the axial force members, and to analyse the trusses using various methods,
- Concept of friction for single and connected bodies.
- Basic concepts of dynamics, their behavior, analysis and motion bodies
- Work energy principles and impulse momentum theory and applications to problem solving

Course Outcomes

After completing this course, the student will be able to:

1. Apply the fundamental concepts of forces, equilibrium conditions for static loads.
2. Determine the centroid and moment of inertia for various sections.
3. Analyse forces in members of a truss using method of joints and method of sections, analyse friction for single and connected bodies.
4. Apply the basic concepts of dynamics, their behavior, analysis and motion bodies.
5. Solve problems involving work energy principles and impulse momentum theory.

UNIT – I

Introduction to Engineering Mechanics: Basic Concepts

System of Forces: Coplanar Concurrent Forces, Components in Space – Resultant of coplanar and spatial systems, Moment of Force and Couple and its Application to coplanar system

Equilibrium of Systems of Forces: Free Body Diagrams, Equations of Equilibrium and applications to Coplanar System.

UNIT – II

Centroid: Centroid of simple areas (from basic principles), Centroid of Composite areas.

Area Moment of Inertia: Definition, Moment of inertia of simple areas (from basic principles), Polar Moment of Inertia, Transfer formula, Moment of Inertia of Composite areas.

Centre of Gravity & Mass moment of Inertia: Centre of gravity and Mass moment of inertia of simple bodies (from basic principles).

UNIT-III

Friction: Theory of friction, Laws of friction, Friction connected to single and connected bodies. Wedge friction.

Analysis of Perfect Frames: (Analytical Method) Types of Frames, Assumptions for forces in members of perfect frame, Method of joints and Method of sections for Cantilever Trusses, simply supported Trusses.

UNIT –IV

Kinematics: Introduction, Motion of particle, Rectilinear and Curvilinear motions, Velocity and Acceleration, Types of Rigid body, Angular motion, Fixed axis rotation.

Kinetics: Introduction, fundamental equation of kinetics for a particle, D' Alembert's principle for particle motion, connected system and Fixed Axis Rotation.

UNIT – V

Work - Energy Method: Introduction, Equations for Translation, Work-Energy Applications to Particle Motion, Connected System and Fixed Axis Rotation.

Impulse Momentum Method: Linear impulse momentum, law of conservation of momentum, coefficient of restitution, Elastic impact**.**

Suggested Readings:

1. Ferdinand L. Singer, *Engineering Mechanics*, Collins, Singapore, 1975.
2. Reddy Vijay Kumar K. and K. Suresh Kumar, Singer's Engineering Mechanics, 2010.
3. S.S Bhavakatti, *Engineering Mechanics*, New age International publishers.
4. Rajeshakharam, S. and Sankarasubrahmanyam, G., *Mechanics,* Vikas Publications, 2002.
5. Junarkar, S.B. and H.J. Shah., *Applied Mechanics*, Publishers, 2001.

Course Code	Course Title						Core/Elective
ES214EC	**Basic Electronics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- To understand the characteristics of diodes and transistor configurations
- To understand the design concepts of biasing of BJT and FET
- To understand the design concepts of feedback amplifiers and oscillators
- To study the design concepts of OP Amp and data converters

Course Outcomes

After completing this course, the student will be able to:

1. Study and analyse the rectifiers and regulator circuits.
2. Study and analyse the performance of BJTs, FETs on the basis of their operation and working.
3. Ability to analyse & design oscillator circuits.
4. Ability to analyse different logic gates & multi-vibrator circuits.
5. Ability to analyse different data acquisition systems

UNIT-I

PN Junction Diode: Characteristics, Half wave rectifier, Full wave rectifier, filters, ripple, regulation, TIF and efficiency, Zener diode and Zener diode regulators. CRT construction and CRO applications

UNIT-II

Transistors: BJT construction and working, modes of operation, configurations of BJT (CB, CE, CC), small signal h-parameter model of CE, CE amplifier analysis. Construction and working of JFET, V-I characteristics of JFET.

UNIT-III

Feedback concepts: Types of negative feedback – modification of gain, bandwidth, input and output impedances, applications.

Oscillators: RC Phase shift, Wein bridge, LC and crystal Oscillators (Qualitative treatment only).

UNIT-IV

Operational Amplifier: OP-AMP Block diagram, Ideal OP-AMP, DC and AC Characteristics, Inverting and Non-Inverting Amplifiers, Adder/Subtractor, Integrator, Differentiator.

Logic gate circuits - Introduction to Digital systems- AND, NAND, NOR, XOR gates, Binary half adder, full adder.

UNIT-V

Data Acquisition Systems: Construction and Operation of transducers- Strain guage LVDT, Thermocouple, Instrumentation systems.

Data Converters: R-2R Ladder DAC, Successive approximation and Flash ADC.

Suggested Readings:

1. Robert Boylestad L. and Louis Nashelsky, *Electronic Devices and Circuit Theory*, PHI, 2007

2. Helfrick D and David Cooper, *Modern Electronic Instrumentation and Measurements Techniques,* 1st edition, Prentice Hall of India, 2006.
3. Salivahanan, Suresh Kumar and Vallavaraj, *Electronic Devices and Circuits,* 2nd edition, Tata McGraw-Hill, 2010.

Course Code	Course Title						Core/Elective
PC221ME	**Metallurgy and Material Science**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Enable to understand structure property relations, analyse the failures of metals and their prevention.
- To broad understanding of phase diagrams.
- Acquire basic knowledge in various heat treatment operations, their purpose and applications.
- Expose to various methods of extractive metallurgy techniques.
- Understand various modes of failure and suggest mechanisms for preventions of failures.
- Understand applications of conventional metals and alloys.

