GURU KASHI UNIVERSITY
PUNJAB - INDIA

Program Syllabus Booklet

Bachelor of Technology in Mechanical Engineering
(B.Tech ME-105)

Session: 2020-21

Guru Gobind Singh College of Engg. & Tech.
Guru Kashi University, Talwandi Sabo

GURU KASHI UNIVERSITY
PUNJAB - INDIA

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Annexure -1

Program: Bachelor of Technology in Mechanical Engineering
Program Code: 105
Program Outcomes (POs):The Program Outcomes (POs) for the program Bachelor of Technology in Mechanical Engineering are as follows:

PO	Statement
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and a mechanical engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex mechanical engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective

	presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Program Specific Outcomes (PSOs) for the Program Bachelor of Technology in Mechanical Engineering are as follows:

PSO	Statement
PSO1	To acquire basic knowledge and expertise necessary for professional practice in mechanical engineering for higher studies and research, and technical skills to identify, analyze and solve complex problems and issues related to mechanical engineering
PSO2	To acquaint the students with the administrative and financial management principles for effective project implementation.
PSO3	To develop a professional attitude as an individual or a team member with consideration for society, professional ethics, environmental factors and motivation for life-long learning.

Annexure-2

Study Scheme										
Semester: 1st (Chemistry Group)										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A103101	Basic Electrical Engineering	T	3	1	0	4	40	60	100
2	105106	Physics –I (Electromagnetism)	T	3	1	0	4	40	60	100
3	105107	Mathematics –I (Calculus and Linear Algebra)	T	3	1	0	4	40	60	100
4	105105	Engineering Graphics & Design	T/P	1	0	4	3	40	60	100
5	105108	Physics –I (Electromagnetism)	P	0	0	4	2	30	20	50
6	A103102	Basic Electrical Engineering Lab	P	0	0	2	1	30	20	50
Total No. of Credits				18						

Semester: 2nd (Physics Group)										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A100102	Engineering Chemistry	T	3	1	0	4	40	60	100
2	105201	Mathematics –II (ODE& Complex Variables)	T	3	1	0	4	40	60	100
3	102202	Programming for Problem Solving	T	3	0	0	3	40	60	100
4	100108	English	T	2	0	0	2	40	60	100
5	105202	Workshop Manufacturing Practices	T/P	1	0	4	3	60	40	100
6	A100106	Engineering Chemistry Lab	P	0	0	4	2	30	20	50
7	102203	Programming for Problem Solving Lab	P	0	0	4	2	30	20	50
8	100109	English Lab	P	0	0	2	1	30	20	50
9	100304	Constitution of India	T	3	0	0	NC	NA	NA	NA
Total No. of Credits				21						

Semester: 3rd										
Sr.	Course Code	Course Name	Type of Course	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
			T/P	L	T	P				
1	A105301	Fluid Mechanics	T	3	1	0	4	40	60	100
2	A105302	Theory of Machines - I	T	3	1	0	4	40	60	100
3	A105303	Machine Drawing	T	1	0	4	3	40	60	100
4	A105304	Strength of Materials-I	T	3	1	0	4	40	60	100
5	A105305	Applied Thermodynamics-I	T	3	1	0	4	40	60	100
6	A103305	Basic Electronics Engineering	T	3	0	0	3	40	60	100
7	A105307	Strength of Materials-I Lab	P	0	0	4	2	30	20	50
8	A105308	Theory of Machines-I Lab	P	0	0	4	2	30	20	50
9	A105309	Fluid Mechanics Lab	P	0	0	4	2	30	20	50
10	A105310	Summer/Institutional Training	NA	NA	NA	NA	S/US*	NA	NA	NA
Total No. of Credits							28			

Note:Instititional Training will be imparted in the Institute at the end of 2nd Semester for 6-weeks duration. However this Subject is **not applicable to LEET Students**.
*** (S/US)** Satisfactory/Unsatisfactory

Semester: 4th										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A105401	Applied Thermodynamics-II	T	3	1	0	4	40	60	100
2		**Professional Elective Course-I**	T	3	1	0	4	40	60	100
3	A105403	Strength of Materials-II	T	3	1	0	4	40	60	100
4	A105404	Theory of Machines-II	T	3	1	0	4	40	60	100
5	A100302	Environmental Studies	T	3	0	0	NC	NA	NA	NA
6	A105405	Materials Engineering	T	3	0	0	3	40	60	100
7	A105406	Applied Thermodynamics-II Lab	P	0	0	4	2	30	20	50
8	A105408	Material Engineering Lab	P	0	0	4	2	30	20	50
9	100306	Mentoring and Professional Development of Students	P	0	0	4	S/US*	NA	NA	NA
		Total No. of Credits					23			
*** (S/US) Satisfactory/Unsatisfactory**										

Semester: 5th

Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A105502	Heat Transfer	T	3	1	0	4	40	60	100
2	A100301	Engineering Mathematic-III	T	3	1	0	4	40	60	100
3	A105504	Mechanical Measurement and Metrology	T	3	1	0	4	40	60	100
4	105514	Manufacturing Process	T	3	0	0	3	40	60	100
5	105515	Engineering Mechanics	T	3	0	0	3	40	60	100
6		**Professional Elective Course - II**	T	4	0	0	4	40	60	100
7	100305	Essence of Indian Traditional Knowledge	T	3	0	0	NC	NA	NA	NA
8	105516	Project-I*	P	0	0	2	1	30	20	50
9	A105508	Heat Transfer Lab	P	0	0	2	1	30	20	50
Total No. of Credits				24						

***Project-I** :- The problem related with design, construction, computer modeling, fabrication, experimentation etc. based on specialization group of electives is to be carried out the result and analysis followed by discussion regarding suitability or non suitability of project with conclusion and recommendation for future extension of the project must be covered. The project work will be carried out in groups(Maximum 5 students are allowed in one group)

Semester: 6th										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A105605	Refrigeration &Air-conditioning	T	3	0	0	3	40	60	100
2	105610	Mechanical Vibration	T	3	1	0	4	40	60	100
3	105611	Manufacturing Technology	T	4	0	0	4	40	60	100
4		Professional Elective Course- III	T	4	0	0	4	40	60	100
5	A105603	Industrial Automation & Robotics	T	3	0	0	3	40	60	100
6	105612	Mechanical Vibration Lab	P	0	0	2	1	30	20	50
7	105614	Project-II*	P	0	0	2	1	30	20	50
8	105615	Mechanical Measurement & Metrology Lab	P	0	0	2	1	30	20	50
Total No. of Credits							21			

*Project-II :- The problem related with design, construction, computer modeling, fabrication, experimentation etc. based on specialization group of electives is to be carried out the result and analysis followed by discussion regarding suitability or non suitability of project with conclusion and recommendation for future extension of the project must be covered. The project work will be carried out in groups(Maximum 5 students are allowed in one group)

Semester: 7th										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1		Professional Elective Course -IV	T	4	0	0	4	40	60	100
2		Professional Elective Course -V	T	4	0	0	4	40	60	100
3	105702	Design of Machine Elements	T	4	0	0	4	40	60	100
4		Open Elective*	T	3	0	0	3	40	60	100
5	105703	Project-III**	P	0	0	6	3	60	40	100
6	105704	Industrial/Institutional Training-I***	NA	NA	NA	NA	4	60	40	100
Total No. of Credits							22			

***Open Elective:**- The open elective will be taken by student as the list of open elective subjects offered by any department.

****Project-III** :- The problem related with design,construction,computer modeling, fabrication, experimentation etc. based on specialization group of electives is to be carried out the result and analysis followed by discussion regarding suitability or non suitability of project with conclusion and recommendation for future extension of the project must be covered The project work will be carried out in groups(Maximum 5 students are allowed in one group)

*** **Industrial/Institutional Training-I** :- The marks of industrial Training-I undergone at the end of 6th semester will be included here (Each students has to complete one project is concerned industry/institution)

Semester: 8th										
Sr.	Course Code	Course Name	Type of Course T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1		Professional Elective Course - VI	T	4	0	0	4	40	60	100
2		Professional Elective Course - VII	T	4	0	0	4	40	60	100
3		Professional Elective Course - VIII	T	4	0	0	4	40	60	100
4	A105804	Operation Research	T	3	1	0	4	40	60	100
5	105808	Project-IV*	P	0	0	6	3	60	40	100
6	105809	Industrial/Institutional Training-II **	NA	NA	NA	NA	5	120	80	200
Total No. of Credits							24			

***Project-IV**: - The problem related with design, construction, computer modeling, fabrication, experimentation etc. based on specialization group of electives is to be carried out the result and analysis followed by discussion regarding suitability or non suitability of project with conclusion and recommendation for future extension of the project must be covered. The project work will be carried out in groups(Maximum 5 students are allowed in one group)

** **Industrial/Institutional Training-II:-** The student will cover this training on the basis of his/her elective subject choice and he will complete the training within the institute or outside of institute(with permission).

Professional Elective Course: - All the professional elective course will be selective from the same group. (Min 5 student group is required for subject choice)

Professional Elective Courses

Note:- All the professional elective courses will be selective from the same group.

Group-I :- Manufacturing	
Course **Code**	Course **Name**
A105907	Non Traditional Machining
A105909	Computer Aided Manufacturing
105921	Computer Aided Process Planning
105922	Modern Welding Formation Process
105923	Machining Science
105924	Metallurgy & Heat Treatment Processes
105925	Composite Material
105926	Rapid Prototyping
105927	Characterization of Material
105928	Surface Engineering
105929	Casting Processes
105930	Micromachining Technologies
105931	Plastic Technology
105947	Process Planning & Cost Estimation

Group-II :- Thermal	
Course **Code**	Course **Name**
A105901	Internal Combustion Engine
A105902	Non Conventional Energy Resources
A105903	Energy Conservation And Management
A105905	Heat Exchange Design
A105501	Automobile Engineering
105940	Gas Dynamics And Jet Propulsion
105941	Cryogenic Technologies
105942	Solar Energy
105943	Power Plant Engineering
105944	Computational Fluid Dynamics
A105402	Fluid Machines

Group-III :- Design	
Course **Code**	Course **Name**
A105908	Mechatronics
A105917	Product Design And Development
A105911	Modelling And Simulation
A105914	Finite Element Method
A105912	Industrial Tribology
105932	Theory Of Plasticity
105933	Design For X
105934	Tool Design
105935	Design of Transmission System
105936	Microprocessor In Automation
105937	Machine Tool Design
105938	Experimental Stress Analysis
105939	Computer Aided Design

Open Elective	
	Course **Name**
A105802	Industrial Safety and Environment
A105918	Total Quality Management
A105920	Management Information System
105945	Operations Management
105946	Industrial Engineering

Annexure-3

Course Name: Basic Electrical Engineering

Course Code: A103101

Semester: 1st

Credits -4

L	T	P
3	1	0

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Discuss the DC and AC electrical circuit elements with RLC in detail.
CO2	Analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.
CO3	Analyze Single Phase AC Circuits and representation of alternating quantities and determining the power in these circuits.
CO4	Classify the different types of Electrical machines.
CO5	Understand the different type of electrical installation devices.

Module 1: DC Circuits (8 hours)

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.

Module 2: AC Circuits (8 hours)

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.

Module 3: Transformers (6 hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)

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.

Module 5: Power Converters (6 hours)

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

Module 6: Electrical Installations (6 hours)

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.

Suggested Text / Reference Books

(i) Kothari, D. P. and Nagrath, I. J. (2010). *Basic Electrical Engineering*. Tata McGraw Hill.
(ii) Kulshreshtha, D. C. (2009). *Basic Electrical Engineering*. McGraw Hill.
(iii) Bobrow, L. S. (2011). *Fundamentals of Electrical Engineering*. Oxford University Press.
(iv) Hughes, E. (2010). *Electrical and Electronics Technology.* Pearson,

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	1	1	2	1	2	1	2	2	2	2
CO2	1	2	2	2	-	1	2	1	1	2	2	1	3	3	2
CO3	2	3	-	3	2	1	1	2	2	1	2	2	2	2	-
CO4	3	2	2	2	2	2	-	1	1	2	-	2	3	2	2
CO5	2	2	2	3	2	1	2	2	1	2	1	2	2	2	2
AVERAGE	**1.8**	**2.2**	**2**	**2.4**	**2**	**1.2**	**1.2**	**1.6**	**1.2**	**1.8**	**1.2**	**1.8**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Physics (Electromagnetism)

Course Code: 105106

Semester: 1st

Credits -4

L	T	P
3	1	0

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

CO	Statement
CO1	Apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances.
CO2	Use the knowledge regarding calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science, and in the professional world.
CO3	Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.
CO4	Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context.
CO5	Acknowledge the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws and analyze and solve RL circuits

Module 1: Electrostatics in vacuum (8 lectures)

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Farady's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module 2: Electrostatics in a linear dielectric medium (4 lectures)

Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magnetostatics (6 lectures)

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module 4: Magnetostatics in a linear magnetic medium (3 lectures)

Magnetization and associated bound currents; auxiliary magnetic field ; Boundary conditions on and . Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module 5: Faraday's law (4 lectures)

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module 6: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations (5 lectures)

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time- dependent electric field; calculating magnetic field due to changing electric fields in quasi- static approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module 7: Electromagnetic waves (8 lectures)

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Suggested Text Books

(i) David J Griffths. (1999). *Introduction to Electrodynamics*. PrenticeHall.
(ii) Walker, Jearl, David Halliday, and Robert Resnick. (2011). *Fundamentals of Physics*. Hoboken, N.J: Wiley.
(iii) Saslow, W. (2008). *Electricity, magnetism and light*. e-book.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	-	3	2	2	2
Average	**2.4**	**2.6**	**2.4**	**2.4**	**1.8**	**1.5**	**1.5**	**1.6**	**2.2**	**2.6**	**2.2**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Mathematics –I (Calculus and Linear Algebra)

Course Code: 105107

Semester: 1st

Credits -4

L	**T**	**P**
3	**1**	**0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	**Statement**
CO1	Perform matrix operations and solvethe matrix equation using elementary matrix operations
CO2	Use systems of linear equations and matrix equations to determine linear dependency or independency and evaluate the eigen values and corresponding eigenvectors for a linear transformation
CO3	Set up and evaluate multiple integrals for regions in the plane to find area of the region bounded by curves and volume, surface area, Mass, C.G and M.I of solid geometric figures.
CO4	Learn the fundamental theorem of calculus and use it for evaluating definite integrals and derivatives of integrals with variable limits of integration

CO5	Distinguish between the concepts of *sequence and series*, and determine limits of sequences and convergence and approximate sums

Course Content

Module 1: Calculus: (6 lectures)

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.

Module 2: Calculus: (6 lectures)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Sequences and series: (10 lectures)

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.

Module 4: Multivariable Calculus (Differentiation): (8 lectures)

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.

Module 5: Matrices (10 lectures)

Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Suggested Text/Reference Books

(i) Thomas, G.B. &Finney, R.L. (2002). *Calculus and Analytic geometry*, 9th Edition, Pearson, Reprint.

(ii) Kreyszig, Erwin. (2006). *Advanced Engineering Mathematics*. 9th Edition, John Wiley & Sons.

(iii) Veerarajan, T. (2008). *Engineering Mathematics for first year*. Tata McGraw-Hill, New Delhi.

(iv) Ramana, B.V. (2010). *Higher Engineering Mathematics*, Tata McGraw Hill New Delhi, 11th Reprint.

(v) Poole, D. (2005). *Linear Algebra*: *A Modern Introduction*, 2nd Edition, Brooks/Cole.

(vi) Bali, N.P. & Goyal, Manish. (2008). *A text book of Engineering Mathematics*. Laxmi Publications, Reprint.

(vii) Grewal, B.S. (2010). *Higher Engineering Mathematics*. Khanna Publishers, 36th Edition.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO /CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	1	2	1	1	1	2	2	2	2	2
CO2	2	3	3	2	2	1	2	-	2	3	2	2	2	1	1
CO3	3	2	2	2	1	-	2	1	-	-	2	3	1	2	2
CO4	2	2	2	2	2	2	-	2	2	3	1	3	2	2	3
CO5	2	2	2	3	1	1	1	-	2	1	1	2	1	3	2
Average	**2.4**	**2.2**	**2.4**	**2.2**	**1.4**	**1.2**	**1.7**	**1.3**	**1.7**	**2**	**1.6**	**2.4**	**1.6**	**2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Engineering Graphics & Design

Course Code: 105105

Semester: 1st

Credits -3

L	T	P
1	0	4

Course Outcomes: On successful completion of this course, the students will be able to:

CO	On successful completion of this course, the students will be able to:
CO1	Understand about engineering drawing applications and its importance in society.
CO2	Learn about the visual aspects of engineering design.
CO3	Understand the engineering graphics standards.
CO4	Understand the concept of solid modeling techniques.
CO5	Apply the computer-aided geometric design in engineering

Course Content

Module 1:

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module 2:

Orthographic Projectionscovering, Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module 3:

Projections of Regular Solidscovering, those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module 4:

Sections and Sectional Views of Right Angular Solidscovering, 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)

Module 5:

Isometric Projections covering, 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;

Module 6:

Overview of Computer Graphics covering, 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];

Module 7:

Customization& CAD Drawing consisting of 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 tolerance; 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;

Module 8:

Annotations, layering & other functions covering 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, Computer-aided 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, multi view, auxiliary, and section views. Spatial visualization
exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling;

Module 9:

Demonstration of a simple team design project that illustrates 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 tolerance; Use of solid-modeling 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 color coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

References Books:

1. Gill, P.S.(2001).*Engineering Drawing*. S.K; Kataria and Sons,Ludhiana.
2. Bhatt, N.D.(2012).*Engineering Drawing*. Charotar Book Stall, Tulsi Sadan, Anand.
3. French, T.E. and Vierck. C.J.(1993).*Graphic Science*. McGraw-Hill, New York.
4. Zozzora, F.(1958).*Engineering Drawing*.McGraw Hill, NewYork.

(Corresponding set of) CAD Software Theory and User Manuals

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	2	2	1	2	1	2	2	1	1	1	2	1	1
CO2	2	1	2	1	2	1	1	2	2	1	1	-	1	2	2
CO3	2	2	2	2	1	2	1	2	2	1	-	1	2	1	1
CO4	1	2	1	2	1	1	2	2	2	2	1	1	1	2	2
CO5	1	2	1	2	2	1	2	1	2	1	1	1	1	2	2
Average	**1.75**	**1.75**	**1.75**	**1.75**	**1.25**	**1.5**	**1.25**	**2**	**2**	**1.25**	**1**	**1**	**1.5**	**1.5**	**1.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Physics (Electromagnetism) Lab

Course Code: 105108

Semester: 1st

L T P

Credits: 02 **0 0 4**

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

CO	Statement
CO1	Apply knowledge Experiments on electromagnetic induction and electromagnetic breaking.
CO2	Predict use LC circuit and LCR circuit.
CO3	Design Resonance phenomena in LCR circuits
CO4	Assess Magnetic field from Helmholtz coil.
CO5	Understand Measurement of Lorentz force in a vacuum tube

Choice of experiments from the following:

- Experiments on electromagnetic induction and electromagnetic breaking;
- LC circuit and LCR circuit;
- Resonance phenomena in LCR circuits;
- Magnetic field from Helmholtz coil;
- Measurement of Lorentz force in a vacuum tube.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	2	2	2	2	2	2	2	2	3	2	3
CO2	1	1	2	1	1	1	2	1	2	2	-	2	2	3	2
CO3	2	1	2	2	2	2	1	-	2	2	2	3	2	3	2
CO4	1	1	2	1	1	2	-	2	1	-	2	2	2	2	2
CO5	1	1	1	2	1	-	1	2	-	2	1	3	3	3	3
Average	**1.5**	**1**	**2**	**1.5**	**1.5**	**1.5**	**1.25**	**1.7**	**1.7**	**2**	**1.5**	**2.4**	**2.4**	**2.6**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Basic Electrical Engineering Lab

Course Code: A103102

Semester: 1st

L T P

Credits: 01 **0 0 2**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basic introduction of measuring instruments instruments – voltmeter, ammeter, multi-meter, oscilloscope etc.
CO2	Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits
CO3	Analysis of Single Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits
CO4	Observe the different waveforms of transformer on CRO.
CO5	Evaluate the torque Speed Characteristic of separately excited dc motor and induction motor.

Course Content

List of experiments/demonstrations:

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
3. Transformers: Observation of the no-load current waveform on an oscilloscope (non- sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.

5. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
6. Torque Speed Characteristic of separately excited dc motor.
7. Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super- synchronous speed.
8. Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
9. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

The mapping of PO/PSO/CO attainment is as follows:

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO3
CO1	3	2	3	2	2	2	1	2	1	2	3	2	2	2	2
CO2	2	2	3	1	2	1	2	1	2	2	-	1	2	2	2
CO3	2	3	2	1	1	2	1	2	2	1	-	2	3	2	2
CO4	2	1	3	2	2	1	1	2	-	1	1	2	2	2	3
CO5	3	2	1	3	2	1	1	1	2	2	3	3	1	3	3
Average	**2.4**	**2**	**2.4**	**1.8**	**1.8**	**1.4**	**1.2**	**1.6**	**1.75**	**1.6**	**2.3**	**2**	**2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Engineering Chemistry

Course Code: A100102

Semester: 2nd

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statements
CO1	Demonstrate Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles,

CO2	Evaluate band structure of solids and the role of doping on band structures.
CO3	Distinguish the ranges of Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging
CO4	Rationalize periodic properties such as ionization potential, electro-negativity, Oxidation states and electro-negativity.
CO5	List the Thermodynamic functions: energy, entropy and free energy and also Estimations of entropy and free energies.

Course Contents

Module 1: Atomic and molecular structure (12 lectures)
Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Molecular orbital's of diatomic molecules and plots of the multicenter orbital. Equations foratomic and molecular orbital. Energy level diagrams of diatomic. Pi-molecular orbital 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.

Module 2: Spectroscopic techniques and applications (8 lectures)
Principles of spectroscopy and selection rules, Electronic spectroscopy, Fluorescence and its applications in medicine, Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques, Diffraction and scattering.

Module 3: Intermolecular forces and potential energy surfaces (4 lectures)
Ionic, Dipolar and Vander Waals interactions, Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module 4: Use of free energy in chemical Equilibria (6 lectures)
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, Water chemistry, Corrosion,Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 5: Periodic properties (4 Lectures)
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, molecular geometries

Module 6: Stereochemistry (4 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Module 7: Organic reactions and synthesis of a drug molecule (4 lectures)
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Suggested Text Books

i. Mahan, B. H. (1987). University chemistry.
ii. Sienko, M. J. & Plane, R. A. *Chemistry. (1979): Principles and* Applications. New York: McGraw-Hill.
iii. Banwell, C. N. (1966). *Fundamentals of Molecular Spectroscop*. New York, McGraw-Hill.
iv. Tembe, B. L., Kamaluddin & Krishnan, (2008). M. S. *Engineering Chemistry (NPTEL Web-book)*.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	-	3	2	2	2
Average	**2.4**	**2.6**	**2.4**	**2.4**	**1.8**	**1.5**	**1.5**	**1.6**	**2.2**	**2.6**	**2.2**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Mathematics –II (ODE & Complex Variables)
Course Code: 105201
Semester: 2nd

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement

CO1	Demonstrate the methods of forming and solving Ordinary differential equations and Solve linear differential equations with constant and variable coefficients
CO2	Explain the concept of differential equations and classify the differential equations with respect to their order and linearity.
CO3	Solve first-order ordinary and exact differential equations and converts separable and homogeneous equations to exact differential equations by integrating factors.
CO4	Apply the method of undetermined coefficients to solve the non-homogeneous linear differential equations with constant coefficients.
CO5	Compare the Methods of Cauchy's Riemann Integral and Analytical methods.

Course Content

Module 1: Multivariable Calculus (Integration): (10 lectures)
Multiple Integration: Double integrals (Cartesian), change of order of integration in doubleintegrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Centerof mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonalcurvilinear coordinates, Simple applications involving cubes, sphere and rectangularparallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vectorsurface integrals, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations: (6 lectures)
Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree:
Equations solvable for p, equations solvable for y, equations solvable for x and Clairaut'stype.

Module 3: Ordinary differential equations of higher orders: (8 lectures)
Second order linear differential equations with variable coefficients, method of variation ofparameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Besselfunctions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (8 lectures)
Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, findingharmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm)and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration: (8 lectures)

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, CauchyResidue theorem (without proof), Evaluation of definite integral involving sine and cosine,Evaluation of certain improper integrals using the Bromwich contour.

Suggested Text/Reference Books

1. Thomes, G.B.and Finney, R.L.(2010)*Calculus and Analytic Geometry*; Ninth Edition; Pearson Education
2. Kreyszig, E.(1998)*Advanced Engineering Mathematics*; Eighth Edition, Johnwiley and sons.
3. Grewal, B.S.(1965) *Higher Engineering Mathematics* ; Khanna Publishers, NewDelhi.
4. Babu Ram(2009) *Advance Engineering Mathematics*; First Edition;PearsonEducation.
5. Richard Courant and Fritz John (2012) ***Introduction to Calculus and Analysis,*** **Volume II , V** Springer Publication
6. Harold M. Edwards (2013)*Advanced Calculus: A Differential Forms Approach*, Birkhauser.

