COURSE STRUCTURE & CURRICULUM
FOR
BACHELOR OF TECHNOLOGY
IN
PRODUCTION AND INDUSTRIAL ENGINEERING
(HONOURS IN FOUNDRY & FORGE)

Applicable from the academic session 2025-29

National Institute of Advanced Manufacturing Technology

(Formerly National Institute of Foundry and Forge Technology)

Deemed to be university (Distinct Category)

Hatia, Ranchi 834003, Jharkhand, India

Course Structure of B.Tech. in Production and Industrial Engineering with honours in Foundry and Forge Technology (2025-2029 batch onwards)

SEMESTER-I

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx BSC 01	Engineering Mathematics-I	3	1	0	4	View
2	xx BSC 02/ xxBSC 04	Engineering Physics/ Engineering Chemistry	3	0	2	4	View
3	xx ESC 01	Basics of Electrical Engineering & Electronics	3	0	2	4	View
4	xx ESC 02/ xx HSMC 01	Engineering Drawing and Computer Graphics/ Communication Skills	1	0	4	3	View
			2	0	2	3	View
5	xx ESC 03	Workshop Practice I	0	0	4	2	View
6	xx ESC 04	Design Thinking & Idea Lab	0	0	2	1	View
7	xx PCC 01	Basic Material Engineering	3	0	0	3	View
8	xx AUC 01	Induction Programme (3 Weeks) At the beginning of the session	0	0	0	0	
9	xx AUC 02	Sports & Yoga or NSS/NCC (Audit)	0	0	2	0	
	Total		15	1	18	21	

SEMESTER –II

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx HSMC 01/ xx ESC 02	Communication Skills/ Engineering Drawing and Computer Graphics	2	0	2	3	View
			1	0	4	3	View
2	xx BSC 03	Engineering Mathematics –II	3	1	0	4	View
3	xx BSC 04/ xx BSC 02	Engineering Chemistry/ Engineering Physics	3	0	2	4	View
4	xx ESC 05	Programming for Problem solving	3	0	2	4	View
5	xx ESC 06	Engineering Mechanics	3	0	2	4	View
6	xx PCC 02	Metrology and Inspection	3	0	0	3	View
7	xx AUC 03	Sports & Yoga or NSS/NCC (Audit)	0	0	2	0	
(Optional) Mandatory for exit with UG certificate		Vocational/ Industrial Training/ Laboratory Work/ Specialized course offered by respective department	8 Hrs/day for 4 weeks/ 4 credit course			4	
	Total		**18**	**1**	**14**	**22/26**	

NOTE: Mandatory Vocational/ Industrial Training (4 weeks) or Laboratory Work/ Specialized course offered by respective department for student opting for exit after first year with UG certificate.

SEMESTER –III

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx BSC 05	Engineering Mathematics –III	3	1	0	4	View
2	xx BSC 06	Biology for Engineers (MOOCs)	2	0	0	2	View
3	xx BSC 07	Environmental Science	2	0	0	2	View
4	xx PCC 03	Strength of Materials	3	0	2	4	View
5	xx ESC 08	Applied Thermodynamics	3	1	0	4	View
6	xx PCC 04	Production, Planning and Control	3	0	0	3	View
7	xx HSMC02	Universal Human Values	2	1	0	3	View
	Total		**18**	**3**	**2**	**22**	

SEMESTER –IV

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx BSC 08	Numerical Methods/ Statistics for Engineers	3	0	0	3	View
2	xx PCC 05	Kinetic of Machine	3	0	0	3	View
3	xx PCC 06	Manufacturing Engineering –I	3	0	2	4	View
4	xx PCC 07	Industrial Engineering	3	0	2	4	View
5	xx PCC 08	Heat and Mass Transfer	3	0	0	3	View
6	xx PCC 09	Fluid Mechanics and Machinery	3	0	2	4	View
7	xx AUC 04	Indian Knowledge System	0	0	0	0	View
(Optional) Mandatory for exit with UG certificate		Vocational/ Industrial Training/ Laboratory Work/ Specialized course offered by respective department	8 Hrs/day for 4 weeks/ 4 credit course			4	
	Total		**18**	**0**	**6**	**21/25**	
	xx M01*	Sustainable Manufacturing	-	-	-	4	View
8	xx H01#	Technology of Ferrous Casting	3	0	2	4	View

NOTE: Mandatory Vocational / Industrial Training (4 Weeks) or Laboratory Work/ Specialized course offered by respective department for student opting for exit after 2nd year with UG Diploma Certificate.

SEMESTER – V

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx PCC10	Manufacturing Engineering- II	3	0	2	4	View
2	xx PCC 11	Dynamics of Machine	3	0	2	4	View
3	xx PCC 12	Machine Design	2	0	2	3	View
4	xx PCC 13	Ergonomics and Work Design	3	0	0	3	View
5	xx PEC 01	Product Design and Value Engg	3	0	0	3	View
6	xx HSMC03	Operation Research	2	1	0	3	View
7	xx PrSI 01	Summer Internship/**	8 Hrs/day for 4 weeks			2	
	Total		**16**	**1**	**6**	**22**	
	xx M02*	Sustainable Manufacturing	-	-	-	4	View
8	xx H02#	Technology of Ferrous Forging	3	0	2	4	View

** students have to do summer internship in summer vacation (after 4th sem) and evaluation of the same will be done in 5th semester

SEMESTER – VI

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx PCC14	Physical Metallurgy and Heat treatment of Casting and Forging	3	0	2	4	View
2	xx PCC15	Production and Operation Management	3	0	0	3	View
3	xx PCC16	Forging Die Design & Product Realisation.	3	0	2	4	View
4	xx PEC02	Management Concept & Techniques	3	0	0	3	View
5	xx OEC01	Casting and Solidification of metals	3	0	0	3	View
6	xx HSMC04	Project Management	2	1	0	3	
(Optional)Mandatory for exit with BSc Engineering		Vocational/ Industrial Training/ Laboratory Work/ Specialized course offered by respective department	8 Hrs/day for 4 weeks/ 4 credit course			4	
	Total		17	1	4	20/24	
	xx M03*	Sustainable Manufacturing	-	-	-	4	View
7	xx H03#	Technology of Non Ferrous Forging	-	-	-	4	View

Note: Mandatory Vocational/Industrial Training (4 weeks) or laboratory work /specialized course offered by respective department for student opting for exit after 3rd year with BSc Engineering

SEMESTER – VII

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx PCC17	Foundry Tooling and Methoding	3	0	2	4	View
2	xx PCC18	Machine Tool Design	3	0	0	3	View
3	xx PCC19	Total Quality Management	3	0	0	3	View
4	xx PEC03	Near Net Shape Process	3	0	0	3	View
5	xx OEC02	Plasticity and Deformation	3	0	0	3	View
6	xx PrSI02	Seminar	0	0	4	2	View
7	xx PrSI03	Summer Internship **	8 hrs/day for 4 weeks			2	
	Total		**15**	**0**	**6**	**20**	
	xx M04*	Sustainable Manufacturing				4	View
8	xx H04#	Simulation of Casting and Forging	3	0	2	4	View

** students have to do summer internship in summer vacation (after 6th sem) and evaluation of the same will be done in 7th semester

SEMESTER – VIII

Sl. No.	Course Code	Course Name	L	T	P	C	Syllabus
1	xx PEC 04	Non-Conventional Machining process	3	0	0	3	View
2	xx OEC 03	Supply Chain Management	3	0	0	3	View
3	xx PrSI 04	Research Project / Dissertation II				10	View
	Total		**6**	**0**	**0**	**16**	
	xx M05*	Sustainable Manufacturing				4	View
4	xx H05#	Technology of Non-Ferrous Casting	3	0	2	4	View

xxMO* MINOR in "Production and Industrial Engineering" (OFFERED ONLY TO OTHER THAN PRODUCTION AND INDUSTRIAL ENGINEERING STUDENTS). Students who have registered for Minor in Production and Industrial Engineering should complete 20 credits and shall opt for courses listed in Sustainable manufacturing and will be given later on.

xxHO# is honours course (in Foundry and Forge Technology) of extra 20 credits which is mandatory for all B Tech students admitted in Production and Industrial Engg.

Total credits is **164+20=184** for award of degree in B Tech in Production and Industrial Engineering with Honours in Foundry and Forge Technology.

Elective Courses	Subject code	Name of subjects	Semester
Programme Elective Courses	xx PEC 01	Product Design and Value Engg	V
		Lean Manufacturing and Six sigma	
		Material Handling system	
		Engineering Optimization	
	xx PEC 02	Total Quality Management	VI
		Circular Economy-sustainable material management	
		Reliability and Maintenance Engineering	
		Industrial Statistic	
		Management Concepts and Techniques	
	xx PEC 03	Near Net shape Process	VII
		Tribology in Engineering	
		Rapid Prototyping and Tooling	
		Material Deformation Processes	
		Non-Destructive Testing and Examination	
	xx PEC 04	Non-conventional Machining Process	VIII
		Advanced Manufacturing Process	
		AI and Data Analytics	
		Surface Engg and Laser Additive Manufacturing	
		Fracture, Fatigue, and Failure Analysis	
Open Elective Courses	xx OEC 01	Technology of Ferrous Casting and Forging	VI
		Recent developments in Casting Process	
		Fuel, Furnace and Refractories	
		Thermo-mechanical Processing	
	xx OEC 02	Tooling and Die Design for Casting and Forging	VII
		Recent development in metal forming process	
		Plasticity and Deformation	
	xxOEC 03	Equipment and Tooling for Foundry and Forging	VIII
		Foundry and Forge Shop Environmental Management	
		Robotics and Automation	

Syllabus

Semester-I

Course Code : xxxBSC01	**Category :** Basic Science Courses
Course Title : Engineering Mathematics – I	**Semester** : First
L-T-P : 3-1-0	**Credit:**4

1. **Calculus (Integration) – 8L**
   Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.
2. **Calculus (Differentiation) – 6L**
   Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.
3. **Sequence and Series – 10L**
   Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.
4. **Multivariate Calculus – 10L**
   Limit, continuity and partial derivatives, Directional derivatives, Total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, Curl and Divergence.
5. **Matrices – 8L**
   Inverse and rank of a matrix, Rank-nullity theorem; System of linear equations; Symmetric, Skew-symmetric and Orthogonal matrices; Determinants; Eigenvalues and Eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Learning Resources:

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Physics	**Semester** : First
L-T-P : 3-0-2	**Credit:**4

Module 1: Harmonic Oscillation 6 Lectures

Simple harmonic motion, damped and forced simple harmonic oscillator with examples,

damped harmonic oscillator – heavy, critical and light damping, Amplitude and energy decay in a damped harmonic oscillator. Forced oscillation and resonance condition.

Module 2: Wave optics 8 Lectures

Superposition of waves, Interference, thin film interference and Newton's ring, Diffraction of light, Diffraction due to single slit, double slits, Unpolarized& Polarized light, Polarization of wave, Production of polarized wave: Brewster's law, Malus' law, Double refraction, Retardation plate, Analysis of polarization.

Module 3: Vector Calculus 6 Lectures

Scalar & Vector field, Gradient of scalar field, Divergence & Curl of Vector field, Gauss' Divergence theorem, Stokes' theorem.

Module 4: Electrostatics 7 Lectures

Laplace's and Poisson's equations for electrostatic potential, Uniqueness theorem. Electric polarization; Relation between **D**, **E** and **P** Electric displacement and boundary conditions; Dielectric sphere in uniform electric field.

Module 5: Magnetostatics 7 Lectures

Biot-Savart's law and applications, Three magnetic vector **B**, **H** and **M** andrelation between them; Boundary conditions on **B** and **H**. magnetic susceptibility, diamagnetic, paramagnetic and ferromagnetic materials. Hysteresis loop Hysteresis loss and its application.

Module 6: Maxwell's equations & EMW 8 Lectures

Continuity equation for current densities; Ampere's law and its modification, Differential and integral forms of Maxwell's equation, Maxwell's equation in vacuum and non-conducting medium; The wave equation; Plane electromagnetic waves in vacuum, transverse character, relation between electric and magnetic fields of an electromagnetic wave; Energy in an electromagnetic field and Poynting theorem.

Text Book:

● Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

Reference books:

● Fundamentals of Physics Electricity and Magnetism, Halliday and Resnick, tenth edition (published 2013).
● Electricity, magnetism and light, W. Saslow, 1st edition
● Electromagnetic Theory, Singh and Prasad, I. K. International Publication, 1/e
● Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
● Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
● Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
● Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
● Optics, AjoyGhatak, 2008, Tata McGraw Hill
● Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
● Engineering physics, Gaur and Gupta, DhanpatRai Publications
● Modern engineering physics, A. S. Vasudeva, S Chand & Company Ltd

COURSE OUTCOMES

Students to get familiarize with the knowledge of harmonic oscillation and wave optics.
To make student understand the basic of electrostatics and magneto statics in vacuum and in material medium.

Students to get familiarized with the vector calculus and Maxwell's equation leading to the application of EMW in vacuum and in media.……

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Physics Laboratory	**Semester** : First
L-T-P : 0-0-2	**Credit:**1

Choice of 08-10 experiments from the following:

- Experiments on electromagnetic induction and electromagnetic breaking;
- Study of LCR circuits
- Magnetic field from Helmholtz coil
- Coupled oscillators
- Experiment on moment of inertia measurement
- Experiments with gyroscope
- Resonance phenomena in mechanical oscillators
- Frank-Hertz experiment
- Photoelectric effect experiment
- Diffraction (from ordinary light or laser pointers)
- interference experiment (from ordinary light or laser pointers)
- Minimum deviation, refractive index and dispersive power of material of a prism
- Study of variation of resistance due to heating effect
- Study of variation of magnetic field along the axis of current carrying coil.
- Use of Carey-Foster bridge
- Measurement of numerical aperture of optical fibre

Text Book:

- Text Book of Practical Physics, Dr. S. K. Ghosh, New Central Book Agency (P.) Ltd., 2000.