Course Outcomes

1. Know the fundamental science and engineering principles relevant to material.
2. Suggest appropriate physical metallurgical methods (phase diagrams).
3. The type of heat treatment operation to be given to any metal in order to improve desired Mechanical properties.
4. Basic ability to plan an extraction process for given ore.
5. Suggest the appropriate methods for prevention of failures.
6. Analyse the applications of conventional metals and alloys.

UNIT-I

Introduction to Materials engineering, classification of materials- metals and alloys, ceramics, polymers and composites,

Space lattice, unit cell, crystal structure, crystal directions and planes, crystal imperfections- point defects, line defects, surface defects, volume defects. Types of dislocations, Effect of slip and twinning on the plastic deformation, Jogs and its effect on yield phenomenon, Hall-Petch equation, Orange peel effect, cold and hot working, strain hardening and Bauchinger effect. Recovery, Recrystallisation, Grain growth and its effect on mechanical properties of metals.

Mechanical properties of materials- Tensile properties, stress-strain diagrams, elasticity, plasticity, ductility, toughness, modulus of elasticity, resolved shear stress, tensile and compression test, hardness and its measurement

UNIT-II

Fracture: Ductile and Brittle fracture, modes of fracture, ductile to brittle transition, crack initiation and propagation.

Fatigue: S-N curve, Structure of fatigue fracture specimen, Fatigue crack propagation, Effect of metallurgical variables on fatigue of metal, Experimental determination of fatigue strength (RR-Moore Test).

Creep: Creep strength, Creep curve, Creep deformation mechanisms, Creep Test, Differences between creep curve and stress rupture curve.

UNIT-III

Structure of Alloys: Types of solid solution, Substitutional and Hume Rothary's rules for solid solution, Construction and interpretation of Binary equilibrium diagram, Isomorphous, Eutectic and Peritectic diagrams, Intermediate phases and phase rule, Iron-Iron Carbide equilibrium diagram, construction and interpretation. Types of Plain Carbon Steels, Cast Iron and their properties and Characteristics.

UNIT-IV

Alloy Steels: Effects of alloying elements like Nickel, Chromium, Manganese, Silicon and Tungsten. Titanium. Study about Stainless steels, HSS, Maraging steels, Brass, Bronze, Muntz Metal, Invar, Duralumin and Ti Alloy (Ti-6Al-4V) – their composition and Properties.

Heat Treatment: Annealing, Normalising, Hardening, Tempering, Construction and interpretation of T.T.T Curve. Austempering and Martempering. Case Hardening: Carburising, Nitriding, Carbo-nitriding, Flame Hardening, Induction Hardening. Brief introduction of Age Hardening.

UNIT-V

Non-ferrous metals and alloys: Properties and applications of –Cu and its alloys, Al and its alloys, Age hardening, Ti and its alloys, Ni- based alloys

Ceramics, Polymers and Composites: Ceramics, crystalline ceramics, glasses, properties and applications of ceramics, polymers-polymerization, thermoplastics and thermosetting plastics, properties and applications of polymers. Composites: concept of composites, matrix and reinforcement, rule of mixtures, classification of composites, applications of composites.

Suggested Readings:

1. V.Raghavan, Material Science and Engineering, Prentice Hall of India Ltd., 4th Edition, 1994.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill, 2nd Edn.1997.
3. S.P. Nayak, Engineering Metallurgy and Material Science, Charotar Publishing House, 6th Edition, 1995.
4. E. Dieter, Mechanical Metallurgy, Metric Editions, Tata McGraw Hill, 3rd Edn,1997.
5. Robert M Jones, Mechanics of Composite Materials, Taylor and Francis.

Course Code	Course Title						Core/Elective
PC222ME	**Thermodynamics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
- The importance and application of first law of thermodynamics.
- The various laws associated with second law of thermodynamics.
- Properties of pure substances and use of Mollier diagram.
- Various air standard cycles, their importance and their comparison.
- Calculation procedures of the air-fuel ratio.

Course Outcomes

1. Correlate the study of thermodynamics with the fundamental conceptual terminologies and Distinguish the different forms of energy
2. Analyse the Laws of Thermodynamics and correlate them for real life problem solving.
3. Read data from the chart of Mollier diagram and its applications.
4. Assess the importance of entropy and recognize the various curves of phase transformation
5. Identify the various air standard cycles, gas cycles and gas laws toward solving practical applications.

UNIT-I

Introduction: Definition and Concept of Thermodynamics, Microscopic and Macroscopic approach of thermodynamics, system, surroundings and property, intensive and extensive properties, Measurement of temperature, Zeroth law of thermodynamics, Temperature Scales, ideal gas and ideal gas thermometer, Reversibility and irreversibility quasi– static process, Specific heats for ideal gases, Thermodynamic Equilibrium, Mole fraction and mass fraction, Partial pressure and Dalton's Law, Amagat-Leduc Law of Partial volumes.

UNIT-II

First law of Thermodynamics: Statement of First Law, Heat and work interactions, Thermodynamics work and Internal energy, Energy as property of system, First Law applicable to Closed system, Thermodynamic processes and calculation of work, Heat transfer, and internal energy, Heat as Path Function, first law analysis of flow processes and limitation, Calculation of work done during flow processes.

UNIT-III

Second Law of Thermodynamics: Physical description of second law, Kelvin– Planck and Clausius statement of Second Law of thermodynamics, Equivalence of Kelvin– Planck and Clausius statement, Reversible and irreversible processes, Carnot Theorem, Clausius Inequality, Calculation of entropy change during various thermodynamic processes, principle of Entropy increase, T– S diagram, Available and Unavailable energies in steady flow, Second Law Analysis of Control Volume, Helmholtz and Gibb's functions, Available function for flow and non– flow processes and applications.