7. **The mapping of PO/PSO/CO attainment is as follows:**

PO/PSO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	2	2	2	2	2	2	2	2	2	2	3	2	3
CO2	1	1	2	1	1	1	2	1	2	2	-	2	2	3	2
CO3	2	1	2	2	2	2	1	-	2	2	2	3	2	3	2
CO4	1	1	2	1	1	2	-	2	1	-	2	2	2	2	2
CO5	1	1	1	2	1	-	1	2	-	2	1	3	3	3	3
Average	**1.5**	**1**	**2**	**1.5**	**1.5**	**1.5**	**1.25**	**1.7**	**1.7**	**2**	**1.5**	**2.4**	**2.4**	**2.6**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Programming for Problem Solving

Course Code: 102202

Semester: 2nd

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Formulate simple algorithms for arithmetic and logical problems
CO2	Translate the algorithms to programs (in C language)

CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Implement conditional branching, iteration and recursion
CO5	Decompose a problem into functions and synthesize a complete program using divide and conquer approach

Course Content

Module 1: Introduction to Programming **(4 lectures)**
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - **(1 lecture).**
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. **(1 lecture)**
From algorithms to programs; source code, variables (with data types) variables and memory Locations, Syntax and Logical Errors in compilation, object and executable code- **(2 lectures)**

Module 2: Arithmetic expressions and precedence (**2 lectures**)

Module 3: Conditional Branching and Loops **(6 lectures)**
Writing and evaluation of conditionals and consequent branching **(3 lectures)**
Iteration and loops **(3 lectures)**

Module 4: Arrays **(6 lectures)**
Arrays (1-D, 2-D), Character arrays and Strings

Module 5: Basic Algorithms **(6 lectures)**
Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of Equations, notion of order of complexity through example programs (no formal definition required)

Module 6: Function **(5 lectures)**
Functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference.
Module 7: Recursion **(4 -5 lectures)**
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module 8: Structure **(4 lectures)**
Structures, Defining structures and Array of Structures

Module 9: Pointers **(2 lectures)**
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)
Module 10: File handling (only if time is available, otherwise should be done as part of the lab)

Textbooks:

1. Gottfried, Byron.(1996). *Schaum's Outline of Programming with C.* McGraw-Hill.
2. Balaguruswamy, E.*Programming in ANSI C*. (2010). Tata McGraw-Hill
3. Kernighan, Brian W. &Ritchie, D. M.(2008). *The C Programming Language*, Prentice Hall of India

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	2	2	1	2	1	1	1	2	2	1	1	2	1
CO2	2	1	2	2	1	2	1	1	1	2	2	1	1	2	2
CO3	1	1	2	2	1	2	1	1	1	2	2	1	1	2	1
CO4	2	1	2	2	1	2	1	1	1	2	2	1	1	2	1
CO5	2	2	1	2	2	1	2	1	1	1	2	2	1	1	2
Average	**1.8**	**1.2**	**1.8**	**2**	**1.2**	**1.8**	**1.2**	**1**	**1**	**1.8**	**2**	**1.2**	**1**	**1.8**	**1.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: English

Course Code: 100108

Semester: 2nd

L T P

Credits: 02 **2 0 0**

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

CO	Statements
CO1	Develop vocabulary and improve the accuracy in Grammar.
CO2	Apply the concepts of accurate English while writing and become equally ease at using good vocabulary and language skills.
CO3	Develop and Expand writing skills through Controlled and guided activities.
CO4	Compose articles and compositions in English.
CO5	Become autonomous and self-directed English language learners.

Course Content

Unit 1: Vocabulary Building

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

Unit 2: Basic Writing Skills

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely

Unit 3: Identifying Common Errors in Writing

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

Unit 4: Nature and Style of sensible Writing

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

Unit 5: Writing Practices

Comprehension, Précis Writing, Essay Writing

Suggested Readings:

1. Swan, Michael. (1995). *Practical English*. OUP.
2. Wood, F.T. (2007). *Remedial English Grammar*. Macmillan.
3. Zinsser, W. (2001). *On Writing Well*. Harper Resource Book.
4. Lyons, L. H. & Heasly, B. (2006). *Study Writing*. Cambridge University Press.
5. Kumar, S & Lata, P. (2011). *Communication Skills*. Oxford University Press.
6. CIEFL, Hyderabad. *Exercises in Spoken English. Parts. I-III*. Oxford University Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	1	1	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	1	-
CO4	-	-	-	-	-	1	-	-	-	3	-	2	1	1	-
CO5	-	-	-	-	-	1	-	-	-	3	-	2	1	2	-
Average						1				3		1.4	0.8	1.4	

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Workshop Manufacturing Practices

Course Code: 105202

Semester: 2nd

L T P

Credits: 03 **1 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Apply the various manufacturing methods in different fields of engineering.

CO2	Learn about the different fabrication techniques.
CO3	Learn about the practices in manufacturing of simple components using different materials.
CO4	Understand the advanced and latest manufacturing techniques being used in engineering industry.
CO5	Prepare different sand molds for various parts

Course Content

Module 1: (3 lectures)
Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods

Module 2: (1 lecture)
CNC machining, Additive manufacturing

Module 3: (1 lecture)
Fitting operations & power tools

Module 4: (1 lecture)
Electrical & Electronics

Module 5: (1 lecture)
Carpentry

Module 6: (1 lecture)
Plastic moulding, glass cutting

Module 7: (1 lecture)
Metal casting

Module 8: (1 lecture)
Welding (arc welding & gas welding), brazing [More hours can be given to Welding for Civil Engineering students as they may have to deal with Steel structures fabrication and erection; 3D Printing is an evolving manufacturing technology and merits some lectures and hands-on training.]

Workshop Practice: (60 hours)
1. Machine shop - 10 hours
2. Fitting shop - 8 hours
3. Carpentry - 6 hours
4. Electrical & Electronics - 8 hours
5. Welding shop - 8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting - 8 hours

7. Smithy - 6 hours
8. Plastic moulding & Glass Cutting -6 hours

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

References Books:-

1. Raghuwanshi, B.S.(2009*). A Course in Workshop Technology, Vol 1 & II*.Dhanpat Rai &Sons.
2. Jain, R.K.(2010*).Production Technology*.Khanna Publishers.
3. Singh, S.(2003).*Manufacturing Practice*.S.K. Kataria &Sons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	3	3	2	3	3	3	3	2	2	3	3	2	3
CO2	2	1	2	2	3	1	3	2	2	3	1	2	2	2	2
CO3	2	1	3	1	2	3	3	3	2	2	2	3	2	1	2
CO4	1	2	1	2	1	2	3	1	3	2	1	2	1	2	3
CO5	2	3	2	2	2	3	2	3	3	3	2	2	3	3	2
Average	**2.4**	**2.6**	**2.6**	**2.6**	**2.4**	**2.6**	**2.8**	**3**	**2.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.2**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Engineering Chemistry Lab

Course Code: A100106

Semester: 2nd

L T P

Credits: 02 **0 0 4**

Course Outcomes: On completion of this course, the successful students will be able to:

CO	Statements
CO1	Estimate rate constants of reactions from concentration of reactants/products as a function of time
CO2	Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
CO3	Apply the theoretical concepts for result analysis and interpret data obtained from experimentation
CO4	Identify the compound using a combination of qualitative test and analytical methods

Course Contents

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
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. Models of potential energy surfaces
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 viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg .

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	2	3	2	2	2
Average	**2.2**	**2.6**	**2.2**	**2.2**	**1.8**	**1.5**	**1.5**	**1.6**	**1.7**	**2.6**	**1.8**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Programming for Problem Solving Lab

Course Code: 102203

Semester: 2nd

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Formulate the algorithms for simple problems
CO2	Translate given algorithms to a working and correct program
CO3	Interpret the correct syntax errors as reported by the compilers
CO4	Identify and correct logical errors encountered at run time
CO5	Write iterative as well as recursive programs

Course Content

Tutorial and Lab: (total 4 contact hours per week)
Tutorial 1: Problem solving using computers
Lab1: Familiarization with programming Environment

Tutorial 2: Variable types and type conversions
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings, memory structure
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration)
Lab 8 and 9: Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling
Lab 12: File operations

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	1	2	2	2	1	2	2	2	2	1	2	2	2	2
CO3	2	1	2	1	2	2	2	2	2	2	2	2	2	1	2
CO4	1	2	1	2	1	2	2	1	2	2	1	2	1	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Average	**1.6**	**1.6**	**1.8**	**1.8**	**1.8**	**1.8**	**2**	**1.8**	**2**	**2**	**1.6**	**2**	**1.8**	**1.8**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: English Lab
Course Code: 100109
Semester: 2nd

L T P

Credits: 01 **0 0 2**

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

CO	Statements
CO1	Illustrate the importance of pronunciation and apply the same day to day conversation
CO2	Apply verbal and non-verbal communication techniques in the Professional Environment
CO3	Develop coherence, cohesion and competence in Oral discourse.
CO4	Handle the interview process confidently.
CO5	Communicate contextually in specific personal and professional situations with courtesy.

COURSE CONTENT:

Oral Communication
(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace

- Interviews
- Formal Presentations

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	1	1	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	1	-
CO4	-	-	-	-	-	2	-	-	-	3	-	2	1	1	-
CO5	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
Average						1.2				3		1.2	0.8	1.4	

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Constitution of India
Course Code: 100304
Semester: 2nd

L T P

Credits: NC **3 0 0**

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

CO	Statement
CO1	Explain the various dimensions of Indian political system.
CO2	Access to the constitutional developments, composition, working of the constituent assembly and draft of the Indian constitution.
CO3	Illustrate fundamental rights, duties and directive principles of state policies.
CO4	Synthesize functioning of Indian government such as legislature, executives and judiciary.
CO5	Synthesize mechanism of human development through various agencies like women empowerment commission, CST commission, human rights commission etc.

Course Content

Module 1

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution.

Preamble to the Indian Constitution Fundamental Rights & its limitations.

Module 2

Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties.

Union Executives – President, Prime Minister Parliament Supreme Court of India.

Module 3

State Executives – Governor Chief Minister, State Legislature High Court of State.

Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.

Module 4

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India.

Powers and functions of Municipalities, Panchyats and Co – Operative Societies.

Module 5

Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility.

Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.

Text Books:

1. Basu, Durga Das. (2012). *Introduction to the Constitution on India (Students Edn.)*. Prentice – Hall EEE
2. Haries, C.E., Pritchard, M.S. & Robins, M.J. (2003). *Engineering Ethics*. Thompson Asia.

The mapping of PO/PSO/CO attainment is as follows

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	1	2	1	1	-	1	2	2	1	-	1	1	1	1	2
CO2	1	1	-	1	-	2	2	2	2	1	2	1	1	1	2
CO3	1	2	2	1	1	1	2	2	2	1	2	2	-	2	2
CO4	2	2	2	2	1	1	2	2	1	2	2	2	1	2	2
CO5	2	1	1	2	1	1	2	1	1	1	2	2	1	2	2

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Fluid Mechanics

Course Code: A105301

Semester: 3rd

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the different fluids and their properties; apply the analytical tools to solve different types of problems related to fluid flow in pipes.
CO2	Understand the behavior of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries
CO3	Learn about the relationship between pressure and elevation as it relates to manometers, barometers and other pressure measuring devices.
CO4	Evaluate how properties of fluids change with temperature and their effect on pressure and fluid flow.
CO5	Classify fluid pressure and its measurement.

Course Content

Module:- I

Fundamentals of Fluid Mechanics: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian andnon-Newtonianfluids.**02 Hrs**

Module:- 2

Fluid Statics: Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subject to: (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii)constantrotation.**06 Hrs**

Module:- 3

Fluid Kinematics: Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and relationship between them;Flownet.**07 Hrs**

Module:- 4

Fluid Dynamics: Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation using principle of conservation of energy and equation of motionand its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forcedvortex motions.**07 Hrs**

Module:-- 5

Dimensional Analysis and Similitude: Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froude, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similaritymodellaws.**04 Hrs**

Module:-- 6

Internal Flows: Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes,Moody'schart.**06 Hrs**

Module:- 7

Pressure and Flow Measurement: Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) andweirs;Rotameters.**04 Hrs**

Reference Books:

1. Kumar,D.S.(2012).*Fluid Mechanics and Fluid Power Engineering*. S.K. Kataria and SonsPublishers.
2. Som,S.K., Biswas,G.,&Chakraborty,S.(2012).*Introduction to Fluid Mechanics and Fluid Machines*. Tata McGrawHill.
3. Ojha,C.S.P., Berndtsson,R.,&Chandramouli,P.N.(2010).*Fluid Mechanics and Machinery*. Oxford UniversityPress.
4. Cengel,Y.A.,&Cimbala,J.M.(2011).*Fluid Mechanics - Fundamentals and Applications*.Tata McGraw Hill.
5. Munson,B.R., Young,D.F., Okiishi,T.H.,&Huebsch,W.W.(2011).*Fundamentals of Fluid Mechanics*.John Wiley andSons.
6. Douglas,J.F.,Gasiorek,J.M., Swaffield,J.A.,&Jack,L.B.(2005).*Fluid Mechanics*.Pearson.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	3	2	2	2	2	1	2	2	1	2	2	2	2
CO2	1	2	2	1	2	3	2	2	2	1	2	1	3	1	2
CO3	3	2	2	2	1	2	1	-	1	2	-	2	2	2	1
CO4	2	2	2	3	1	2	2	1	2	2	-	2	2	3	1
CO5	3	2	2	2	2	2	-	2	-	1	2	-	2	3	2
Average	**2.2**	**2**	**2.2**	**2**	**1.6**	**2.2**	**1.7**	**1.5**	**1.7**	**1.6**	**1.6**	**1.7**	**2.2**	**2.2**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Theory of Machines-I
Course Code: A105302
Semester: 3rd

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Describe the basic concepts of mechanisms computing the velocity and acceleration with diagrams of basic link mechanism.
CO2	Analyze the turning moment and crank effortdiagram.
CO3	Learn about the types of lowerpairs.
CO4	Understand the types of drives such as: belts, ropes and chains for enhancement of skill and employability.
CO5	Understand the functions, types and characteristics of governors and related numerical problems for skill development

Course Content

Module: - I

Basic Concept of machines: Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain andDouble Slider-

Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms includingCorliolis Components.**06 Hrs**

Module: - 2

Lower and higher Pairs: Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs with examples.**05 Hrs**

Module:-3

Belts, Ropes and Chains: Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect onpowertransmission.**05 Hrs**

Module:- 4

Cams: Types of cams and follower, definitions of terms connected with cams. Displacement,velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation,cycloidal Motion). Analysis of follower motion for circular, convex and tangentcamprofiles.**05Hrs**

Module:- 5

Friction Devices: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption,andtransmission).**06 Hrs**

Module:- 6

Flywheels: Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines andpunchingmachines.**03 Hrs**

Module:- 7

Governors: Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect ofsleevefriction.**06 Hrs**

Reference Books:

1. Ballaney,P.L.(1965).*Theory of Machines*.KhannaPublications.
2. Shigley.(2013).*Theory of Machines*. Mc GrawHill.
3. Rattan,S.S.(1972).*Theory of Machines*,Tata Mc. GrawHill.
4. Ghosh & Mallick.(2008).*Theory of Mechanisms and Machines*. Affiliated East West Pvt.Ltd

5. Singh,V.P. (2004)*Theory of Machines*. Dhanpat Rai & Company,P.Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	2	3	2	2	2	1	-	2	1	2	2	1	2
CO2	1	2	2	2	2	2	2	1	1	1	2	1	3	2	3
CO3	2	3	1	2	2	2	2	2	-	2	-	-	2	3	2
CO4	3	2	2	2	3	2	-	2	2	2	2	2	2	1	2
CO5	2	1	2	2	2	2	2	1	-	1	2	-	2	2	3
Average	**2**	**1.8**	**1.8**	**2.2**	**2.2**	**2**	**2**	**1.4**	**1.5**	**1.6**	**1.7**	**1.6**	**2.2**	**1.8**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Machine Drawing
Course Code: A105303
Semester: 3rd

L T P

Credits: 03 **1 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basics of machine drawings and layouts.
CO2	Understand completely engineering drawings of basic machine parts and components.
CO3	Analyze various terminologies used in machine drawing.
CO4	Understand the various terminologies used in production drawing.
CO5	Understand the CAD tools for making drawings of machine components and assemblies

Generic : Too many missing spaces/blanks in Text of Course Content. Run a spell check on all Booklet documents of all departments

Course Content

Module:- 1

Introduction: Classification of drawings, Principles of drawing, Requirements of machine Drawing, sectional views and conventional representation, dimensioning, concept of limits, fits & tolerances and their representation, machining symbols, various types of screw threads, types of nuts and bolts, screw fasteners, welded joints and riveted joints, introduction and familiarization of code SP 46:2003 by Bureau of Indian Standards.**15 Hrs**

Module:- 2

1. **Free hand sketches of:**
   a. **Couplings**: solid and rigid couplings, protected type flange coupling, pin type flexible coupling, muff coupling.
   b. Knuckle and cotterjoints.
   c. **Pipe and Pipe fittings**: Flanged joints, spigot and socket joint, union joint, hydraulic andexpansion joint.**15 Hrs**

2. **Assembly of:**
   a. **IC Engine Parts:** piston and connectingrod.
   b. **Boiler Mountings**: Steam stop valve, blow off cock, feed check valve and spring loaded safetyvalve.
   c. **Bearing:** Swivel bearing, Plummer Block and Foot Stepbearing.

3. **Miscellaneous:** Screw jack, Tail Stock andcranehook.**20 Hrs**

4. Practice using Computer Aided Drafting (CAD) toolsfor:
   (a) Machine components, screw fasteners, Keys cotters and joint, shaft couplings, Pipe joints and fittings, riveted joints and weldedJoints.
   (b) Assemblies: - Bearings (Plumber Block, Footstep, Swivel), boiler mountings, screw jack, Exercise in computer Plots ofdrawing
   (c) Case studies in computer plots andindustrialblueprint**10 Hrs**

Reference Books:

1. Gill, P.S.(2013).*Machine Drawing*.S.K. Kataria & Sons.
2. Bhatt,N.D.(2014).*Machine Drawing*.Charotar. Publishing House.
3. Sidheshwar,N.(2011).*Machine Drawing*.Charotar Publishing House.
4. Behl,R.C.&Goel,V.K.(1982).*Machine Design*.Standard Publishers. Distributors.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	2	2	2	2	2	1	1	1	1	1	1	2	3
CO2	2	1	2	1	2	2	3	1	1	-	2	2	2	3	2
CO3	3	2	3	2	1	2	2	2	2	1	1	1	1	2	3
CO4	2	1	1	1	2	1	3	3	1	1	1	-	3	1	1
CO5	2	1	3	2	1	2	-	2	2	-	2	-	2	2	2

Average	**2.4**	**1.4**	**2.2**	**1.6**	**1.6**	**1.8**	**2.5**	**1.8**	**1.4**	**1**	**1.4**	**1.3**	**1.8**	**2**	**2.2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Strength of Materials-I

Course Code: A105304

Semester:3rd

L T P

Credits: 04 **3 10**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the fundamental concepts of mechanics of deformable solids, including static equilibrium, geometry of deformation, and material constitutive behavior
CO2	Apply the systematic methods for solving the engineering problems in solid mechanics.
CO3	Apply the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.
CO4	Understand the necessary theoretical background for further structural analysis and design courses.
CO5	Select the materials for various applications.

Course Content

Module-1

Simple, Compound Stresses and Strains: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress. Generalized Hook's law, principal stresses related to principal strains.**08 Hrs**

Module-2

Bending Moment (B.M) and Shear Force (S.F) Diagrams: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation ofmaximum

B.M and S.F and the point of contra flexure under different loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated and uniformly distributed load, uniformly varying loads and Application of moments.**06 Hrs**

Module-3

Bending Stresses in Beams: Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams.**05 Hrs**

Module-4

Torsion: Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal stress and maximum shear stresses under combined loading of bending and torsion.**05Hrs**

Module-5

Columns and struts: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and theirapplications.

05 Hrs

Module-6

Slope and deflection: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for: Cantilevers, Simply supported beams with or without overhang, Under concentrated loads, uniformly distributed loads or combination of concentrated &uniformlydistributed loads.**07 Hrs**

Reference Books:

1. Ferdinand, P.B. &Johnston, E.R.(Jr).(2009).*MechanicsofMaterials*.McGraw Hill.
2. Popov, E.P. (1976). *Mechanics of Materials,SI (2nd Edition)*.Prentice HallIndia.
3. Shames,D.H.(1999).*Introduction to Solid Mechanics*.Prentice HallInc.
4. Bedi, D.S. (2004). *Strength of materials*, Khanna book publishingCompany.
5. Lehri,R.S.,&Lehri,A.S.(1978).*Strength of materials*. S.K Kataria andSons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	1	2	2	2	2	2	1	1	1	-	2	1	2
CO2	1	1	2	1	3	3	1	1	1	2	-	1	1	2	1
CO3	3	2	1	2	2	2	2	-	1	1	1	2	2	1	2
CO4	1	1	2	1	3	2	1	1	-	2	-	1	1	2	1
CO5	3	2	1	2	2	2	2	2	1	1	1	3	2	1	2
Average	**2**	**1.6**	**1.4**	**1.6**	**2.4**	**2.2**	**1.6**	**1.5**	**1**	**1.4**	**1**	**1.75**	**1.6**	**1.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Applied Thermodynamics-I
Course Code: A105305
Semester: 3rd

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Evaluate the performance of reciprocating air compressors.
CO2	Analyze the combustion phenomenon in boilers and I.C. engines.
CO3	Apply the steam tables and Mollier Chart to solve vapour power cycle problems.
CO4	Understand the constructional features and working of steam power plants and to evaluate their performance.
CO5	Evaluate the performance of thermal power plant

Course Content

Module-1

Reciprocating Air Compressors:-Single stage single acting reciprocating compressor(with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic and mechanical efficiency, Clearance volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; **Multistage compressors:** purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal,

isentropic, polytropic and mechanical efficiencies; Performance curves.**5 Hrs**

Module-2

Thermodynamics of Combustion in Boilers and IC Engines: Principle of Combustion; Stoichio-metric and non-stoichiometeric combustion; Combustion Problems in boilers & IC Engines; Calculations of air fuel ratio: Analysis of products of combustion, conversion of volumetric analysis into gravimetric analysis and vice versa, Actual weight of air supplied, use of mols. For solution of combustion problems; Heat of formation; Enthalpy of formation; Enthalpy of reaction/combustion and its evaluation; first law analysis of reacting system: steady flow and Closed Systems, adiabatic flame temperature and its determination. Various stages of combustion inICEngines.**5 Hrs**

Module-3

Steam: Properties of Steam Pure substance ; Steam and its formation at constant pressure: wet, dry, super-saturated and super-heated (*super-saturated*) steam; Sensible heat*(sensible enthalpy)*, latent heat (*latent enthalpy*) and total or stagnation heat (*total or stagnation enthalpy*) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Charts; Basic thermodynamic processes with steam(isochoric, isobaric, isothermal, isentropic and adiabatic processes) and their representation on T-S Charts and Mollier Charts(**h-s** diagrams), significance ofMollier Charts.**5 Hrs**

Module-4

Vapour Power Cycle: Carnot Cycle and its limitations; Rankine steam power cycle, Ideal and actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding(feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heatingcycles.**5 Hrs**

Module-5

Steam Nozzles: Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of throat and at exit for maximum discharge; Effect of friction; Nozzle efficiency; Convergent and Convergent - divergent nozzles. Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow throughnozzle.**5 Hrs**

Module-6

Steam Turbines (Impulse Turbine): Introduction; Classification; Impulse versus Reaction turbines. Simple impulse/**De Level** turbine: pressure and velocity variation, Compounding of impulse turbines: purpose, types and pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency overall efficiency and relative efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition foraxialdischarge. **5 Hrs**

Module-7

Reaction Turbine:- Pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; **Multistaging:** Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction Turbines ; Co-generation; Economic assessment; Governing ofsteamturbines.**5 Hrs**

Module-8

Steam Condensers:- Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; Cooling towers: function, types andtheiroperation.**5 Hrs**

Reference Books:

1. Yadav, R.(2011).*Applied Thermodynamics*. Central PublishingHouse.
2. Rajadurai, J.S. (1985).*Thermodynamics and Thermal Engineering*. New Age International (P) Ltd. Publishers.
3. Nag, P.K.(2008).*Basic and Applied Thermodynamics*. Tata McGraw Hill.
4. Kumar,D.S. &Vasandani,V.P.(1979).*Heat Engineering*. Metropolitan Book Co. Pvt.Ltd.
5. Soman,K.(2010).*Thermal Engineering*. PHI Learning Pvt.Ltd.
6. Rogers,G. and Mayhew,Y.(1992).*Engineering Thermodynamics*. Pearson.
7. Keartan,W.A.J.(2004).*Steam Turbine: Theory and Practice*. ELBSSeries.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	1	1	2	1	2	1	1	1	1	2	-	1	1	2
CO2	2	2	3	2	2	1	-	2	1	2	2	2	3	3	1
CO3	1	1	1	1	1	-	1	1	2	1	1	1	1	1	3
CO4	2	2	3	1	1	1	2	2	1	-	2	2	3	2	1
CO5	3	1	1	3	2	-	1	1	2	1	1	1	1	1	2
Average	**2.2**	**1.4**	**1.8**	**1.8**	**1.4**	**1.3**	**1.25**	**1.4**	**1.4**	**1.25**	**1.6**	**1.5**	**1.8**	**1.6**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Basic Electronics Engineering
Course Code: A103305
Semester: 3rd

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand Construction of diodes and their rectifier applications.
CO2	Appreciate the construction and working bipolar junction transistors and MOSFETs.
CO3	Design Op-Amp IC based fundamental applications.
CO4	Comprehend working of basic elements of digital electronics and circuits.