Reference books:

- Laboratory Manual in Applied Physics, Hannah Sathyaseelam, New Age International Pvt. Ltd.
- B.Sc. Practical Physics, C.L. Arora, S. Chand Publication.
- Practical optics, NattalyMenn, Elsevier Publication

LABROTARY OUTCOMES

Students to have hands on experience with experiments on the basic laws and principles of Physics in the field of Mechanics, Optics, Electricity, Magnetism, Modern Physics, etc.

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Chemistry	**Semester** : Second
L-T-P : 3-0-0	**Credit:**3

Atomic and molecular structure - 10L

Schrodinger equation. Particle in box solutions and their applications for conjugated molecules. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi- molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level

diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Spectroscopic techniques and applications - 6L

Principles and Applications of Electronic spectroscopy and Nuclear magnetic resonance. Vibrational and rotational spectroscopy of diatomic molecules and its applications. Fluorescence and its applications in Medicine. Surface Characterisation Techniques (Scanning Electron Microscopy and Transmission Electron Microscopy)

Intermolecular forces – 4L

Ionic, dipolar and van Der Waals interactions. Measurement of non-covalent interaction, Hydrogen bond, Equations of state of real gases and critical phenomena.

Use of free energy in chemical equilibria – 8L

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion: Introduction, Causes, consequences, Mechanism, Laws of Dry Corrosion, Wet Corrosion , Factors Influencing Corrosion, Protective measures against corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

Periodic properties and Stereochemistry – 8L

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases. Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Polymer – 6L

Classification of polymers, Mechanism of Polymerisation, structure-property relationship, conductive polymers.

Learning Resources:

1. University Chemistry, by B.H.Mahan Chemistry, Second Edition, By Prasanta Ratha and S. Chakroborty –Cengage pub
2. Engineering Chemistry by Jaya Shree Anireddy, Wiley publication
3. Text book of Engineering Chemistry , First Ed.2019, By Sashi Chawala, Dhanpat
4. Rai, publication Chemistry: Principles and Applications, by M.J.Sienko and R.A.Plane
5. Fundamentals of molecular Spectroscopy, by C.N.Banwell
6. Engg Chemistry(NPTEL Web Book),by B.L.Tembe, Kamaluddin and
7. M.S.Krishnan Physical Chemistry, by P.W.Atkins
8. Organic Chemistry: Structure and Function by K.P.C. Volhardt and N.E. Schore,
9. 5 th Edition http://bcs.whfreeman.com/volhardtschore5e/default.asp

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Chemistry Laboratory	**Semester** : Second
L-T-P : 0-0-2	**Credit:**1

Choice of 08-10 experiments from the following

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Preparation of a metal complex
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Redox-titration (Estimation of Iron using permanganometry)
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscometers to demonstrate the isoelectric point as the pH of Minimum viscosity for gelatin sols and/ or coagulation of the white part of egg.

Course Code :	**Category :** Engineering Science course
Course Title : Basic of Electrical Engineering and Electronics	**Semester** : First
L-T-P : 3-0-0	**Credit:**3

1. **DC Circuits – 4L**

   Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.
2. **AC Circuits – 4L**

   Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.
3. **Transformers – 3L**

   Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.
4. **Electrical Machines – 4L**

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque- speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

5. **Power Converters – 3L**

   DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

6. **Electrical Installations – 3L**

   Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Semiconductor Devices and Applications – 3L

Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Operational amplifier and its applications – 3L

Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator anddifferentiator.

Timing Circuits and Oscillators – 3L

RC-timing circuits, IC 555 and its applications as tableand mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-Cphase shift and Wein bridge oscillator.

Digital Electronics Fundamentals – 3L

Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/sub tractor, multiplexers, De-multiplexers, flip-flops, shift registers, counters, Block diagram ofmicroprocessor/microcontroller and their applications.

Electronic Communication Systems – 3L

The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM andFM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

Learning Resources:

1. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain , "Modern Digital Electronics", Tata McGraw Hill, 3rd Edition, 2007.
3. S.Biswas, Basic Electronics, Khanna Publishing House, 2019
4. Frenzel, "Communication Electronics: Principles and Applications", Tata McGraw Hill,

3rd Edition, 2001
5. Shanti Ram Kal, Basic Electronics, PHI
6. RituSahdev, Basic Electrical Engineering, Khanna Book Publishing Co. (P) Ltd., Delhi.
1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Code :	**Category :** Engineering Science course
Course Title : Basic of Electrical Engineering and Electronics Laboratory	**Semester** : First
L-T-P : 0-0-2	**Credit:**1

Choose 10 experiments from the following:

1. First activity: Introduction to basic safety precautions and mentioning of the do's and Don'ts. Noting down list of experiments to be performed, and instruction for writing the laboratory reports by the students. Group formation. Students are to be informed about the modalities of evaluation.
2. Introduction and uses of following instruments:
(a) Voltmeter
(b) Ammeter
(c) Multimeter
(d) Oscilloscope
Demonstration of real life resistors, capacitors with color code , inductors and autotransformer.
3. Demonstration of cut-out sections of machines: DC machine, Induction machine, Synchronous machine and single phase induction machine.
4. Calibration of ammeter and Wattmeter.
5. Determination of steady state and transient response of R-L, R-C and R-L-C circuit to a step change in voltage.
6. Determination of steady state response of R-L and R-C and R-L-C circuit and calculation of impedance and power factor.
7. Determination of resonance frequency and quality factor of series and parallel R-L-C circuit.
8. (a) Open circuit and short circuit test of a single-phase transformer
(b) Load test of the transformer and determination of efficiency and regulation
9. Demonstration of three phase transformer connections. Voltage and current relationship, phase shifts between the primary and secondary side.
10. Measurement of power in a three phase unbalanced circuit by two wattmeter method.
11. Determination of Torque –Speed characteristics of separately excited DC motor.
12. Determination of Torque speed characteristics and observation of direction reversal by change of phase sequence of connection of Induction motor.

13. Determination of operating characteristics of Synchronous generator.
14. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for speed control of an Induction motor
15. Demonstration of components of LT switchgear.

Course Code :	**Category :** Engineering Science course
Course Title : Engineering Drawings and Computer Graphics	**Semester** : First
L-T-P : 1-0-4	**Credit:**3

Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.

Lettering, Dimensioning, Scales

Plain scale, Diagonal scale and Vernier Scales.

Geometrical Construction and Curves

Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archemedian Spiral.

Projection of Points, Lines, Surfaces

Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes- Auxiliary Planes.

Projection of Regular Solids

Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).

Combination of Regular Solids, Floor Plans

Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Isometric Projections

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

Overview of Computer Graphics, Customisation & Cad Drawing

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and

erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Annotations, Layering & Other Functions

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computeraided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Demonstration of A Simple Team Design Project

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solidmodeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Learning Resources:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals

Course Code :	**Category :** Humanities and Social Sciences courses
Course Title : Communication Skills	**Semester** : First

L-T-P : 2-0-2	**Credit:**3

1. Vocabulary Building

1.1 The concept of Word Formation: Compounding, Backformation, Clipping, Blending.

1.2 Root words from foreign languages and their use in English

1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.

1.4 Synonyms, antonyms, and standard abbreviations: Acronyms

2. Basic Writing Skills

2.1 Sentence Structures & Types: Simple, Compound, Complex

2.2 Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration

2.3 Importance of proper punctuation

2.4 Creating coherence: Arranging paragraphs & Sentences in logical order

2.5 Creating Cohesion: Organizing principles of paragraphs in documents

2.6 Techniques for writing precisely

3. Identifying Common Errors in Writing

3.1 Subject-verb agreement

3.2 Noun-pronoun agreement

3.3 Misplaced modifiers

3.4 Articles

3.5 Prepositions

3.6 Redundancies

3.7 Clichés

4. Nature and Style of sensible Writing

4.1 Describing

4.2 Defining

4.3 Classifying

4.4 Providing examples or evidence

4.5 Writing introduction and conclusion

5. Writing Practices

5.1 Comprehension

5.2 Précis Writing and Essay Writing

5.3 Business Letter, Cover Letter & CV; E-mail

Learning Resources:

(i) Kulbushan Kumar, R S Salaria,Effective Communication Skills, Khanna Publishing House, Delhi.

(ii) Practical English Usage. Michael Swan. OUP. 1995.

(iii) Remedial English Grammar. F.T. Wood. Macmillan.2007

(iv) On Writing Well. William Zinsser. Harper Resource Book. 2001

(v) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

(vi) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
(vii) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
(viii) Universal English Prof. Prasad Kataria Publications, 2019.
(ix) "Communication Skills for Professionals"-NiraKonar, Prentice Hall of India 2nd edition, New Delhi, 2011
(x) Gajendra Singh Chauhan, SmitaKashiramka and L. Thimmesha. Functional English. Cengage , 2019.

Course Code :	**Category :** Engineering Science course
Course Title : Workshop Practice I	**Semester** : First
L-T-P : 0-0-4	**Credit: 2**

Detailed contents:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical &Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

Workshop Practice:

Machine shop

Typical jobs that may be made in this practice module:

To make a pin from a mild steel rod in a lathe.

To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or millingmachine.

Fitting shop

Typical jobs that may be made in this practice module:

To make a Gauge from MS plate.

Carpentry

Typical jobs that may be made in this practice module:

To make wooden joints and/or a pattern or like.

Welding shop

Typical jobs that may be made in this practice module:

ARC WELDING: To join two thick (approx 6mm) MS plates by manual metal arcwelding. GAS WELDING: To join two thin mild steel plates or sheets by gas welding.

Foundry shop

Typical jobs that may be made in this practice module:

One/ two green sand moulds to prepare, and a casting be demonstrated.

Smithy shop

Typical jobs that may be made in this practice module:

A simple job of making a square rod from a round bar orlike.

Plastic moulding & Glass cutting Shop

Typical jobs that may be made in this practice module:

For plastic moulding, making at least one simple plastic component should be made. For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made.

Learning Resources:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited,Mumbai.
2. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India,1998.

Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Code :	**Category :** ESC
Course Title : Design Thinking and Idea Lab	**Semester** : First
L-T-P : 0-0-2	**Credit: 1**

Course Contents

Introduction to Engineering: "Engineering" as a vehicle for social and economic development;

the impact of science/engineering on our day-to-day lives; the process of engineering a product; various career options.

Introduction and identifying the need: Understanding the unique needs of the user - empathize - define - ideate - prototype - test. Case Studies - Develop an appreciation for the design process and its application in specific settings (Guest lectures, Videos, Field visits, Interplay lectures of design-based movies).

Problem Formulation: Framing a problem statement neutrally using adequate checks.

Case studies. Concept Generation: Generate multiple concepts using various creativity tools and thinking styles. Prototyping: Select from ideas and make quick prototypes (mock-ups) using available material.

Evaluation: Iterative process of ideation, prototyping and testing-Take the mock-ups to users for feedback and iterate the process till users feel delighted.

Course Code :	**Category :** Professional Core Courses
Course Title : Basic Material Engineering	**Semester** : First
L-T-P : 3-0-0	**Credit: 3**

Introduction – 3L

Historical perspective of Materials Science, Structure and properties relationship of

Engineering Materials, Classification of materials, Advanced Materials.

Structure of Solids and Characterization of Materials – 6L

Introduction to crystal structures and systems, Metallic structures, Ceramic crystal structures, Carbon nano-structures, Crystallographic directions and planes, Miller indices, Density computations, Crystallography, Diffraction methods, Electron microscopy, Metallography, Thermal characterization techniques.

Imperfections in Solids – 4L

Point defects, Dislocations, Interfacial Defects, Bulk defects.

Diffusion – 4L

Diffusion mechanisms, steady and non-steady state diffusion, Factors that influence diffusion, Law's of diffusion, Applications of Diffusion.

Mechanical Behaviour of Materials – 6L

Elastic and plastic properties, Creep, Fatigue, Fracture, Heat treatment of steels.

Phase Diagrams and Phase Transformations – 6L

Unary, Binary, Equilibrium phase diagrams, Eutectic, Eutectoid, Peritectic and peritectoidreactions**,** Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system, Iron-Carbon (Fe-C or Fe-Fe3C) Diagram.

Ceramic Materials – 2L

Ceramic types, Properties, Processing Application, Advanced ceramics.

Composites – 2L

Introduction, Applications, Particle reinforced composites, Fiber reinforced composites, Structural composites.

Thermal, Electrical, Magnetic, Optical Properties – 5L

Heat capacity, Thermal expansion, Thermal conductivity, Thermal stresses, Electrical conduction, Semi conductivity, Super conductivity, Electrical conduction in ionic ceramics and in polymers, Dielectric behaviour, Ferroelectricity, Piezoelectricity, Diamagnetism and paramagnetism, Ferromagnetism, Antiferromagnetism and ferrimagnetism, Influence of temperature on magnetic behaviour, Domains and hysteresis, Optical properties of metals, Optical properties of non-metals, Application of optical phenomena.

Economic, Environmental and Social Issues of Material Usage – 2L

Economic considerations, Environmental and societal considerations, Recycling issues, Life cycle analysis and its use in design.

Learning Resources:

1. Materials Science and Engineering An Introduction by Callister W. D. Jr.
2. Material Science by Van Vlack.
3. Material Science by Raghavan V.
4. Material Science and Engineering by K. M. Gupta.

Semester II

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Mathematics – II	**Semester** : Second
L-T-P : 3-1-0	**Credit:**4

Multivariate Calculus (Integration) – 11L

Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

First order ordinary differential equations – 5L

Exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders – 9L

Second order linear differential equations with constant coefficients, Use of D- operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Complex Variable – Differentiation – 6L

Differentiation of complex functions, Cauchy-Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties

Complex Variable – Integration – 9L

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour

Learning Resources:

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
7. E. L. Ince, Ordinary Differential Equations, Dover Publications.

Course Code :	**Category :** Engineering Science course
Course Title : Programming for Problem Solving	**Semester** : Second
and Data Structure	
L-T-P : 3-0-2	**Credit:**4

Introduction to Programming – 6L

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.). Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Arithmetic expressions and precedence - 12L

Conditional Branching and Loops Writing and evaluation of conditionals and consequent branching, Iteration and loops

Arrays - 3L

Arrays (1-D, 2-D), Character arrays and Strings

Basic Algorithms, Searching, Basic Sorting Algorithms – 4L

(Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Function and Pointers – 6L

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation).