UNIT-IV

Thermodynamic properties of Fluids: Properties of pure substances, Concept of phase change, Graphical representation of pressure, Volume and Temperature, (PVT)– T and H diagrams, Properties of steam, Use of

steam Tables and Mollier diagram, Thermodynamic relations involving entropy, Enthalpy, Internal Energy, Maxwell relations and Clapeyron equation.

UNIT-V

Analysis of Thermodynamic Cycles: Air standard cycles: Otto, Diesel, Dual Combustion Cycle, Joule/ Brayton cycle. Vapour Power cycles: Rankine cycle and Modified Rankine cycle. Refrigeration cycles: Reversed Carnot cycle, Bell Coleman cycle, Vapour compression refrigeration cycle.

Suggested Reading:

1. P.K. Nag, Basic & Applied Thermodynamics, Tata McGraw Hill, 2nd Edn., 2008.
2. Yunus A Cengel & Michael A Boles, Thermodynamics- An Engineering Approach, Tata Mcgraw-Hill, 7th Edition in SI Units (Special Indian Edition),2011
3. Y.V.C. Rao, An Introduction to Thermodynamics, Universities Press, 2nd Edn., 2010.
4. P.L Ballaney, Thermal Engineering, Khanna Publishers 2004.
5. E. Rathakrishnan, Fundamentals of Engineering Thermodynamics, PHI Learning Pvt Ltd, 2005.

Course Code	Course Title						Core/Elective
PC251ME	**Metallurgy and Material Testing Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
- Expose to Metallographic study and analysis of various metals.
- Acquire knowledge in determining the hardness of metals before and after various Heat treatment operations.
- Understand differences between different heat treatment methods.
- Expose to T-T-T curve and its application in engineering metallurgy.
- Understand the relation between micro structure and properties.

Course Outcomes

After completing this course, the student will be able to:

1. Prepare specimen for metallographic observation
2. Analyse and identify low, medium and high carbon steels, different types of cast irons, non-ferrous alloys, from the study of their microstructure
3. Underlines the importance of grain size in evaluating the desired mechanical properties.
4. Correlate the heat treatment methods and the mechanical properties obtained.
5. Analyse and identify microstructures after annealing, normalizing, hardening and tempering Relate the properties of the materials using image analyser

List of Experiments:

A: Metallurgy Experiments:

1. Study of: Metallurgical Microscope, Iron-Iron Carbide diagram, Procedure for specimen preparation
2. Metallographic Study of Pure Iron& Low carbon steel
3. Metallographic Study of Medium carbon steel, Eutectoid steel & Hyper Eutectoid steel
4. Metallographic Study of Grey cast-iron, White cast-iron, & Black heart Malleable cast iron
5. Metallographic Study of Aluminium, Brass & Bronze
6. Jominy Quench test or Study of microstructure after heat treatment

B: Materials testing Lab

1. Uni-axial tension test, to draw stress- strain diagram, and estimate modulus of elasticity, % of elongation and toughness.
2. Compression test on bricks and Impact test
3. Hardness test: Brinell & Vickers
4. Shear force & bending moments tests.
5. Bending test on fixed beam, simply supported beam
6. Spring test and torsion test

Note: At least ten experiments should be conducted

Course Code	Course Title						Core/Elective
PC252ME	**Machine Drawing and Modelling Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To understand format of drawing sheet, angle of projections, isometric projections and practice on simple machine elements
- To practice free hand sketching of machine elements
- To understand Modelling of assembly drawings of typical machine parts.

Course Outcomes

At the end of the course, the student

1. Will be able to draw isometric and orthogonal projections and sectional views of various mechanical components.
2. Will be able to draw free hand sketches of various mechanical components
3. Will be able to understand the shape and structure of different types of joints, screws, keys and Couplings
4. Will be sufficiently knowledgeable to use both the software and drafter to produce assembly views of various mechanical components from part drawings.

List of Experiments:

I. Machine Drawing (AutoCAD):

1. Format of drawing sheet & title block,
2. Conventions of drawing lines and dimensions,
3. Convention for sectional views.
4. Simple machine elements.
5. Riveted and screwed fastenings.
6. Joints and coupling.

II. Assembly drawing (SOLIDWORKS/ CATIA/ PRO-E):

7. Connecting rod.
8. Eccentric.
9. Cross head.
10. Stuffing box.
11. Lathe Tool Post.
12. Revolving centre.
13. Pedestal bearing (Plummer block).
14. Screw Jack.

Note: The test is for the ability of the student to read and interpret drawing. The drawing should include part list in standard format.

Suggested Readings:

1. N.D. Bhatt, Machine Drawing, Charotar Publishing house, Anand, New Delhi, 28th edition, 1994.

2. K.L. Narayana, P. Kannaiah, K. Venkat Reddy, Machine Drawing, New Age International (P) Ltd., 2nd edition 1999.
3. N. Siddeshwar, Machine Drawing, Tata McGraw Hill Publishing Co. Ltd., 5th edition, 1994
4. K. C. John, Text book of Machine Drawing, PHI Learning,

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Mechanical Engineering) IV – SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	MC112CE	Environmental Science	2	-	-	2	30	70	3	-
2	MC113PY	Essence of Indian Traditional Knowledge	2	-	-	2	30	70	3	-
3	HS213MP	Industrial Psychology	3	-	-	3	30	70	3	3
4	BS206BZ	Biology for Engineers	3	-	-	3	30	70	3	3
5	ES213ME	Energy Sciences and Engineering	2	-	-	2	30	70	3	2
6	PC231ME	Mechanics of Materials	3	-	-	3	30	70	3	3
7	PC232ME	Applied Thermodynamics	3	-	-	3	30	70	3	3
8	PC233ME	Kinematics of Machinery	3	-	-	3	30	70	3	3
9	PC234ME	Manufacturing Processes	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
10	PC261ME	Thermal Engineering Lab – I	-	-	2	2	25	50	3	1
11	PC262ME	Manufacturing Processes Lab	-	-	2	2	25	50	3	1
			24	**-**	**04**	**28**	**320**	**730**		**22**

HS: Humanities and Social Sciences BS: Basic Science ES: Engineering Science
MC: Mandatory Course PC: Professional Core
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)
PY: Philosophy BZ: Biology/ Life Sciences CE: Civil Engineering
MP: Mechanical / Production Engineering ME: Mechanical Engineering

Note:

1. Each contact hour is a clock hour
2. The duration of the practical class is two hours, however it can be extended wherever necessary, to enable the student to complete the experiment.
3. The students have to undergo a Summer Internship of two-week duration after IV – Semester and credits will be awarded in VII – Semester after evaluation.