Course Content

Module I:

Semiconductor Diodes and Applications - Semiconductor Diode - Ideal versus Practical, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications;

Module II:

Transistors & Amplifiers - Bipolar Junction Transistor (BJT) – Construction, Operation, Common Base, Common Emitter and Common Collector Configurations, Distortion, Operating Point, Voltage Divider Bias Configuration; Introduction to nMOS and pMOS.

Module III:

Operational Amplifiers and Applications - Introduction to Op-Amp, Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground, Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Differentiator and Integrator, Square Wave and Triangular Wave Generation.

Module IV:

Digital Electronics -Boolean Algebra - Binary, Octal, Hexadecimal Number Systems, Addition, Subtraction using 1's and 2's compliment method, Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); K-Map simplification Truth Tables and Functionality of Flip-Flops – SR, JK and D Flip-Flop.

Reference Books:

1. David. A. Bell. (2003). Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India.
2. Santiram, Kal (2002). Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India.
3. Floyd , Thomas L. &Jain,R. P. (2009), Digital Fundamentals by Pearson Education.
4. Paul, B. Zbar, Malvino , A.P. &Miller, M.A. (2009), Basic Electronics – A Text-Lab. Manual, TMH
5. Paynter, R. T. (2009). Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	1	1	2	1	2	1	1	2	1	2	1
CO2	2	1	2	2	2	2	1	2	2	-	2	1	2	2	2
CO3	1	2	1	2	1	1	2	1	2	1	1	2	1	2	1
CO4	2	1	2	2	2	2	1	2	-	2	2	-	2	2	2
Average	**1.5**	**1.5**	**1.5**	**2**	**1.5**	**1.5**	**1.5**	**1.5**	**2**	**1.3**	**1.5**	**1.6**	**1.5**	**2**	**1.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Strength of Materials Lab

Course Code: A105307

Semester:3rd

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the fundamental concepts of mechanics of deformable solids, including static equilibrium, geometry of deformation, and material constitutive behavior
CO2	Utilize the systematic methods for solving engineering problems in solid mechanics.

CO3	Apply the necessary theoretical background for further structural analysis and design courses.
CO4	Select the materials for various applications.

Course Content

1. To perform tensile and compression test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2. To perform any hardness tests (Any one from Rockwell, Brinell &Vicker's test).
3. To perform impact test to determine impact strength.
4. To perform torsion test and to determine various mechanical properties.
5. To perform Fatigue test on circular test piece.
6. To perform bending test on beam and to determine the Young's modulus and modulus of rupture.
7. Determination of Bucking loads of long columns with different end conditions.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	1	1	1	3	1	1	2	1	2	1	1	1	2
CO2	1	2	3	3	2	1	3	2	1	-	2	2	3	3	1
CO3	1	1	1	1	1	3	1	1	2	1	-	1	1	1	3
CO4	2	2	3	1	1	1	3	2	1	2	-	2	3	2	1
Average	**1.5**	**1.5**	**2**	**1.5**	**1.2**	**2**	**2**	**1.5**	**1.5**	**1.3**	**2**	**1.5**	**2**	**1.7**	**1.7**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name Theory of Machines Lab
Course Code: A105308

Semester: 3rd

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Describe the various links and mechanisms which are useful for real life.
CO2	Illustrate various inversions of 4- bar chain and single slider crank chain.
CO3	Develop velocity and diagram of engine mechanism using graphical methods.
CO4	Evaluate various types of governors and draw graphs between height and equilibrium speed of a governor.
CO5	Understand the gear- train value of compound gear trains and Epicyclical gear trains.

Course Content

1. Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.
2. Determination of gyroscopic couple (graphical method).
3. Balancing of rotating masses (graphical method).
4. Cam profile analysis (graphical method)
5. Determination of gear- train value of compound gear trains and epicyclic gear trains.
6. To draw circumferential and axial pressure profile in a full journal bearing.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	3	2	1	3	2	1	2	1	2	2	2	2	1	2
CO2	1	1	1	3	1	1	2	-	2	-	-	1	1	2	1
CO3	3	1	1	1	3	2	1	2	1	2	2	2	2	1	2
CO4	1	3	2	3	1	1	2	2	1	2	2	2	2	1	2
CO5	3	3	2	1	3	2	1	-	2	-	1	1	1	2	1
Average	**2.2**	**2.2**	**1.6**	**1.8**	**2.2**	**1.6**	**1.4**	**2**	**1.4**	**2**	**1.75**	**1.6**	**1.6**	**1.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name Fluid Mechanics Lab

Course Code: A105309

Semester: 3rd

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Calculate the flow through a variable area duct with Bernoulli's energy equation.
CO2	Compare the coefficient of discharge for various obstruction flow meters.
CO3	Calculate the transition from laminar to turbulent flow based on Reynolds numbers.
CO4	Evaluate the various head losses in flow pipes under different conditions.

Course Content

1. To determine the metacentric height of a floating vessel under loaded and unloaded
2. conditions.
3. To study the flow through a variable area duct and verify Bernoulli's energy equation.
4. To determine the coefficient of discharge for an obstruction flow meter (venturi meter/ orifice meter)
5. To determine the friction coefficients, head loss in pipes.
6. To determine the velocity distribution for pipeline flow with a pitot static probe.
7. Experimental evaluation of free and forced vortex flow.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	2	1	3	2	2	1	3	2	2	1	3
CO2	3	3	1	1	1	3	1	-	1	3	1	1	1	3	1
CO3	1	1	3	2	1	1	3	2	-	1	3	2	1	1	3

CO4	2	1	3	2	2	1	3	2	2	1	3	2	2	1	3
Average	**2**	**1.5**	**2.5**	**1.75**	**1.5**	**1.5**	**2.5**	**2**	**1.25**	**1.5**	**2.5**	**1.75**	**1.5**	**1.5**	**2.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Applied Thermodynamics-II

Course Code: A105401

Semester: 4th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Compare the concept of petrol and diesel engines with their knocking phenomenon and methods to reduce the effects.
CO2	Describe the concept of supercharging with their applications and compute the efficiency of different types of engines.
CO3	Examine the theory of different types of compressors based upon design attributes and theory of various heads of enthalpy during the working process.
CO4	Compute the efficiency of all compressors to solve problems based upon compression of the air.
CO5	Illustrate the concept of gas turbines with the use of compressors and their applications.

Course Content

Module I:

IC Engines: Pressure-Time/Pressure-ɵ diagram, Characteristics of the fuel oil for a diesel engine; Combustion process in diesel engine, and various parameters controlling the delay Period; Uncontrolled combustion, Diesel knock or Fuel knock, period of controlled combustion, effect of turbulence on power and efficiency, after-burning etc. **Petrol Engines:** Royal Automobile club rating of Petrol Engines, causes of lower pressure rise during combustion than expected; Process of combustion in a Petrol engine, Ignition lag and factors effecting it, Rate of flame propagation and various factors effecting it, detonation(in Petrol engines) and various factors affecting it; comparison of diesel knock and detonation and effect of various

parameters on these; comparison of pre-ignition and detonation; dopes/antiknock substances for SI/CI Engines; Effect of compression ratio and fuel-air ratio on power and efficiency of **(i)** Diesel Engines **(ii)** Petrol Engines. Performance curves for a petrol engine at constant speed; Consumption loops for Petrol and Diesel engines; Effect of turbulence on Petrol and Diesel engines; Dissociation and it's effect on power and efficiency; Octane and Cetane numbers, Knock-meter; Use of high speed cinematography for observation of burning gases characteristics; various methods of Governing IC Engines; Super-charging and its methods, Advantages of super-charging; Variation of Engine power with altitude; causes of pressure loss at high altitudes and power requirements of Super-chargers; Effect of Super-charger on PV- diagrams of SI Engines; High Speed Engine Indicators: Farnborough balanced Engine Indicator; Cathode-ray Oscillograph Engine Indicator; Construction and working principle of Rotary or Wankel Engine, it's advantages and disadvantages over reciprocating piston engines; application of Wankel Engine; Logrithmic plotting of PV-diagrams. **6 Hrs**

Module 2:

Air Compressors:- Introduction, Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Complete representation of compression process(for Reciprocating and Rotary compressors) on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing energy lost in internal friction, energy carried away by cooling water and additional flow work being done for un-cooled and cooled compression processes on T-S coordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-S coordinates. Applications of Steady-Flow-Energy Equation and thermodynamics of dynamic (i.e., centrifugal and axial flow machines); Stagnation and static **5 Hrs**

Module 3

Positive Displacement Rotary Compressors:- Introduction and general classification of rotary Comressors**;** Comparison of rotary positive displacement compressors with reciprocating compressors; **Classification** of rotary compressors: Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compres4or and Vane-type Blower. **5 Hrs**

Module 4:

Centrifugal Compressors:- Complete thermodynamic analysis of a centrifugal compressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in a centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and

finally to the delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of Slip factor and its effect on efficiency and out coming***velocity profile*** from the impeller; Derivation of non-dimensional parameters for plotting compressor characteristics; Centrifugal compressor characteristic curves; Surging and choking in centrifugal compressors. **5 Hrs**

Module 5:

Axial Flow Compressors:- Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus Compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work Done on the compressor and Power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on Work Done factor, degree of reaction, blade efficiency and their derivations; Isentropic, polytropic and isothermal efficiencies; Surging, Choking and Stalling in axial flow compressors; Characteristic curves for axial flow compressor; flow parameters of axial flow compressor like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors. **5 Hrs**

Module 6:

Gas Turbines:- Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion(at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and reheating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels. Values of pressure, Temperature and enthalpy (and their co-relation) etc. for flow through dynamic,rotary machines. **5 Hrs**

Module 7

Jet Propulsion: - Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like **(i)** Athodyd (ramjet and pulse-jet), **(ii)** Turbojet engine, and **(iii)** Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal(*internal*) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors(e.g. ***solid propellant*** and ***liquid propellant*** systems); Various common propellant combinations (i.e. of fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units. **5 Hrs**

Reference Books:

1. Yadav, R., Sanjay& Rajay.(2011).*Applied Thermodynamics*. Central PublishingHouse.
2. Nag, P.K.(2010).*Basic and Applied Thermodynamics*.Tata McGrawHill.
3. Kumar,D.S. &Vasandani,V.P.(1985).*Heat Engineering*. Metropolitan Book Co. Pvt.Ltd.
4. Soman,K.(2010).*Thermal Engineering*. PHI Learning Pvt.Ltd.
5. Rogers,G. and Mayhew,Y.(2002).*Engineering Thermodynamics*.Pearson.
6. Yadav,R.(1989).*Thermodynamic and Heat Engines-Vol. II*.Central PublishersHouse.
7. Shephered, D.G.(1961).*Principles of Turbo machinery*.Macmillan.
8. Cohen,H., Rogers,G.F.C.,&Sarvan,M.(1951).*Gas Turbine Theory*.Longmans.
9. Mattingly,J.D.(1996).*Elements of Gas Turbine Propulsion*.McGrawHill.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	1	1	1	1	-	1	1	2	1	2	1	1	1	2
CO2	2	2	3	3	2	1	3	2	1	2	2	2	3	3	1
CO3	1	1	1	1	1	2	1	1	2	1	1	1	1	1	3
CO4	2	2	3	1	1	1	-	2	1	2	2	2	3	2	1
CO5	2	1	1	3	2	3	1	1	-	1	1	1	1	1	2
Average	**1.6**	**1.4**	**1.8**	**1.8**	**1.4**	**1.75**	**1.5**	**1.4**	**1.5**	**1.4**	**1.6**	**1.4**	**1.8**	**1.6**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Strength of Materials-II
Course Code: A105403
Semester: 4th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Apply the basics to find stresses in various applications (shells, curved beams and rotating discs).
CO2	Analyze the change in dimensions of shells, curved beams and rotating discs under operation.
CO3	Determine stresses, deflection and energy stored in various kinds of springs subjected to load and twist.
CO4	Describe the concept of failure theories and strain energy.
CO5	Evaluate shear stress variation in beams of different cross-section and materials.

Course Content

Module-1

Strain Energy: Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection. **05 Hrs**

Module-2

Theories of Failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two-dimensional stress systems. **05 Hrs**

Module-3

Springs: Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation. Leaf spring deflection and bending stresses. **05 Hrs**

Module-4

Thin Cylinders and Spheres: Calculation of Hoop stress, longitudinal stress in a cylinder, effects of joints, change in diameter, length and internal volume. Principal stresses in sphere, change in diameter and internal volume. **05 Hrs**

Module-5

Thick Cylinders: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress. **05 Hrs**

Module-6

Bending of Curved Beams: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides. **04 Hrs**

Module-7

Shear Stresses in Beams: Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance. **04 Hrs**

8.Rotational Discs: Stresses in rotating discs and rims of uniform thickness; disc of uniform strength. **03Hrs**

Reference Books:

1. Crandell, Dahl & Lardner.(1978).*Introduction to Mechanics of Solids*. McGrawHill
2. Singh, Dr.Kirpal,(2003).*Mechanics of Materials*.Standard Publishers &Distributors.
3. Lehri,R.S.(2010).*Strength of Materials*.S.K Kataria and Sons.
4. Beer,F. P., and Johnston,E. Russel (Jr).(2016).*Mechanics of Materials*.McGraw Hill,India.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	3	2	1	-	1	2	2	2	2	1	2
CO2	2	1	1	2	1	1	2	1	2	1	1	1	1	2	1
CO3	3	1	1	1	3	2	1	2	1	2	2	2	2	1	2
CO4	1	3	2	3	1	1	2	-	1	-	2	2	2	1	2
CO5	3	3	2	1	3	3	1	1	2	1	1	1	1	2	1
Average	**2.2**	**2.2**	**1.6**	**1.6**	**2.2**	**1.8**	**1.4**	**1.3**	**1.4**	**1.5**	**1.6**	**1.6**	**1.6**	**1.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Theory of Machines-II

Course Code: A105404

Semester: 4th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Compute, both analytically and graphically forces and couples for reciprocating parts and dynamically equivalent system.
CO2	Understand the theory of inertia force and apply to four-bar linkage mechanism.
CO3	Learn about the types of balancing and its need & balancing to reciprocating and Rotating masses.
CO4	Understand the types of both tooth gear and the nomenclature of gears & various types of gear trains.
CO5	Apply Gyro effect on moving bodies.

Course Content

Module-1

Static force analysis: Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces. **05 Hrs**

Module-2

Dynamic force analysis Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four-bar linkage. **05 Hrs**

Module-3

Balancing: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses,and condition of balance in multi cylinder in line V-engines, concept of direct and reverse crank, balancing of machines, rotors, reversible rotors. **06 Hrs**

Module-4

Gears: Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears. **07 Hrs**

Module-5

Gear Trains: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of velocity ratio of worm and worm wheel. **05 Hrs**

Module-6

Gyroscopic motion and couples: Effect on supporting and holding structures of machines. Stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles. **03 Hrs**

Module-7

Kinematic synthesis of Mechanism: Freudenstien equation, Function generation errors in Synthesis, two- and three-point synthesis Transmission angles, least square technique. **05 Hrs**

Reference Books:

1. Ballaney,P.L.(1965).*Theory of Machines*.KhannaPublications.
2. Shigley.(1980).*Theory of Machines*. Mc GrawHill.
3. Singh, V.P.(2005).*Theory of Machines*. Dhanpat Rai & Company,P.Ltd.
4. Rattan, S.S.(2009).*Theory of Machines*,Tata Mc. GrawHill.
5. Ghosh & Mallick.(2008).*Theory of Mechanisms and Machines*.Affiliated East West Pvt.Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	2	1	2	2	1	-	1	2	2	-	2	1	2
CO2	1	1	1	3	1	1	2	1	2	1	1	1	1	2	1
CO3	2	1	1	1	3	2	1	2	1	2	2	2	2	1	2
CO4	1	3	2	3	1	1	2	-	1	2	2	2	2	1	2
CO5	3	3	2	1	3	2	-	1	2	1	1	1	1	2	1
Average	**2**	**2**	**1.6**	**1.8**	**2**	**1.6**	**1.5**	**1.3**	**1.4**	**1.6**	**1.6**	**1.5**	**1.6**	**1.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Environmental Science

Course Code: A100302

Semester: 4th

L T P

Credits: NC **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Measure environmental variables and interpret results
CO2	Evaluate local, regional and global environmental topics related to resource usage and management

CO3	Propose solutions to environmental problems related to resource usage and management
CO4	Interpret the results of scientific studies of environmental problems
CO5	Describe threats to global biodiversity, their implications and potential solutions

Course Content

Module-1

Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness. **02 Hrs**

Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources. **02 Hrs**

Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity. **03 Hrs**

Module-2

Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies. **04 Hrs**

Module-3

Disaster Management: Floods, earthquake, cyclone and landslides. **01 Hrs**

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

05 Hrs

Module-4

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Program. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies. **04 Hrs**

References Books:

1. Agarwal, K. C.(1987). *Environment Biology*. Nidi Publ. Ltd.Bikaner.
2. Jadhav, H, & Bhosale, V.M.(1995).*Environment Protection and Laws*. Himalaya Pub House,Delhi
3. Rao, M. N. & Datta, A.K.(2008).*Waste Water Treatment*. Oxford & IBH Publ. Co. Pvt.Ltd

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	2	1	1	2	2	2	-	2	1	2	1
CO2	2	1	2	1	2	2	2	2	1	2	1	2	2	1	2
CO3	1	2	1	1	2	1	1	1	2	1	1	2	2	1	1
CO4	1	1	1	1	1	2	1	1	1	1	-	1	1	2	1
CO5	1	2	1	2	2	1	2	-	2	-	2	2	1	1	2
Average	**1.2**	**1.6**	**1.2**	**1.4**	**1.8**	**1.4**	**1.4**	**1.5**	**1.6**	**1.5**	**1.3**	**1.8**	**1.4**	**1.4**	**1.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Material Engineering
Course Code: A105405
Semester: 4th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Know the significance of structure-property-correlation for engineering materials including ferrous and nonferrous.
CO2	Explain the use and importance of various heat treatment processes used for engineering materials and their practical applications.

CO3	Describe the various structural changes occurring in metals with respect to time temperature transformations.
CO4	Analyze the significance of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.

Course Content

Module-1

1. Crystallography: Atomic structure of metals, atomic bonding i solids, crystal structures, crystallattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and noncrystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and nonsteady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery,re-crystallization.

12 Hrs

Module-2

2. Phase Transformation: General principles of phase transformation in alloys, phase rule andequilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagramand various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications. **09 Hrs**

Module-3

3. Heat Treatment: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening.Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of harden-ability.Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced byalloying elements. Composition of alloy steels. **09 Hrs**

Module-4

4. Ferrous Metals and Their Alloys: Introduction, classification, composition of alloys, effect ofalloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. **06 Hrs**

Reference Books:

1. Avner, S. H.(1974*).Introduction to Physical Metallurgy*.McGraw Hill BookCompany.
2. Raghavan,V.(2015*).Physical Metallurgy: Principles and Practice*. Prentice Hall ofIndia.
3. Wadhwa,A. S.,&Dhaliwal, H. S.(2008).*Engineering Materials and Metallurgy*. Laxmi Publications Pvt. Ltd.
4. Callister,William D.(2010).*Material Science and Engineering*.John Wiley&Sons.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	2	3	2	3	2	3	-	-	2	3	2	3
CO2	3	2	3	2	3	2	3	2	2	2	3	2	3	2	3
CO3	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

CO4	1	2	3	2	3	2	3	2	3	2	3	2	3	2	3
Average	**2.25**	**1.75**	**2.75**	**1.75**	**2.75**	**1.75**	**2.75**	**1.75**	**2.5**	**1.6**	**2.6**	**1.75**	**2.75**	**1.75**	**2.75**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Applied Thermodynamics Lab
Course Code: A105406
Semester: 4th

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Compare the construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines models.
CO2	Describe the construction and operation of steam condensers and cooling towers.
CO3	Evaluate the equivalent evaporation and efficiency of a fire tube/ water tube boiler.
CO4	Calculate the dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
CO5	Analyze the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).

Course Content

1. Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines and to plot actual valve timing diagram of 4 stroke petrol and diesel engines and study its impact on the performance of engine.
2. Study of working, construction, mountings and accessories of various types of boilers.
3. To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.

4. Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
5. Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
6. Performance testing of a Petrol and Diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emission. Draw/obtain power consumption and exhaust emission curves. Also make the heat balance sheet.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	3	2	3	2	3	2	3	2	3	2	3	2	3
CO2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO3	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1
CO4	3	2	3	2	3	2	3	2	3	-	3	2	3	2	3
CO5	1	2	1	2	1	2	-	2	1	2	1	2	1	2	1
Average	**1.6**	**1.6**	**2**	**1.6**	**2**	**1.6**	**2.25**	**1.6**	**2.2**	**1.5**	**2**	**1.6**	**2**	**1.6**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Material Engineering Lab
Course Code: A105408
Semester: 4th

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), co-ordination number etc.

CO2	Understand the concept of mechanical behavior of materials and carry out calculations of same using appropriate equations
CO3	Investigate the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy and understand the construction and identification of phase diagrams and reactions
CO4	Analyze the microstructure of prepared specimens of Mild Steel, Aluminum alloys and hardened steel with or without heat treatment.

Course Content

1. Preparation of models/charts related to atomic/crystal structure of metals.
2. Hardening/Annealing of steel specimen and study the effect of quenching time/annealing time and temperature on hardness of steel.
3. Practice of specimen preparation (cutting, mounting, polishing, and etching) of mild steel, Aluminium and hardened steel specimens.
4. Study of the microstructure of prepared specimens of Mild Steel, Aluminium and hardened steel.
5. Identification of ferrite and pearlite constituents in given specimen of mild steel.
6. Determination of hardenability of steel by Jominy End Quench Test.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	2	3	2	3	2	-	2	3	2	3	2	3
CO2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3
Average	**2.25**	**1.5**	**2.25**	**1.5**	**2.25**	**1.5**	**2.25**	**1.5**	**2**	**1.5**	**2.25**	**1.5**	**2.25**	**1.5**	**2.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Heat Transfer

Course Code: A105502

Semester: 5th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Apply the phenomenon of heat transfer in various applications.
CO2	Illustrate the various types of heat transfer modes
CO3	Compare the various methods which can improve the heat transfer rate
CO4	Compare and contrast the Free Convection and Forced Convection.
CO5	Describe the Radiation type heat transfer.

Course Content

Module-1

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts. **12Hrs**

Module-2

Heat convection,basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow-Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection. **8 Hrs**

Module-3

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.**8 Hrs**

Module-4

Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods.**6 Hrs**

Boiling and Condensation heat transfer, Pool boiling curve **(3)** Introduction mass transfer, Similarity between heat and mass transfer **(3)**

Reference Books:

1. Kumar,D.S.(2013).*Fundamentals of Heat and Mass transfer*. SK Kataria and SonsDelhi.
2. Domkundwar,S.(2007).*A Course in Heat and Mass Transfer*. Dhanpat Rai and Sons Delhi.
3. Rajput,R.K.(2015).*Heat and Mass Transfer*. S. Chand & CompanyLtd.
4. Holmans,J.P.(1997).*Heat transfer*. McGraw Hill, London.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	3	2	1	3	2	1	2	1	2	2	2	2	1	2
CO2	1	1	1	3	1	1	2	-	1	1	1	1	1	2	1
CO3	3	1	1	1	3	2	1	2	1	2	2	2	2	1	2
CO4	1	3	2	3	1	1	2	2	1	2	2	2	2	1	2
CO5	3	3	2	1	3	2	1	1	-	1	1	1	1	2	1
Average	**2.2**	**2.2**	**1.6**	**1.8**	**2.2**	**1.6**	**1.4**	**2**	**1**	**1.6**	**1.6**	**1.6**	**1.6**	**1.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Engineering Mathematic-III
Course Code: A100301
Semester: 5th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the fundamentals of mathematics and its application in solution of design and technology problems.
CO2	Develop mathematical skills and apply mathematical methods & principals in solving problem from Engineering field.
CO3	Relate the importance and symbiosis between Mathematics and Engineering.
CO4	Compare a formal proof and a less formal arguments and understanding the different roles these play in mathematics.
CO5	Illustrate the impact of engineering mathematics on real life mechanical engineering problems.

Course Content

Module-1

Fourier Series Periodic functions, Euler's formula. Even and odd functions, half range Expansions.

Module-2

Laplace Transforms Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function, periodic functions, applications to solution of ordinary linear differential equations with constant coefficients.

Module-3

Partial Differential Equations Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients Applications: Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation, solution by the method of separation of variables.

Module-4

Functions of ComplexVariable Limits, continuity, derivative of complex functions, analytic function, Cauchy-Riemann equation, conjugate functions, harmonic functions; Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proof),

Module—5

Residues and Contour integration singular points, poles, residue, complex integration using the method of residues, evaluation of real integrals by contour integration.