Recursion and Structure – 9L

Recursion, as a different way of solving problems. Example programs, such as Finding, Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. Structures, Defining structures and Array of Structures

Learning Resources:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Course Code :	**Category :** Engineering Science course
Course Title : Programming for Problem Solving Laboratory	**Semester** : Second
L-T-P : 0-0-2	**Credit: 1**

Lab1: Familiarization with programming environment

Lab 2: Simple computational problems using arithmetic expressions

Lab 3: Problems involving if-then-else structures

Lab 4: Iterative problems e.g., sum of series

Lab 5: 1D Array manipulation

Lab 6: Matrix problems, String operations

Lab 7: Simple functions

Lab 8 and 9: Programming for solving Numerical methods problems

Lab 10: Recursive functions

Lab 11: Pointers and structures

Lab 12: File operations

Course Code :	**Category :** Engineering Science Courses
Course Title : Engineering Mechanics	**Semester** : Second
L-T-P : 3-0-0	**Credit:**3

Introduction to Engineering Mechanics covering, Force Systems – 4L

Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy.

Friction – 5L

Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack

Truss and Frame – 5L

Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines.

Centroid and Centre of Gravity covering – 5L

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Virtual Work and Energy Method – 5L

Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Review of particle dynamics – 6L

Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy.Impulse-momentum (linear, angular); Impact (Direct and oblique).

Introduction to Kinetics of Rigid Bodies covering – 6L

Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

Mechanical Vibrations covering – 5L

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree

of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.

Learning Recourses:

1. M.P. Poonia& D.S. Bedi, Engineering Mechanics, Khanna Publishing House, 2019
2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
3. R.S. Khurmi, Engineering Mechanics, S.Chand Publications, Delhi
4. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
5. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
6. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
7. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
8. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
9. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
10. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
11. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Course Code :	**Category :** Professional Core Courses
Course Title : Metrology and Inspection	**Semester** : Second
L-T-P : 3-0-0	**Credit: 3**

Introduction – 6L

Introduction to measurement and measuring instrument, generalized measuring system and functional elements, static and dynamic performance, characteristics of measurement devices, concept of error, sources of error, statistical analysis of errors.

Sensors and transducers – 5L

Sensors and transducers- types and their characteristics, measurement of pressure, direct acting and elastic pressure transducers, measurement of very low pressures. Strain measurement- types of strain gauges and their working, strain gauge circuits, temperature strain rosettes.

Measurement of force and torque – 5L

Measurement of force and torque, temperature measurement by thermometers, bimetallic thermocouples, thermistors and pyrometers. Measurement of flow, vibration and noise measurement, seismic instruments. Data acquisition system.

Standards of liner measurement – 6L

Standards of liner measurement, line and end standards, system of limits and fits, linear and angular measurement devices and systems, limit gauges and their design.

Measurements of geometric forms – 6L

Measurements of geometric forms like straightness, flatness, roughness and circularity, optical projectors, tool , makers microscope, autocollimators, principle and use of interferometry, optical flat interferometers, laser interferometers. Comparators-types, working principles and magnification range, measurement of screw threads and gears.

Surface texture-quantitative evaluation – 6L

Surface texture-quantitative evaluation of surface roughness and its measurement, introduction

to CMM, in-process gauging systems, inspection- in-process and final inspection, sampling and 100% inspection, sampling plans.

Learning Resources:

1. Beckwith Thomas G., Mechanical Measurement, Narosa Publishing House.
2. Doeblein, E.O., Measurement Systems: Application and Design, McGraw Hill.
3. Hume, K.J., Engineering Metrology, MacDonald and Co.
4. Gupta, I.C., Engineering Metrology, DhanpatRai& Sons.
5. Bewoor, A.K. and Kulkarni, V. A., Metrology & Measurement, Tata McGraw-Hill Education Pvt. Ltd.
6. Sawhney, A.K. and Mahajan, M., A textbook of measurement and metrology, DhanpatRai& Co.

Semester-III

Course Code :	**Category :** Basic Science Courses
Course Title : Engineering Mathematics III	**Semester** : Third
L-T-P : 3-1-0	**Credit: 4**

Partial Differential Equation – 14L

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. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variable.

Probability – 12L

Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random varibales and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Statistics – 12L

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.

Test of significance: Large sample test for single proportion, difference of proportions, 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.

Learning Resources:

1.Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

2. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2019.

3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).

5. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

6. Ramana, Higher Engineering Mathematics, TMH

7. Sashtry, Advanced Engineering Mathematics, PHI

Course Code :	**Category :** Professional Core Courses
Course Title : Biology for Engineers	**Semester** : Third
L-T-P : 2-0-0	**Credit: 2**

UNIT I-BASIC CELL BIOLOGY

1. Introduction to Biology
2. The cell: the basic unit of life
3. Expression of genetic information - protein structure and function
4. Cell metabolism; Cells respond to their external environments
5. Cells grow and reproduce
6. Cellular differentiation

UNIT II- BIOCHEMISTRY AND MOLECULAR ASPECTS OF LIFE

7. Biodiversity - Chemical bonds in Biochemistry; Biochemistry and Human biology
8. Protein synthesis –DNA; RNA
9. Transcription and translation factors play key roles in protein synthesis
10. Differences between eukaryotic and prokaryotic protein Synthesis
11. Stem cells and their applications

UNIT III-ENZYMES AND INDUSTRIAL APPLICATIONS

12. Enzymes – significance, factors
13. Mechanism and effective catalysis – proteases, carbonic anhydrase
14. Restriction Enzymes; Nucleoside Monophosphate Kinases
15. Photosynthesis and carbon fixation; Biological energy production
16. Metabolism-anabolism and catabolism

UNIT IV-MECHANOCHEMISTRY

17. Protein motors convert chemical energy into mechanical work
18. ATP synthase structure
19. The bacterial flagellar motor

20. Cytoskeleton
21. Biosensors - types, applications
22. Bioremediation

UNIT V-NERVOUS SYSTEM, IMMUNE SYSTEM AND CELL SIGNALING

23. Basics of nervous system and “neural networks"
24. The cellular basis of immunity
25. The functional properties and structure of antibodies
26. T cell receptors and subclasses
27. General principles of cell signalling

Course Code :	**Category :** BSC
Course Title : Environmental Science	**Semester** : Third
L-T-P : 2-0-0	**Credit: 2**

Course Code :	**Category :** Professional Core Courses
Course Title : Strength of Material	**Semester** : Third
L-T-P : 3-0-0	**Credit: 3**

Analysis of Stress & Strain – 13L

Uniaxial Stress and Stain: Stress, Strain, Hook’s Law, Stress-Strain Curves, Elastic Constants, Strain Energy, Statically Indeterminate problems, Thermal Effects, Impact Loading, Biaxial Stress and strain: Stress at a Point, Variation of stress, Stress Transformation, Analysis of Strain, Concept of compatibility equation, Principal stresses and strain

Bending & Shear Stresses – 6L

Introduction, Bending Moment diagram and Shear Force Diagram, Pure Bending, Normal stresses in beams, Shear Stress, Strain energy in bending/Shear

Torsion – 5L

Introduction, Torsion of Circular Shaft, Power Transmitted by a Shaft, Tapered Shaft, Applications of Torsions as coiled springs

Thin & Thick Cylinders & Spheres – 5L

Introduction, Stresses and strain involved Thin-Walled Cylinders and Shells, Thick Cylinders and Shells

Deflections of Beams – 5L

Introduction, Equation of Elastic Curve, Methods for determining deflection: Double Integration, Macaulay’s Method, Moment-Area Method

Columns, Combined loading and Theories of failure- 6L

Introduction, Euler’s Theory for Long Columns, Eccentrically Loaded Columns, Combined Bending and Axial Stress, Combined Bending and Twisting, Theories of failure

Learning Resources:

1. Elements of Strength of Materials, S.P. Timoshenko and D.H. Young, East-West Press Pvt. Ltd. Publications.
2. Mechanics of Materials, Pytel and Kiusalaas, Cengage Learning Publications.
3. Mechanics of Materials, Gere and Timosheinko, CBS Publications.
4. Mechanics of Materials, E. P. Popov, Prentics Hall Publications.
5. Strength of Materials, G. H. Ryder, Macmillan India Limited.
6. Strength of Materials- Pytel and Singer, Harpercollins College division publications.
7. Strength of Materials-S. Ramamrutam, R. Narayanan, Dhanpat Rai Publication Company
8. Strength of Materials, Crandal, Dahal and Lardener, Tata Mcgraw Hill Publications.
9. Mechanics of Materials- Riley, Struges and Morris, John Wiley & Sons.

Course Code :	**Category :** Professional Core Courses
Course Title : Strength of Material Lab	**Semester** : Third
L-T-P : 0-0-2	**Credit:**1

Any Six experiments from the following:

Experiment 1: Tension Test
Experiment 2: Compression Test
Experiment 3: Impact Tests
Experiment 4: Brinell Hardness Test
Experiment 5: Rockwell Hardness Test
Experiment 6: Vicker's Hardness Test
Experiment 7: Torsion Test
Experiment 8: Shear Test
Experiment 9: Beam Bending
Experiment 10: Buckling of Struts
Experiment 11: Closed and Open coiled springs

Course Code :	**Category :** ESC
Course Title : Applied Thermodynamics	**Semester** : Third
L-T-P : 3-1-0	**Credit: 4**

Introduction – 8L

Introduction to thermodynamic system, surrounding, state, process, properties, equilibrium, heat and work, Zeroth Law of Thermodynamics

Properties of Pure Simple Compressible Substance – 5L

PvT surface, Pv, Tv, TP diagrams. Equation of state for ideal and real gases. Virial equation of state, van der Waal equation, use of steam tables and Mollier diagram

First Law of Thermodynamics – 5L

First law application to non-flow processes such as isochoric, isobaric, isothermal, adiabatic

and polytropic processes. Steady flow energy equation, flow work. Application to various practical systems viz. nozzles, diffuser, turbines, heat exchangers etc. Application of energy equation to transient flow problems.

Second Law of Thermodynamics – 5L

Second law, reversible and irreversible processes, Clausius and Kelvin Planck statements, Carnot cycle, corollaries of second law: thermodynamic temperature scale, Clausius inequality, entropy as a property, principle of increase of entropy. Calculation of entropy change.

Entropy and Exergy – 5L

Entropy and its generation, entropy balance for closed system and for control volume, basic concepts of exergy and irreversibility, exergy for closed system and control volume, exegetic efficiency.

Gas-Vapour Mixtures and Air-conditioning – 8L

Properties of gas-vapour mixtures, adiabatic-saturation and wet-bulb temperatures, psychrometric chart, human comfort and air conditioning, various air conditioning processes.

Gas and Vapour Power Cycles: Otto, Diesel, Dual, Stirling, Joule-Brayton cycle. Thermal efficiency and mean effective pressure, Rankine cycle.

Refrigeration Cycles – 4L

Reverse Carnot cycle, vapour compression refrigeration cycle.

Learning Resources:

1. Borgnakke, C. and Sonntag, R.E., " Fundamentals of Thermodynamics," Wiley India, 2011
2. Cengel, Y.A. and Boles, M.A., "Thermodynamics an Engineering Approach", Tata McGraw-Hill, 2008
3. Moran, M.J. and Shapiro, H.M., "Fundamentals of Engineering Thermodynamics", 4th Ed., John Wiley, 2010
4. Russel, L.D., Adebiyi, G. A.," Engineering Thermodynamics", Oxford University Press, 2007
5. Arora, C.P., "Thermodynamics", Tata-McGraw Hill, 2001
6. Nag, P.K., "Engineering Thermodynamics", Tata-McGraw Hill, 200

Course Code :	**Category :** Professional Core Courses
Course Title : Production Planning & Control	**Semester** : Third
L-T-P : 3-0-0	**Credit:**3

Introduction – 4L

Manufacturing function; Elements of production systems; Types of production systems; Objectives and functions of production planning and control.

Product Design – 10L

Identification of product ideas and selection, product development and design, product analysis: marketing aspects, product characteristics, economic analysis, profitability and competitiveness, production aspects.

Forecasting – 11L

Concepts and applications, demand forecasting, principle of forecasting, forecasting

techniques, quantitative and qualitative, Delphi technique.

Production Planning – 10L

Preplanning, selection of materials, methods, machines and man power, aggregate production planning, master production planning, Break Even Analysis (BEA), concepts, make or buy decisions.

Production Control – 7L

Dispatching rules, dispatching of work card, inspection card and reports, control boards and charts, expediting, progress reporting, corrective change in schedules.

Learning Resources:

1. Buffa, E.S., Sarin, R.K., "Modern Production / Operations Management", John Willey and Sons 1994

2. Mukhopadhyaya, S.K., "Production Planning and Control – Text and Cases", Prentice Hall of India 2004 3. Adam, Jr., E.E., Ebert, R.J., "Production and Operations Management Concept, Models and Behaviour", 5th 2001 Ed., Prentice Hall of India

4. Vollman, T.E., Berry, W.L., Whybark, D.C., "Manufacturing Planning and Control Systems" 4th 1997 Ed., McGraw Hill,

Sipper, D., Buffin, R.L., "Production: Planning Control and Integration", McGraw Hill, . 1997

Semester IV

Course Code :	**Category :** Professional Core Courses
Course Title : Numerical Methods	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:**3

Module I

Complex Variable – Differentiation:

Differentiation, Cauchy-Riemann equations, Analytic functions, Harmonic functions, Finding harmonic conjugate; Elementary analytic functions (exponential, trigonometric, logarithm) and their properties, Bilinear transformations and their properties.

Module II

Complex Variable – Integration:

Contour integrals, Cauchy Integral theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof) and its applications.

Module III

Numerical Method-Interpolation, Differentiation and Integration:

Lagrange's interpolation, Newton's divided differences interpolation formulas, Interpolating polynomial using finite differences. Numerical Differentiation, Numerical Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's 1/3" rule, Simpson's 3/8" rule.