4. All mentioned **Mandatory Courses** for BE (All Branches) should be offered either in I – Semester or II – Semester only **from the academic year 2019-2020**.
5. For those of the students admitted in BE (All Branches) during the academic year 2018-2019 the Mandatory Courses were not offered during the I – Semester or II – Semester may be compulsorily offered either in III – Semester or IV – Semester **for the academic year 2019-2020 only**.

Course Code	Course Title						Core/Elective
MC112CE	**Environmental Science**						**Mandatory**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To create awareness and impart basic knowledge about the environment and its allied problems.
- To know the functions of ecosystems.
- To understand importance of biological diversity.
- To study different pollutions and their impact on environment.
- To know social and environment related issues and their preventive measures.

Course Outcomes

After completing this course, the student will be able to:

1. Adopt environmental ethics to attain sustainable development.
2. Develop an attitude of concern for the environment.
3. Conservation of natural resources and biological diversity.
4. Creating awareness of Green technologies for nation's security.
5. Imparts awareness for environmental laws and regulations.

UNIT-I

The Multidisciplinary Nature of Environmental Studies: Definition, scope and importance, need for public awareness.

Natural Resources: Water Resources – Use and over utilization of surface and ground water, flood, drought, conflicts over water, Dams: Benefits and Problems. Food Resources –World Food Problems, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, Forest Resources –Use and over exploitation, deforestation & its effect on tribal people. Land Resources –Land Degradation, environmental effect of mining, man induced landslides, soil erosion and desertification**.** Energy Resources –Growing energy needs, Renewable and Non-renewable energy resources.

UNIT-II

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in ecosystem, food chains, ecological pyramids, ecological succession, types of ecosystems (marine, pond, river, forest, grassland, desert)

UNIT-III

Biodiversity: Levels of Biodiversity, Bio-geographical classification of India, Value of biodiversity, Threats to biodiversity, endangered and endemic species of India, Conservation of biodiversity, global and national efforts.

UNIT-IV

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, solid waste management.

Environment Protection Act: Air, water, forest and wildlife Acts, issues in the enforcement of environmental legislation.

UNIT-V

Social Issues and the Environment: Watershed management and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion.

Environmental Disaster Management: Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology. Disaster management cycle and disaster management in India.

Field Work:

- Visit to a local area to document environmental issues- agricultural area/ pond/lake/terrestrial ecosystem
- Visit to a local polluted area- market/slum area/Industrial area/traffic area

Suggested Reading:

1. A.K. De, *Environmental Chemistry,* Wiley Eastern Ltd.
2. E.P. Odum, *Fundamentals of Ecology,* W.B. Sunders Co., USA.
3. M.N. Rao and A.K. Datta, *Waste Water Treatment,* Oxford and IBK Publications.
4. Benny Joseph, *Environmental Studies,* Tata McGraw Hill, 2005.
5. V.K. Sharma, *Disaster Management,* National Centre for Disaster Management, IIPE,1999.

Course Code	Course Title						Core/Elective
MC113PY	**Essence of Indian Traditional Knowledge**						**Mandatory**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

The course will introduce the students to

- To get a knowledge in Indian Philosophical Foundations.
- To Know Indian Languages and Literature and the fine arts in India & Their Philosophy.
- To explore the Science and Scientists of Medieval and Modern India

Course Outcomes

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

1. Understand philosophy of Indian culture.
2. Distinguish the Indian languages and literature among difference traditions.
3. Learn the philosophy of ancient, medieval and modern India.
4. Acquire the information about the fine arts in India.
5. Know the contribution of scientists of different eras.
6. The essence of Yogic Science for Inclusiveness of society.

UNIT – I

Introduction to Indian Philosophy: Basics of Indian Philosophy, culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian culture, Ancient Indian, Medieval India, Modern India.

UNIT – II

Indian Philosophy & Literature: Vedas Upanishads, schools of Vedanta, and other religion Philosophical Literature. Philosophical Ideas the role of Sanskrit, significance of scriptures to current society, Indian Philosophies, literature of south India.

Indian languages and Literature-II: Northern Indian languages & Philosophical & cultural & literature.

UNIT – III

Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only)

UNIT – IV

Indian Fine Arts & Its Philosophy (Art, Technology & Engineering): Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in Indian, development of science in ancient, medieval and modern Indian.

UNIT – V

Education System in India: Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Suggested Readings:

1. Kapil Kapoor, “Text and Interpretation: The India Tradition’’, ISBN: 81246033375, 2005
2. “Science in Samskrit”, Samskrita Bharti Publisher, ISBN-13:978-8187276333,2007

3. NCERT, "Position paper on Arts, Music, Dance and Theatre'', ISBN 81-7450-494-X, 2006
4. S. Narain, "Examination in Ancient India", Arya Book Depot, 1993
5. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
6. M.Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN-13: 978-8120810990,2014
7. Chatterjee. S & Dutta "An Introduction to Indian Philosophy"

Course Code	Course Title						Core/Elective
HS213MP	**Industrial Psychology**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The course will introduce the students to

- To Know Industry Structures and functions.
- Develop an awareness of the major perspectives underlying the field of Industrial Psychology
- Understanding for the potential Industrial Psychology has for society and organizations now and in the future.