Reference Books:

1. Thomes, G. B, Finney, R.L.(1998).*Calculus & Analytic Geometry*.Ninth Edition, Addison Wesley.
2. Kreyszig, E.(1998).*Advanced Engineering Mathematics*. Eighth edition, JohnWiley.
3. Grewal, B.S.(1965).*Higher Engineering Mathematics*. Khanna Publishers, NewDelhi.
4. Babu Ram.(2009).*Advance engineering Mathematics*.PearsonEducation.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO2	1	2	2	1	1	2	2	1	-	2	2	1	1	2	2
CO3	2	1	1	2	2	1	1	2	2	1	1	2	2	1	1
CO4	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO5	1	2	2	1	1	2	2	1	-	2	2	1	1	2	2
Average	**1.6**	**1.4**	**1.8**	**1.2**	**1.6**	**1.4**	**1.8**	**1.2**	**1.2**	**1.4**	**1.8**	**1.2**	**1.6**	**1.4**	**1.8**

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Course Name: Mechanical Measurement and Metrology

Course Code: A105504

Semester: 5th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to :

CO	Statement
CO1	Describe the measurement of various quantities using instruments, their accuracy & range, and the techniques for controlling devices automatically.
CO2	Apply the principles of measuring devices and error measurements
CO3	Illustrate working of various displacements, strain measuring devices
C04	Evaluate angular velocity, pressure measurement and vacuum by using various instruments
C05	Explain the various measurement control system in manufacturing engineering

Course Contents

Module-1

Need and classification of measurements and instruments, basic and auxiliary functional elements of a measurement system, mechanical, electrical, electronic instruments, Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution, speed of response, lag, fidelity and dynamic error, dead time and dead zone

Module-2

Line, end and wavelength standards, linear measurements - vernier scale and micrometer, vernier height gauge and depth gauge, Angular measurements, Sin bar, Clinometers, Measurement of geometric forms like straightness, flatness, roundness comparators -their types, relative merits and limitations, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads, measurement of tooth thickness, pitch and checking of profile for spur gears, angle gauge.

Module-3

Strain measurement, Types of strain gauges and their working, temperature compensation, strain rosettes, calibration, application of strain gauges for direct, bending and Torsional loads. Introduction to amplifying, transmitting and terminating devices. Mechanical tachometers, vibration reed tachometer and stroboscope, proving ring, hydraulic and pneumatic load cells, torque on rotating shafts, Absorption, transmission and driving dynamo meters

.

Module-4

Bourdon tube, diaphragm and bellows, vacuum measurement - McLeod gauge, thermal conductivity gauge and ionization gauge, Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer, flow visualization techniques. Temperature measurement, Thermometers, Thermistors and Pyrometer, thermo-electric sensors, common thermocouples.

Reference Books:

1. Doebelin, E.O. (1988). *Measurement System Application and Design.* McGraw Hill Publishing. Company.
2. Holman, J.P. (1989). *Experimental Methods for Engineers*. McGraw Hill Publication Company.
3. Kumar, D.S. (1979). *Mechanical Measurement and Control*, Metropolitan Book Co Pvt.Ltd.
4. Jain, R.K. (2013). *Engineering Metrology*, Khanna publishers.
5. Kuo, B.C. (1975). *Automatic Control systems*, Prentice Hall.

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CO1	3	3	2	3	2	3	2	3	2	1	2	-	2	3	2
CO2	1	2	1	3	3	2	2	3	1	2	2	2	3	2	2
CO3	2	1	3	2	2	3	3	2	2	2	-	2	2	3	3
CO4	2	3	2	3	2	1	2	1	2	1	2	-	2	3	2
CO5	3	2	2	3	3	2	1	3	1	2	2	2	3	2	2
Average	**2.2**	**2.2**	**2**	**2.8**	**2.4**	**2.2**	**2**	**2.4**	**1.6**	**1.6**	**2**	**2**	**2.4**	**2.6**	**2.2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name: Manufacturing Processes

Course Code: 105514

Semester: 5th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	**Statement**
CO1	Evaluate the mechanism of metal cutting and different forces acting on the tools according to the tool wear and tool life
CO2	Explain the different gear manufacturing processes and gear finishing operations.

CO3	List the different advance manufacturing processes and their applications.
CO4	Describe the advance welding processes with the jigs and fixtures.
CO5	Understand the various Unconventional Machining Processes:

Course Content

Module-1

Conventional Manufacturing processes:

Casting and moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses. **5 Hrs**

Module-2

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.**4 Hrs**

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining. **8 Hrs**

Additive manufacturing: Rapid prototyping and rapid tooling **3 Hrs**

Module-3

Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding. **4 Hrs**

Module-4

Unconventional Machining Processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters**5 Hrs**

Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish. **8 Hrs**

Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining **3 Hrs**

Reference Books:

1. Rao, (2013).*Manufacturing Technology: Foundry, Forming and Welding*. Tata McGrawHill.
2. Campbell, J.S. (1982).*Principles of Manufacturing Materials and Processes*. Tata McGrawHill.
3. Hajra & Choudhury. (2008).*Elements of Workshop Technology, Vol. I and II*. Media Promoters Pvt. Ltd.
4. Sharma, P.C. (2014).*A text book of production technology*. S. Chand and Company.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	1	3	2	1	2	2	1	3	2	1	3

CO2	2	3	2	1	3	2	1	3	2	1	-	2	1	3	2
CO3	2	1	3	2	1	3	2	1	-	2	1	3	2	1	3
CO4	1	3	2	1	3	2	1	1	2	1	-	2	1	3	2
CO5	2	1	3	2	1	2	2	1	-	2	1	3	2	1	3
Average	**1.8**	**1.8**	**2.6**	**1.6**	**1.8**	**2.4**	**1.6**	**1.4**	**2**	**1.6**	**1**	**2.6**	**1.6**	**1.8**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Engineering Mechanics
Course Code: 105515
Semester: 5th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basic force system.
CO2	Apply the principles of particle kinematics
CO3	Examine the concept of particle dynamics
CO4	Identify the general equations of equilibrium
CO5	Describe the methods of minimization of potential energy.

Course Content

Module 1*: Introduction to Engineering Mechanics covering,* Force Systems 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 Indeterminacy

Module 2*: Friction covering,* Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

Module 3*: 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;

Module 4*: Centroid and Centre of Gravity covering,* 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.

Module 5*: Virtual Work and Energy Method*- 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.

Module 6*: Review of particle dynamics*- 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).

Module 7: *Introduction to Kinetics of Rigid Bodies covering,* 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;

Module 8: *Mechanical Vibrations covering,* 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 torsionpendulums;

Text/Reference Books:

1. Shames, Irving H. (2006). *Engineering Mechanics*4th Edition. PrenticeHall
2. Beer, F. P. & Johnston, E. R. (2011). *Vector Mechanics for Engineers*. Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGrawHill
3. Hibbler, R.C. (2006). *Engineering Mechanics: Principles of Statics and Dynamics*. PearsonPress.
4. Ruina, Andy &Pratap, Rudra. (2011). *Introduction to Statics and Dynamics*. Oxford University.
5. Shanes & Rao. (2006). *Engineering Mechanics*. PearsonEducation,
6. Hibler & Gupta (2010). *Engineering Mechanics (Statics, Dynamics)*. PearsonEducation
7. Reddy, Vijay. K. and Suresh,K. K. (2010). *Singer's EngineeringMechanics*
8. Bansal, R.K. (2010). *A Text Book of Engineering Mechanics*. LaxmiPublications
9. Khurmi, R.S. (2010). *Engineering Mechanics*. S. Chand &Co.
10. Tayal, A.K. (2010), *Engineering Mechanics.* UmeshPublications

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	1	3	2	1	2	2	1	3	2	1	3

CO2	3	3	2	1	3	2	1	3	2	1	-	2	1	3	2
CO3	2	1	3	2	1	3	2	1	2	1	1	3	2	1	3
CO4	3	3	2	1	3	2	1	-	2	1	3	2	1	3	2
CO5	1	1	3	2	1	3	2	1	3	2	1	3	2	1	3
Average	**2.2**	**1.8**	**2.6**	**1.6**	**1.8**	**2.6**	**1.6**	**1.5**	**2.2**	**1.4**	**1.5**	**2.6**	**1.6**	**1.8**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Essence of Indian Traditional Knowledge

Course Code: 100305

Semester: 5th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the connection and the basics of Indian traditional Knowledge in modern scientific perspective.
CO2	Apply the pedagogy for problem based learning, group discussion, collaborative mini projects
CO3	Understand the concept of yoga and holistic health care
CO4	Learn about the Indian Linguistic Tradition (Phonology, morphology, syntax and semantics)

Course Content

Module-1

i. Basic Structure of Indian Knowledge system
ii. Modern Science and Indian Knowledgesystem
iii. Yoga and Holistic HealthCare
iv. Casestudies

Pedagogy: Problem based learning, group discussion, collaborative mini projects

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Module-2

i. PhilosophicalTradition
ii. Indian Linguistic Tradition (Phonology, morphology, syntax andsemantics)
iii. Indian Artistic Tradition

iv. Casestudies

References

1. V.Sivaramakrishnan (Ed.). (2014). *Cultural Heritage of India-Course material*. Bhartiya Vaidya Bhawan Mumbai 5th Edition
2. Chaterjee, S.C & Datta, D. M. (1984). *An introduction to Indian Philosophy*. Universityof Calcutta
3. Subrahmanialyer, K.S.(1965*). Vakyapadiya of Bhattaraihari (Brahma Kanda).* DeccanCollege Pune
4. Jha, V.N. Language Thought andReality
5. Chandra, Pramod. (1983) *India Arts HowardUniv*. Press
6. Chaitanya, Krishna. (1987). *Arts of India.* Abhinav Publications.
7. Nagaswamy, R. (2002). *Foundations of Indian Art Tamil ArtsAcademy*.

Pedagogy: Problem based learning, group discussion, collaborative mini projects

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	2	1	1	2	-	1	2	2	1	2	1
CO2	2	1	2	1	2	2	2	2	1	2	1	2	2	1	2
CO3	1	2	1	1	2	1	1	-	2	1	1	2	2	1	1
CO4	1	1	1	1	1	2	1	1	1	1	-	1	1	2	1
Average	**1.25**	**1.5**	**1.25**	**1.25**	**1.75**	**1.5**	**1.25**	**1.6**	**1.3**	**1.25**	**1.3**	**1.75**	**1.5**	**1.5**	**1.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Mechanical Engineering Laboratory (Heat Transfer)-I
Course Code: A105508
Semester: 5th

L T P

Credits: 01 **0 0 2**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement

CO1	Evaluate heat transfer through lagged pipe, Insulating powder and Drop and Film wise condensation.
CO2	Calculate the Thermal conductivity of a given metal Rod.
CO3	Measure the Heat transfer coefficient for Pin Fin, Forced convection, Natural Convection / parallel and counter flow heat exchanger.
CO4	Understand the emissivity, Stefan Boltzmann Constant and Critical Heat flux of material
CO5	Compare the performance of Refrigeration and Air conditioning and to determine the overall heat transfer coefficient for a composite slab.

Course Content

1. Determination of thermal conductivity of a solid insulating material by slab method.
2. Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept:
   i) Along the direction of flow
   ii) Perpendicular to the direction of flow
   iii) Inclined at an angle to the direction of flow.
3. To determine total resistance and thermal conductivity of composite wall.
4. Determination of heat transfer coefficient for
   i) Film condensation
   ii) Drop-wise condensation.
5. Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6. To determine the emissivity of non black plate surface.
7. Evaluate the performance of a heat pipe.
8. To study the rate of heat transfer through different types of fins (1-4) under free convection heat transfer.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	3	2	1	2	1	2	-	1	2	2	1	3
CO2	2	1	3	2	1	-	1	3	2	1	-	2	1	3	2
CO3	3	2	1	3	2	1	2	1	2	2	1	2	2	1	3
CO4	2	1	3	2	1	3	1	1	2	1	-	2	1	3	2
CO5	3	2	1	3	2	1	2	1	2	2	1	3	2	1	3
Average	**2.4**	**1.6**	**1.8**	**2.6**	**1.6**	**1.5**	**1.6**	**1.4**	**2**	**1.5**	**1**	**2.2**	**1.6**	**1.8**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Refrigeration &Air-conditioning -I

Course Code: A105605

Semester: 6th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
CO2	Examine cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.
CO3	Learn about the properties, applications and environmental issues of different refrigerants.
CO4	Evaluate cooling load for air conditioning systems used for various.
CO5	Analyze the refrigeration and air conditioning systems.

Course Content

Module-1

Classification of refrigeration systems

Module-2

Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics -Ozone depletion and global warming issues-System components: Compressors, Condensers, Expansion devices and Evaporators-Performance matching of components of refrigeration systems

Module-3

Advanced sorption refrigeration systems and their components.

Module-4

Review of Psychrometry and Air-conditioning processes-Comfort air conditioning and Cooling load calculations - Applications of AC systems - Concept of enthalpy potential - Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils.

Reference Books:

1. Arora, C.P. (1983).*Refrigeration and Conditioning.* Tata McGraw Hill.

2. Prasad, Manohar.(2011)*Refrigeration and Conditioning.* Wiley EasternLimited.
3. Jordon, R.C.& Priester, G.B.(1956).*Refrigeration and Conditioning.* Prentice Hall ofIndia.
4. Stoecker, W.F.(2014). *Refrigeration and Conditioning*.Tata McGraw Hill.
5. Rajput, R.K.(2010). *Refrigeration and Conditioning*. KhannaPublications.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	3	2	1	2	1	2	-	1	3	2	1	3
CO2	2	1	3	2	1	3	1	-	2	1	3	2	1	3	2
CO3	3	2	1	3	2	1	2	1	-	2	1	-	2	1	3
CO4	2	1	3	2	1	3	1	3	2	1	1	2	1	3	2
CO5	3	2	1	3	2	1	2	1	3	2	1	2	2	1	3
Average	**2.4**	**1.6**	**1.8**	**2.6**	**1.6**	**1.8**	**1.6**	**1.5**	**2.25**	**1.5**	**1.4**	**2.25**	**1.6**	**1.8**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Mechanical Vibrations
Course Code: 105610
Semester: 6th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Describe the principle of conventional and advanced vibrations.
CO2	Develop basic knowledge on problem modeling for vibration analysis.
CO3	Illustrate various techniques for solving Vibration models/ systems.
CO4	Compare the various the iterative procedures for solving vibration problems for multi degree of freedom systems.
CO5	Apply the vibration solver techniques for analyzing the realistic complex structures.

Course Content

Module-1

Introduction:

Basic concepts and its cause, Scope of vibration, degree of Freedom, Methods of vibration analysis, Types of vibration, Periodic &Harmonic vibrations .Beats and Beat Phenomena. Fourier analysis For Single degree of freedom system

Module-2

Un-damped free vibrations:

Torsional Vibration of rotor shaft system, compound Pendulum, Beam with several masses.

Module-3

Damped free vibrations:

Types of damping, Differential equations of damped free vibration, Use of Critical damping

Module-4

Damped force vibrations

Source of excitation, Equation of motion with harmonic Force, magnification Factor, Response of rotating and reciprocating unbalance system. Support motion vibration isolation transmissibility.

Module-5

Vibration measuring instruments:-Vibrometer, Accelerometer, Frequency measuring device:-Frahm tachometer and Fullarton tachometer,Critical Speed

Module-6

Two degrees of Freedom systems:

a) Principal modes of vibrations, natural frequencies, amplitude ratio, forced harmonic vibration combined rectilinear & angular modes.

b) Application; Vibration absorber - principle, centrifugal pendulum vibration absorber, torsional vibration damper, unturned viscous damper, dry friction dampers, torsional vibration of two rotor systems.

Module-7

Multi-degree of freedom systems:

Un-damped free vibrations, influence coefficients, generalized coordinates, orthogonality principal, matrix alteration methods,: Rayleigh and Dunkerley, Holzer's , stodola method, Eigen values &Eigen vector

Module-8

Continuous systems:

Vibration of a string, longitudinal vibrations of bars, Euler's equation of motion for beam vibration, natural frequencies for various end conditions, torsional vibration of circular shafts

Reference Books:

1. Grover, G.K.(2009). *Mechanical Vibrations*. Nem Chand & Bros Roorkee.
2. Purjara, K. &Pujara, R.S. (1984). *Vibrations for Engineers*. Dhanpat rai and sons Delhi
3. Singh,V.P.(2015).*MechanicalVibrations*. Dhanpat rai and sons Delhi
4. Rao, S.S.(2003). *MechanicalVibrations*.Pearson
5. Thompson, W.T.(1961). *MechanicalVibrations*.Prentice Hall Press
6. Srinivasan, P.(1996). *Mechanical Vibrations and Analysis*.John Wiley & Sons Inc.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	1	1	1	3	2	1	-	2	1	3	2	3	2
CO2	1	3	2	1	2	1	3	2	1	3	-	1	3	1	3
CO3	2	2	1	3	1	3	2	1	2	2	1	3	2	3	2
CO4	3	2	1	3	1	3	2	1	-	3	1	3	2	3	2
CO5	1	3	2	1	2	1	2	2	1	3	-	1	3	1	3
Average	**1.8**	**2.4**	**1.4**	**1.8**	**1.4**	**2.2**	**2.2**	**1.4**	**1.3**	**2.6**	**1**	**2.2**	**2.4**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Manufacturing Technology
Course Code: 105611
Semester: 6th

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the manufacturing processes and tools commonly used to convert cast, Forged, molded, and wrought materials into finished products.
CO2	Understand the basic mechanisms of material removal, measurement, quality control, assembly processes.

CO3	Understand the different metal removing processes and super finishing processes for component production.
CO4	Learn about surface finishing techniques.
CO5	Examine the working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.

Course Content

Module-1

Mechanism of Metal Cutting: Deformation of metal during machining, nomenclature of lathe, milling tools, mechanics of chip formation, built-up edges, mechanics of orthogonal and oblique cutting, Merchant cutting force circle and shear angle relationship in orthogonal cutting, factors affecting tool forces. Cutting speed, feed and depth of cut, surface finish. Temperature distribution at tool chip interface. Numerically on cutting forces and Merchant circle.

Module-2

Tool Wear and Machinability: Types of tool wear, tool life, factors governing tool life, Machinability: Definition and evaluation. Economics of machining, Numerical on tool life.

Module-3

Gear Manufacturing: Introduction, methods of manufacture. Gear generation and forming: Gear cutting by milling, single point form tool, gear hobbing and shaping. Gear finishing operations: Gear shaving, gear burnishing, gear grinding, lapping.

Module-4

Cutting Tool Materials & Cutting Fluids: Characteristics of tool materials, various types of cutting tool materials, coated tools, cutting tool selection, Purpose and types of cutting fluids, basic actions of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid Jigs & Fixtures: Introduction, location and location devices, clamping and clamping devices, Drill Jigs, Milling Fixtures.

Module-5

Unconventional Machining Processes: introduction, classification of unconventional machining processes, Abrasive jet machining: Principles, advantages, disadvantages and applications. Ultrasonic machining: Principles, advantages, disadvantages and applications. Electro-chemical machining and grinding: Principles of operation, advantages, disadvantages and applications. Electric discharge machining: Principles, advantages, disadvantages and applications. Electron beam machining: principle, advantages, disadvantages and applications. Laser beam machining: Principles and applications.

Reference Books:

1. Rao, P.N. (1992).*Manufacturing Technology: Foundry, Forming and Welding*. Tata McGrawHill.
2. Campbell, J.S. (1961).*Principles of Manufacturing Materials and Processes*. Tata McGrawHill.
3. Hajra& Choudhury. (2008). *Elements of Workshop Technology, Vol. I and II*. Media Promoters Pvt Ltd.
4. Sharma, P.C. (2003).*A text book of production technology*. S Chand and Company.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	3	1	3	2	1	3	2	1	3	2	3	2
CO2	1	3	2	1	2	1	3	2	1	3	2	1	3	1	3
CO3	3	2	1	2	1	3	2	1	-	2	1	3	1	3	3
CO4	2	1	3	1	3	2	1	3	2	1	3	2	3	2	2
CO5	2	1	3	1	-	2	1	-	2	1	3	2	3	2	2
Average	**2.2**	**1.8**	**2**	**1.6**	**1.75**	**2.2**	**1.8**	**1.75**	**2**	**1.8**	**2**	**2.2**	**2.4**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Industrial Automation & Robotics

Course Code: A105603

Semester: 6th

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Acquire an overview of industrial automation.
CO2	Understand the concepts of automation and robotic support which cater to the needs of the larger manufacturing enterprise.
CO3	Differentiate between the various sensors in construction & application which are used in robotic & automation systems.
CO4	Acquire the knowledge and skills associated with robot control.

Course Content

Module-1

Introduction: Concept and scope of automation: Socio economic impacts of automation, Types of Automation, Low Cost Automation

Module-2

Fluid Power: Fluid power control elements, Standard graphical symbols, Fluid power generators, Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control.

Module-3

Basic hydraulic and pneumatic circuits: Direct and Indirect Control of Single/Double Acting Cylinders, designing of logic circuits for a given time displacement diagram & sequence ofoperations, Hydraulic & Pneumatic Circuits using Time Delay Valve & Quick Exhaust Valve, Memory Circuit & Speed Control of a Cylinder, Troubleshooting and "Causes & Effects of Malfunctions" Basics of Control Chain, Circuit Layouts, Designation of specific Elements in a Circuit.

Module-4

Fluidics: Boolean algebra, Truth Tables, Logic Gates, Coanda effect.

Module-5

Electrical and Electronic Controls: Basics of Programmable logic controllers (PLC), Architecture & Components of PLC, Ladder Logic Diagrams

Module-6

Transfer Devices and feeders: Classification, Constructional details and Applications ofTransfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders

Module-7

Robotics: Introduction, Classification based on geometry, control and path movement,Robot Specifications, Robot Performance Parameters, Robot Programming, Machine Vision, Teach pendants, Industrial Applications of Robots

Reference Books:

1. Esposito, A. (2009).*Fluid Power withapplications*.Pearson Prentice Hall.
2. Majumdar, S.R. (1996).*PneumaticControl*.Tata McGrawHill Education
3. Deb, S.R. & Dev, S.(2001). *Robotics and FlexibleAutomation*.Tata McGraw-Hill Education.
4. Goyal, K.&Bhandari, D. (2011).*IndustrialAutomationandRobotics*.S.K. Katariaand Sons.
5. Gupta, A.K.,& Arora,S.K.(2009).*Industrial Automation and Robotics*.Laxmi Publications.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	3	1	3	2	1	3	2	1	3	2	3	2
CO2	1	3	2	1	2	1	3	2	1	-	2	1	3	1	3
CO3	3	2	1	2	1	3	2	1	3	2	1	3	1	3	3
CO4	2	1	3	1	3	2	1	-	2	1	-	2	3	2	2
Average	**2.25**	**2**	**1.75**	**1.75**	**1.75**	**2.25**	**2**	**1.3**	**2.25**	**1.6**	**1.3**	**2.25**	**2.25**	**2.25**	**2.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Mechanical Engineering Laboratory (Vibration)-II

Course Code: 105612

Semester: 6th

L T P

Credits: 01 **0 0 2**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Determine the viscosity of given fluid by single wire Torsional pendulum.
CO2	Examine the natural frequencies of a coupled pendulum.
CO3	Determine the fundamental natural frequency of a cantilever beam
CO4	Correlate the modules of elasticity from free vibrationtest
CO5	Understand the forced vibration of a two degree of freedom system under harmonic excitation

Course Content

1. Determine the viscosity of given fluid by single wire torsional pendulum.
2. Determine the natural frequencies of a coupled pendulum.
3. Find out the fundamental natural frequency of a cantilever beam
4. Determine the modulas of elasticity from free vibration test
5. Study of forced vibration of a two degree of freedom system under harmonic excitation
6. Study of a dynamic absorber

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	3	1	3	2	1	2	2	1	3	2	3	2
CO2	1	3	2	1	2	1	3	2	1	3	2	1	3	1	3
CO3	3	2	1	2	1	3	2	1	-	2	1	3	1	3	3
CO4	2	1	3	1	3	2	1	3	2	1	-	2	3	2	2

CO5	2	1	3	1	3	2	1	3	2	1	3	2	3	2	2
Average	**2.2**	**1.8**	**2**	**1.6**	**2**	**2.2**	**1.8**	**2**	**1.75**	**1.8**	**1.75**	**2.2**	**2.4**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Mechanical Measurement and Metrology Lab

Course Code: 105615

Semester: 6th

L T P

Credit: 01 **0 0 2**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	
CO1	Exhibit the use of instruments for measuring linear (internal and external), angular dimensions and surface roughness
CO2	Perform alignment tests on various machine tools.
CO3	Validate the use of instruments for measuring pressure, flow, speed, displacement and temperature
CO4	Calibrate the Bourdon tube pressure gauge

Course Content

1. Measurement using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
5. Measurement of Screw threads Parameters using two wire or Three-wire methods.
6. Measurement of Surface roughness, using Tally Surf/Mechanical Comparator.
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer.
8. Calibration of Micrometer using slip gauges.
9. Measurement using Optical Flats.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3

CO1	3	2	1	2	1	3	2	1	-	2	1	2	1	3	2
CO2	2	1	3	1	3	2	1	3	2	1	3	1	3	2	1
CO3	3	2	1	2	1	3	2	1	3	2	1	2	1	3	2
CO4	2	1	3	1	3	2	1	-	2	1	-	1	3	2	1
Average	**2.5**	**1.5**	**2**	**1.5**	**2**	**2.5**	**1.5**	**1.6**	**2.3**	**1.5**	**1.6**	**1.5**	**2**	**2.5**	**1.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Design of Machine Elements
Course Code: 105702
Semester: 7th

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the different concepts & considerations of machine design.
CO2	Analyze the design of different types of mechanical joints
CO3	Examine the different types of keys & couplings
CO4	Develop a design procedure of transmission of shafts.
CO5	Differentiate the various types of springs & Conceptualize the design of different types of clutches

Course Content

Module-1

Principles of Mechanical Design: General considerations & procedure of design of machine elements, Engineering materials & their mechanical properties, Selection of material, theories of failures, static loading, factor of safety under different loading conditions, stress concentration, Concept of fatigue failures for dynamic loading.