Module IV

Numerical Method-Nonlinear Equations, System of Linear Equations:

Solution of Nonlinear equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method.

Gauss-Elimination, Gauss-Jordan, Gauss-Jacobi and Gauss- Siedel methods to solve linear system of equations.

Module V

Numerical Method- Solution of Ordinary Differential Equations:

Euler's method, Runge - Kutta Methods of second and fourth order to solve initial value problems.

Text Books

- Irwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons
- M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004.

Reference Books

- R. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi,2010.
- J. W. Brown And R. V. Churchill, Complex Variables And Applications, 7th Edition, Mc-Graw Hill, 2004.

Course Code :	**Category :** Professional Core Courses
Course Title : Kinetics of Machine	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:**3

Introduction to mechanisms – 12L

Introduction to mechanisms, Applications of mechanisms, Kinematics of mechanisms, kinematic diagrams, Degree of freedom, Position and displacement analysis, graphical methods, Velocity analysis, relative motion, graphical method, instant center, Mechanical advantage, Acceleration analysis, graphical method.

Analytical methods in mechanism analysis - 10

Analytical methods in mechanism analysis, Computer oriented methods in kinematic analysis, Cam Design, Cam and follower types, Displacement diagrams, Cam profile synthesis, graphical and analytical methods, Design of plate cam, reciprocating flat faced follower – roller follower, Advanced cam profile techniques.

Gears –10L

Gears – Law of gearing, Involute spur gears, involutometry, Spur gear details, interference, backlash, Gear standardization, Internal gear, Cycloidal gear, Non-standard gears, Bevel, helical and worm gearing, Gear Trains – simple and compound gear trains, planetary gear trains, solution of planetary gear train problems, applications.

Kinematic synthesis – 10

Kinematic synthesis, Tasks of kinematic synthesis, type and dimensional synthesis, graphical synthesis for motion, path generation without and with prescribed timing, Function generation, overlay method, Analytical synthesis techniques, Complex number modelling, loop closure equation technique, Freudenstein's equation, Case studies in synthesis of mechanisms.

Learning Resources:

1. Uicker, J.J.Jr., Pennock, G.R., and Shigley, J.E., Theory of Machines and Mechanisms, 3rd ed., Oxford University Press, 2009.
2. Sandor, G.N., and Erdman, A.G., Advanced Mechanism Design: Analysis and Synthesis, Vol. I & II, Prentice-Hall of India, 1988.
3. Mabie, H.H., and Reinholtz, C.F., Mechanisms and Dynamics of Machinery, 4th ed., John Wiley & Sons, 1987.
4. Ghosh, A, and Mallik, A.K., Theory of Mechanisms and Machines, 3rd ed., Affiliated East-West Press, 1998.
5. Waldron, K.J., and Kinzel, G.L., Kinematics, Dynamics and Design of Machinery, John Wiley & Sons, 2004.
6. Norton, R.L., Design of Machinery, Tata McGraw-Hill, 2004.
7. Martin, G.T., Kinematics and Dynamics of Machines, McGraw-Hill, 1969.
8. Rattan, S.S., Theory of Machines, 3rd ed., Tata McGraw-Hill, 2009.
9. Nikravesh, P.E., Planar Multibody Dynamics, CRC Press, 2008.

Course Code :	**Category :** Professional Core Courses
Course Title : Manufacturing Engineering I	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:**3

Introduction – 2L

Classification of different manufacturing processes, application areas and limitations, selection of a manufacturing process.

Casting – 4L

Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern, materials color coding and storing of patterns.

Moulding methods – 4L

Moulding methods and processes-materials, equipment, moulding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making.

Design considerations in casting, gating and Risering, directional solidification in castings. Sand castings-pressure die casting-permanent mould casting-centrifugal casting-precision investment casting, shell moulding, CO2 moulding, squeeze casting-electro slag casting. Fettling and finishing, defects in Castings.

Advanced Casting Processes – 4L

Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting (Introductory)

Massive Metal Forming Science and Technology – 14L

Need and Classification, Elastic and Plastic deformation-Yield and Flow; Rolling: Classification of Rolling, Process geometry and Analysis of Plate rolling for Rolling load and power calculations; Rolling mills and Roll pass design; Defects in Rolled Products; Forging: Classification of Forging, Process Geometry and Analysis of Strip and Disc forging for Forging

Load and Power calculations; Defects in Forged Products; Drawing: Process Geometry and Analysis of Wire and Sheet Drawing for Load and Power calculations, Maximum Reduction Possible. Extrusion: Classification, Process Geometry and Analysis of Rod and Sheet Extrusion for Load and Power calculations, Maximum Reduction Possible; Defects in Extruded Product.

Welding– 8L

Types of welding-gas welding-arc welding-shielded metal arc welding, TAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-atomic hydrogen arc welding-thermit welding soldering, brazing and braze welding. Welding symbols-Positions of welding-joint and groove design-weld stress-calculations-design of weld size estimation of weld dilution, heat input, preheat, and post heat temperature-

computer applications in weld design, dissimilar metal. Gas welding equipments-welding power sources and characteristics safety aspects in welding-automation of welding, seam tracking, vision and arc sensing-welding robots. Defects in welding-causes and remedies-destructive testing methods

Advanced Welding Processes – 6L

Plasma arc welding, stud welding, friction welding, explosive welding, underwater welding, roll bonding, diffusion bonding, cold welding, welding of plastics Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW) (Introductory)

Learning Resources:

1. Manufacturing Science by Ghosh and Mallik, East West Press Pvt. Ltd., New Delhi
2. Fundamentals of Modern Manufacturing by M. P. Groover, John Wiley and Sons, New Delhi
3. Fundamentals of Metal Forming Processes by B. L. Juneja, New Age International Ltd., New Delhi
4. Manufacturing Engineering and Technology by Kalpakjian and Schmid, Pearson Education Pvt. Ltd. New Delhi
5. Lindberg R.A., “Processes and Materials of Manufacture”, Prentice-Hall of India, 1990.
6. Groover M.P., “Fundamentals of Modern Manufacturing”, John Wiley & Sons 2002.
7. DeGarmo E.P., Black J.T., and Kohser R.A., “Materials and Processes in Manufacturing”, Prentice-Hall of India, 1997.
8. Richard, A., Little., *Welding and Welding Technology*, Tata McGraw Hill, 2001.
9. Heine, R., and Rosenthal, P., *Principles of Metal Casting*, Tata McGraw Hill, 1985.

Course Code :	**Category :** Professional Core Courses
Course Title : Manufacturing Engineering I Laboratory	**Semester** : Fourth
L-T-P : 0-0-2	**Credit: 1**

1. To prepare the pattern and core.
2. To prepare a green sand mold and cast few engineering components.
3. To prepare the metal matrix composite by stir casting.

4. To fabricate the butt joint in the given sample using tungsten inert gas welding and studying the parametric effect on the weld quality.

5. To fabricate the butt joint in the given sample using metal inert gas welding process and studying the parametric effect on the weld quality.

6. To fabricate the butt joint in the given sample using submerged arc welding process and studying the parametric effect on the weld quality.

7. To study the mechanical properties of casted and welded specimens.

8. To study the metallurgical properties of casted and welded specimens.

9. Dye penetration testing, to study the defects of Casted and Welded Specimens

10. Ultrasonic flaw detection and Magnetic crack detection to study the defects of Casted and Welded Specimens

Learning Resources:

1. Rao,P.N., "Manufacturing Technology", (Vol. 2), Tata McGraw-Hill 1998
2. R. S. Parmar.," Welding Engineering and Technology" (Vol.2), Khanna Publishers, 2010

Course Code :	**Category :** Professional Core Courses
Course Title : Industrial Engineering	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:**3

Industrial Engineering – 6L

Introduction to industrial engineering, Functions of organization, Elements of organization, Principles of organization, Types of organization and their selection.

Plant Layout and Material Handling – 8L

Site selection, types of layout, factors affecting layout, plant building, flexibility and expandability, Principles of material handling, types and selection of materials handling equipment's.

Production Planning and Control – 8L

Functions, forecasting, routing, operations planning; Gantt chart, work order, dispatching and follow-up; CPM and PERT techniques.

Inventory Control – 4L

Scope, purchasing and storing, economic lot size, ABC Analysis.

Quality Control – 10L

Statistical quality control, control charts for variables and attributes: X bar, R, p & c charts, Concepts &Scope of TQM and QFD. Acceptance Sampling: Consumer's risk, Producers risk, LQL, AQL, OC curves, Types of sampling plans, AOQ, ATI.

Work Study – 6L

Scope, work measurement and method study, standard data, ergonomics and its industrial applications.

Learning Resources:

1. Mitra, A., "Fundamentals of Quality Control and Improvement", John Wiley & Sons, Inc, 2008
2. Russell, R.S., Taylor, B.W.,"Operations Management", Pearson 2003 Education

3. Jocobs, C.A., “Production and Operations Management”, Tata McGraw Hill 1999
4. Groover,M.P.,“Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education 2001
5. Maynard, H.B.,“Industrial Engineering Handbook”, McGraw Hill 2001
6. BesterfieldD.H. et al., “Total Quality Management, Pearson Education 1999

Course Code :	**Category :** Professional Core Courses
Course Title : Industrial Engineering Lab	**Semester** : Fourth
L-T-P : 0-0-2	**Credit: 1**

1. To prepare the following charts and diagrams:
   a) Outline process chart
   b) Multiple activity chart
   c) Flow process chart and Flow diagram
   d) String diagram
2. To construct Left hand and Right chart for the assembly of: (a) Nut & Bolt, (b) Parts of Pen, and (c) Parts of sine centre.
3. To conduct the method study for assembling simple components and office work.
4. Rating practice during walking.
5. Rating practice using pin board assembly.
6. Rating practice for dealing a deck of cards.
7. Rating practice for marble collection activity.
8. Determination of the standard time for a given operation using stop watch time study.
9. To conduct the office work measurement through work sampling.
10. Measurement of parameters (heart beat rate, calorie consumption) during walking.
11. Measurement and multi-correlation between pulse rate and calorie consumption during walking.

Course Code :	**Category :** Professional Core Courses
Course Title : Heat and Mass Transfer	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:**3

Conduction – 5L

Basic law of heat conduction – Fourier’s law, thermal conductivity, its dependence on temperature, steady state heat conduction through a composite solid and its electric analogue, steady state heat conduction through cylinders, spheres and variable area of solids, different insulating materials and their applications for process equipment and pipelines, Fourier’s law in three dimensions, lumped capacity method of unsteady state conduction.

Convection – 6L

Convection heat transfer and the concept of heat transfer coefficient, individual and overall heat transfer coefficient, heat transfer between fluids separated by plane wall, heat transfer between fluids separated by cylindrical wall (pipes), critical/ optimum insulation thickness,

heat transfer through extended surfaces.

Forced Convection – 6L

Over a flat plate, thermal boundary layer, dimensionless groups and Dimensional analysis, Buckingham Pi-theorem, heat transfer correlations- internal and external flows, laminar and turbulent flows,

Free convection – 6L

Heat transfer correlations for free convection, free convection from flat surfaces, free convection from a cylinder.

Heat Transfer with phase change – 6L

Boiling phenomena and analysis of boiling curve, correlation for nucleate boiling, critical heat flux, condensation phenomena, film condensation on a vertical surface (Nusselt equation, effect of non-condensable gases, drop wise condensation.

Radiation – 6L

Basic principle of radiation from a surface, blackbody radiation, Planck's law, Wein's displacement law, the Stefan Boltzmann law, Kirchhoff's law, gray body, radiation exchange between black bodies & grey bodies.

Heat Exchanger – 4L

Types of heat exchangers; fouling factors; overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method.

Introduction to Mass Transfer – 3L

Introduction; Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film.

Learning Resources:

1. Holman J P, "Heat Transfer", McGraw Hill Book Co. (1992).
2. Yunus A. Cenegel, "Heat & Mass Transfer: A practical Approach", McGraw Hill Book Co. (2007).
3. Incropera F P and DeWitt D P, "Introduction to Heat Transfer," 2nd Ed John Wiley New York (1996).
4. Geankopolis C J, "Transport Processes and Separation Process Principles", Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
5. Kern D Q, "Process Heat Transfer", McGraw Hill Book Co. (1997).
6. Coulson J M and Richardson J F, "Chemical Engineering" Volume 1, Pergamon Press (1999).
7. Whitaker, S., Fundamental Principles of Heat Transfer, New York, Per gammon, 1997.
8. Cussler, E, L., Diffusion. Mass Transfer in Fluid Systems, Cambridge, 1985.

Course Code :	**Category :** Professional Core Courses
Course Title : Fluid Mechanics and Machinery	**Semester** : Fourth
L-T-P : 3-0-0	**Credit: 3**

Introduction to Fluid Mechanics:4L

Statics and Kinematics Fluid and continuum, Physical properties of fluids, Rheology of fluids, surface tension, capillarity, vapour pressure, Manometers, pressure transducers, pressure on plane and

curved surfaces, centre of pressure.

Kinematics of Fluid Flow: 4L

Description of fluid motion, Types of fluid flows, streamline, streakline, pathline, rate of flow, continuity equation, stream function and velocity potential function, equipotential line.

Dynamics of Fluid Flow: 8L

Dynamics of Fluid Flow and Dimensional Analysis Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications, momentum equation and its application to pipe bends, Dimensional Analysis, Rayliegh method, Buckingham's Pi theorem, important dimensionless numbers and their physical significance, geometric, kinematic and dynamic similarity, model studies.

Laminar and Turbulent Flows: 10L

Equation of motion for laminar flow through pipes, Stokes law, transition from laminar to turbulent flow, types of turbulent flow, isotropic and homogenous turbulence, scale and intensity of turbulence, eddy viscosity, Prandtl's mixing length theory, velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, three reservoir problems and pipe network.

Hydrodynamic Boundary Layer: 8L

Introduction with a historical background, boundary layer, displacement and momentum thickness, boundary layer over a flat plate, Prandtl boundary layer equation, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation and its control, drag and lift, drag on a sphere, airfoil, Magnus effect.