Course Outcomes

After completing this course, the student will be able to:

1. Understanding of key concepts, theoretical perspectives, and trends in industrial psychology.
2. Evaluate the problems thorough and systematic competency model.
3. Analyse the problems present in environment and design a job analysis method.
4. Create a better work environment for better performance.
5. Design a performance appraisal process and form for the human behavior.

UNIT-I

Industrial Engineering: Meaning, Definition, Objective, Need, Scope, Evolution and developments. Concept of Industrial Engineering, Historical development of Industrial Engineering, main departments of Industry.

Organization Structure: Introduction, Principles of Organization, Organizational theories, Departmentalism, Authority, power, Organizational effectiveness, structuring the Organization, Organizational change, Organization charts.

UNIT-II

Motivation, Morale and Behavioural Science: Motivation, Characteristics, Kinds of motivation, Thoughts of motivational philosophy, Human needs, Incentive as motivators, Managing Dissatisfaction and frustration, Morale, Absenteeism, Behavioural Science.

Social environment: Group dynamics in Industry Personal psychology, Selection, training, placement, promotion, counselling, job motivations, job satisfaction. Special study of problem of fatigue, boredom and accidents.

UNIT-III

Understanding Consumer Behavior: Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale: The nature and scope of engineering psychology, its application to industry

UNIT-IV

Work Methods: Efficiency at work, the concept of efficiency, the work curve, its characteristics, the work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction, the working environment, noise, illumination, atmospheric conditions, increasing efficiency at work; improving the work methods, Time and motion study, its contribution and failure resistance to time and motion studies, need for allowances in time and motion study.

UNIT-V

Work and Equipment Design: Criteria in evaluation of job-related factor, job design, human factors, Engineering information, input processes, mediation processes, action processes, methods design, work space and its arrangement, human factors in job design. Accident and Safety: The human and economic costs of accidents, accident record and statistics, the causes of accidents situational and individual factors related to accident reduction.

Suggested Readings:

1. TR Banga and SC Sharma, *Industrial Engineering and Management*, Khanna Publishers, 11th Edn., 2014.
2. Tiffin, J and McCormic E.J., *Industrial Psychology*, Prentice Hall, 6th Edn., 1975.
3. McCormic E.J., *Human Factors Engineering and Design*, McGraw Hill, 4th Edn.,1976.
4. Mair, N.R.F., *Principles of Human relations*
5. Gilmer, *Industrial Psychology*
6. Ghiselli & Brown, *Personnel and Industrial Psychology.*
7. Myer, *Industrial Psychology.*
8. Dunnete, M.D., *Handbook of Industrial and Organizational Psychology.*
9. Blum & Taylor, *Industrial Psychology*

Course Code	Course Title						Core/Elective
BS206BZ	**Biology for Engineers**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

Gain vivid knowledge in the fundamentals and uses of biology, human system and plant system.

Course Outcomes

After completing this course, the student will be able to:

1. Apply biological engineering principles, procedures needed to solve real-world problems.
2. Understand the fundamentals of living things, their classification, cell structure and biochemical constituents.
3. Apply the concept of plant, animal and microbial systems and growth in real life situations.
4. Comprehend genetics and the immune system.
5. Know the cause, symptoms, diagnosis and treatment of common diseases.
6. Apply basic knowledge of the applications of biological systems in relevant industries.

UNIT-I

Introduction to Life: Characteristics of living organisms, Basic classification, cell theory, structure of prokaryotic and eukaryotic cell, Introduction to Biomolecules: definition, general classification and important functions of carbohydrates, lipids, proteins, vitamins and enzymes.

UNIT-II

Biodiversity: Plant System: basic concepts of plant growth, nutrition, photosynthesis and nitrogen fixation. Animal System: Elementary study of digestive, respiratory, circulatory, excretory systems and their functions. Microbial System: History, types of microbes, economic importance and control of microbes.

UNIT-III

Genetics and Evolution: Theories of evolution and Evidences; cell division–mitosis and meiosis; evidence of laws of inheritance; variation and speciation; nucleic acids as a genetic material; central dogma; Mendel laws, gene and chromosomes.

UNIT-IV

Human Diseases: Definition, causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, influenza, AIDS and Hepatitis. Immunity immunization, antigen – antibody immune response.

UNIT-V

Biology and its Industrial Applications: Transgenic plants and animals, stem cell and tissue engineering, bioreactors, bio pharming, recombinant vaccines, cloning, drug discovery, biological neural networks, bioremediation, biofertilizer, biocontrol, biofilters, biosensors, biopolymers, bioenergy, biomaterials, biochips, basic biomedical instrumentation.

Suggested Readings:

1. A Text book of Biotechnology, R.C. Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004

4. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
5. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
6. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012.

Course Code	Course Title						Core/Elective
ES213ME	**Energy Sciences and Engineering**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**2**

Course Objectives

The objectives of this course is to impart knowledge of

- Able to identify various sources of energy.
- Understand the difference between Conventional and renewable energy sources.
- Identify various storage devices of Energy.
- Able to estimate the costing of power plant.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the basics of various sources of energy
2. Analyse the present status of conventional energy sources.
3. Understand the working principles of Renewable Energy systems
4. Design and develop waste heat recovery systems.
5. Relate energy economics, standards and future challenges.

UNIT-I

Introduction: Various sources of energy, relative merits and demerits, Statistics and prospects of conventional and Renewable energy sources.