Module-2

Mechanical Joints: Design of riveted &welding joints under different static load conditions. Design of screwed joints against static load, eccentrically loading, Design of cotter joints and knuckle joint.

Module-3

Keys & Couplings: Design of different type of keys; sunk key, saddle key, tangent key, round key & splines. Design of different shaft couplings against torque; Rigid & Flexible couplings.

Module-4

Transmission Shafts: Design of shaft subjected to static loading: pure torsion, simple bending, combined bending and torsion, combined bending torsion and axial loads. Design of shafts for fluctuating loads.

Module-5

Springs: Terminologies of springs, Different type of springs, Design of helical springs for static & dynamic loading, Eccentric loading, Surge in springs, Springs in series & parallel connection, Type of leaf springs, Design of leaf springs.

Module-6

Clutches: Various types of clutches, Design of friction clutches; Single plate clutch, Multi-plate clutch, Cone clutch & Centrifugal clutch.

References Books:

1. Shigley, J. E. (1983).*Mechanical Engineering Design*. Tata McGraw Hills.
2. Bhandari,V.B.(2010). *Design of Machine Elements*.Tata McGraw Hills.
3. Norton, R. L.(2000).*Machine design: an integrated approach*. Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	2	1	-	2	1	2	1	3	2
CO2	2	1	3	1	3	2	1	3	2	1	3	1	3	2	1
CO3	1	2	1	2	1	3	2	1	3	2	1	2	1	3	2
CO4	2	1	3	1	3	2	1	-	2	1	3	1	3	2	1
CO5	1	3	1	3	2	1	3	2	1	-	1	3	2	1	3
Average	**1.8**	**1.8**	**1.8**	**1.8**	**2**	**2.2**	**1.8**	**1.75**	**2**	**1.5**	**1.8**	**1.8**	**2**	**2.2**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Operation Research

Course Code: A105804

Semester:8th

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement

CO1	Comprehend the role of operation research in decision-making, and its applications in industry and design for real-world problems through models & experiments
CO2	Apply various types of deterministic models like linear programming, transportation model etc.
CO3	Analyze various types of stochastic models like waiting line model, project line model, simulation etc.
CO4	Develop the relationship between a linear program and its dual and perform sensitivity analysis.
CO5	Understand the decision making environment and apply decision making process in the real world situations.

Course Content

Module-1

Introduction:

Origin & development of OR and its role in solving industrial problems: General approach for solving OR problems. Nature and characteristic feature of OR. Use and limitation of OR. Classification of mathematical models:

Deterministic Models:

Formulation of deterministic linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis: transportation models, test for optimality, degeneracy in transportation. Assignment problems (Hungarian method) travelling salesman problems, and sequencing models; Introduction to goal programming; Solution techniques of linear goal programming problems.

Module-2

Probabilistic Models:

Decision making: various decision making environments. Maximum and minimum models; Introduction to decision tree. Game theory: Solution of simple two person zero-sum games: Examples of simple competitive situation.

Module-3

Simulation:

Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems.

Dynamic Programming:

Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. Advantages of dynamic

Module-4

Queuing theory:

Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.

Replacement Models:

Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy.

Inventory models:

Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, and inventory models with price breaks. Advantages and disadvantage of inventory

Module-5

Network models:

PERT & CPM introduction, analysis of time bound project situations, construction of net works, identification of critical path, slack and floats, crashing of network for cost reduction, resource leveling and smoothening.

Reference Book:

1. Wagner, H.M.(1980). *Principles of Operations Research.* PrenticeHall.
2. Gupta, P.K.& Hira, D.S.(1976).*Operations Research.* S. Chand &Co.
3. Taha, H.(1999). *Introduction to OperationResearch*. Pearson.
4. Hillier, F. S. & Lieberman, G. J. (1967). *Introduction to Operations Research*. San Francisco: Holden-Day.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	2	1	-	-	1	3	2	1	2	1	3	2
CO2	2	3	3	1	3	2	1	3	2	1	3	1	3	2	1
CO3	3	1	3	2	1	3	2	1	3	1	-	2	1	3	1
CO4	1	2	1	3	2	1	3	2	1	2	1	-	2	1	2
CO5	1	3	1	3	2	1	3	2	1	3	1	3	2	1	3
Average	**2**	**2.2**	**2.2**	**2.2**	**1.8**	**1.75**	**2.25**	**1.8**	**2**	**1.8**	**1.5**	**2**	**1.8**	**2**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Non Traditional Machining

Course Code: A105907

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the need of Non Traditional Machining Processes and be able to Classify various processes.
CO2	Comprehend the role of mechanical energy in non-traditional machining processes.
CO3	Apply the knowledge of machining electrically conductive material through electrical energy in non-traditional machining processes.
CO4	Understand the concept of machining the hard material using chemical energy and electrochemical energy.
CO5	Learn about the various thermal energy based nontraditional machining processes.

Course Content

Module I [8 Hours]

Modern Machining Processes: An Overview, trends in Manufacturing machining, transfer machining, flexible machining system, and computer integrated manufacturing

Module II [8 Hours]

Advanced Mechanical Processes: Ultrasonic machining and Abrasive Flow Machining-elements of process, Applications and limitations

Module III [8 Hours]

Electrochemical & Chemical Removal Processes: Principle of operation, elements and applications of Electrochemical Machining, Electrochemical grinding, Electrochemical deburring, Electrochemical honing, Chemical Machining:

Module IV [10 Hours]

T**hermal Metal Removal Processes:** Electric Discharge Machining, Mechanism of metal removal, electrode feed control, die electric fluids flushing, selection of electrode material, applications. Plasma Arc, Machining- Mechanism of metal removal, PAM parameters, Equipment's, safety precautions and applications. Laser Beam machining- Material removal, limitations and advantages. Hot machining-method, Applications and limitations. Electron-Beam Machining-, Generation and control of electron beam, process capabilities and limitations

Reference Books:

1. Panday, P.C. & Shan, H.S.(1980).*Modern Machining Processes.* Tata McGrawHill
2. Boothroyd, G.& Knight, W.A.(2005).*Fundamentals of Machining and Machine Tools.* CRC Press Inc.
3. Benedict, G.F.(1981).*Non Traditional Manufacturing Processes*. Marcel DekkerInc.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	1	3	1	-	2	1	3	1	2	1	3
CO2	1	2	1	3	2	1	2	1	3	2	1	2	3	2	1
CO3	3	2	1	3	2	1	-	1	3	2	1	-	3	2	1
CO4	2	1	3	2	1	3	1	3	2	1	3	1	2	1	3
CO5	3	2	1	3	2	1	2	1	3	2	1	-	3	2	1
Average	**2.2**	**1.6**	**1.8**	**2.6**	**1.6**	**1.8**	**1.5**	**1.5**	**2.6**	**1.6**	**1.8**	**1.3**	**2.6**	**1.6**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Computer Aided Manufacturing
Course Code: A105909

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
CO2	Apply the computer design tools for aerospace and mechanical engineers.
CO3	Evaluate the CAD/CAM system based on costing.
CO4	Learn about data management and its importance for decision making in CIMS environment.

CO5	Comprehend the Computer Aided Quality control and Process Planning Control.

Course Content

Module I [10 Hours]

Introduction: Historical Background, Role of Computers in Manufacturing, automation, Types of Automation, Automation Strategies.

Fundamentals of CNC Machines: CNC Technology, functions of CNC Control in Machine Tools, Classification of CNC Systems, Contouring System, Interpolators, Open loop and Closed loop CNC System, CNC Controllers, Hardware Features, Direct Numerical Control(DNC Systems) and Adaptive Control.

Module II [10 Hours]

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, Slides linear bearings, Ball Screws, Spindle drives and feed drives, Work holding devices and tool holding devices, Automatic tool changers. Feedback devices, Principles of Operation, Machining Centers, Tooling for CNC machines.

Part Programming For CNC Machines: Numerical control codes, Standards, Manual Programming, Canned cycles and subroutines, Computer Assisted Programming, CAD/CAM approach to NC part programming, APT language, machining from 3D models.

Module III [12 Hours]

Introduction to Robot Technology in CAM: Group Technology and Cellular manufacturing: Introduction, Part families, parts classification and coding, production flow analysis, machine cell design. Computer Aided Process Planning (CAPP): Types of Process planning system, Advantages of CAPP.

Production Planning and Control: Introduction to production planning and control, Shop Floor Control Systems, Just-in –time approach, Engineering Challenges in CAD/CAM, Product Data Management, Product Modeling, Assemble and Tolerance Modeling.

Module IV [8 Hours]

Integrated Manufacturing System: Introduction toFlexible Manufacturing Systems(FMS), different types of flexibilities in FMS, type of FMS, machining system of FMS, Tool Management systems, work piece handling system, FMS Control, Lay out considerations in FMS, Advantages of FMS. Introduction to Computer Aided Manufacturing Systems (CIMS), the future automated factory, trends in manufacturing, human factors in future automated factory, the social impact. Rapid Prototyping, Artificial Intelligence and Expert system in CIM.

References Books:-

1. Groover, M.P.(1980).*Automation: Production Systems & CAM*.Englewood Cliffs New Jersey
2. Chang, T.C.&Wysk, R.A.(1985).*An introduction to Automated Process Planning*.Longman Higher Education
3. Singh, N. (1995).*System approach to Computer Integrated Design and Manufacturing*.Wiley.
4. Pable, B.S.&Adithan, M.(1994). CNC Machines.New Age International(P) Ltd.
5. Dalela, S. & Jain, P.K.(2000).*CAD/CAM*.S Chand & Company Pvt Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3

CO1	1	2	1	3	2	1	2	3	2	1	-	1	2	1	3
CO2	2	1	3	2	1	3	1	1	-	2	1	2	3	2	1
CO3	1	2	1	3	2	1	2	1	2	2	1	3	3	2	2
CO4	1	3	2	1	3	1	1	3	2	1	2	1	3	2	1
CO5	2	1	3	2	1	2	1	3	2	1	3	2	1	3	2
Average	**1.4**	**1.8**	**2**	**2.2**	**1.8**	**1.6**	**1.4**	**2.2**	**2**	**1.4**	**1.75**	**1.8**	**2.4**	**2**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Computer Aided Process Planning

Course Code: 105921

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	
CO1	Understand the structure of automated process planning system and use the principle of generative and retrieval CAPP systems for automation.
CO2	Apply the manufacturing sequence to reduce the total set up cost for a particular sequence.
CO3	Examine the effect of machining parameters on production rate, cost and surface quality and determination of manufacturing tolerances.
CO4	Comprehend the generation of tool path and solve optimization models of machining processes.
CO5	Understand the design strategies. Planning, modeling and coding scheme.

Course Content

Module I [8 Hours]

Introduction: Traditional process planning; processplanning elements; product design evaluation; selection of tooling and process parameters; operation sequence evaluation.

Group Technology: Introduction; advantages; part families; classification and coding systems; production flow analysis; design of machine cells.

Module II [12 Hours]

Production Systems at Operation Level: Manufacturing support systems and concepts at the level of production processes; computer generated time standards; machinability data system; cutting condition optimization.

Production Systems at Plant Level: Communication oriented production information and control system (COPICS); material requirements planning; capacity planning; shop floor control and operation scheduling.

Module III [5 Hours]

Automated Process Planning: Advantages of automated process planning; standardization of manufacturing process plans; variant process planning; its features; and different stages; different variant systems; advantages and limitations of variant process planning

Module IV [10 Hours]

Generative process planning: Its features; design strategies; planning modeling and coding scheme; decision mechanism for software; decision trees for process; process information.

Artificial intelligence: overview & application; search strategies for AI production systems; resolution and reduction systems; knowledge acquisition; machine selection, cutting tool selection; software; various generative process planning systems; advantages of generative process planning systems; case studies.

References Books:

1. Chang, T.C.andWysk, R.A.(1984).*An Introduction to the Automated Process Planning*. Prentice Hall.
2. Groover, M.P.&Zimmers, E.W.(1984).*Computer Aided Design & Manufacturing*. Prentice Hall.
3. Gallagher, C.C. and Knight, W.A.(1998).*Group TechnologyProduction Methods in Manufacturing*, Ellis Hosewood.
4. Groover, M.P.(2008).*Automation; Production System & Computer Integrated Manufacturing*. Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	3	2	1	2	1	2	1	-	1	2	1	3
CO2	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO3	3	1	2	2	1	3	3	2	-	3	1	2	1	3	2
CO4	1	1	2	1	3	1	1	3	2	1	2	1	3	2	1
CO5	2	1	3	2	1	3	3	2	-	3	-	2	1	3	2
Average	**1.8**	**1.2**	**2.2**	**2**	**1.6**	**2.2**	**2.4**	**2**	**1.6**	**2.2**	**1.3**	**1.6**	**1.6**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Modern Welding Formation Process

Course Code: 105922

Semester:Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Illustrate the modern manufacturing operations, including their capabilities and limitations.
CO2	Apply the modern welding techniques to influence the manufacturing schedule and cost.
CO3	Analyze the manufacturability and processing cost of modern welding techniques.
CO4	Develop the relationship between customer desires, functional requirements, and manufacturing process selection.

Course Content

Module I [8 Hours]

Introduction: Overview of general trends in Manufacturing, concept and significance of important properties related to manufacturing processes, limitations of conventional manufacturing processes need and evolution of advanced manufacturing, selection and economics of manufacturing processes.

Module II [10 Hours]

Advanced Machining Processes: Classification, Review of conventional machining processes, Principles, process parameters, capabilities and mechanism of material removal of AJM, WJM, AWJM, USM

Module III [10 Hours]

Electro Chemical Type Advanced Machining Processes: ECM-Process principle, mechanism of material removal; Kinematics and dynamics of ECM; Tooling design; Choice and analysis of process parameters; Surface finish and accuracy.

Module I [15 Hours]

Thermal Type Advanced Machining Processes: EDM, LBM and EBM processes: Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy: Shape and materials applications, limitations.

Derived And Hybrid Advanced Machining Processes: Introduction of processes like rotary ultra sonic machining, electro stream drilling, shaped tube electro machining, wire electro discharge machining, electro chemical grinding, electro chemical honing, electro chemical deburring and electrochemical spark machining.

Reference Books:

1. Panday, P.C. and Shan, H.S. (1980).*Modern Machining Processes*, Tata McGrawHill
2. Boothroyd, G.and Knight, W.A.(1996).*Fundamentals of Machining and Machine Tools*.MareelDekkerInc.
3. Benedict, G.F.(1987).*Nontraditional Manufacturing Processes*. Marcel DekkerInc.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	2	1	3	-	2	1	3	1	2	1	3	2
CO2	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO3	1	3	2	1	3	1	1	2	2	1	2	1	3	2	1
CO4	2	1	3	2	1	3	-	2	1	-	1	2	1	3	2
Average	**1.75**	**1.5**	**2.75**	**1.75**	**1.5**	**2.5**	**2**	**2**	**1.25**	**2.3**	**1.25**	**1.75**	**1.5**	**2.75**	**1.75**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name: Machining Science

Course Code: 105923

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Evaluate the values of various forces involved in the machining operations
CO2	Analyze the various single and multipoint cutting tools performance
CO3	Understand the heat generation in machining &application of coolant in operation
CO4	Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
CO5	Develop the inter-relationship between cutting parameters and machining performance.

Course Content

Module I [10 Hours]

Machining: Plastic Deformation, Tensile Test, Stress and Strain; Mechanism of Plastic Deformation: Slips, defects, plastic deformation on atomic scale; Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation;

Tool specification; Tool angle relationships in ORS and ASA and NRS; Selection of Tool Angles; Multiple-point cutting tools: twist drill, helical milling cutter.

Module II [12 Hours]

Merchant's Circle Diagram: Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship; Thick Zone model: Okushima and Hitomi Analysis; Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Determination of mean angle of friction.

Module III [15 Hours]

Mechanism of Oblique Cutting: Normal Rake angle, velocity rake angle and effective rake angle; shear angles; velocity relationship; Force relationships in oblique cutting; Practical Marching Processes: Turning, shaping and planning, Slab milling, Drilling: Machining Parameters, force magnitudes, power consumption, material removal rate, time per pass.

Module IV [15 Hours]

Measurement of Cutting Forces:Basic methods of measurement: Axially Loaded members, Cantilever Beam, Rings and Octagon, dynamometer requirements; machine tool dynamometers; Types of tool wear; Mechanisms of wear: Abrasion, Adhesion and Diffusion. Progressive tool wear: flank and crater wear. Tool Life: variables affecting tool life - cutting conditions, tool geometry, Types of tool materials, fabrication of cutting inserts, coatings, work material and cutting fluid; Machinability and their criteria.

Reference Books:

1. Rowe &Geoffrey W. (1977).*An introduction to the principles of Metal working*. Edward Arnold.
2. Bhattacharya,A.& Sen, G.C.(1969).*Principle of metal cutting*. New Central Book Agency.
3. Boothroyd, G. & Knight, W.A. (2005).*Fundamental of machining and machine tools*.CRC. Press.
4. Kalakjjan, S. (1992). Manufacturing Engineering & Technology.Addison-Wesley Pub Company.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO2	2	1	3	2	1	3	-	2	1	3	1	2	1	3	2
CO3	1	3	2	1	3	1	1	-	2	1	2	1	3	2	1
CO4	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO5	3	2	1	3	1	1	3	2	1	2	1	3	2	1	3
Average	**2**	**1.6**	**2.4**	**2**	**1.4**	**2.2**	**2.5**	**2**	**1.2**	**2.4**	**1.2**	**2**	**1.6**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Metallurgy & Heat Treatment Processes
Course Code: 105924

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the atomic, crystal structure of metals and their imperfections
CO2	Comprehend the phase transformation and equilibrium diagrams.
CO3	Understand the allotropic changes in alloys, Iron carbon phase diagram, TTT diagram
CO4	Relate the heat treatment processes and theirapplications
CO5	Draw the effect of cooling on heat-treated alloying elements' microstructures.

Course Content

Module I [16 Hours]

Atomic structure and crystal structure of metals: crystal lattice of (i) body centered cubic (ii) face centered cubic (iii) closed packed hexagonal structure, miller Indices, polymorphism and allotropy, isotropy and anisotropy

Solidification: concept of free energy, degree of super cooling, homogeneous (spontaneous) or self-nucleation, heterogeneous nucleation, critical size of nucleus, rate of nucleation and crystal growth, grain size, Inoculation, dendrites, equiaxed (globular) and columnar grains, introduction to lattice imperfections, various defects in crystals, solid solutions, intermediate alloy phases, phenomenon of slip and twinning, theory of dislocation, theories of plastic deformation, recovery, re-crystallization and grain growth, hot working and cold working.

Module I [16 Hours]

General principles of phase transformation in alloys, phase rule and binary equilibrium diagrams, equilibrium diagrams in which two elements are completely soluble in liquid and solid state (isomorphous system), equilibrium diagrams in which two components are completely soluble in liquid state but completely insoluble in solid state (eutectic system) forming mechanical mixture, equilibrium diagrams in which components are completely soluble in the liquid state and limited solubility in the solid state and in which the solid state solubility deceases with decrease in temperature, equilibrium diagrams for alloys forming limited solubility solid solution and undergoing a peritectic transformation, equilibrium diagrams of a system whose components are subject to allotropic change.

Iron carbon equilibrium diagram, components and phases of the iron–carbon system, iron–carbon equilibrium diagram, development of microstructures in iron – carbon alloys, hypo-eutectoid, hyper-eutectoid and eutectoid alloys.

Module III [16 Hours]

Isothermal Transformations: time temperature transformation (TTT diagram), Plotting of TTT diagram for steels, factors affecting the position and shape of TTT diagram, pearlite transformation, mechanism of the martensite and intermediate (bainite) transformations, properties of martensite and bainite transformations, possible microstructure of steel by continuous cooling at different rates, critical cooling rate, modification of properties through change in microstructure

Introduction of heat treatment and various heat treatment processes, Principles and applications of annealing, normalizing, hardening, tempering, possible defects, causes and their remedies in heat treatment, Hardenability: difference between hardness and hardenability, significance and determination of hardenability, critical diameter, Jominy end quench test, estimate of hardness from chemical composition.

Module IV [12 Hours]

Introduction to chemical heat treatment for case (surface) hardening, mechanism and applications of carburizing, cyaniding, nitriding, introduction to flame hardening, induction hardening, laser and electron beam hardening processes.

Effects produced by various alloying elements (Si, S, Cu, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel, composition of alloy steels

Reference Books:

1. Avner, S. H.(1974*). Introduction to Physical Metallurgy*. Tata McGraw Hill BookCompany.
2. Raghavan, V.(2015*). Physical Metallurgy: Principles and Practice*. Prentice Hall ofIndia.
3. Wadhwa, A. S. & Dhaliwal, H. S.(2008).*Engineering Materials and Metallurgy*. Laxmi Publications Pvt. Ltd.
4. Callister, W. D.(2010). *Material Science and Engineering*.John Wiley&Sons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	2	1	-	-	2	1	3	1	2	1	3	2
CO2	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO3	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
CO4	1	3	2	1	3	1	1	3	2	1	2	1	3	2	1
CO5	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
Average	**1.8**	**1.4**	**2.8**	**1.8**	**1.4**	**2.5**	**2.5**	**2.2**	**1.2**	**2.6**	**1.2**	**1.8**	**1.4**	**2.8**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Composite Material

Course Code: 105925

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the various types of metal and reinforcements used in composites.
CO2	Understand the polymer matrix composites, metal matrix composites, ceramic matrix composites,their manufacturing and applications.
CO3	Analyze the post processing operations and micromechanics of composites.
CO4	Illustrate the metal matrix and ceramic composites.
CO5	Examine the stress strain transformation, graphic interpretation in testing of composite materials.

Course Content

Module I [10 Hours]

Basic concepts and characteristics: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

Module II [10 Hours]

Micromechanics: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties. Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

Module III [10 Hours]

Coordinate transformation: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

Module IV [10 Hours]

Strength of unidirectional lamina: Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria,

application to design. The failure envelope, first ply failure, free-edge effects. Micros mechanical predictions of elastic constants.

Reference Books:

1. Jones, R. M. (1998).*Mechanics of Composite Materials*.McGraw Hill Company.
2. Daniel, I.M. &Ishai, O. (1994). *Engineering Mechanics of Composite Materials*. Oxford University Press.
3. Agarwal B. D. &BroutmanL. J.(1980).*Analysis and performance of fibre Composites*.Wiley-Interscience.
4. Autar, K. K.(2005).*Mechanics of Composite Materials*. CRC Press.
5. Calcote, L. R.(1968).*Analysis of Laminated Composite Structures*.Van Nost. Reinhold.
6. Vasiliev, V.V.&Morozov, E.V. (2007).*Advanced Mechanics of Composite Materials*. Elsevier.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	-	1	3	2	-	2	1	3	2
CO2	2	1	3	1	2	1	3	2	2	1	3	1	2	1	3
CO3	2	1	3	2	1	3	2	1	2	1	3	2	1	3	2
CO4	1	2	1	3	2	2	-	3	1	2	1	1	2	2	1
CO5	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
Average	**2**	**1.4**	**2.2**	**2**	**1.4**	**2.4**	**2.6**	**1.8**	**1.8**	**1.8**	**2**	**1.6**	**1.4**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Rapid Prototyping
Course Code: 105926
Semester:Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the concept of Machining, Machining Process, Tool Geometry, and Mechanics of Metal Cutting.
CO2	Apply the concept of Friction in Metal Cutting, Mechanism of Oblique

	cutting, Practical Machining Operations, Measurement of cutting Forces.
CO3	Examine the Tool Material for wear and life under different operating conditions.
CO4	Understand the concept of Prototype.
CO5	Differentiate the direct, AIM, quick cast processes.

Course Content

Module I

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo lithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application. 10 Hours

Module II

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation, Applications. 6 Hours

Module III

Solid Ground Curing: Principle of operation, Machine details, Applications, Laminated Object Manufacturing: Principle, of operation, LOM materials, process details, application. Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, GenisysXs printer HP system 5, object Quadra systems, Laser Engineering Net Shaping (LENS) 12 Hours

Module IV

Rapid Tooling : Indirect Rapid tooling -Silicon rubber tooling —Aluminum filled epoxy tooling Spray metal tooling ,Cast kirksite, 3D keltool etc. Direct Rapid Tooling — Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool ,DMILS, ProMetal ,Sand casting tooling ,Laminate tooling soft Tooling vs. hard tooling. 8 Hours

Reference Books:

1. Jacobs, P. F. (1996). *Stereo lithography and other RP & M Technologies*. SME NY.
2. Flham, D.T.&Dinjoy, S.S.(2001). *Rapid Manufacturing*. Verlog London.
3. Wohler,T. (2000). *Wohler's Report 2000*. Wohler's Association.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	2	1	-	-	1	2	1	3	2
CO2	2	1	3	1	2	1	3	2	2	1	3	1	2	1	3

CO3	2	1	3	2	1	3	2	1	2	1	3	2	1	3	2
CO4	1	2	1	3	2	2	1	3	1	2	1	1	2	2	1
CO5	2	1	3	2	1	3	3	2	1	-	1	2	1	3	2
Average	**2**	**1.4**	**2.2**	**2**	**1.4**	**2.4**	**2.2**	**1.8**	**1.5**	**1.3**	**1.8**	**1.6**	**1.4**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Characterization of Material
Course Code: 105927
Semester:Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the different methods which are used to characterize the materials.
CO2	Correlate the fundamental of physics to the basic operation of the equipment.
CO3	Evaluate the results obtained from different equipment.
CO4	Examine the basic failure analysis of materials.
CO5	Understand the X-ray Diffraction (XRD); Small Angle X-ray Scattering (SAXS); High Power X-ray (Syncrotron).