Measurement Techniques: 2L

Flow measurement by Pitot tube, orifice, Venturi, nozzle, bend meter, rotameter, notches and weirs, Turbine flowmeter.

Introduction to Hydraulic Machines: 6L

Introduction to Hydroelectric power station and its components, Impact of jet, Classification of turbines and pumps, similarity laws and specific speed, efficiency, cavitation.

Learning Resources:

1. Fox, R.W., McDonald, A.T., Introduction to Fluid Mechanics, 7th edition, Wiley India.
2. Ojha, C.S.P., Berndtsson, R., Chandramouli, P.N., Fluid Mechanics and Machinery, Oxford University Press, New Delhi.
3. Majumdar, B., Fluid Mechanics with Laboratory Manual, PHI Learning, New Delhi.
4. Som, S.K. and Biswas G, Introduction of Fluid Mechanics & Fluid Machines, TMH, New Delhi.
5. Mohanty, A.K., Fluid Mechanics, PHI Learning, New Delhi.
6. Shames, I.H., Mechanics of Fluids, McGraw Hill, International Students Edition.
7. Agarwal, S.K., Fluid through Problems, New Age International Pvt. Ltd, New Delhi.
8. Lal, J., Hydraulic Machines, Metropolitan Book Co. Pvt. Ltd., Delhi.

Course Code :	**Category :** Professional Core Courses
Course Title : Fluid Mechanics Lab	**Semester** : Fourth
L-T-P : 0-0-2	**Credit:1**

Experiment 1: To measure the pressure head of water in a pipeline by means of a piezometer tube.

Experiment 2: To verify the Bernoulli's theorem.
Experiment 3: To determine the different regimes of flow by Reynold's experiment.
Experiment 4: To determine the friction factor for pipes of different sizes.
Experiment 5: Flow measurement by venturimeter.
Experiment 6: To calibrate the given orificemeter.
Experiment 6: To study the impact of jets in a flat plate.
Experiment 7: To study the operation and performance of a Pelton wheel/ Francis turbine/ Kaplan Turbine.
Experiment 8: To study performance of two Centrifugal pumps connected in series and parallel.
Experiment 9: To study performance of a Reciprocating pump.

Learning Resources:
1. Singh, S. Experiments in Fluid Mechanics, PHI Learning, New Delhi.

Course Code :	**Category :** AUC
Course Title : Indian Knowledge System	**Semester** : Fourth
L-T-P : 2-0-0	**Credit: 0**

Module I -Basics of Ancient Indian Knowledge and Diverse Fields from Health (Yoga), Agriculture, Performing Arts etc.

Yoga - Patanjali and Panini, Yoga Sutras & Mahabhashya, Yoga from Ancient Rishis, Munies, Sages and Seers, Different types of Yogas, Asanas & Pranayamas, Vagbhata Samhita for Health Benefits. Agriculture - Ancient Agricultural Trends, Practices & means of Transportation in Agriculture. Performing Arts - Different types of Ancient Arts, i.e; Murtikala, Embossing in Jewellery, Different School of Arts in Ancient India: Mathura, Gandhara and Amravati School, Pottery & Utensil making from Mud.

Module II- Ancient Indian Knowledge in Various Science Streams like Physics, Chemistry, Biology, Forestry, Mathematics etc.

Gravitational Laws, Concept of Pendulum, Ancient knowledge of Space & Astronomy related to Outer Space and different Celestial Bodies, i.e; Planetary System, Stars and their Movement. Chemistry - Ancient Knowledge of Rasayanas, Preservative Methods using Oil and Salt etc. Biology & Forestry - Rich Cultural Heritage of Ayurveda, Different types of Medicinal uses of Plants, Fauna, Flora. Study of Animal and Plant Fossils, Interaction/ Interrelation of Mankind and Nature on Mutually Beneficial Basis. Traditional methods for conservation of Forests, Trees and Preventing Soil Erosion. Mathematics - Present Day Decimal System traces its History to Ancient India, Giving the concept of Zero as a number to the World, Negative Numbers, basic Arithmetic and Algebraic concept, Knowledge of Advance Trigonometry in Ancient India.

Module III - Ancient Indian Knowledge in Civil Engineering, Metallurgy, Mechanical Sciences, Textile Technology etc

Civil Engineering Concept and Familiarity with Sthapaty Kala, the Art of Construction in Ancient India, Civil Engineering Knowledge in Architecture in Making a Well Planned City by the Harappan Civilization Remains Undisputed. World Heritage Sites of Ajanta, Ellora, Khajuraho, Sanchi, Mahabalipuram are the Testaments of Excellent Civil Engineering Craftsmanship and Architecture, Well Developed Architecture During Cholas, Pal Dynasty is Evident in Various Ancient Temples in Present India. Concept of Canals and Wells for Irrigation & Human Needs in Ancient India is Well Documented Metallurgy - Concept Well Mentioned in Vedic Age Texts

Using the Term Ayas for Metals, Minting/ Metal Casting Of Gold, Silver, Bronze, Copper for Utensils and Jewellery During Ancient India. Mechanical Sciences - Agriculture and Military Equipments like Hammer, Tongs, Idea of Basic Mechanical Concept for Transportation Using Bullock-Carts, Handpulled Carts Using Wheels, Chariots, Boats Using Patwar (Rudder) During Vedic Age ss Well Known, Use of Ploughing Tools Made of Metals and Wood etc. Textile Technology - Archaeological Evidence of Cotton Textile at Mohenjo Daro in the Indus Valley, Use of Charkhas and Traditional Yarns like Khadi, Silk Fabric from Silk Worm and export of quality Silk to West and European Countries is well established.

Module IV - Ancient Indian Knowledge in Electrical, Electronics, Computational Studies, Instrumentation etc.

Ancient India Knowledge in Generation of Electricity from Water, Silk and Clouds, Agastya Samhita Speaks about Electroplating, Basic knowledge of Computations and Instrumentation during Vedic Period, Musical Instruments like Seven-Holed Flute and other Stringed Instruments like Ravanahatha, Cymbals, Dhol (Drum) found by Archaeologists from Indus Valley Civilization Sites.

Course Code :	**Category :** Honours Elective Courses
Course Title : Technology of Ferrous Casting	**Semester** : Fourth
L-T-P : 3-0-0	**Credit:** 3

Classification of cast iron, Chemical composition, Brief history of iron making, Raw Materials for Iron Making,Molding and core making practices in iron casting, routine sand testing, Solidification process of cast iron, Fe-Gr and Fe-Fe_3C phase diagrams, microstructure, properties of cast iron, melting of cast iron, furnaces used for melting of cast iron their construction, principle, operation and charge calculation (Cupola, Reverberatory furnace, Electric arc furnace, Induction furnace), gating and risering, fluidity of grey iron, shrinkage characteristics, chill test.

Metallurgical operation: Selection of iron composition, section size, cooling rate and properties, chemical composition effect, solidification of Fe-C- Si alloy, graphitization during solidification, inoculation, microstructure and properties of cast iron

Brief history of steel making, Raw Materials for Steel Making,classification, properties and applications of steel, Fe-C phase diagrams; Solidification behavior of steel. effect of alloy additions.

Basic steps in casting production of steel, materials and types of patterns, Molding and core making practices in steel casting. Routine sand testing.

Melting furnaces used for steel: electric arc furnace, induction furnace, etc. Charge calculation for steel casting, melting practices and melt controls for steel. De-oxidation and degassing of steel, electro slag remelting(ESR)and central zone refining(CZR).

Gating and feeding practices for steel castings. Fettling, cleaning, salvaging and heat

treatments of castings; Defect analysis.

Production and characterization of gray cast iron, ductile iron, austempered ductile iron, and compacted graphite iron, malleable iron, Specification of cast iron, application of cast iron.

Alloy iron, alloying elements

Cleaning and inspection of cast iron, Defect analysis,heat treatment of cast iron.
Fe-C phase diagrams; classification, properties and applications of cast irons and steel. Solidification behavior and effect of alloy additions. 1**4L**

Melting furnaces used for iron and steel: electric arc furnace, induction furnace, cupola, rotary furnace. Melting practices and melt controls for iron and steel. De-oxidation and degassing of steel; Inoculation and alloying of cast irons. **14L**

Production of grey, S.G., C.G. and malleable irons. Moulding and core making practice for iron and steel. Gating and feeding practices for iron and steel. Fettling, cleaning and heat treatments of castings; Defect analysis.**14L**

Learning Resources:

1. Foundry Technology by P.L. Jain
2. ASM Handbook Volume 15: Casting, ISBN: 978-0-87170-711-6
3. Principles of Metal Casting by Richard Heine, Carl Loper, Philip Rosenthal
4. Metal Casting Principles and Techniques by Lerner Yury, Posinasetti Nageswara
5. FOSECO Ferrous Foundryman's Handbook, John R. Brown

Semester V

Course Code :	**Category :** Professional Core Courses
Course Title : Manufacturing Engineering –II	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

Metal Cutting Principle – 6L
Mechanism of Chip Formation; Types of Chips; Orthogonal and Oblique cutting, Cutting Forces and Merchant Circle Diagram, Shear angle and Friction angle, Shear Velocity and Chip Velocity, Length of shear and friction plane , Stresses in shear and friction plane, Energy in shear and friction plane, Strains in shear and friction plane, Temperature in shear and friction plane; **Cutting Tools and Fluids**: Cutting Tool Materials, Cutting Tool Life, Cutting Tool Geometries, and Cutting Fluid Applications
Cutting Machining Operations – 12L
Cutting Tool Technology, Machine Tool Technology and Holding Tool Technology, Process Geometry, Cutting Conditions, Calculation of Material Removal Rate (MRR), Surface Roughness (Ra), Cutting Forces and Power for Turning and related operations; Drilling and related operations; Milling and Gear Cutting, Shaping and Planning; Broaching and Sawing operations; Economics of Machining by Cutting
Abrasive Machining Operations – 12L
Features, Need and Classifications of Abrasive Machining; Abrasive Grinding- Wheel

Specification, Wheel Life; Balancing, Truing and Dressing of Wheels; Classifications of Abrasive Grinding Processes; Chipping action in grinding, Calculation of Grinding Time and Material Removal Rate, Forces and Power, Heat and Temperature; Working Principle and Applications of grinding processes for prismatic and rotational surfaces; Abrasive Finishing- Conventional abrasive finishing-Honing, Lapping, Polishing and Buffing; Modern Abrasive Finishing - Abrasive Flow Finishing and Magnetic Abrasive Finishing

Advanced Machining Operations – 6L

Need and Classification of Erosion based Machining Processes; Process Principle, Equipments and Applications of Electro-Discharge Machining (EDM) and Beam Machining Processes (e.g. LBM, EBM, IBM,); Electro-Chemical Machining (ECM) and Chemical Machining Processes (e.g. CHM, PCM, BCM), Ultra-Sonic Machining (USM) and Jet Machining Processes (AJM, WJM, AWJM), Introduction to Hybrid Machining Processes

Jigs and Fixtures – 6L

Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures, Indexing Jigs and fixtures, etc

Learning Resources:

a) Manufacturing Science by Ghosh and Mallik**,** East West Press Pvt. Ltd., New Delhi
b) Fundamentals of Modern Manufacturing by M. P. Groover, John Wiley and Sons, New Delhi
c) Introduction to Machining Science by G. K. Lal, New Age International Ltd., New Delhi
d) Manufacturing Engineering and Technology by Kalpakjian and Schmid, Pearson Education Pvt. Ltd. New Delhi
e) Jigs and Fixtures by P. H. Joshi, Tata-McGraw Hill

Course Code :	**Category :** Professional Core Courses
Course Title : Manufacturing Engineering –II Lab	**Semester** : Fifth
L-T-P : 0-0-2	**Credit:**1

1. Preparation of a SINGLE POINT CUTTING TOOL as per the given tool specification. Also write the process sheet for the same.
2. To make a job as per drawing on the CAPSTAN LATHE. Write the process sheet and draw the sketches of the machine tool and tools used.
3. To make a job as per drawing using RADIAL DRILLING MACHINE. Write the process sheet and draw the sketches of the machine tool and tools used.
4. Study of Indexing Mechanism for Gear Cutting and to cut gear on a gear blank using Indexing Mechanism on HORIZONTAL MILLING MACHINE. Write the process sheet and draw the sketches of the machine tool and tools used.
5. To make a slot as per drawing using VERTICAL MILLING MACHINE. Write the process

sheet and draw the sketches of the machine tool and tools used.

6. To make a job as per drawing using CYLINDRICAL GRINDING MACHINE. Write the process sheet and draw the Sketches of the machine tool and tools used.
7. To make a job as per drawing using SURFACE GRINDING MACHINE. Write the process sheet and draw the Sketches of the machine tool and tools used.
8. Study of SHAPER, PLANER and SLOTTER
9. Study of MIG WELDING MACHINE and preparation of T-joint. Study the welding defects induced. Also draw the sketches of the tools used.
10. Demonstration and study about CUTTING, DRILLING AND WELDING operation on LASER BEAM MACHINE
11. Study of ELECTRICAL DISCHARGE MACHINE

Course Code :	**Category :** Professional Core Courses
Course Title : Dynamics of Machine	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

Force analysis – 8L

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- follower mechanism.

Balancing – 6L

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

Free vibration – 10L

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

Forced vibration – 8L

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

Mechanism for control – 10L

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

Learning Resources:

1. Ratan SS, "Theory of Machines", 1st Edition, Tata McGraw Hill, New Delhi (1993).
2. Theory of Mechanisms and Machines, Amitabh Ghosh and Mallik, East West Press Publication.
3. Design of Machinery, Robert L Norton, Mc. Graw Hill.
4. Theory of Machines, P.L. Ballaney, Khanna Publishers, New Delhi

5. Mechanism and Machine Theory, J.S. Rao and R.V. Dukkipati, 2nd Edition, New Age International, Delhi

Course Code :	**Category :** Professional Core Courses
Course Title : Dynamics of Machine Lab	**Semester** : Fifth
L-T-P : 0-0-2	**Credit:**1

1. Determination of velocity ratios of simple, compound, epicyclic and differential gear trains
2. Studying kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
3. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, wiper, drafter, etc.
4. Motion studies of different cams & followers
5. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient
6. Determination of torsional natural frequency of single and double rotor systems undamped and damped natural frequencies
7. Studying machine vibration using sensor
8. Solving simple balancing problems experimentally

Course Code :	**Category :** Professional Core Courses
Course Title : Machine Design	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

General Introduction and Selection of Materials – 3L

Definition, Methods, Standards in Design and Selection of Preferred Size, BIS system of Designation of Steels, Steels and Alloys, Plastics and Rubbers.