UNIT-II

Conventional Energy Sources: Fossil Fuels: Power generation using steam turbine and gas turbine power plants, Nuclear Fuels: Parts of reactor core, Nuclear power plant outline, Methods to dispose radioactive waste. Hydro Energy: Spillways, Hydroelectric power plant outline.

UNIT-III

Renewable Energy Systems: Solar Energy – Types of collectors and concentrators, Solar Photo Voltaic Cell. Wind Energy – Types of Wind Turbines and their working, geothermal power plant, Biomass conversion, Wave Energy power plant, Tidal Energy power plant, Ocean thermal energy power plant.

UNIT-IV

Storage: Methods to store Mechanical Energy, Electrical Energy, Chemical Energy and Thermal Energy. Co-generation &Tri-generation: Definition, application, advantages, classification, saving Potential. Energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

UNIT-V

Power Plant Economics and Environmental Considerations: Costing, Estimation of power production - Pollutants and Pollution Standards -Methods of pollution control. Energy Efficiency rating and BEE standards, Future energy needs and challenges.

Suggested Readings:

1. Wakil MM, *Power Plant Technology*, McGraw Hill
2. P.K. Nag, *Power Plant Engineering*, McGraw-Hill

3. G.D. Rai, *Non-Conventional Energy Sources,* Khanna Publishers
4. Mili Majumdar, *Energy Efficient Buildings in India,* Ministry of Non-Conventional Energy Sources.

Course Code	Course Title						Core/Elective
PC231ME	**Mechanics of Materials**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the basic concept of stress and strains for different materials.
- To know the mechanism of the development of shear force and bending moment in beams and the stresses in thin cylinders & spheres.
- To know the theory of simple bending, direct & bending stress and distribution of shear stress.
- To analyse and understand shear stress, torsional stress and spring applications.
- To study the deflections and its applications.

Course Outcomes

1. To understand the theory of elasticity and Hooke's law
2. To analyse beams to determine shear force and bending moments
3. Analyse shear stress distribution in different sections of beams.
4. To analyse and design structural members subjected to combined stresses
5. To solve problems on bars and to determine deflections at any point of the beams

UNIT – I

Simple Stresses & Strains: Types of stresses & strains, Stress-Strain relations (Hooke's law), Relation between elastic constants, Volumetric strain, Composite bars, Temperature stresses. **Strain energy:** Gradual, Sudden, Impact and Shock loading.

Compound Stresses: Stresses on oblique planes, Principal stresses and Principal planes. Mohr's circle and ellipse of stresses & strains.

UNIT – II

Shear Force and Bending Moment: Construction of S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads, Point of contraflexure and Relation between S.F & B.M.

Thin Cylinders & Spheres: Derivation of formulae for longitudinal stress, Circumferential (hoop) stress, Volumetric strains, Changes in diameter and volume.

UNIT – III

Bending stresses in Beams: Assumptions made in pure bending, Derivation of bending moment equation, Modulus of section, Moment of resistance, Determination of bending stresses. Direct and Bending Stresses: Basic concepts, Core of sections for square, rectangular, solid and hollow circular.

Distribution of shear stress: Equation of shear stress, Distribution across rectangular section.

UNIT – IV

Torsion of Circular Shafts: Theory of pure torsion, Assumptions made, Derivation of basic torsion equation, Torsional moment of resistance, Polar section modulus, Power transmitted by shafts, Combined bending and torsion.

Helical Springs: Close and open coiled helical springs subjected to axial loads, axial couples, Strain energy in springs.

UNIT - V

Deflection of Beams: Deflections of cantilever and simply supported beams including overhanging beams for point loads and uniformly distributed loads by Double integration method, Macaulay's method, Strain energy method, Moment area method, Conjugate beam method and Maxwell reciprocal theorem.

Suggested Readings:

1. S. Ramamrutham, Strength of Materials, Dhanpat Rai & Sons, 1993.B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Publishers, Delhi, 2000.
2. R.K. Rajput, Strength of Materials, S. Chand & Co., 2003.
3. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
4. Gere & Timoshenko, Mechanics of Materials, 2nd Edition, CBS Publishers and Distributors Pvt. Ltd.
5. Ferdinand P. Beer et.al., Mechanics of Materials, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2005.

Course Code	Course Title						Core/Elective
PC232ME	**Applied Thermodynamics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study the application of thermal science in mechanical engineering, consisting of the fundamental laws and processes for energy conversion.
- To understand thermal design aspects of reciprocating machinery-reciprocating compressors and IC Engines.
- To analyse Rankine cycle applied to thermal power plants and its improvements.
- To gain the knowledge on the power plant thermal Devices-Boilers, Condensers, Pumps &Nozzles.

Course Outcomes

1. Expected to be able to quantify the behavior of reciprocating compressors.
2. Expected to be able to explain thermal design and working principles of IC Engines, their supporting systems and Combustion chambers.
3. Expected to be able to quantify the behavior of power plants based on the Rankine cycle, including the effect of enhancements such as superheat, reheat and regeneration.
4. Expected to be able to explain the thermal design and working principles of Power plant devices.
5. Expected to be able to explain working principles of Boilers, Condensers, Pumps &Nozzles.

UNIT-I

Reciprocating Air Compressors: Classification and applications. Ideal and actual P-V diagrams, work input and efficiency relations for single and multi-stage compressors. Effect of clearance volume on work input and efficiency. Inter cooling and after cooling concepts.

UNIT-II

Internal Combustion Engines: Classification and applications. Working principles of four stroke and two stroke engines, Spark Ignition and Compression ignition engines. Deviation of actual cycles from Air Standard cycles. Performance parameters of I.C. Engines. Heat balance sheet of I. C. Engine. Overview of Engine supporting systems- Cooling Systems, Lubrication systems- Wet sump, Dry sump and Mist Systems. Working principles of S.I. Engine fuel systems- Carburettors, Battery and Magneto Ignition systems. Working principles of C.I. Engine fuel systems- Fuel pump and Fuel injector.