Course Content

Module I [10 Hours]
Introduction to materials and methods, Fundamentals of Materials Characterization, Basic operation, sample preparation and interpretation of data using different characterization equipment.

Module II [6 Hours]
BET surface area analyzer, Atomic force Microscopy (AFM), Scanning Electron Microscopy (SEM).

Module III [12 Hours]
X-ray Diffraction (XRD); Small Angle X-ray Scattering (SAXS); High Power X-ray (Syncrotron). Topic IV UV-VIS Spectrophotometer; FT-IR Spectrophotometer; Micro-raman Spectrometer, Electrical Impedance Spectroscopy (EIS), Electrical transport measurement.

Module IV [10 Hours]

Thermal Gravimetric Analysis (TGA), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC) and Differential Mechanical Analysis (DMA). Teaching methods the theoretical part of the course is presented in the Moodle learning environment in the form of presentation, lecture notes and video presentation.

References Books:

1. Leng, Y. (2008). *Materials Characterization: Introduction to Microscopic and Spectroscopic*. John Wiley & Sons.
2. Zhang, S., Li, L. & Kumar, A.(2008). *Materials Characterization Techniques*. CRC Press.
3. Vickerman, J.C. &Gilmore, I.S.(2011). *Surface Analysis: The Principal Techniques*. John Wiley & Sons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	2	1	3	2	1	2	1	3	2
CO2	2	1	3	1	2	1	3	2	2	1	3	1	2	1	3
CO3	2	1	3	2	1	3	2	1	2	-	3	2	1	3	2
CO4	1	2	1	3	2	2	1	3	1	2	1	1	2	2	1
CO5	2	1	3	2	1	3	3	2	1	-	1	-	1	3	2
Average	**2**	**1.4**	**2.2**	**2**	**1.4**	**2.4**	**2.2**	**1.8**	**1.8**	**1.6**	**1.8**	**1.5**	**1.4**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Surface Engineering

Course Code: 105928

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the importance of surface engineering
CO2	Apply the concept of thermal spray for coating

CO3	Examine the process and mechanism of different diffusion coating processes
CO4	Understand the different methods of non-metallic coating
CO5	Develop the testing procedure for quality assurance

Course Content

Module I [15 Hours]

Metal cleaning and preview on surface engineering: Need and relevance of surface engineering – pre-treatment of coating, General cleaning process for ferrous and non-ferrous metals and alloys – selection of cleaning process – alkaline cleaning – emulsion cleaning- ultrasonic cleaning – acid and pickling salt bath descaling – abrasive bath cleaning– polishing and short peening – classification of surface engineering processes.

Module II [10 Hours]

Thermal spraying processes and electrodeposited coatings: Thermal spraying – flame, arc, plasma and HVOF processes – PLV process – design for thermally sprayed coatings – coating production – spray consumables principles of electroplating – Technology and control electroplating systems – properties and Faraday's Law – factors affecting throwing power – Applications of electrodeposites – non-aqueous and electroless deposition.

Module III [10 Hours]

Hot dip coating and diffusion coatings: Principles – surface preparation batch coating and continuous coating process – coating properties and applications, Principles of cementation – cladding – Diffusion coating of C.N. Al, Si, Cr and B – structure, properties and application of diffusion coatings – chemical vapour deposition – physical vapour deposition.

References Books:

1. Parthasarathy, N.V.(1992).*Electroplating Handbooks*. Prentice Hall.
2. ASM (1994). *Metals Hand Book vol.2*.ASM Internationals.
3. Gabe, D.R. (1990). *Principles of Metal surface treatment and protection*.Pergamon.
4. Lavi, N. (1990). *Advances in surface treatments*.Pergamon.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	2	1	3	2	1	2	1	3	2
CO2	2	1	3	1	2	1	3	2	2	1	3	1	2	1	3
CO3	2	1	3	2	1	3	2	1	-	1	3	2	1	3	2
CO4	1	2	1	3	2	2	1	3	1	2	1	1	2	2	1
CO5	2	1	3	2	1	3	3	2	-	-	1	2	1	3	2
Average	**2**	**1.4**	**2.2**	**2**	**1.4**	**2.4**	**2.2**	**1.8**	**2**	**1.5**	**1.8**	**1.6**	**1.4**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Casting Processes
Course Code: 105929

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the principles of metal casting processes and develop analytical relation between input and output process parameters.
CO2	Understand the concept of cooling rate of materials in metal casting.
CO3	Apply theoretical and experimental techniques for measurement of important outcomes of casting processes like hardness, dimensional accuracy etc.
CO4	Comprehend the model of casting economics and optimization and its measurement.
C05	Apply the fundamentals of physics to develop theoretical relations for different types of casting processes

Course Content

Module I [10 Hours]

Structure of Silica and Different Types of Clays: Bonding mechanism of silica – water-clay Systems. Swelling of clays, sintering adhesion and colloidal clay; silica grain shape and size distribution standard permeability A.F.S. clay.

Characteristics: Ingredients and additives of moulding sand, core sands.

Module II [10 Hours]

Solidifications of Metals, nucleation, free energy concept, critical radius of nucleus. Nucleation and growth in metals and alloys. constitutional super cooling. Columnar equiacquiesced and dendritic structures. Freezing of alloys centreline feeding resistance. Rate of solidification, time of solidification, mould constant. Fluidity of metals, volumes redistribution.

Various Moulding and Casting Processes, hot box, cold box process, investment, shell moulding, full mould process, die casting, ceramic shell mould, vaccummoulding etc.

Module III [10 Hours]

Riser Designshape, size and placement. Effect of appendages on risering. Effective feeding distances for simple and complex shapes. Use of chills, gating design, filling time. Aspiration of gases. Top, bottom and inside gating. Directional solidifications stresses in castings. Metal mould reactions. Expansion scale and metal penetration.

Module IV [10 Hours]

Non-Ferrous Die-casting of Aluminum and its alloys, brass and bronze.
Inspection and testing of casting i.e. visual, mechanical, ultrasonic, dye penetration, magnetic particle and x-ray., Casting Defects.

References Books:

1. Flinn, R.A.(1963). *Fundamentals of Metals Casting*. Addison Wesley.
2. Heine, R.W.(1967). *Principles of Metal Casting*.Tata McGraw Hill.
3. Niebel, B.W.& Draper, A.B.(1974). *Product Design & Process Engineering*. Tata McGraw Hill.
4. ASME (1988). *Metals Handbook- Metal Casting*. ASM International.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	1	2	1	3	2	1	3	2	1	2	1	3	2
CO2	2	1	3	1	2	1	3	2	2	1	3	1	2	1	3
CO3	2	1	3	2	1	3	2	1	2	1	-	2	1	3	2
CO4	2	2	1	3	2	2	1	3	1	-	1	1	2	2	1
CO5	2	1	3	2	1	3	3	2	1	3	1	2	1	3	2
Average	**2**	**1.4**	**2.2**	**2**	**1.4**	**2.4**	**2.2**	**1.8**	**1.8**	**1.75**	**1.5**	**1.6**	**1.4**	**2.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name: Micromachining Technologies
Course Code: 105930
Semester: Professional Elective Group -I

L T P
Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understandthe principle of micro-systems and feedback systems
CO2	Differentiate the different methods of micro-fabrication.
CO3	Examine the properties and microstructure of materials
CO4	Apply the integration processes in machining
CO5	Acquire the knowledge of semiconductor manufacturing processes.

Course Content

Module I [10 Hours]

Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport – feedback systems.

Module II [12 Hours]

Micromechanics : Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials

Module III [12 Hours]

Basic micro-fabrication: Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes – Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining. Electron beam machining.

References Books:

1. Franssila,S.(2004). *Introduction to Micro Fabrication*. John Wiley and sons Ltd.
2. Madore, J.(2002). *Fundamental of Micro Fabrication*. CRC Press.
3. Jackson,M. J. (2006). *Microfabrication and Nano-manufacturing*. CRC Press.
4. Zant, P.V.(2004). *Microchip fabrication*.Tata McGraw Hill.
5. Gad-el-Hak, M.(2006). *The MEMS Handbook*. CRC Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	2	1	3	2	1	2	2	1	2	1	3	2
CO2	2	1	3	1	3	2	1	3	2	1	3	1	3	2	1
CO3	3	2	1	2	1	3	2	1	-	2	1	2	1	3	2
CO4	2	1	3	1	3	2	1	3	2	-	3	1	3	2	1
CO5	1	3	1	3	2	1	3	2	2	1	1	3	2	1	3
Average	**2.2**	**1.8**	**1.8**	**1.8**	**2**	**2.2**	**1.8**	**2**	**2**	**1.5**	**1.8**	**1.8**	**2**	**2.2**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Plastic Technology

Course Code: 105931

Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the various aspects of plastics technology viz. plastic materials manufacturing, properties, applications, processing, product design, mold design, testing & quality control, and recycling
CO2	Apply the various aspects of product design, mold design, testing & quality control, and recycling.
CO3	Develop the processes for the manufacturing of plastic materials, and analyze their properties.
CO4	Examine the effect of crystalline on properties of cross-linked plastics

Course Content

Module I [8 Hours]

Introduction to Polymer Chemistry Sources of raw materials- Monomers - Polymers- Polymerization - Types of Polymerization – Classification. Definition and Classification of Plastics – General properties – Historical development of plastic industry-future trends, Thermoplastics, Thermosetting, Engineering & High performance plastics.

Module II [8 Hours]

Structure of Plastics: Molecules –Crystallinity – Effect of Crystallinity on properties – crosslinked plastics – Determination of Molecular weight – Effect of Molecular weight on processing and properties – Molecular weight distribution. Linear, Branched and cross linked structures in polymers. Flexibility and movement of macromolecules. Glass transition temperature (Tg). Relationship

Module III [8 Hours]

Sources and manufacture of raw materials- basic chemistry- Methods of manufacture, Flow behavior- General properties and applications of Olefin Polymer and Co- polymers Vinyl chloride polymers and co-polymers

Module IV [8 Hours]

Introduction – Sources and manufacture of raw materials –basic chemistry – Methods of manufacture – Flow behavior – General properties and applications of Styrene and Styrene co- polymers PMMA. Cellulose polymers

Module V [8 Hours]

Bio degradable and Bio Plastics Principle and Mechanism of Plastics degradation, Natural Bio-degradable Polymers – Synthetic Biodegradable Polymers – Water soluble Polymers. Bio plastics types, properties and applications Case studies on applications of above materials.

References Books:

1. Brydson, J.A. (1999). *Plastics Materials*. Butterworth-Heinemann.
2. Schwartz, S.S.&Goodman, S.H.(1982). *Plastics materials and processing*. Van Nostrand Reinhold.
3. Irwin, I. R. (1990). *Hand book of Plastic Materials and Technology*. New York: Wiley

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	1	3	2	1	3	2	1	3	1	3	2	3	1	2
CO2	1	2	1	3	2	1	3	2	1	2	1	3	1	2	1
CO3	3	1	3	2	1	3	2	1	3	1	3	2	3	1	2
CO4	3	1	3	2	1	3	2	1	-	-	3	2	3	1	1
Average	**2**	**1.25**	**2.5**	**2.25**	**1.25**	**2.5**	**2.25**	**1.25**	**2.3**	**1.3**	**2.5**	**2.25**	**2.5**	**1.25**	**1.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Process Planning and Cost Estimation
Course Code: 105947
Semester: Professional Elective Group -I

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Apply the concepts of process planning and cost estimation for various products.
CO2	Establish process planning concepts to make cost estimation for various products
CO3	Analyze the machining time and cost estimation

CO4	Determine the production costs in various processes

Course Content

Module 1

Introduction of Process Planning- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection

Module 2

Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies

Module 3

Introduction to cost estimation- importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciationcost.

Module 4

Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculations, Machining time calculation for Milling, Shaping, Planing and Grinding

Module 5

Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost

Reference Books:

1. Scalon, Peter (2002). Process Planning, Design/ Manufacture Interface. Elsevier Sci. &Tech..
2. Ostwaal, P.F. & Munez J. (1998). Manufacturing Processes and Systems. 9th ed., John Wiley.
3. Chitale A.V. & Gupta R.C. (2002). Product Design and Manufacturing, 2nd ed., Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	2	1	3	2	1	-	1	-	2	3	1	2
CO2	1	2	1	-	2	1	-	2	1	2	1	3	1	2	1
CO3	2	1	3	2	1	3	2	1	2	1	3	2	1	1	2
CO4	2	1	3	2	1	2	2	1	-	1	3	2	2	1	1
Average	**2.2**	**1.2**	**2.2**	**2.2**	**1.4**	**2.2**	**1.7**	**1.2**	**1.6**	**1.2**	**2**	**2**	**1.6**	**1.2**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Internal Combustion Engines
Course Code: A105901

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the different types of reciprocating internal combustion engines (ICE), their typical design features and performance characteristics.
CO2	Analyze the power cycle of internal combustion engines using ideal gas cycles, air cycles, and fuel-air cycles. Compute indicated power and thermal efficiency.
CO3	Illustrate the gas exchange process and power boosting by means of turbo charging.
CO 4	Solve engine heat transfer problems and its relation to thermal loading of engine components and cooling.
CO 5	Examine the rate of heat release based on measured dynamic cylinder pressure.

Course Content

Module-1: INTRODUCTION (6hours)
Review of Otto, Diesel, Dual and Stirling Cycle, Comparison of Cycles, Actual Cycles and their Analysis, Classification of IC Engine, Two Stroke and Four Stroke cycle Engines, Difference between C.I. and S.I. Engines, Engine Design and Operating Parameters.

Module-2: COMBUSTION IN S.I. ENGINES (8hours)
: Combustion in S.I. Engines, Flame Front Propagation, Flame Speed, Ignition Delay, Abnormal Combustion, Combustion Chambers for S.I. Engines.

Module-3: COMBUSTION IN C.I. ENGINES (8hours)
Combustion in C.I. Engines, Ignition Delay, combustion Knock, Combustion Chamber for C.I. Engines, Fuel Injection Testing.

Module-4 TESTING AND PERFORMANCE (8hours)
Parameters, Engine Power, Engine Efficiencies, Type Of Tests And Characteristic Curves, Variables Affecting Performance Characteristics, Methods of Improving Engine Performance.

Module-5 CARBURETTION, LUBRICATION, COOLING AND IGNITION SYSTEMS (6hours)
Simple and Complex Carburettors, Gasoline Injection, Combustion Design For S.I. Engines, Friction And Lubrication, Types Of Lubrication Systems, Engine Cooling, Ignition Systems, Magneto And Battery Ignition Systems, Ignition Timing.

Module -6 EMISSIONS (4hours)
Engine Economy, Air Pollution Due To IC Engines, Engine Emissions, Particulates, Emission Control Methods, EGR (Exhaust Gas Recirculation),

Module -7 FUELS (3 hours)

Fuels and Their Properties, Stoichiometric and Actual Air Requirements, Flue Gas Analysis.

Reference Books:

1. Heywood, B.J.(1988). *Internal Combustion Engine Fundamentals*. Tata McGraw Hill Book Co.
2. Richard, S.(1985). *Introduction to Internal Combustion Engines*. Palgrave Macmillan.
3. Pulkrabek, W.W.(2004). *Engineering Fundamentals of the Internal Combustion Engine*. Prentice Hall International, Inc.
4. Somasundaram, S.L.(1996). *Thermal Engineering*. New Age International Publishers.
5. Kumar, D.S. &Vasandhani, V.P.(1996). *Heat Engineering*.New Delhi Metropolitan Book Co. Pvt. Ltd.
6. Mathur, R.P. & Sharma, M.L.(1994). *A Course in ICEngine.*Dhanpat Rai & Sons. NDelhi.
7. Ganesan, V.(2003). *Internal Combustion Engine*. Tata McGraw Hill

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	1	3	2	1	3	2	1	3	1	3	2	3	1	2
CO2	1	2	1	3	2	1	3	2	1	2	1	3	1	2	1
CO3	3	1	3	2	1	3	2	1	3	1	-	2	3	1	2
CO4	1	3	2	1	2	1	3	1	2	1	1	3	2	1	2
CO5	3	2	1	3	1	3	2	3	1	-	3	2	1	3	1
Average	**2.2**	**1.8**	**2**	**2.2**	**1.4**	**2.2**	**2.4**	**1.6**	**2**	**1.25**	**2**	**2.4**	**2**	**1.6**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Non-Conventional Energy Resources

Course Code: A105902

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the generation of electricity from various Non-Conventional sources of energy and working knowledge on types of fuel cells.
CO2	Estimate and evaluate the solar energy, it's utilization, principles involved in solar energy collection and its conversion to electricity generation.

CO3	Comprehend the ocean energy and explain the operational methods of their utilization.
CO4	Illustrate the applications of geothermal energy, wind energy & tidal energy.
CO5	Understand the concepts of Tidal and Wind Energy.

Course Content

Module-1:Introduction (4 hours)

Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nation's Development: strategy for meeting the future energy requirements.

Module-2: Solar Energy (6hours)

Solar radiations-beam and diffused radiations; earth sun angles, attenuation and measurement of solar radiations; Optical properties of materials and selective surfaces.

Module-3: Solar Energy Equipment's

Principles, introduction to different types of collectors, flat plate, cylindrical and parabolic collectors; solar energy storage systems-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process heating, solar refrigerant and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries.

1. **Wind Energy:** Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their constructional features; wind data and site selection considerations.
2. **Direct Energy Conversion Systems:** i) Magneto Hydrodynamic (MHD) Generators; Operating principle, types and working of different MHD system –their relative merits; MHD materials and production of magnetic fields ii) Thermo-Electric Generators; Thermo-electric effects and materials; thermoelectric devices and types of thermo-electric generators; thermo-electric refrigeration iii) Thermionic Generators; Thermionic emission and materials; working principle of thermionic convertors iv) Fuel Cell; Thermodynamic aspect; types, components and working of fuel cell. Performance, applications and economic aspects of above mentioned direct energy conversion systems.
3. **Bio-Mass:** Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their type's constructional features and functioning; fuel properties of bio gas and community bio gas plants.
4. **Geothermal:** Sources of geothermal energy types, constructional features and associated prime movers.
5. **Tidal and Wave Energy:** Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy systems.

Reference Books:

1. Prakash, J.& Garg, H.P.(1997).*Solar Energy: Fundamentals and Applications*. TataMcGraw Hill.
2. Sukhatme, S.P.(1996). *SolarEnergy: Principles of thermal collection & storage*. Tata McGrawHill.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	1	3	2	1	3	2	1	2	1	3	2	3	1	2
CO2	1	2	1	3	2	1	3	2	-	1	1	3	1	2	1
CO3	3	1	3	2	1	3	2	1	2	1	3	2	3	1	2
CO4	1	3	2	1	2	1	3	1	2	1	1	3	2	1	2
CO5	3	2	1	3	1	3	2	3	2	-	3	2	1	3	1
Average	**2.2**	**1.8**	**2**	**2.2**	**1.4**	**2.2**	**2.4**	**1.6**	**2**	**1**	**2.2**	**2.4**	**2**	**1.6**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Energy Conservation and Management
Course Code: A105903

Semester:Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Calculate the efficiency of various thermal utilities.
CO2	Develop the suitable energy monitoring system to analyze and optimize the energy consumption in an organization.
CO3	Improve the thermal efficiency by designing suitable systems for heat recovery and co-generation.
CO4	Examine the cost- benefit analysis of various investment alternatives for meeting the energy needs of the organization.
CO5	Encourage the employees of the organization for various methods of energy conservation for implementation.

Course Content

Module-1

Need for Energy Conservation, Its Potentials, Fiscal Incentives, Primary Energy Sources Such as Coal, Gas, Oil, Nuclear Fuel

Module-2

Optimum Use of Prime Movers for Power Generation Such As Steam Turbines, Gas Turbines, Diesel and Gas Engines, Energy Intensive Industries i.e. Iron and Steel, Aluminum, Pulp and Paper, Textile and Oil Refineries and Their Energy Usage Pattern.

Module-3

Plant: Good Housekeeping, Measures in Air Conditioning, Boilers, Combustion System, Steam, Furnaces and General Awareness, Energy Audit, Methodology And Analysis, Energy Conservation Case Studies In Air Conditioning, Boiler And Burners

Module-4

Waste Heat Recovery Systems i.e. Recuperates, Economizers Waste Heat Boilers, Heat Pipe Heat Exchangers, Regenerators etc. Energy Storage Systems Thermal Storage, Insulation, Refractory, Specialized Processes such As Dielectric & Micro Wave Heating, Electronic Beam Welding, Fluidized Bed Technology, Laser as a Welding Tool, Alternative Sources of Energy.

Reference Books:

1. Reay, D.A.(1977). *Industrial Energy Conservation Handbook.*Pergamon Press.
2. Richard, G.(1982). *Process Energy Conservation (Chemical Engineering)*. Tata McGrawHill Publication Co.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	1	3	2	2	1	2	1	3	2	3	1	2
CO2	3	2	1	2	1	3	3	2	2	-	1	3	1	2	1
CO3	2	1	3	1	3	2	2	1	-	1	3	2	3	1	2
CO4	3	1	2	1	1	3	3	1	2	1	1	3	2	1	2
CO5	2	3	1	2	3	2	2	3	2	1	3	2	1	3	1
Average	**2.4**	**1.6**	**2**	**1.4**	**2.2**	**2.4**	**2.4**	**1.6**	**2**	**1**	**2.2**	**2.4**	**2**	**1.6**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Heat Exchanger and Design

Course Code: A105905

Semester:Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the essentials and basic concepts of heat exchangers.

CO2	Illustrate the heat exchanger types and selection criteria of heat exchanger according to usage area.
CO3	Evaluate thermal, pressure drop, strength, and cost analysis of heat exchangers.
CO4	Comprehend the fundamentals of convective heat transfer process.
CO5	Analyze the consequence of heat transfer in thermal analyses of engineering systems.

Course Content

Module-1

Introduction: Classification, types and applications of heat Exchangers, Heat Exchanger Design methodology, Selection of Heat Exchangers.

Module-2

Single Phase Heat Exchangers: LMTD and NTU methods, Rating and sizing methods, design criteria, geometry, process parameters, pressure drops and applications.

Module-3

Two Phase Heat Exchangers: Types of Boiling, Boiling mechanisms, two phase flow boiling pressure drop.

Module-4

Condensation Mechanism, types of condensers and design procedures, Evaporators, Multiple effect evaporators, Design procedures, Liquid chillers, kettle, thermosiphon and forced circulation.

Modue-5

Augmented surface heat exchangers, Heat transfer coefficients, pressure drops, compact heat exchangers and air coolers, plate heat exchangers and plate fine heat exchangers.

Module-6

Heat Pipe Heat Exchangers: Types and design procedure and applications Installation, Operation and Maintenance: Fouling factors, type of fouling and cleaning methods.

Mdule-7

Mechanical Considerations: Codes and Standards, Mechanical design requirements and materials.

Reference Books:-

1. Saunders, E.A.D.(1989). *Heat Exchangers Selection Design and Construction*. Longman Scientific and Technical John Wiley and Sons Inc. NewYork
2. Kern, D.Q.(1965). *Process Heat Transfer*. McGraw HillBook Company.
3. Holman, J.P.(1997). *Heat Transfer*. McGraw Hill Book CompanySingapore.
4. Gupta, J.P.(1986). *Fundamentals of Heat Exchangers and Pressure Vessels Technology*. Hemisphere Publishing Corporation.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	3	1	3	2	2	1	-	1	3	2	3	1	2
CO2	3	2	1	2	1	3	3	2	1	2	1	3	1	2	1
CO3	2	1	3	1	3	2	2	1	2	1	3	2	3	1	2
CO4	3	1	2	1	1	3	3	1	2	1	1	3	2	1	2
CO5	2	3	1	2	3	2	2	3	-	2	3	2	1	3	1
Average	**2.4**	**1.6**	**2**	**1.4**	**2.2**	**2.4**	**2.4**	**1.6**	**1.6**	**1.4**	**2.2**	**2.4**	**2**	**1.6**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name: Automobile Engineering
Course Code: A105501

Semester:Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the functioning of automobiles, maintenance and their manufacturing.
CO2	Examine the servicing of automobiles or trading/ manufacturing of auto components this helps to make skillful.
CO3	Illustrate the types of air compressors, working principle of two stroke and four stroke engines.
CO4	Differentiate the operating characteristics of common internal combustion engines.
CO5	Apply the various thermodynamics laws in engineering applications.

Course Content

Module-1

VEHICLE STRUCTUREANDENGINES

Types of Automobiles - Vehicle Construction – Chassis – Frame and Body – Aerodynamic forces.Engine components, Materials and functions - Cooling and Lubrication systems in engines – Turbo Chargers – Engine Emission Control by three way Catalytic converter – Electronic Engine

Management System.

Module-2

ENGINEAUXILIARYSYSTEMS

Carburetor–working principle - Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Construction, Operation and Maintenance of Lead Acid Battery - Electrical systems – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type) - Regulators-cut outs.

Module-3

TRANSMISSION SYSTEMS

Clutch – Types and Construction – Gear Boxes, Manual and Automatic – Floor Mounted Shift Mechanism – Over Drives – Fluid flywheel - Torque converters– Propeller shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive and Torque Tube Drive – Introduction to rear wheel drive.

Module-4

STEERING, BRAKESANDSUSPENSION

Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box– Power Steering – Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.

Module-5

ALTERNATIVEENERGYSOURCES

Use of Natural Gas, LPG, Biodiesel, Alcohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells – Introduction to off road vehicles.