Design against Static and Fluctuating Load – 4L

Concept of Three Dimensional State of Stress and Strain, Stress-Strain Relationship, Principle Stresses, Stress Concentration, Stress Concentration Factor and Notch Sensitivity Factor, Factor of Safety, Theories of Failure, Fluctuating Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

Shafts, keys and coupling – 4L

Design of Shafts against Static and Fluctuating Load, Strength and Rigidity Design, Design of Square and Flat Keys and Splines, Rigid and Flexible Couplings. 5(L)

Power Screws and Joints – 6L

Form of Threads, Square Threads, Trapezoidal Threads, Stresses in Screw, Design of Screw Jack, Screwed Joints, Riveted Joints, Welded Joint and Eccentric Loading of above Joints, Design for Fatigue Loading. 9(L)

Mechanical Springs – 5L

Helical Springs, Stress Equations, Deflection Equation, Design against Static and Fatigue

Loading, Multi Leaf Springs, Spiral Springs.

Belts, Brakes and Clutches – 5L

Flat Belts, V Belts, Static Analysis of Brakes and Clutches, Internal Expanding and External Contracting Rim Brakes and Clutches, Band type Brakes and Clutches, Frictional contact Axial Clutches, Disc Brakes, Cone Clutches and Brakes

Helical Gears – 5L

Kinematics, geometry and nomenclature, force analysis, Design of helical gears: bending stress, contact stress, Crossed helical gears Worm Gears: Geometry and nomenclature, Force analysis, Friction analysis and efficiency, thermal capacity, bending and surface strength, power rating efficiency, worm gear standards and proportions.

Bevel Gears – 5L

Introduction, Geometry and terminology, Force analysis, Bending stress analysis, Contact stress analysis, Permissible bending fatigue stress, Permissible contact fatigue stress Spiral bevel gears, hypoid gears.

Antifriction bearing – 5L

Types of ball bearings, roller bearings, needle bearings, friction life of bearings, reliability considerations, selection of ball bearings, roller bearing, tapered roller bearing, thrust bearing, lubrication and sealing, Mounting of bearings.

Lubrication and sliding bearings – 5L

Type of lubrication, viscosity, hydrodynamic theory of lubrication, types of bearing, design of bearing using design charts, boundary lubrication, hydrostatic bearing, hydrodynamic thrust bearings.

Learning Resources:

1. Joseph E. Shigley, "Mechanical Engineering Design", Mc-Graw Hill Publications.
2. Richard M. Phelan, "Fundamentals of machine design" Tata Mc-graw Hill pub.
3. Robert L. Norton, "Machine Design: An Integrated approach" Prentice Hall
4. Robert C Juvinall and Kurt M. Marshek, " Fundamentals of Machine Component Design, Wiley-India
5. Nam P. Suh, "Principles of Design", Oxford University Press, 1990.
6. V. B. Bhandari, "Design of Machine Elements" 3rd Ed., Tata Mc-Graw Hill

Course Code :	**Category :** Professional Core Courses
Course Title : Machine Design Lab	**Semester** : Sixth
L-T-P : 0-0-2	**Credit:**1

Assembly drawing of machine elements using AutoCAD/Solid works

a) Threaded joints.
b) Cotter and Knuckle joint.
c) Couplings.
d) Screw Jack.
e) Tailstock.
f) Plummer block.
g) Rams bottom safety value.
h) Cylinder relief value.

i) Blow-off cock.
j) Tool post.
k) Gear box.

Course Code :	**Category :** Professional Core Courses
Course Title : Ergonomics and Work Design	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

Productivity – 6L

Concept, objectives, Factors affecting productivity, Productivity measurement, causes of low productivity, Tools and techniques to improve productivity, work study and productivity

Work Study – 4L

Purpose, scope and developments, human aspects, techniques of work study and their scope

Method Study – 10L

Objectives and scope, recording techniques: operation process charts, flow process charts, two hand process chart, activity chart, other charts, their analysis, flow diagram, string diagram, critical examination techniques, development, installation and maintenance of improved methods, Principles of motion economy, Micro Motion study, Therbligs, motion analysis, preparations of motion film and its analysis, SIMO charts, memo-motion study, cyclegraph and chronocyclegraph

Time Study – 10L

Scope and objectives, concepts of measurement of work in units of time, Techniques of work measurement, stop watch time study, allowances and calculation of standard time, standard time and its applications, Work sampling and introduction to Predetermined motion time systems

Ergonomics – 6L

Introduction to industrial ergonomics, constituents areas of ergonomics, man-machine system, anthropometry and ergonomics, metabolism and organization of work, ergonomic aspects in design of controls and displays and their layout, light and vibration consideration in ergonomically designed system, working conditions and environment, ergonomics and safety

Ergonomic Design – 6L

Design methodology and criteria for designing, design for improving occupational safety and reduction in fatigue and discomfort, work system design, environmental factors, visual issues in design, case studies

Learning Resources:

1. Introduction to Work Study by ILO. 2005
2. Barnes, R.M., “Motion and Time Study”, John Wiley & Sons. 1980
3. McCormick, E.J., “Human Factors in Engineering and Design”, TMH. 1976
4. Bridger, R.S., “Introduction to Ergonomics”, CRC Press. 2008

5. Murrel, K.F.H., “Ergonomics”, Longsman. 1971
6. Dul, J. and Weerdmeester, B. Ergonomics for beginners, a quick reference guide, Taylor & Francis 1993
7. Green, W.S. and Jordan, P .W, Human Factors in Product Design, Taylor & Francis 1999

Course Code :	**Category :** Professional Core Courses
Course Title : Product Design and Value Engineering	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

Product Design

Traditional and modern design processes; Organization objectives; Innovation, creation, and diffusion techniques; Evaluation of new product ideas – functional, technological, ecological, legal. **6L**

Product Modeling and Reverse Engineering

Wireframe modeling; Surface modeling – boundary representation; Solid modeling – CSG; Concept of reverse engineering. Product Data Exchange **–** Neutral file formats for product data exchange–DXF, IGES, STEP. **10L**

Introduction to Value engineering concepts:

advantages, applications in product development, process improvement, service improvement and system design, problem recognition, role in productivity **5L**

Analysis of Functions: Anatomy of function, use, antique, cost, esteem and exchange values, primary versus secondary versus tertiary/unnecessary functions, functional analysis: FAST (Function Analysis System Technique) and quantitative evaluation of ideas, case studies. **8L**

Value Engineering Techniques: Selecting products and operations for VE action, timing; VE programmes, determining and evaluating functions(s), assigning rupee equivalents, developing alternate means to required functions(s), decision making for optimum alternative, use of decision matrix, make or buy decisions, measuring profits, reporting results and follow up. **10L**

Implementation: Action plan, record progress, report progress, review meetings, problems in implementation, human factors. **3L**

Learning Resources:

1. Andrearsen, M. M., and Hein, L., “Integrated Product Development”, Springer, 1987
2. Huang, G. Q., “Design for X: Concurrent Engineering Imperatives”, Chapman and Hall, 1996
3. Chitale, A. K. and Gutpa, R. C., “Product Design and Manufacturing”, Prentice Hall, 1997
4. ZeidI., “CAD/CAM: Theory and Practice”, Tata McGraw Hill., 1998
5. Mortenson, M. E., “Geometric Modeling”, 3rd Ed., Industrial Press, 2006
6. Boothroyd G., Dewhurst P., and Knight, “Product Design for Manufacture and

Assembly", 2nd Ed., Marcel Dekker., 2002
7. Chua, C. K and. Leong, K. F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons, 1997

Course Code :	**Category :** Professional Core Courses
Course Title : Operations Research	**Semester** : Fifth
L-T-P : 2-1-0	**Credit:**3

Introduction – 2L

Definition and scope of OR; techniques and tools; model formulation; general methods for solution; classification of optimization problems; optimization techniques.

Linear optimization models – 12L

Complex and revised simplex algorithms; duality theorems; sensitivity analysis; assignment, transportation and transshipment models; travelling salesman problem as an assignment problem; integer and parametric programming; goal programming.

Game problems – 6L

Minimax criterion and optimal strategy; two person zero sum game; games by simplex dominance rules.

Waiting line problems – 8L

Classification of queuing situations; Kendall's notation, Poisson arrival with exponential or Erlang service time distribution; finite and infinite queues; optimal service rates; application of queuing theory to industrial problems.

Dynamic programming – 6L

Characteristic of dynamic programming problems (DPPs); Bellman's principle of optimality; problems with finite number of stages; use of simplex algorithm for solving DPPs.

Non- linear programming – 8L

One dimensional minimization methods; unconstrained optimization techniques; optimization techniques- characteristics of a constrained problem; indirect methods; search and gradient methods.

Learning Resources:

1. Taha H. A., "An Introduction to Operations Research", 6th Edition, Prentice hall of 2001 India;.
2. Hillier F. J. and Lieberman G.J., "Introduction to Operations Research", 7th 2001 3 0 4 25 0 25 50 0 Edition Holden Day Inc.
3. Loomba N.P., "Linear Programming", 2nd Edition, Mcmillan Publishing Inc. New 1976 York.
4. Wagner H. M., "Principles of OR with Applications to Managerial Decisions", 2nd 1975 Edition, Prentice Hall.
5. Giffin, Walter G., "Queueing Basic Theory and Applications", Grid Inc., Ohio. 1978

Course Code :	**Category :** Honours Elective Courses
Course Title : Technology of Ferrous Forging	**Semester** : Fifth
L-T-P : 3-0-0	**Credit:**3

Forging – 14L

Introduction of forging, Classification of forging process, Application of forging, Technology of open die forging, application of forging, allowances and tolerances for free forging with respect to Indian and foreign standards, developing forging drawing and process chart for manufacturing of typical components such as straight, stepped, hollow shaft, rings and discs etc. Methods of blank preparation, Acceptance criteria for bars and billets in forging industry, Advanced technology for production of large forging ingots.

Technology of closed die forging – 8L

Factors affecting metal flow in the dies, Forgeability, Friction and lubrication, die temperature, size and shape factors etc.

Die material – 6L

Die failure analysis and methods for improving die life.

Forging of metals – 10L

Forging practice and forging behavior of ferrous alloys like carbon and low alloy steel, stainless steel, tool steel. Heat treatment of above alloys.

Forging defects – 4L

Forging defects and their remedial measures, Problems of gases, Overheating and burning of steels.

Course Code :	**Category :** Honours Elective course
Course Title : Technology of Ferrous Forging Lab	**Semester** : Fifth
L-T-P : 0-0-2	**Credit:**1

1. Layout of forging laboratory
2. To study initial mechanical properties and microstructure of given steel
3. To study mechanical properties and microstructure of given steel after open die forging at different strain levels at room temperature
4. To study mechanical properties and microstructure of stainless steel after hot die forging at different strain levels
5. To study dependency of different forging equipment on characteristics of given steel after forging
6. To study dependency of heat treatment on characteristics of given steel after forging

Semester VI

Course Code :	**Category :** PCC
Course Title : Physical Metallurgy and Heat Treatment of Casting and Forging	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Crystal structure and bonding characteristics of metals, alloys, structure of surfaces and interfaces, nano-crystalline and amorphous structures; imperfection in crystal, solid solutions;

Theory of solidification: Nucleation and growth, mechanism of nucleation and driving force for growth. Morphology, Zone refining, crystal growth, spinodal decomposition. Mechanism and kinetics of precipitation of age hardenable alloys. solidification; phase transformation and binary phase diagrams; Solidification of metals & alloys, Casting grain structure; Ingot structure dendritic and cellular dendritic growth, multiphase microstructures. Micro & Macro segregation, Micro & Macro porosity and residual stresses in casting.

Elastic and plastic deformation (atomistic mechanisms), modulus, slip in perfect crystal, CRSS, Dislocations and their role in plastic deformation, twinning, deformation in single crystals. Hot and cold working of metals & alloys, recovery, recrystallisation and grain growth. principles of heat treatment of steels, cast iron and aluminum alloys; surface treatments; industrially important ferrous and non-ferrous alloys.

Metallography: Metallurgical microscope, Specimen preparation, Techniques for microscopic observation. High temperature microscopy, Quantitative metallography.

X- Ray crystallography; principles of scanning and transmission electron microscopy.

Reference:

1. Reed-Hill, R. E. (1972). Physical Metallurgy Principles, John Wiley & Sons, Incorporated.
2. Avner, S. H. (1974). Introduction to Physical Metallurgy, McGraw-Hill.
3. Raghavan, V. (2006). Physical Metallurgy: Principles and Practice, PHI Learning.
4. Haasen, P. and B. L. Mordike (1996). Physical Metallurgy, Cambridge University Press.
5. Mechanical Metallurgy, George E. Dieter, 3rd edition, McGraw-Hill,
6. Mechanical Behaviour of Materials, Thomas H. Courtney, MeGraw-Hill. 1990
7. Mechanical Metallurgy, Principles and Applications, Marc Andre Meyers and Krishan Kumar Chawla.

Course Code :	**Category :** PCC
Course Title : Physical Metallurgy and Heat Treatment of Casting and Forging Lab	**Semester** : Sixth
L-T-P : 0-0-2	**Credit:**1

Course Code :	**Category :** Professional Core Courses
Course Title : Production and Operations Management	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Introduction – 3L

Types and characteristics of manufacturing systems, concept of manufacturing cell, system planning and design.

Operations Scheduling – 8L

Concepts, loading, scheduling and sequencing, single processor scheduling, flow shop

scheduling, jobshop scheduling, scheduling criteria; Gantt charts.