UNIT-III

I.C. Engine Combustion phenomena: Stages of combustion in S.I. Engines- Ignition delay, Flame front propagation and After burning. Abnormal combustion- Pre-ignition and Knocking.

Factors affecting Knocking. Stages of combustion in C.I. Engines, Delay period, Period of Uncontrolled Combustion, Period of Controlled Combustion and after burning. Abnormal Combustion-Knocking. Factors affecting Knocking. Octane and Cetane rating of fuels. Design considerations for combustion chamber and cylinder head. Type of combustion chambers of S.I. engines and C.I. engines.

UNIT-IV

Steam Boilers: Classification and Working Principles. Water tube boilers- Babcok & Wilcox and Stirling boilers. Fire tube boilers- Cornish, Cochran, Locomotive and Lancashire boilers. High Pressure boilers /

Supercritical boilers: La-mont, Benson boiler, Loeffler boiler and Velox boiler. Boiler Mountings and Accessories. Boiler Draught. Calculation of Chimney height.

Steam Condensers: Jet and Surface condensers, Principle of Operation and Applications.

UNIT-V

Steam Power Plant Cycles: Carnot and Rankine cycles of operation and their efficiencies. Analysis of Rankine cycle with superheating, reheating and regeneration (Direct and Indirect types).

Steam Nozzles: Flow of steam through convergent - divergent nozzles, velocity of steam flowing through the nozzle, mass of steam discharge through the nozzle, condition for maximum discharge, critical pressure ratio and nozzle efficiency. Super saturated expansion of steam through nozzles. General relationship between area, velocity and pressure in Nozzle flow.

Suggested Reading:

1. R.K. Rajput, " Thermal Engineering", Laxmi Publications, 9th Edn., 2013
2. V. Ganesan, "Internal Combustion Engines", Tata McGraw Hill Publishing, 2007
3. P.L. Ballaney, "Thermal Engineering", Khanna Publishers, 19th Edn., 1993.
4. Richard Stone, "Introduction to I.C. Engines", Mac Millan, 2nd Edn., 1997

Course Code	Course Title						Core/Elective
MC233ME	**Kinematics of Machinery**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Analysis of mechanisms.
- Drawing displacement diagrams for followers with various types of motions.
- Cam profile drawing for various followers.
- Estimation of transmission of power by belts and application of various gears and gear trains.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2. Analyse the planar mechanisms for position, velocity and acceleration.
3. Design frictional systems like belt drives, rope drives, clutches, bearings and screw threads
4. Design cams and followers for specified motion profiles.
5. Evaluate gear tooth geometry and select appropriate gears for the required applications.

UNIT-I

Definition of link, pair, kinematic chain, mechanism and machine, Kutzbach and Grubler criterion, Grashoff's law, inversions of quadratic cycle chain, inversions of single and double slider crank chains. Fundamentals of coupler curves, Robert's law, Pantograph, Geneva mechanism, Hooke's joint, Davis and Ackerman's Steering gear mechanisms.

Introduction to Type, Number and Dimensional synthesis of four bar planar mechanisms

UNIT-II

Analysis of Mechanisms: Instantaneous centre, body centrode and space centrode, Kennedy's theorem, Graphical methods (relative velocity method, instantaneous center method) to find velocities and accelerations including Coriolis component of acceleration of planar mechanisms. Angular velocity theorem.

UNIT-III

Laws of Friction: Friction in screw threads, pivots, collars and clutches, friction axis of link and friction circle

Belts and Rope drives: Open and closed belt drives, length of belt, ratio of tensions, effect of centrifugal tension and initial tension on power transmission, condition for maximum power transmission

Brakes: Block or shoe brake, internal expanding shoe brake, disc brake, belt brakes

Dynamometers: Rope brake, belt transmission and Torsion type dynamometers

UNIT-IV

Cams: Types of cams and followers, Displacement, velocity, acceleration and jerk (SVAJ) diagrams for follower motion, Analysis of uniform motion, parabolic motion, simple harmonic motion and cycloidal motion profiles. Graphical synthesis of planar cams with knife edge, roller and flat face followers. Eccentric circle cam with translating roller follower.

UNIT-V

Gears: Classification of gears. Spur gears- Nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycloidal tooth profile.

Helical gears: Helical gear tooth relations, contact of helical gear teeth.

Gear trains- Simple, compound, reverted, and epicyclic gear trains.

Suggested Readings:

1. S.S. Rattan, Theory of Machines, Tata McGraw-Hill, 3rd Edition,2009.
2. J. E. Shigley, Theory of Machines and Mechanisms, McGraw-Hill Publications,2005.
3. Thomas Bevan, Theory of Machines, Pearson Education
4. Norton RL, Kinematics and Dynamics of Machinery, McGraw-Hill Publications
5. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Press Pvt. Ltd,2008

Course Code	Course Title						Core/Elective
MC234ME	**Manufacturing Process**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the basic principles of major manufacturing processes such as metal casting, welding and forming of engineering materials.
- To know the advantages and limitations of each process.
- To be able to select the optimal process to produce a product.
- To know the basic principle of advanced forming processes.

Course Outcomes

1. Describe the concepts of Foundry Technologies consisting of pattern making, mould making, gating design and solidification.
2. Discuss the importance of special casting processes, categorize various casting defects and describe the processing of plastics.
3. Classify and differentiate various Arc welding, Gas welding and Advanced welding processes, discuss their advantages, applications and limitations.
4. Differentiate various Solid State welding and Resistance welding processes, discuss their applications, and identify various welding defects.
5. Describe various forming processes, sheet metal operations and discuss the importance of unconventional forming processes.