Reference Books:

1. Crouse, W.H. (1965). *Automotive Mechanics*.Tata McGrawHill.
2. Singh, K.(2009).*Automobile Engineering(Vol. I & II)*. StandardPublishers.
3. Newton, K., Steeds, W. & Garrett, T.K. (1996).*The Motor Vehicle*.ButterworthInternational.
4. Heitner, J.(2004).*Automotive Mechanics*.East WestPress.
5. Gupta, R.B.(2016).*Automobile Engineering*. SatyaPrakashan publications.

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CO1	2	1	3	1	3	2	2	1	3	1	2	2	3	1	2
CO2	3	2	1	2	1	3	3	2	1	1	-	3	1	2	1
CO3	2	1	3	1	3	2	2	1	3	1	2	2	3	1	2
CO4	3	1	2	1	1	3	3	1	2	1	2	3	2	1	2
CO5	2	3	1	2	3	2	2	3	1	-	2	2	1	3	1
Average	**2.4**	**1.6**	**2**	**1.4**	**2.2**	**2.4**	**2.4**	**1.6**	**2**	**1**	**2**	**2.4**	**2**	**1.6**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Gas Dynamics and Jet Propulsion

Course Code: 105940

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the differences between compressible and incompressible flows.
CO2	Comprehend the rocket propulsion and various propellants in real life problems.
CO3	Solve the problems in Rayleigh and Fanno flow.
CO4	Appreciate the compressible flow fundamentals.
CO5	Apply the compressible flow with friction and heat transfer in engineering applications.

Course Content

Module-1

COMPRESSIBLE FLOW–FUNDAMENTALS

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility.

Module-2

FLOW THROUGH VARIABLEAREADUCTS

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

Module-3

FLOW THROUGH CONSTANTAREADUCTS

Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length.

Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

Module-4

NORMAL AND OBLIQUE SHOCK

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl – Meyer equation, impossibility of

shock in subsonic flows, flow in convergent and divergent nozzle with shock. Flow with Oblique Shock – Fundamental relations, Prandtl‟s equation, Variation of flow parameters

Module-5

PROPULSION

Aircraft propulsion – types of jet engines – study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines.

Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants.

REFERENCES:

1. Yahya, S.M.(2005).*Fundamental of compressible flow with Aircraft and Rocket propulsion*. New Age International (p) Ltd.
2. Patrich, H. (1997). *Compressible fluid flow.*Tata McGraw-Hill.
3. Cohen, H. (1987). *Gas TurbineTheory*. Addison Wesley Ltd.
4. Ganesan, V.(1999). *Gas Turbines.* Tata McGraw-Hill.
5. Rathakrishnan, E.(2001). *Gas Dynamics*. Prentice Hall of India.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
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CO2	1	3	3	2	1	2	1	3	1	-	1	1	3	3	2
CO3	3	2	2	1	3	1	3	2	-	1	2	3	2	2	1
CO4	1	3	3	1	2	1	1	3	2	1	2	1	3	3	1
CO5	3	2	2	3	1	2	3	2	1	1	1	3	2	2	3
Average	**2.2**	**2.4**	**2.4**	**1.6**	**2**	**1.4**	**2.2**	**2.4**	**1.75**	**1**	**1.6**	**2.2**	**2.4**	**2.4**	**1.6**

The correlation levels are: “1” – Low Correlation, “2” – Medium Correlation, “3” – High Correlation and “-” indicates there is no correlation

Course Name: Cryogenic Technologies

Course Code: 105941

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement

CO1	Apply the cryogenic engineering to real applications
CO2	Comprehend the basics of thermodynamics, heat transfer as well as refrigeration
CO3	Understand the various methods to create cryogenic temperatures and to maintain it.
CO4	Critically examine the various techniques used in applications of cryogenics in various fields.
CO5	Recognize the engineering problems solvable by applying cryogenic techniques.

Course Content

MODULE : 1

Definition and history of cryogenics, Gas-Liquefaction and refrigeration systems, thermodynamics of gas liquefaction, liquefaction cycles, cryogenic refrigeration systems down to milli Kelvin range, Dilution Refrigerator and adiabatic demagnetization. 10 15

MODULE : 2

Properties of cryogenic liquids, superfluidity, properties of solids at cryogenic temperatures, mechanical, thermal, electrical and magnetic properties, superconductivity 10 15

MODULE : 3

Cryogenic insulations, storage and transfer of cryogenic liquids, cryostats, introduction to vacuum technology, cool down of cryogenic transfer lines, frost phenomena 9 15

MODULE : 4

Instrumentation in Cryogenics: measurement temperature, thermocouples, platinum resistance and semiconductor thermometry liquid level, flow rate, quality 9 15

MODULE : 5

Cryogenics and its applications: applications of cryogenics in engineering, space technology, liquid fuel rockets, space simulation chambers, cryogenic heat pipes, nuclear research, bubble chambers, spectroscopy, cryo pumping, food processing, biology, medicine and LNG technology, cry cooler and its applications. 9 20

MODULE: 6

Principle of air separation, production of gases like oxygen, nitrogen and argon

Reference Books:

1. Baron, R.F. (1966). *Cryogenic systems*. Tata McGraw Hill.
2. Haselden, G.G. (1971). *Cryogenic fundamentals.* Academic press New York.
3. Robert W.(1964). *Cryogenic technology*. American Journal of Physics
4. Bailey, C.A. (1971). *Advance cryogenic*. Plenum Press
5. Scott, &Russell, B.(1959).*Cryogenic engineering*. Princeton.

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CO1	3	2	2	1	3	1	3	2	1	1	2	-	2	2	1
CO2	1	3	3	2	1	2	1	3	-	2	2	1	3	3	2
CO3	3	2	2	1	3	1	3	2	2	1	2	3	2	2	1
CO4	1	3	3	1	2	1	1	3	2	1	2	1	3	3	1
CO5	3	2	2	3	1	2	3	2	2	3	-	3	2	2	3
Average	**2.2**	**2.4**	**2.4**	**1.6**	**2**	**1.4**	**2.2**	**2.4**	**1.4**	**1.6**	**2**	**2**	**2.4**	**2.4**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Solar Energy
Course Code: 105942

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the technology, economics and regulation related issues associated with solar power development and management.
CO2	Analyze the viability of solar power projects.
CO3	Integrate various options and assess the business and policy environment regarding solar power projects.
CO4	Explain the strategic and policy recommendations on usage of solar power.
CO5	Develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding Solar Power Development and Management.

Course Content

Module-1

Solar Flux and Weather Data : Introduction, Solar Constant, Spectrum of sun, Diurnal Variation of Direct Sunlight, Height variation of direct sunlight. Standard Atmosphere, Zenith Distance Flux Variation, Geographical distribution of sun-shine and effects of weather on Solar Flux. Introduction to solar Flux observation, Instruments such as pyranometer, Phyrheliometer and Sunshine Recorder,

Correlation between direct and total Insulation, Solar flux variation dynamic, Correlation of sunshine with Wind Velocity, Environmental Thermal Infrared Flux and ETIR Model.

Module-2

Solar Availability: Introduction, Zenith Distance Vs time, Time of sunrise and sun-set fully Tracking collector, Variation of flux curves with latitude and geometry, Introduction to Fixed
Flat plate (horizontal, latitude Tilted, fixed latitude + 15°, Vertical South-facing, Seasonally Tilted) N-S and horz, east west tracking and N-S polar east west tracking, East west horz and N-S tracking, Comparison of theoretical curves with observation, Comparison of daily output; Peak flux Vs Average flux,

Module-3

Heat Transfer in Solar Collectors: Introduction, Heat Losses in a Distributed Collector system. The Liquid Transfer Module System, Solar Heat Availability, Fluid Mechanics, Fluid Properties, Temperature Rise, Solar Flux, Pressure Drop Relations, Reynolds Number, Ratio of
Power Expended to Power Generated, Magnitude of Power Output/Input Ratio, Parametric Relationships for Fluid Transfer, Variation of Output/Input Ratio with Solar Flux. Air-Transfer Systems.

Module-4

Flat-Plate Collectors: Introduction, Basic Collector Configurations, Diurnal Temperature, Profile, Thermal Inertia U-Factor, Collector Heat Balances. Sample Calculation, Surface Temperature. Efficiency versus-Temperature Curves, General Properties of efficiency Vs
Change and Temperature, The Bare Collector; Single –Window Collector, Double Window Collector Improvement of Performance, Geometrical Suppression of Convection, Window Temperature. Effect of Selective Absorber Surface, Selective Windows Facing Selective Surface Combination of Absorber and selective windows, Problems.

Module-5

Energy Storage: Introduction, Basic System Diagram, Peaking Effect of Back up Demands, Energy Storage, Hydro storage, Chemical Batteries, Flywheels, Chemical Storage, Compressed Air, Biological Storage, Thermal Storage, Sensible-Heat Storage, Latent-Heat Storage, Salt Eutectics, Zoned Thermal Storage Fluid Tank, Rock Thermal Storage Tank, Farm Thermal Storage Tank.

Module-6

Application of Solar Energy: (History and Survey Application) Community Heating & Cooling system, Solar Water pumping, solar gas absorption refrigeration, MEC Cooling system, Two stage evaporative cooling etc.

Module-7

Direct Conversion to Electricity: Introduction, Direct conversion by Means of Solar Cells, Silicon Cells, Manufacture of Silicon Cells, Ribbon Silicon Cells, Polycry silicon cells, Cadmiumsulfide Solar Cells, Manufacture of Cadmium Sulfide Cells Gallium Arsenide Solar Cells, Thermal Behaviors of Solar Cells Cooled Solar Cells for Concentrating System. Thermo-electric Solar Cells, Thermonic Solar Cells, Phase-Change Thermal Direct Conversion, Problems.

Reference Books:-

1. Meinel, A.B. &Meinel, M.P.(1976). *An Introduction to Applied Solar Energy*.Addison-Wesley.
2. Kreider, J. F. &Kreith, F.K.(1981).*Hand Book of Solar Energy*. Tata McGraw Hill

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CO1	2	1	3	2	3	1	2	3	2	2	1	3	1	3	2
CO2	1	2	1	3	1	2	1	1	3	2	2	1	2	1	3
CO3	2	1	3	2	3	1	2	-	2	2	1	3	1	3	2
CO4	2	1	1	3	2	1	2	1	3	-	1	2	1	1	3
CO5	1	2	3	2	1	3	1	-	2	2	3	1	2	3	2
Average	**1.6**	**1.4**	**2.2**	**2.4**	**2**	**1.6**	**1.6**	**1.7**	**2.4**	**2**	**1.6**	**2**	**1.4**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Power Plant Engineering
Course Code: 105943
Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the layout, construction and working of the components inside a thermal power plant.
CO2	Learn about the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
CO3	Understand the layout, construction and working of the components inside nuclear power plants.
CO4	Comprehend the construction and working of the components inside Renewable energy power plants.
CO5	Understand the power plant economics and environmental hazards and estimate the costs of electrical energy production.

Course Content

Module-1
COAL BASED THERMAL POWER PLANTS
Rankine cycle – improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC

Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

Module-2

DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS

Otto, Diesel, Dual &Brayton Cycle – Analysis &Optimisation. Components of Diesel and Gas Turbine power plants.Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

Module-3

NUCLEAR POWER PLANTS

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

Module-4

POWER FROM RENEWABLE ENERGY

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

Module-5

ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Reference Books:-

1. Nag. P.K. (2008). *Power Plant Engineering*. Tata McGraw Hill Publishing Company Ltd.
2. Elliott, T. C. &Swanekamp, R.C. (1998). *Standard Handbook of Power Plant Engineering*. Tata McGraw Hill.
3. El-Wakil, M.M. (2010). *Power Plant Technology*. Tata McGraw Hill Publishing Company Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	3	1	2	3	2	2	1	2	1	1	2	3	3
CO2	2	3	1	2	1	1	1	1	-	-	2	1	3	1	1
CO3	3	2	3	1	2	3	2	2	1	1	1	2	2	3	3
CO4	1	3	2	1	2	1	1	1	1	2	1	1	3	1	2
CO5	2	2	1	3	1	3	2	2	1	1	2	1	2	3	1
Average	**2**	**2.4**	**2**	**1.6**	**1.6**	**2.2**	**1.6**	**1.6**	**1**	**1.5**	**1.4**	**1.4**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Computational Fluid Dynamic

Course Code: 105944

Semester: Professional Elective Group -II

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Develop the governing equations for fluid flow
CO2	Apply finite difference, finite volume and finite element methods to solve the flow problems
CO3	Understand the concept of grid generation.
CO4	Examine the stability and conduct a grid-convergence assessment
CO5	Evaluate turbulence models to engineering fluid flow problems

Course Content

Module-1

Equations of fluid dynamics

Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation. Initial and boundary conditions.Classification of equation of motions – hyperbolic, parabolic, elliptic.

Module-2

Mathematical Preliminaries

Numerical integration. Review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss- Sidel method, successive over relaxation method.

Module-3

Grid Generation

Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.

Module-4

Finite difference discretization

Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis.Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order up winding. Finite difference applications in heat transfer – conduction, convection.

Module-5

Finite Volume Method

Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and vibrationalformulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer

Reference Books:-

1. Ferziger J. H.&Peric, M. (1999). *Computational Methods for fluid Dynamics*.Springer-Verlag.
2. Anderson J. (1995). *Computational fluid Dynamics*. McGraw Hill Inc.
3. Patankar, S. P. (1980). *Numerical Heat Transfer & Fluidflow*. CRC Press.
4. Sunderarajan& Muralidhar, K.(2009). *Computational Fluid Flow and Heat Transfer*.NarosaPublishing

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	1	2	3	2	2	1	2	1	1	2	3	3
CO2	2	3	1	2	1	1	1	-	-	-	2	1	3	1	1
CO3	3	2	3	1	2	3	2	2	1	1	1	2	2	3	3
CO4	1	3	2	1	2	1	1	-	1	2	1	1	3	1	2
CO5	2	2	1	3	1	3	2	2	1	1	2	1	2	3	1
Average	**2**	**2.4**	**2**	**1.6**	**1.6**	**2.2**	**1.6**	**2**	**1**	**1.5**	**1.4**	**1.4**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Fluid Machines
Course Code: A105402

Semester: Professional Elective Group -II

L T P

Credits: 04 **3 1 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Calculate the performance of turbines and pumps
CO2	Understand the applications of momentum principles.
CO3	Develop models for prototypes of hydraulic structures.
CO4	Gain knowledge about the different types of flows and channels.
CO5	Compare and contrast the various types of hydraulic devices and systems

Course Content

Module 1

General Concepts: Impulse momentum principle; jet impingement on stationary and moving flat plates; and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted; work done and efficiency of jet. Basic components of a turbo machine and its

classification on the basis of purpose; fluid dynamic action; operating principle; geometrical features; path followed by the fluid. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes. **07 Hrs**

Module 2

Pelton Turbine: Component parts and operation; velocity triangles; work output; Effective head; available power and efficiency; design aspects such as mean diameter of wheel; jet ratio; number of jets; number of buckets with working proportions; governing of Pelton turbine. **05 Hrs**

Module 3

Francis and Kaplan Turbines: Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks; governing of reaction turbines. **06 Hrs**

Module 4

Centrifugal Pumps: Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump; Heads of a pump - suction; delivery; static; manometric; total; net positive suction head and Euler's head; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; model testing and Priming and priming devices; Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems; causes and remedies.

06 Hrs

Module 5

Similarity Relations and Performance Characteristics: Unit quantities; specific speed and model relationships; scale effect; Cavitation and Thomas's cavitation number; Concept of Net PositiveSuction Head (NPSH) and its application. **04 Hrs**

Module 6

Reciprocating Pumps: Introduction to single acting and double acting reciprocating pumps; their components; and parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Functions of Air vessels. **05 Hrs**

Module 7

Hydraulic Devices and Systems: Construction; operation and utility of simple and differential accumulator; intensifier; fluid coupling and torque converter; Air lift and jet pumps; gear; vane and piston pumps; Hydraulic Ram; Hydraulic lift; Hydraulic crane and Hydraulic press. **03 Hrs**

Reference Books:

1. Daughaty, R.L., (1914). Hydraulic Turbines, McGraw Hill Book Co.
2. Cengel,Y.A.,&Cimbala,J.M.(2013).*Fluid Mechanics - Fundamentals and Applications*.Tata McGraw Hill.
3. Munson,B.R., Young,D.F., Okiishi,T.H.,&Huebsch,W.W.(2013).*Fundamentals of Fluid Mechanics*.John Wiley andSons.
4. Douglas,J.F.,Gasiorek ,J.M., Swaffield,J.A.,&Jack,L.B.(2005).*Fluid Mechanics*.Pearson.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	3	3	2	1	3	1	3	2	3	3	2	1	3
CO2	1	2	1	1	3	2	1	2	1	3	1	1	3	2	1
CO3	2	2	3	2	2	1	-	1	3	-	3	3	2	1	3
CO4	1	3	1	2	3	1	2	1	1	3	1	2	3	1	2
CO5	3	2	3	1	2	-	1	2	3	2	-	1	2	3	1
Average	**1.6**	**2.2**	**2.2**	**1.8**	**2.4**	**1.25**	**1.75**	**1.4**	**2.2**	**2.5**	**2**	**2**	**2.4**	**1.6**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Mechatronics
Course Code: A105908
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basic structure of mechatronics system, different sensors and its characteristics.
CO2	Comprehend the various types of hydraulic and pneumatic actuators used in mechatronics and develop simple hydraulic/ pneumatic automation circuits.
CO3	Illustrate micro electro mechanical system (MEMS), its fabrication technologies and various applications.
CO4	Develop the PLC programs and structure of PLC / CNC machines.
CO5	Analyze different case studies of mechatronic systems used in our daily life.

Course Content

Module-1
Introduction:

What is mechatronics, systems, measurement systems, control systems, microprocessor- based controllers, the mechatronics approach.

Module-2

Sensors Strain Gauge, Potentiometer, Optical Encoders:

Incremental and absolute encoders, linear variable differential transformer (LVDT), piezoelectric, proximity sensor, resistance temperature detector, (RTD), thermostats, thermocouple, hall effect sensor.

Module-3

Electronic Fundamentals:

Signal conditioning process, operational amplifier, digital logic, logic gates, Boolean algebra, sequential logic, data acquisition systems, measurement systems, testing and calibration.

Module-4

Precision Mechanical Actuation:

Pneumaticactuationsystems,electro-pneumaticactuationsystems,hydraulic actuationsystems,electro-hydraulicactuationsystems,mechanicalsystems,typesof motion,kinematics,inversekinematics,timingbelts,ballscrewandnut,linear motion guides,linearbearings,harmonictransmission,bearings,motor/driveselection.

Module-5

Electromechanical Drives:

Relays andsolenoids, steppermotors,DCbrushedandbrushless motors, DCservo motors, AC / DCmotors for non-servo motion drives, braking methods, pulse width modulated,bipolardriver,MOSFETdrives,SCRdrives,variablefrequencydrives.

Module-6

Microprocessor and Computers:

Introduction to 8085 , architecture, programming, computer interfacing, function of PLC, architecture, components of PLC, selection of PLC, ladder logic diagram, logic functions: latching, sequencing, counters, shift registers, jumpers, manipulation of data, arithmetic operations

Module-7

Input/Output Systems:

Interfacing, input / output ports, interface requirements,peripheral interface adapters, serialcommunicationinterface,directmemoryaccess.

Module-8

Control System:

System transfer function, Laplacetransformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PIDcontrol,digitalcontrollers,controlsystemperformance,controllertuning, adaptive control, frequency response, PLC, PMC, introduction to fuzzy logic and neuralnetworks.

Reference Books:-

1. Bolton, W.(2010).*Mechatronics*. Pearson Education
2. Rafiquzzaman, M.(2016). *Microprocessors*.Pearson Education India.
3. Boennett, S.(1988). *Real time computer controls*.Longman Higher Education
4. Kuo, C.B.(1990). *Automatic Control Systems.* Prentice Hall , New Delhi

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	3	1	2	3	2	2	1	2	1	1	2	3	3
CO2	2	3	1	2	1	1	1	2	-	-	1	1	3	1	1
CO3	2	2	3	1	2	3	2	2	1	1	1	2	2	3	3
CO4	1	3	2	1	2	1	1	2	1	2	1	1	3	1	2
CO5	2	2	1	3	1	3	2	2	1	1	-	1	2	3	1
Average	**1.8**	**2.4**	**2**	**1.6**	**1.6**	**2.2**	**1.6**	**2**	**1**	**1.5**	**1**	**1.4**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation**.**

Course Name: :Product Design & Development
Course Code: A105917
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the Product Design and Development Process, as a means to manage the development of an idea from concept through to production.
CO2	Analyze the methodologies as these pertain to the product design process, meaning, and user experience.
CO3	Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
CO4	Validate the hand drawing and drafting principles to convey concepts.
CO5	Understand the Product Design and Development Process, as means to manage the development of an idea from concept through to production.

Course Content

Module-1

Basics of Product Design:

Introduction to product design, concept, terminology, principles, requirements of a good product

design, product types and design considerations for engineering, production consumption cycle, flow and value addition in production consumption cycle.

Module-2

Basic Design Considerations:

Functional & aesthetics consideration, basic design considerations, role of aesthetics in product design, basic concept and elements of visual design, functional design practice.

Module-3

Manufacturing Consideration:

Producibility requirements in the design of machine components, forging design, pressed component design, design for machining, ease of location and clamping, some additional aspects of production design, design of powder metallurgical parts, redesigning on basis of production consideration.

Module-4

Legal & Economic Considerations in Design:

Product value, design for safety, reliability and environmental considerations, economic analysis, profit and competitiveness, break even analysis, economics of a new product design, concurrent design, reverse engineering and rapid prototyping.

Module-6

Value Engineering:

Definition of value, nature, measurement & importance of value, maximum value, normal degree of value, the value analysis job plan, creativity, problem solving and value analysis, value engineering, cost reduction, materials and process selection in value engineering.

Module-7

Product Development:

Definition, concept and objective, role of designer in product development, manufacturing & economic aspects of product development, product promotion & development.

Reference Books:

1. Mayall, W.H.(1967). *Industrial Design for Engineers.* London Llifee Books Ltd.
2. Huchingson, D.R.(1981). *New Horizons for Human Factors in Design.* Tata McGraw Hill College

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	1	2	3	2	2	1	2	1	1	2	3	3
CO2	2	3	1	2	1	1	1	2	1	-	1	1	3	1	1
CO3	2	2	3	1	2	3	2	2	1	2	1	2	2	3	3
CO4	2	3	2	1	2	1	1	2	1	2	1	1	3	1	2
CO5	2	2	1	3	1	3	2	2	1	2	-	1	2	3	1
Average	**2.2**	**2.4**	**2**	**1.6**	**1.6**	**2.2**	**1.6**	**2**	**1**	**2**	**1**	**1.4**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Modeling and Simulation
Course Code: A105911
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the role of important elements of discrete event simulation and modelling paradigm.
CO2	Intellectualise real world situations related to systems development decisions, originating from source requirements and goals. .
CO3	Develop skills to apply simulation software to construct and execute goal-driven system models
C04	Derive the equations of motion for simple systems of rigid bodies, that gives a basis for modeling of mechanical systems.

Course Content

Module-1

Introduction and Overview:

Concept of system, system environment, elements of system, simulation, a management laboratory, advantages limitations of system simulation, continuous and discrete systems.

Module-2

Technique of Simulation:

Monte-Carlo method, System simulation, comparison of simulation with analytical methods, experimental nature of simulation, advantages, limitations and application of system simulation.

Module-3

Numerical Computational Techniques:

For continuous and discrete models. distributed lag models. Cobwals models, examples involving numerical methods of analysis.

Module-4

Simulation of Continuous Systems:

Characteristics of a continuous system, comparison of numerical integration with continuous simulation system, simulation of an integration formula, simulation of trajectories, pure pursuit, serial pursuit, chemical reaction and auto pilot, analog methods, digital-analog simulation time simulation, hybrid simulation.

Module-5

Simulation of Discrete System:

Time flow mechanisms, discrete and continuous probability density functions, generation of random numbers, testing of random numbers for randomness and for auto correlation, generation of random varieties for discrete distribution, generation of random varieties for continuous probability distributions-binomial, normal, exponential and beta distributions, combination of discrete event and continuous models, the rejection method, simulation of reliability, queuing and inventory problems.

Module-6

Design of Simulation Experiment:

Length of run, elimination of initial bias, variance reduction techniques, stratified sampling, antipathetic sampling, common random numbers, time series analysis, spectral analysis, model validation, optimisation procedures, search methods, single variable deterministic case search, single variable non-deterministic case search, regenerative technique.

Module-7

Simulation of PERT:

Simulation of maintenance and replacement problems, capacity planning production system, reliability problems, computer time sharing problem, the elevator system.

Module-8

Simulation Languages:

Continuous and discrete simulation languages, block structured continuous languages, special purpose simulation languages, SIMSCRIPT, GESS SIMULA importance and limitations of special purpose languages.

Reference Books:

1. Bequette, B.W.(1998). *Process Dynamics. Modeling, Analysis, and Simulation*. Prentice Hall International.
2. Leuben, W.L.(1973). *System Modeling & Simulations Control for Chemical Engineers*. PHI.
3. Prada, C.D. (2013). *Process Modeling & Simulation.* Tata McGrawHill

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	2	3	3	2	1	2	2	-	2	1	1	2	1	1
CO2	1	3	1	1	3	2	1	3	1	2	1	1	3	2	2
CO3	2	2	3	3	2	1	1	2	-	2	1	2	2	1	1
CO4	1	3	1	2	3	1	2	3	1	2	1	2	3	1	1
Average	**1.5**	**2.5**	**2**	**2.25**	**2.5**	**1.25**	**1.5**	**2.5**	**1**	**2**	**1**	**1.5**	**2.5**	**1.25**	**1.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Microprocessor in Automation
Course Code: 105936

Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the applications of 8086microprocessor
CO2	Illustrate the basic operations- arithmetic, sorting, searching on 8086 Microprocessor.
CO3	Apply the basic modes of operations and its suitability for applications
CO4	Comprehend the Block diagram based upon Minimum and maximum mode operation
CO5	Analyze thefivestage instruction pipe line – Integrated coprocessor – On board cache – Burst Bus mode.