Project Management – 5L

Project management techniques; Introduction to CPM and PERT techniques, activities and events, conventions adopted in drawing networks, graphical representation of events and activities, dummy activities, identification of critical activities.

Materials Planning and Control – 10L

Field and scope, materials planning; Inventories-types and classification; ABC analysis, economic lot size, EOQ model, lead time and reorder point, inventory control systems, modern trends in purchasing, store keeping, store operations; Introduction to MRP and MRP-II, bills of material; Introduction to ERP.

Zero Inventory Systems – 5L

Introduction to the new manufacturing concepts; JIT, lean manufacturing and agile manufacturing, pull and push systems of production; Kanban system.

Capacity Planning – 7L

Definition of capacity, capacity planning, capacity requirement planning, capacity available and required, scheduling order.

Supply Chain Management – 4L

Introduction – understanding supply chain, supply chain performance, supply chain drivers and obstacles, 4 planning demand and supply in a supply chain.

Learning Resources:

1. Russell, R.S., and Taylor, B.W., 'Operations Management", Pearson Education 2003
2. Jocobs, C.A., "Production and Operations Management", Tata McGraw Hill 1999
3. Ramamurthy, P. "Production and Operations Management", New Age International 2002
4. Adam Jr., E.E., and Ebert, R.J., "Production and Operations Management Concept, Models, and Behaviour", 5th 2001 Ed., Prentice Hall of India
5. Buffa, E.S., and Sarin, R.K., "Modern Production / Operations Management", John Willey & Sons 1994

Course Code :	**Category :** PCC
Course Title : Forging Die Design and Product Realization	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Job analysis, Product drawing, Standard for allowances and tolerances for closed die forging, Development of forging drawing and its simplification from die design point of view, Criteria for selection of parting line, Preliminary design considerations like parting line position, rib and web dimensions, draft angle, fillet and corner radii etc.

Importance of flash and gutter, Load and displacement curve, Design of flash and gutter dimensions. Design of preform impressions, Design of reduce roll die, Design of blocker,

Design of finisher

Design of trimming and piercing tool, die clearance between punch and die. Design of stripping tool. Assembly detail for trimming. Laws governing the design of the dies of horizontal forging machine. Design of punches and heading tools for up setter (horizontal forging machine). upsetting rule, Coning tool design method.

Determination of stock size, Capacity calculation of drop hammer, mechanical press, Determination of capacity of trimming and piercing press. Instruction for mounting, setting and working of dies, die materials and die sizes, Die life improvement

Computer aided design of forging dies, Optimization of die design parameters, Optimum material utilization, Modelling and analysis of forging process using software.

Die Design of forge components like Drive shaft, Connecting Rod, Stub Axle, Crankshaft, Axle beam, Steering arm etc.

Course Code :	**Category :** PCC
Course Title : Forging Die Design and Product Realization Laboratory	**Semester** : Sixth
L-T-P : 0-0-2	**Credit:**1

Course Code :	**Category :** PEC
Course Title : Management Concepts and Techniques	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Module- I Definition of management, science or art, manager vs. entrepreneur; Types of managers managerial roles and skills; Evolution of management-scientific human relations, system and contingency approaches. (10 hrs)

Module- II Types of Business organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; current trends and issues in management, Nature and purpose of planning, types of planning, objectives, policies, Strategic Management, planning Tools and Techniques, Decision making steps & processes. (10hrs)

Module- III Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization. Job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, carrier planning and Management. (10 hrs)

Module- IV Directing, individual and group behavior, motivation, motivation theories, motivational techniques, Job satisfaction, job enrichment, leadership, types and theories of leadership, effective communication. (10 hrs)

References:

1. Robbins S.P. and Couiter M, Management, Prentice Hall India, 10th ed., 2009
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata Mcgraw Hill, 1999.
4. O.P. Khanna - Industrial Engineering and Management – Dhanpat Rai Publications

Course Code :	**Category :** Open Elective Courses
Course Title : Casting and Solidification of metal	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Introduction – 8L

Casting as a process of Manufacturing. Moulding Processes, Equipment and Mechanization: Different types of Moulds, Moulding Materials and Moulding processes, Pattern and other mould making equipment, forces acting on moulds, Mould factors in metal flow, Moulding factors in casting design. Different types of binders and their uses in mould and core- makings.

Melting of Metals and Alloys for casting – 8L

Brief mention of various melting units, melting and post melting treatments, melting practices as adopted for a few metals and alloys such as CI, Al, Cu, steels, cast irons.

Solidification of Metals and Alloys – 8L

Nucleation, Growth, Role of alloy constitution, Thermal conditions and inherent nucleation and growth conditions in the liquid melt, Significance, and practical control of caststructure.

Principles of Gating and Rise ring – 8L

Feeding characteristics of alloys, Types of Gates and Risers, Time of solidification andChowrinov rule, Wlodawer system for feeder head calculations, gating ratio, concept of directionality in solidification,Yield of casting and prescription for its augmentation.

Special casting Methods – 8L

Investment casting, Die casting,Centrifugal casting, Full mould casting, Vacuum sealed casting.

Casting Defects – 2L

Casting defects and analysis, their causes and prescription of remedial measures.

Learning Resources:

1. P. R. Beeley, Foundry Technology, Newnes-Buttterworths

2. P. D. Webster, Fundamentals of Foundry Technology, Portwillis press, Red hill
3. P. C. Mukherjee, Fundamentals of Metal casting Technology, Oxford IBH
4. R. W. Hein, C. R. Loper and P. C. Rosenthal, Principles of Metal casting, Mc Graw Hill

Course Code :	**Category :** Honours Elective Courses
Course Title : Technology of Non-Ferrous Forging	**Semester** : Sixth
L-T-P : 3-0-0	**Credit:**3

Classification, Properties, Metallurgical characteristics and applications of non-ferrous alloys like Aluminum, Magnesium, Titanium and Copper.

Forging practice and forging behavior of following nonferrous alloys: Aluminum, Magnesium, Titanium and Copper.

Heat Treatment Technology of important non-ferrous alloys for example: Aluminum, Magnesium, Titanium and Copper.

Current Forging Technology for aerospace materials, Forging of Aluminum-Lithium alloys.

Tribological behavior during forging.

Course Code :	**Category :** Honours Elective Courses
Course Title : Technology of Non-Ferrous Forging Laboratory	**Semester** : Sixth
L-T-P : 0-0-2	**Credit:**1

Semester VII

Course Code :	**Category :** PCC
Course Title : Foundry Tooling and Methoding	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Pattern materials; wood, manufactured timber, metals, plaster, plastics, rubbers, & their characteristics & criteria for selection, design and constructional features suiting to various moulding machines.

Use and types of core prints; pattern accessories; pattern allowances and their selection; pattern layouts & material required. Pattern making hand tools and machinery; pattern coatings storage & Repair of patterns.

Core Boxes: type, materials used, design and constructional features for core blowing and shooting machines.

Special design features for high pressure moulding machines, Special features for shell core shooters, Core print. Gravity Die casting: Die-Types, and design features. Pressure Die-casting: die- design features, Application of CAD, cam and additive manufacturing for pattern development and design.

Principle of solidification of castings; Elements of gating system. Design of gating systems: gating ratio; pressurized and un- pressurized systems; types of gates; Slag traps and filters etc. with reference to different cast metals and alloys.

Design of feeding systems: - Directional and progressive solidification; design and positioning of feeders; feeding range and controlled directional solidification; feeding efficiency. Principles of casting design.
Module VI: Design of feeding systems: - Directional and progressive solidification; design and positioning of feeders; feeding range and controlled directional solidification; feeding efficiency. Principles of casting design.

Reference Books:

1. Foundry Technology by P.L. Jain
2. ASM Handbook Volume 15: Casting, ISBN: 978-0-87170-711-6
3. Foundry Technology by Peter Beeley
4. Pattern Making and Foundry Practice, by L. H. Hand

Course Code :	**Category :** PCC
Course Title : Foundry tooling and Methoding Lab	**Semester** : Seventh
L-T-P : 0-0-2	**Credit:**1

1. Introduction of hand tools & machine tools for pattern making
2. Demonstration for study of component drawing
3. Layout and construction of a pattern
4. Development of 3D model of pattern from component drawing using CAD software
5. Demonstration of pattern manufacturing
6. Pattern making of supplied drawing of various component V-block, corner bracket and rope pulley
7. Molding and casting of V-block, corner bracket and rope pulley
8. Study of the dimensional variations of the castings produced.
9. Effect of temperature on fluidity of metal.
10. Study of metal flow in different types of gates
11. Experiment on flow of liquid in different type of gating system via water model.

12. Study of shrinkage of an alloy
13. Study of shrinkage in different types of junctions
14. Experiments on open riser and blind riser provided on a casting
15. Study of internal and external chill to a casting
16. Effect of exothermic material on efficiency of riser.
17. Visit of any pattern making and core making shop of a Foundry

Course Code :	**Category :** PCC
Course Title : Machine Tool Design	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Contents:

Module- I Introduction to Machine Tools: Classification, similarities; various cutting tools and cutting fluids: speed of cutting, feed rate, machining rate and machining time. (4 hrs)

Module- II Lathe: Construction, important mechanisms viz. apron, tail stock, head-stock, feed box; specification, operations e.g., taper turning, eccentric turning, screw cutting. (4 hrs)

Module- III Milling machine: Construction, types specifications; cutters, dividing head, simple compound and differential indexing; various operations: Slab milling, angle cutting, slot milling, fly milling, slit gear milling, spur and bevel, T- slot milling, nature of operations, up and down milling. (10hrs)

Module- IV Shaper, Slotter, Planer: Construction, automatic feed mechanism, quick return mechanisms: operations e.g., horizontal, vertical and inclined machining, spline cutting, keyway cutting, contour machining. (7 hrs)

Module- V Drilling machine: Construction, feed mechanism: Specification, geometry and nomenclature of twist drill, operations e.g. reaming, boring, tapping. (5 hrs)

Module- VI Grinding Machines: M, N types and construction features, Operations e.g. Plane, cylindrical,internal and centreless grinding, tool and cutter grinding, grinding wheelsspecifications, shapes,setting, dressing, truing. (10 hrs)

Course Outcomes: At the end of the course, the student will be able to, Understand basic motions involved in a machine tool. Design machine tool structures. Design and analyze systems for specified speeds and feeds. Select subsystems for achieving high accuracy in machining. Understand control strategies for machine tool operations.

Text Books:

1. B.L.Juneja, G.S.Sekhon&Nitin Seth, Fundamentals of Metal Cutting & Machine Tools, New Age International Publications

2. P.N.Rao, Manufacturing Technology: Metal Cutting & Machine Tools, Tata McGraw Hill Publications.

3. G.K.Lal, Introduction to Machining Science ,New Age International Publications.

4. B.S.Raghuwanshi, Workshop Technology , Dhanpat Rai& Sons, Publications

5. HazraChandhari, Elements of Workshop Technology.

Course Code :	**Category :** Professional Core Courses
Course Title : Total Quality Management	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Objective: To facilitate the understanding of total quality management principles and processes.

Contents:

Module-I Introduction, evolution of quality control; Definitions of quality, Quality and productivity; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby.; Quality conformance, customer need, customer orientation & satisfaction, customer complaints; Quality cost, product & service costing, measuring quality cost (8 Hrs).

Module-II TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment;6 Hrs.

Module-III Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection. 8 Hrs.

Module-IV The seven traditional tools of quality management; New management tools; Six sigma concepts, methodology, applications to manufacturing, Bench marking process, evaluation; FMEA-stages, types. 6 Hrs.

Module-V TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.8 Hrs.

Module-VI Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000-concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.6 Hrs.

Course Outcomes: At the end of course, the students will be able to 1. Understand the importance of quality and its assurance. 2.Analyze quality statements, customer focus and market plan. 3.Evaluate quality-based products & methods. 4.Develop tools, methodology for the assurance of quality. 5.Apply & use the tools and techniques of TQM in manufacturing and service sector.

Textbooks:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janaki raman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Course Code :	**Category :** Professional Elective Courses
Course Title : Near Net Shape Processes	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Concept of Shape, size, accuracy, tolerances and surface roughness. Economical and technological factors; improved material and energy efficiency, dimensional accuracy, product integrity and reduced manufacturing cost through near net processing . Foundry processes ; Shell process, investment casting, ceramic moulding , plaster mould process, V-process, squeeze casting, rheo-casting, permanent mould casting, low pressure die casting and pressure die casting processes.

Precision Forging process like flashless forging, powder forging, Isothermal and hot die forging. Semi solid forging, Orbital forging, , liquid forging, cross wedge rolling, Superplastic forging, long forging machine, HERF, HIP, Electrical upsetters, Multi axial forging. Incremental Forging.

Electro forming; principles of electro deposition, production of dies and moulds by electro-forming

Course Code :	**Category :** Open Elective Courses
Course Title : Plasticity and Deformation	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Fundamental of classical plasticity – 7L
Concept of stress and strain components, Mohr stress circles for two- and three-dimensional stress system, strain rate and strain rate tensors, yield criteria, yield locus and physical concepts of Tresca, Mises and twin shear stress yield criteria, effective stress and effective strain.
Mechanical properties under uniaxial tension and non-uniaxial loading – 7L

Yield criteria of different material, anisotropic material – 7L

Plastic constitutive relations of materials, flow rules – 7L

Stress and strain analysis of plane-stress metal forming processes such as tube drawing, deep drawing, tube hydroforming – 7L

Stress and strain analysis for bulk forming and sheet forming – 7L

Course Code :	**Category :** Professional Core Courses
Course Title : Simulation in Casting and Forging	**Semester** : Seventh
L-T-P : 3-0-0	**Credit:**3

Length and time scales in computational modeling of materials; review of thermodynamic models, conservation and continuity equations, constitutive laws in materials engineering; introduction to computational linear algebra - linear and nonlinear system of equations, interpolation and curve fitting, numerical differentiation and integration, basic numerical optimization - applications in thermodynamics, ordinary and partial differential equations – initial and boundary value problems, numerical methods – finite difference, finite volume, and finite element methods; random numbers and random walk models, Monte Carlo simulations of phase transformations in model binary alloys, concepts of potentials and Molecular Dynamics simulations, mesoscale models, introduction to ICME concepts and tools

Development of numerical routines to solve problems involving heat transfer, fluid flow, solidification, diffusion, phase change, on MATLAB and open-source tools. Simulation of fluid Flow, heat transfer, solidification, deformation, solid flow under applied forces. Understanding the application of appropriate commercial softwares like Pro Cast, Magma Soft, Deform, Simufact etc.