UNIT-I

Casting Process : Casting terms, pattern materials, types of patterns, pattern allowances, colour code for patterns, Moulding sands, core sands, properties of moulding sand and its ingredients, different types of moulding machines, Directional solidification, use of chaplets, chills, riser and gating design.

UNIT-II

Special Casting Processes: Shell moulding, Co_2 moulding, die casting, centrifugal casting, investment or lost wax process; Casting defects, causes and remedies, Inspection and testing of castings. **Processing of Plastics** - Extrusion, Injection moulding, Blow moulding and Thermoforming. **Introduction to Powder Metallurgy**- Process, Production of powders, blending, mixing, compaction techniques and finishing operations employed in powder metallurgy processes.

UNIT-III

Welding Processes: Introduction, Classification of welding processes, principle of gas welding, equipment and techniques, types of flames and applications, advantages, limitations and applications of Gas welding; Arc welding equipment electrode materials and specifications, polarity, types of arc welding.- SMAW, SAW, GMAW, GTAW, PAW, Atomic hydrogen welding, principle of Electro slag welding, Soldering and Brazing, Gas cutting.

UNIT-IV

Solid State Welding Process: Forge Welding, Friction Welding, Friction Stir Welding, and Explosive Welding.

Resistance welding processes - Spot welding, Projection welding, Percussion welding, Seam welding, Butt welding, weldability, Welding defects

UNIT-V

Forming Processes: Cold & Hot working, Yield criteria, Process description of Forging, Rolling, Extrusion, Wire drawing.

Sheet Metal Operations: Blanking, Piercing, Bending, Deep drawing, Stretch forming, Spinning. **Advance Forming Processes**- High energy rate forming processes such as Explosive forming, Electro-magnetic forming and Electro-hydraulic forming; Rubber pad forming

Suggested Readings:

1. P.N. Rao, “Manufacturing Technology,” Vol. 1, Tata McGraw Hill Publ., 3nd Ed., 2011
2. Amitabh Ghosh & Mallick, “Manufacturing Science”, Assoc. East west Press Pvt. Ltd. 4th Ed., 2011
3. Roy A. Lindberg, "Processes and Materials of Manufacture", 3rd Edition, Pearson Education, 2015.
4. Serope Kalpakjian, “Manufacturing Engineering and Technology”, Pearson Education, 2018
5. George. E. Dieter, "Mechanical Metallurgy", SI Metric Edition McGraw-Hill Book Company
6. J.P. Kaushish, "Manufacturing Processes", PHI Learning Pvt. Ltd., 2nd, 2010

Course Code	Course Title						Core/Elective
MC261ME	**Thermal Engineering Lab - I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To understand applications of thermal engineering concepts through experimentation.
- To provide knowledge in testing of properties of fuels and lubricating oils
- To demonstrate and conduct experiments, Interpret and analyse data and report results of IC engine testing

Course Outcomes

1. Perform experiments to find the efficiency of Petrol and Diesel engines.
2. Find the properties of unknown fuels/lubricants.
3. Perform experiments on CI and SI engines.
4. Perform experiments on Reciprocating Air Compressor.

List of Experiments:

1. To determine volumetric efficiency, isothermal efficiency and mass flow rate of a two stage reciprocating air compressor.
2. To determine valve timing diagram of a Petrol/Diesel engine.
3. To determine port timing diagram of a Petrol/Diesel engine.
4. To conduct performance test on single cylinder Diesel engine.
5. To conduct heat balance test on a Diesel engine.
6. To conduct Morse test on multi cylinder Petrol engine.
7. To conduct performance test on multi cylinder Petrol engine.
8. To conduct performance test on a two-stroke Petrol engine.
9. To conduct performance test on multi cylinder Diesel engine.
10. To study the performance of a Petrol engine under different compression ratios.
11. Exhaust gas analysis of Petrol engine for carbon-monoxide and unburnt hydrocarbons.
12. Exhaust gas analysis of Diesel engine for carbon deposits using smoke meter.
13. Determination of viscosity of lubricating oil.
14. Determination of flash and fire points of a fuel
15. Study of Boiler Models

Note: At least ten experiments should be conducted in the Semester

Course Code	Course Title						Core/Elective
PC262ME	**Manufacturing Processes Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To gain knowledge and skill in various manufacturing processes such as casting, welding and forming.
- To understand and perform operations like pattern making, sand testing and casting.
- To join metal pieces by various welding techniques and gain hands on experience.
- To understand the working principle and produce some components by various metal forming techniques.

Course Outcomes

1. Conduct experiments and put hands-on experience on various processes in foundry, welding, forging, forming and plastic manufacturing technologies.
2. Demonstrate the understanding of the theoretical concepts of above technologies while working in small groups.
3. Demonstrate writing skills through clear laboratory reports
4. Identity the defects / imperfections and discuss their causes and suggest remedies to eliminate them.
5. Transfer group experience to individual performance of exercises and demonstrate effective oral communication skills.

List of Experiments:

Foundry

1. Single piece pattern making with wood as material considering allowances (Draft, Shrinkage and Machining)
2. Green sand mould making processes with complete sprues, gates, riser design.
3. Testing of green sand properties
4. Melting and casting of aluminium metal.

Welding

I. Evaluation of strength and hardness of a
   1. Butt Joint prepared by gas welding using different types of flames
   2. Lap joint by resistance welding process
   3. V-Joint by Arc welding process

II. Exercises using TIG and MIG welding processes.

Forming:

1. Evaluation of formability using Erichsen cupping test
2. Performing wire drawing operation on different materials (ex. Cu, Al, etc)
3. Performing blanking and piercing operations using hydraulic/fly presses.
4. Manufacturing of a simple component using Plastic Injection moulding machine

Note: Minimum ten experiments should be conducted in the semester