Reference:

1. "Applied Numerical Analysis (7th edition)", Curtis F Gerald and Patrick O. Wheatley, Pearson Education India
2. "Mathematical Methods for Physics and Engineering (3rd edition)", K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge University Press
3. Richard LeSar, "Introduction to Computational Materials Science: Fundamentals to Applications", Cambridge University Press, 2013

Course Code : PEC611	**Category :** Honors Courses
Course Title : Simulation in Casting and Forging Laboratory	**Semester** : Seventh
L-T-P : 0-0-2	**Credit:**1

Semester VIII

Course Code :	**Category :** PEC
Course Title : Non- Conventional Machining Process	**Semester** : Eight
L-T-P : 3-0-0	**Credit:**3

Course Code :	**Category :** Open Core Courses

Course Title : Supply Chain Management	**Semester** : Eight
L-T-P : 3-0-0	**Credit:**3

Objective: To provide an insight into functioning and networking of supply chain decisions for the success of a business. The course will provide foundation for design, analysis and performance metrics and to frame a sound supply chain network in the country.

Details of Course:

1 Introduction: Understanding supply chain, supply chain performance; supply chain drivers and obstacles. (4 Hrs)

2 Planning Demand and Supply in a Supply Chain: Demand forecasting in supply chain, aggregate planning in supply chain, planning supply and demand; managing predictable variability, Economic Order Quantity Models, Reorder Point Models, Multi-echelon Inventory Systems. (12 Hrs)

3 Planning and Managing inventories in a Supply Chain: Managing economies of supply chain, managing uncertainty in a supply chain, determining optimal levels of product availability. (6 Hrs)

4 Transportation, Network Design and Information Technology: Transportation aspects in a supply chain, facility Decision, Network design in a supply chain, Information technology and its use in supply chain. (10 Hrs)

5 Coordination in Supply Chain and effect of E- Business: Role of Coordination and E- business in a supply chain; financial evaluation in a supply chain. (10 Hrs) Total 42 (Hrs)

Suggested Books:

1 Hopp W. J., Spearman M. L. and Irwin, "Factory Physics: Foundations of Manufacturing", McGraw-Hill Inc. New York. 1996

2 Viswanadham N., "Analysis of Manufacturing Enterprises", Kluwer Academic Publishers, UK. 2000

3 Sridhar Tayur, Ram Ganeshan and Michael Magazine (editors), "Quantitative Models for Supply Chain Management", Kluwer Academic Publishers, UK. 1999

4 Handfield R.B. and Nochols E.L.Jr., "Introduction to Supply Chain Management", Prentice Hall Inc. Englewood- Cliff, New Jersey. 1999

5 Viswanadham N. and Narahari Y., "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi. 1998

6 Chopra S. and Meindel P., “Supply Chain Management: Strategy, Planning, and Operation”, Prentice Hall of India, New Delhi. 2002

7 Shapiro J. F., Duxbury Thomson Learning, “Modeling the Supply Chain”, Duxbury Thomson Learning Inc., Duxbury, Pacific Grove. 2001

8 Levi D. S., Kaminsky P. and Levi E. S., “Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies”, McGraw Hill Inc. New York. 2000

Course Code : HEC 621	**Category :** Honors Courses
Course Title : Technology of Non-Ferrous Casting	**Semester** : Eight
L-T-P : 3-0-0	**Credit:**3

Non-ferrous alloys based on Al, Cu, Zn, Mg, Tiand Ni. their properties and applications, classification of alloys, solidification and microstructure of important non ferrous alloys.

Melting, fluxing, degassing and pouring practices, electro slag remelting(ESR)and central zone refining(CZR). Filtration of non- ferrous melts. Melt treatment: modification and grain refinement.

Charge calculation, Oxidation and gas absorption in metals and alloys, detection of gases.

Moulding and core making practices, metal-mould reaction, gating and feeding practices. Defect analysis, salvaging of castings, heat treatment.

Different casting techniques of Al, Cu, Mg, Ti, Ni, Zr and other precious metals like Au, Ag and Pt, effect of **a**ddition of alloying element,Casting defects.

Learning Resources:

1. Foundry Technology by P.L. Jain
2. ASM Handbook Volume 15: Casting, ISBN: 978-0-87170-711-6
3. Principles of Metal Casting by Richard Heine, Carl Loper, Philip Rosenthal
4. Metal Casting Principles and Techniques by Lerner Yury, Posinasetti Nageswara
5. FOSECO Non-Ferrous Foundryman’s Handbook, John R. Brown

Course Code :	**Category :** Honors Courses
Course Title : Technology of Non-Ferrous Casting Laboratory	**Semester** : Eight
L-T-P : 0-0-2	**Credit:**1

Elective Courses

XXPEC04: Fracture, Fatigue, and Failure Analysis (40 Lectures)

Module 1: Introduction to Failure of Materials (4 Lectures)

- Overview of engineering materials, service environments, and failure modes
- Distinction between failure by fracture, fatigue, creep, wear, and corrosion
- Historical case studies of major failures (bridges, aircraft, turbines, implants)
- Importance of failure analysis in design and life prediction

Module 2: Fundamentals of Stress, Strain, and Microstructure (4 Lectures)

- Stress–strain behavior of metals, polymers, and ceramics
- Role of microstructure and defects (grain boundaries, inclusions, dislocations)
- Stress concentration: notches, holes, geometrical discontinuities
- Residual stresses and their influence on failure

Module 3: Fundamentals of Fracture Mechanics (8 Lectures)

1. Introduction to fracture mechanics — Griffith's theory of brittle fracture
2. Linear Elastic Fracture Mechanics (LEFM) concepts and stress intensity factor (K)
3. Critical stress intensity factor (K_IC) – fracture toughness
4. Plane stress vs. plane strain fracture toughness
5. Crack-tip plasticity (Irwin's correction, Dugdale model)
6. Energy release rate (G) and J-integral concept
7. Dynamic fracture and crack propagation velocity
8. Experimental determination of fracture toughness

Module 4: Fatigue of Materials (10 Lectures)

1. Fundamentals — high cycle vs. low cycle fatigue
2. Stress-life (S–N) curves and endurance limit
3. Factors affecting fatigue life: mean stress, surface finish, size effect, temperature
4. Fatigue crack initiation and propagation mechanisms
5. Paris law and crack growth rate models
6. Variable amplitude loading and Miner's rule (cumulative damage models)
7. Low cycle fatigue and Coffin-Manson relationship
8. Fatigue of nonmetals (composites, polymers, ceramics)
9. Experimental methods for fatigue testing
10. Design for fatigue resistance

Module 5: Creep and Time-Dependent Failures (4 Lectures)

- Creep deformation stages (primary, secondary, tertiary)
- Creep fracture mechanisms: intergranular cavitation, grain boundary sliding
- Creep testing methods and parameters (creep curves, Larson–Miller parameter)
- Design against creep in high-temperature applications (turbines, boilers)

Module 6: Failure Analysis Methods (6 Lectures)

1. Failure investigation methodology and procedures
2. Visual, fractographic, and metallographic examination
3. Scanning Electron Microscopy (SEM) in failure analysis
4. Case studies of fatigue, brittle, and ductile fracture
5. Non-destructive testing (NDT) methods in failure prevention
6. Root cause analysis and remediation

Module 7: Industrial Case Studies and Applications (4 Lectures)

- Failures in aerospace (aircraft structures, turbine blades)
- Failures in civil engineering (bridges, pressure vessels, pipelines)
- Failures in automotive and railway components
- Failures in biomedical implants and prosthetics; design for reliability

References:

- "Fatigue and Fracture" by F. C. Campbell, Year: 2011 (Latest edition), Publisher: Elsevier, Edition: 2nd Edition
- ASM handbook Volume 19 for Fracture and Fatigue

XXPEC03: Non-Destructive Testing and Examination (40 Lectures)

Module 1: Introduction and Basics of NDT (4 Lectures)

- Definition and importance of NDT in industry
- Types of defects and discontinuities in materials
- Overview of common NDT methods and their applications
- Codes, standards, and specifications related to NDT

Module 2: Visual and Optical Inspection (4 Lectures)

- Visual testing (VT) techniques and tools
- Lighting, magnification, and optical aids
- Surface condition evaluation
- Advantages, limitations, and qualification requirements for VT

Module 3: Liquid Penetrant Testing (LPT) (4 Lectures)

- Principles of dye penetrant inspection
- Types of penetrants and developers
- Inspection procedures and standards
- Detection of surface-breaking defects

Module 4: Magnetic Particle Testing (MPT) (4 Lectures)

- Magnetic properties of materials and magnetization methods
- Types of magnetic particle inspection (dry and wet)
- Equipment, procedures, and interpretation of results
- Limitations and applications for ferromagnetic materials

Module 5: Ultrasonic Testing (UT) (8 Lectures)

- Fundamentals of ultrasonic waves and propagation
- Ultrasonic inspection techniques (pulse-echo, through-transmission)
- Calibration and use of ultrasonic flaw detectors
- Interpretation of UT signals and sizing defects
- Advanced ultrasonic methods: Phased Array Ultrasonics, Time-of-Flight Diffraction (TOFD)
- Thickness measurements and material characterization by UT

Module 6: Radiographic Testing (RT) and Radiation Safety (6 Lectures)

- Principles of radiography using X-rays and gamma rays
- Image formation and interpretation
- Radiographic equipment and film processing
- Radiation safety and regulatory requirements
- Digital radiography and computed radiography basics

Module 7: Eddy Current Testing (ECT) and Electromagnetic Methods (4 Lectures)

- Principles of eddy current testing for conductive materials
- Equipment and inspection techniques
- Detection of surface and near-surface defects
- Applications in tubing, heat exchangers, and surface cracks

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Module 8: Acoustic Emission Testing and Leak Testing (3 Lectures)

- Principles of acoustic emission inspection for monitoring damage
- Sensors and signal analysis
- Leak testing methods: bubble, pressure, vacuum, halogen diode, helium mass spectrometry

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Module 9: Infrared Thermography and Emerging NDT Techniques (3 Lectures)

- Fundamentals of infrared and thermal NDT methods
- Active and passive thermography applications
- Introduction to terahertz imaging and strain gauge testing
- Optical and laser-based NDT methods

Module 10: Practical Aspects and Case Studies (4 Lectures)

- NDT equipment calibration and standards adherence
- Selection of appropriate NDT techniques for components
- Case studies on industrial failures detected by NDT
- Role of NDT in quality assurance and maintenance

References:

- "Practical Non-Destructive Testing" by Baldev Raj, T. Jayakumar, M. Thavasimuthu, Year: 2009, Publisher: Woodhead Publishing (Elsevier), Edition: 3rd Edition
- Introduction to Non-Destructive Testing, by Dr. V. Jayakumar Dr.K.Elangovan, Laxmi Publication
- ASM Handbook Volume 17, Non-Destructive Testing

XXOEC01/XXOEC02 Thermo-mechanical Processing

Module 1: Introduction and Fundamentals (4 Lectures)

- Definition and scope of thermomechanical processing (TMP)
- Overview of phase transformations, microstructure evolution, and mechanical properties
- Basic metallurgy relevant to TMP (crystal structure, defects, diffusion)
- Importance of TMP in industry and applications

Module 2: Deformation Mechanics and Hot Working (6 Lectures)

- Fundamentals of metal deformation: stress, strain, strain rate
- Hot working processes: rolling, forging, extrusion, drawing
- Dynamic recrystallization and recovery mechanisms
- Effect of temperature and strain rate on flow behavior
- Hot deformation processing maps

Module 3: Phase Transformations in TMP (5 Lectures)

- Thermodynamics and kinetics of phase transformations during TMP
- Recrystallization, grain growth, and phase stability
- Role of deformation on phase transformation (strain-induced transformations)
- Inter-critical annealing and its effects
- Time-temperature-transformation (TTT) and continuous cooling transformation (CCT) diagrams

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Module 4: Cold Working and Work Hardening (4 Lectures)

- Cold deformation processes and mechanisms
- Strain hardening, recovery, recrystallization during cold working
- Effect on mechanical properties and microstructure
- Comparison of hot vs cold processing

Module 5: Thermomechanical Processing of Steels (7 Lectures)

- Thermomechanical controlled processing (TMCP) of HSLA steels
- Controlled rolling and controlled cooling techniques

- Influence on microstructure refinement and mechanical properties
- Applications in pipeline, automotive, and structural steels
- Case studies of TMP in steel manufacturing

Module 6: Thermomechanical Processing of Nonferrous Metals and Alloys (4 Lectures)

- TMP in aluminum, titanium, and copper alloys
- Hot and cold working considerations for nonferrous metals
- Microstructural control during TMP
- Industrial relevance and specific challenges

Module 7: Simulation and Modeling of TMP (4 Lectures)

- Introduction to process simulation tools (Gleeble, finite element modeling)
- Modelling hot deformation behavior and microstructure evolution
- Use of software in optimizing TMP parameters
- Case examples of TMP simulation

Module 8: Advanced TMP Techniques and Applications (3 Lectures)

- Thermomechanical processing combined with surface treatments (e.g., thermo-chemical processing)
- TMP in additive manufacturing and novel processes
- Emerging trends and research directions

Module 9: Laboratory and Industrial Case Studies (3 Lectures)

- Analysis of microstructural changes through microscopy and hardness tests
- Case studies from industry showcasing TMP benefits and challenges
- Quality control and testing methods relevant to TMP

References:

- Thermomechanical Processing of Metallic Materials by Verlinden et al. year 2007, Elsevier, 1st Edition