Course Content

Module-1

8086 MICROPROCESSOR:

Intel 8086 Microprocessor - Internal architecture — Interrupt and Interrupt applications – DMA data transfer –8086 memory organization – even and odd memory banks – segment registers - logical and physical address – advantages and disadvantages of physical memory.

Module-2

8086 MICROPROCESSOR I/O INTERFACING

Intel 8086 microprocessor – Architecture – Instruction set and assembler directives – Addressing modes – Assembly language programming- Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications.

Module-3

80286 MICROPROCESSOR

Intel 80286 Microprocessor - 80286 Architecture, system connection – Real address mode operation – Protected mode operation

Module-4

80486 MICROPROCESSOR AND INFORMAL LABORATORY

Advanced Intel Microprocessors - 80486 – Processor model – Reduced Instruction cycle – five stage instruction pipe line – Integrated coprocessor – On board cache – Burst Bus mode. Pentium – super scalar architecture – u-v pipe line – branch prediction logic – cache structure – BIST (built in self-test) – Introduction to MMX technology. Case Study

Reference Books:

1. Gaonkar,R.S. (2000). *Microprocessor - Architecture, Programming and Applications with the 8085*.Penram International publishing private limited.
2. Ray,A.K. &Bhurchandi, K.M. (2002). *Advanced Microprocessors and peripherals- Architectures, Programming and Interfacing*. Tata McGraw Hill.
3. Brey,B. B.(1987). *The Intel Microprocessors*.Pearson Education India.
4. Hall,D. V.(2003). *Microprocessor and Interfacing*. Tata McGraw Hill

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CO1	3	2	3	3	2	1	3	2	1	2	3	3	2	1	1
CO2	1	3	1	1	3	2	1	3	1	-	1	1	3	2	2
CO3	2	2	3	3	2	1	3	2	2	2	3	3	2	1	1
CO4	3	1	1	3	2	1	3	1	2	2	1	3	2	1	3
Co5	2	3	3	2	1	3	2	3	2	-	3	2	1	3	2
Average	**2.2**	**2.2**	**2.2**	**2.4**	**2**	**1.6**	**2.4**	**2.2**	**1.6**	**2**	**2.2**	**2.4**	**2**	**1.6**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Machine Tool Design

Course Code: 105937

Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the design of various components of structures, guide ways, spindles of machine tools.
CO2	Comprehend the recent trends of tool design required as per the applications**.**

CO3	Apply the design considerations of electrical, mechanical and hydraulic drives in machine tool
CO4	Analyze the kinematics of machine tools, basic principles of machine tool design.
CO5	Examine the various types of automation drives for machine tools, degree of automation, semi-automation, analysis of collet action, design of collet, bar feeding mechanism

Course Content

Module-1

Introduction to Machine Tool Design:

Introduction to metal cutting machine tools, kinematics of machine tools, basic principles of machine tool design.

Module-2

Design of Drives:

Design considerations of electrical, mechanical and hydraulic drives in machine tool, selection of speeds and feeds, stepped and stepless regulation of speed, estimation of power requirements and selection of motor for metal cutting machine tool spindles, design of gear box.

Module-3

Design of Machine Tool Structures:

Principles, materials, static & dynamic stiffness, shapes of machine tool structures, design of beds, columns, housings, tables, ram etc.

Module-4

Design of Spindles, Guide ways and Slide ways:

Design of machine tool spindles- materials of spindles, machine tool compliance, design of bearings- anti friction bearings, sliding bearings, design of guide ways and slide ways.

Module-5

Design of Control Mechanisms:

Basic principles of control, mechanical, electrical, hydraulic, numeric and fluid controls, Selection of standard components, dynamic measurement of forces and vibrations in machine tools, stability against chatter, use of vibration dampers.

Module-6

Automation, Testing and Standardization:

Automation drives for machine tools, degree of automation, semi-automation, analysis of collet action, design of collet, bar feeding mechanism, tooling layout, single spindle mechanism, analysis, Swiss type automatic machine, loading and unloading, transfer-devices, modulator-design concept, in process gauging, acceptance tests and standardization of machine tools.

Reference Books:

1. Juneja, B.L. &Sekhon, G.S. (2017).*Fundamentals of metal cutting and machine tools.* New Age International (P) Ltd.
2. Shaw,M.C. (2012).*Metal Cutting Principles.* Oxford Clarendon Press.

3. Bhattacharya, A. (1899).*Metal Cutting Theory and Practice*. New Central Book Agency (P) Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	1	2	2	1	3	2	2	1	-	1	2	1	3
CO2	3	2	2	3	3	2	1	3	2	2	1	2	3	2	1
CO3	2	1	1	2	2	1	3	2	2	1	-	1	2	1	3
CO4	2	1	1	1	2	1	3	1	2	1	2	1	2	1	3
Co5	1	3	3	3	1	3	2	3	2	3	2	3	1	3	2
Average	**2**	**1.6**	**1.6**	**2.2**	**2**	**1.6**	**2.4**	**2.2**	**2**	**1.6**	**1.6**	**1.6**	**2**	**1.6**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: :Theory of Plasticity
Course Code: 105932
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to :

CO	Statement
CO1	Select the most appropriate plasticity model according to the materials and applications
CO2	Calibrate constitutive models using experimental data
CO3	Apply analytical methods for the calculation of collapse loads with limit analysis
CO4	Recognize all the components of a non-linear constitutive model of solid mechanics
CO5	Appreciate the capabilities and limitations of the constitutive simulations with finite element programs

Course Content

Module-1

Introduction:

Introduction to the concept of plastic deformation using simple ideas and familiar examples, On the role of microstructure and thermodynamics in plastic deformation, relevant concepts from continuum mechanics, Constitutive responses: elastic, viscoelastic, plastic, viscoplastic, anisotropy etc. Physical overview of crystal plasticity, plasticity of granular media, plasticity in rubber-like materials, etc. (Rate independent plastic deformation).

Module-2

Formulation of rate-independent plasticity:

Rate dependent and rate independent plasticity, Plastic strain, incremental strain, objective rates, and hardening variables, Yield criteria, Ilyushin's postulate of maximum plastic work (including Drucker's postulate), Maximum dissipation and normality rule (Associated flow rules), Hardening rules (isotropic and kinematic), Non-associated flow rules, Axisymmetric problems in plasticity (Plane problems in Plasticity)

Module-3

Flow rules and hardening rules:

Basic equations of plane strain and plane stress, Slip lines and their properties, Solution to several problems (such as indentation, necking, drawing, etc), Application of slip line theory (Geophysics, tectonics, metal forming, etc.) (Some theorems in plasticity).

Module-4

Theorems and analysis:

Uniqueness theorems and variational principles in plasticity, Limit analysis and shakedown theorems (Plastic stability and waves), The concept of plastic stability (3-0-0-9), Global stability criteria according to Hill, Elastoplastic column buckling, Local stability criteria (localization, shear bands, ellipticity), Introduction to dynamic plasticity, One-dimensional waves.

Reference Books:

1. Lubliner, J.(1990). *Plasticity Theory.* Macmillan Publishing Comp.
2. Kachanov, L. M. (2004).*Fundamentals of the theory of plasticity.* Courier Corporation.
3. Bigoni, D. (2012). *Nonlinear Solid Mechanics*.Cambridge University Press.
4. Dixit,P. M. &Dixit, U. S. (2014). *Plasticity: Fundamentals and applications*.CRC Press.
5. Chakrabarty, J. (2012). *Theory of Plasticity*.Butterworth-Heinemann

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	2	1	3	2	2	1	1	1	-	1	2	2	1
CO2	2	3	3	2	1	3	3	2	1	1	2	2	3	3	2
CO3	1	2	2	1	3	2	2	1	1	1	2	1	2	2	1
CO4	1	1	2	1	3	1	2	1	1	1	2	1	1	2	1
Co5	3	3	1	3	2	3	1	3	-	-	-	3	3	1	3
Average	**1.6**	**2.2**	**2**	**1.6**	**2.4**	**2.2**	**2**	**1.6**	**1**	**1**	**2**	**1.6**	**2.2**	**2**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Design for X

Course Code: 105933

Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the impact of manufacturing constraints on product design and process planning
CO2	Analyze the variation in the shapes that control the production rate and influence the quality, cost and flexibility of processes and systems
CO3	Develop cross disciplinary idea for design problems
CO4	Critically examine the design and prototype based upon an innovative idea
CO5	Work in cross-functional groups and to apply the concepts learnt in theory to a practical problem

Course Content

Module-1

Introduction to Design Methodology, Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Concurrent Engineering.

Module-2

Material Selection: Properties of Engineering Materials, Selection of Materials, Case Studies, Selection of Shapes, Case Studies.

Module-3

Process Selection: Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes.

Module-4

Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Design for Additive Manufacturing, Case-Studies.

Module-4

Review of Assembly Processes, Design for Welding, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies.

Module-6

Manual assembly, Design for PCB Manufacturing and assembly, Electrical Connections and Wire harness assembly, Design for Automated and Robotic Assembly.

Reference Books:

1. Ashby,M. F. &Johnson,K. (2014).*Materials and Design: The Art and Science of Material Selection in Product Design*. Butterworth-Heinemann Ltd.
2. Dewhurst,P. (2010). *Product Design for Manufacture and Assembly*. CRC Press.
3. Schmidt,L.C. &Dieter,G.(2013).*Engineering Design*. McGraw Hill Education India Pvt. Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	3	2	1	3	3	2	1	-	1	2	1	3
CO2	2	1	3	2	1	3	1	1	2	-	1	2	3	2	1
CO3	3	2	1	3	2	1	2	1	1	1	1	3	3	2	2
CO4	1	3	2	1	3	1	1	3	2	1	-	1	3	2	1
CO5	2	1	3	2	1	2	1	3	2	1	1	2	1	3	2
Average	**2.2**	**1.8**	**2**	**2.2**	**1.8**	**1.6**	**1.6**	**2.2**	**1.8**	**1**	**1**	**1.8**	**2.4**	**2**	**1.8**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Tool Design
Course Code: 105934
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the basic motions involved in a machine tool.
CO2	Design the machine tool structures.
CO3	Analyze systems for specified speeds and feeds, Select subsystems for achieving high accuracy in machining.
CO4	Comprehend the control strategies for machine tool operations, Apply appropriate quality tests for quality assurance

Course Content

Module-1

Introduction to Machine Tool Drives and Mechanisms

Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.

Module-2

Regulation of Speeds and Feeds

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.

Module-3

Design of Machine Tool Structures

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity.

Module-4

Materials for Machine Tool Structures

Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages.

Reference Books:

1. Mehta, N.K. (1984).*Machine Tool Design and Numerical Control*. Tata McGraw Hill.
2. Sen, G.C. &Bhattacharyya, A. (1967). *Principles of Machine Tools*. New Central Book Agency
3. Pal, D. K&Basu, S. K. (2008).*Design of Machine Tools*. Oxford and IBH Publishing.
4. Acherkhan, N. S. (2000). *Machine Tool Design, Vol. I, II, III and IV*. University Press of the Pacific.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	**PSO 1**	**PSO 2**	**PS0 3**
CO1	3	2	1	3	2	1	1	-	2	1	2	1	2	1	3
CO2	2	1	3	2	1	3	1	1	2	2	1	2	3	2	1
CO3	3	2	1	3	2	1	1	1	2	2	-	3	3	2	2
CO4	1	3	2	1	3	1	1	-	2	1	2	1	3	2	1
Average	**2.25**	**2**	**1.75**	**2.25**	**2**	**1.5**	**1**	**1**	**2**	**1.5**	**1.6**	**1.75**	**2.75**	**1.75**	**1.75**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: :Design of Transmission Systems
Course Code: 105935

Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to

CO	Statement
CO1	Understand the concepts of design for belts, chains and rope drives.
CO2	Comprehend the concepts of design for spur, helical gears.
CO3	Apply the concepts of design for worm and bevel gears.
CO4	Relate the concepts of design for gear boxes assembly.
CO5	Examine the designs of cams, brakes and clutches under various conditions of applications.

Course Content

Module-1

Design of Flexible Elements: Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

Module-2

Spur Gears and Parallel Axis Helical Gears: Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane Equivalent number of teeth-forces for helical gears

Module-3

Bevel, Worm and Cross Helical Gears: Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

Module-4

Gear Boxes; Geometric progression - Standard step ratio - Ray diagram, kinematics layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

Module-5

Cams, Clutches and Brakes: Cam Design; Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Reference Books:

1. Bhandari, V.(2016). *Design of Machine Elements*. Tata McGraw-Hill Book Co.
2. Shigley, J.(2008). *Mechanical Engineering Design*. Tata McGraw-Hill.
3. Merhyle, F.(2003). *Design of Machine Elements*.Printice Hall.
4. Orthwein, W.(2003). *Machine Component Design*.Jaico Publishing Co.
5. Prabhu, T.J.(2000). Design of Transmission Elements. Mani Offset.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	1	3	2	1	2	-	2	1	1	1	2	1	3
CO2	2	1	3	2	1	3	2	2	1	1	1	3	2	1	3
CO3	1	3	2	1	3	1	1	2	2	1	-	2	1	3	1
CO4	2	1	3	2	1	2	1	2	2	2	1	3	2	1	2
CO5	3	2	1	3	1	1	2	2	1	-	1	1	3	1	1
Average	**2.2**	**1.8**	**2**	**2.2**	**1.6**	**1.6**	**1.6**	**2**	**1.6**	**1.25**	**1**	**2**	**2**	**1.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Finite Element Method

Course Code: A105914

Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the numerical methods involved in Finite Element Theory.
CO2	Understand the role and significance of shape functions in finite element formulations

	and use linear, quadratic, and cubic shape functions for interpolation
CO3	Compare direct and formal (basic energy and weighted residual) methods for deriving finite element equations.
CO4	Examine the use of the FE methods for heat transfer problems.
CO5	Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use.

Course Content

Module-1

Introduction:

Finite element methods, history and range of applications.

Module-2

Finite Elements:

Definition and properties, assembly rules and general assembly procedure, features of assembled matrix, boundary conditions.

Module-3

Continuum Problems:

Classification of differential equations, variational formulation approach, Ritz method, element equations from variations. Galerkin's weighted residual approach, energy balance methods.

Module-4

Element Shapes and Interpolation Functions:

Basic element shapes, generalized coordinates, polynomials, natural coordinates in one-, two- and three-dimensions, Lagrange and Hermite polynomials, two-D and three-D elements for C^o and C^1 problems, coordinate transformation, iso-parametric elements and numerical integration.

Module-5

Applications & Case Studies:

Application of finite element methods to elasticity and structural, heat transfer, fluid-flow, lubrication and general field problems.

Reference Books:

1. Chandrupatla, T. &Belegundu, A.(2011). *Introduction to Finite ElementsinEngineering*. PHI Learning Pvt. Ltd.
2. Bathe, K.J.(1996). *Finite Element Procedures.* PHI Learning Pvt. Ltd.
3. Reddy, J.(2005). *An Introduction to Finite Element Method*. Tata McGraw Hill Education.
4. Huebner, K.H.(2001). *The Finite Element Methods for Engineers*. JohnWiley
5. Zienkiewicz, O.C.(2007). *The Finite Element Method.* Tata McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3

CO1	3	2	1	3	2	1	1	2	2	1	2	1	2	1	3
CO2	2	1	3	2	1	3	2	2	1	2	1	3	2	1	3
CO3	1	3	2	1	3	1	1	-	2	1	1	2	1	3	1
CO4	2	1	3	2	1	2	1	2	2	2	1	3	2	1	2
Co5	3	2	1	3	1	1	2	2	1	2	2	1	3	1	1
Average	**2.2**	**1.8**	**2**	**2.2**	**1.6**	**1.6**	**1.4**	**2**	**1.6**	**1.6**	**1.4**	**2**	**2**	**1.4**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Industrial Tribology
Course Code: A105912
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Apply the concept of design friction, wear and Lubrication in practical problems
CO2	Identify different types of sliding and rolling friction, Wear and related theories
CO3	Distinguish among the different Lubricant regimes.
CO4	Select materials for bearing for the applicable designs.

Course Content

Module-1

Wear

Types of wear – Simple theory of Sliding Wear Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations – Corrosive wear – Surface Fatigue wear situations – Brittle Fracture – wear – Wear of Ceramics and Polymers – Wear Measurements.

Module-2

Lubricants and Lubrication Types

Types and properties of Lubricants – Testing methods – Hydrodynamic Lubrication – Elasto-hydrodynamic lubrication- Boundary Lubrication – Solid Lubrication- Hydrostatic Lubrication.

Module-3

Surface Engineering and Materials for Bearings

Surface modifications – Transformation Hardening, surface fusion – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes – Vapour Phase processes -Materials for rolling Element bearings – Materials for fluid film bearings – Materials for marginally lubricated and dry bearings.

References Books:

1.Cameron, A. (1981).*Basic Lubrication Theory.* Longman.
2.Bowden,E. P. & Tabor, D. (1974).*Friction and Lubrication.* Heinemann Educational Books Ltd.
3.Khonsari, M. M. &Booser,E. R.(2001).*Applied Tribology.* John Willey &Sons.
4.Neale M. J. (1995).*Tribology Handbook*. Butterworth-Heinemann.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	3	3	2	1	2	1	2	2	-	1	1	2	1	3
CO2	3	1	1	3	2	1	3	2	1	2	1	1	3	1	3
CO3	1	3	3	2	1	2	1	1	2	-	2	1	2	3	1
CO4	2	1	3	2	1	2	1	1	2	2	1	-	2	1	2
Average	**1.75**	**2**	**2.5**	**2.25**	**1.25**	**1.75**	**1.5**	**1.5**	**1.75**	**2**	**1.25**	**1**	**2.25**	**1.5**	**2.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name:Experimental Stress Analysis
Course Code: 105938
Semester: Professional Elective Group -III

L T P
Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the measurement of strain under static and dynamic loads.
CO2	Understand the Mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
CO3	Develop and awareness about the fixing of gauges and temperature effects in bonded gauges and measurement of stress in stress gauges.
CO4	Analyze the strains of different strain gauge rosettes.

Course Content

Module-1

Extensometers and Displacement Sensors:

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages, Capacitance gauges, Laser displacement sensors.

Module-2

Electrical Resistance Strain Gauges:

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells, Data acquisition, six component balance**.**

Module-3

Photoelasticity:

Two dimensional photo elasticity, Photo elastic materials, Concept of light – photoelastic effects, stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

Module-4

Introduction to Brittle Coatings:

Historical development of brittle coatings, Methodology of brittle coatings, Crack patterns produced by direct loading, Uniaxial, Biaxial and Isotropic stress fields, Steps in brittle coating tests, Coating selection, Surface preparation.

Reference Books:

1. Dally, J.W.& Riley, W.F.(1998)*Experimental Stress Analysis*. McGraw Hill Inc.
2. Srinath, L.S. (1984). *Experimental Stress Analysis*. Tata McGraw Hill.
3. SinghS. (1996). Experimental Stress Analysis. Khanna Publishers.
4. Kumar, R. (2000).*Digital Photoelasticity – Advanced Techniques and Applications*. Springer.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	3	2	1	3	2	1	2	2	1	1	-	2	1	3
CO2	3	2	1	2	1	1	3	2	1	2	1	1	3	1	3
CO3	1	3	2	1	3	2	1	-	2	1	-	2	1	3	1
CO4	2	1	3	2	1	2	3	2	1	-	1	-	2	1	3
Average	**1.75**	**2.25**	**2**	**1.5**	**2**	**1.75**	**2**	**2**	**1.5**	**1.33**	**1**	**1.5**	**2**	**1.5**	**2.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Computer Aided Design
Course Code: 105939
Semester: Professional Elective Group -III

L T P

Credits: 04 **4 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the various software used in CAD and the functions of a graphics package.
CO2	Understand the various concepts and characteristics in geometric modeling.
CO3	Analyze the components and systems of NC and CNC machine tools.
CO4	Apply the various programming methods for specific jobs.
CO5	Differentiate the FMS and CIMS with reference to components, advantages and applications.

Course Content

Module-1

Introduction:

Overview of conventional design & manufacturing process, computer's role in design, benefits of computer application, relation of CAD with CAM, history of CAD development, current trends in CAD.

Module-2

CAD Hardware & Software:

Central processing unit, memory, input & output devices, types of computer systems, computer programming, general information of various software for CAD, types of file formats & their exchange, graphics standards**.**

Module-3

Geometric Modeling:

Curve representation methods, surface representation methods, half spaces, boundary representation (B-rep),sweeprepresentation,constructivesolid geometry (CGS),solidmanipulations, modeling facilities desired.

Module-4

Transformations:

Translation, rotation, scaling symmetry, reflection, homogeneous transformations, orthographic projections, axonometric projections, oblique projections, perspective transformation.

Module-5

VisualRealization:

Basicconceptsofvisual realization,hiddenline removal,hiddensurfaceremoval,shading surfacesandsolids visibility techniques, sorting coherence, hidden line removal for curved surface.

Module-6

CADandCAMintegration:

Introduction, part production cycle, manufacturing system, process, integration requirements, process planning, tool path generation and verification, Design and Engg. applications.

Module-7

Introductionto Reverse Engineeringand Rapid Prototyping:

Introduction to Design and Engineering Applications:

Geometry and mass property formulations.

Practice on Drafting and Modeling systems : Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling on available CAD packages.

Reference Books:

1. Groover, M. &Zimmers,E.(1984). *CAD/CAM*. Prentice Hall of India
2. Groover, M.P.(1980).*Automation: Production Systems & CAM*.Englewood Cliffs New Jersey
3. Chang, T.C. &Wysk, R.A.(1985). *An introduction to Automated Process Planning*.Longman Higher Education
4. Singh, N.(1995).*System approach to Computer Integrated Design and Manufacturing*.Wiley.
5. Pable, B.S. &Adithan, M.(1994). CNC Machines. New Age International(P) Ltd.
6. Dalela, S.& Jain, P.K.(2000).*CAD/CAM*. S Chand & Company Pvt Ltd.
7. Ibraham,Z. (2009). *CAD/CAM - Theory and Practice*. Tata McGraw Hill Pub Co.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1
CO2	2	2	2	2	1	2	2	2	-	-	1	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	-	2	1	1
CO4	2	2	2	2	2	2	2	1	-	2	1	2	1	2	2
CO5	1	2	2	1	2	1	2	2	2	2	2	-	2	2	2
Average	**1.6**	**2**	**2**	**1.8**	**1.8**	**1.8**	**2**	**1.8**	**2**	**2**	**1.6**	**2**	**1.8**	**1.8**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Industrial Safety and Environment

Course Code: A105802

Semester: Open Elective Group

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Evaluate the workplace to determine the existence of occupational safety and health hazards
CO2	Identify the relevant regulatory and national consensus standards along with best practices that are applicable.
CO3	Select appropriate control methodologies based on the hierarchy of controls
CO4	Analyze injury and illness data for trends.
CO5	Enhance their skill sets to deal with any situation in industry.

Course Content

Module I [8 Hours]

Meaning & need for safety: Relationship of safety with plant design, equipment design and work environment. Safety measures in a manufacturing organization, safety and economics, safety and productivity. Employees participation in safety. Safety standards and legislation

Industrial accidents: Industrial accidents, their nature, types and causes. Assessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.

Module II [8 Hours]

Planning for safety: Definition, purpose, nature, scope and procedure. Range of planning, variety of plans. Policy formulation and implementation of safety policies.

Environment and need for environmental : Meaning of environment and need for environmental control. f factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.

Module III [8 Hours]

Ventilation, Lighting and heat Control : Ventilation and heat Control Purpose of ventilation. Physiology of heat regulation. Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation. Mechanical ventilation. Air conditioning Process ventilation. Control of heat exposures: control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation. Local relief. Industrial Lighting: Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting installation. Maintenance standards relating to lighting and colour.

Module IV [6 Hours]

Noise & Vibrations: Continuous and impulse noise. The effect of noise on man. Noise measurement and evaluation of noise. Noise isolation. Noise absorption techniques. Silencers vibrations: Effect, measurement and control measures.

Environment Standards: Introduction to ISO 14000; Environment standards for representative industries.

Reference Books:

1. Joselin, E.L.(1934). *Ventilation.* EdwardArnold.
2. Beranek, L.L.(1960). *Noise Reduction*. McGraw Hill.
3. DeReamer, R.(1980). *Modern Safety and health Technology*. RWiley.
4. Heinrich, H.W.(1959). *Industrial Accident Prevention.* McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	2	1	1	2	2	1	-	2	1	2	1
CO2	2	1	2	1	2	2	2	2	1	-	1	2	2	1	2
CO3	1	2	1	1	2	1	1	1	2	1	1	2	2	1	1
CO4	1	1	1	1	1	2	1	1	1	1	1	-	1	2	1
CO5	1	2	1	2	2	1	2	1	2	1	-	2	1	1	2
Average	**1.2**	**1.6**	**1.2**	**1.4**	**1.8**	**1.4**	**1.4**	**1.4**	**1.6**	**1**	**1**	**2**	**1.4**	**1.4**	**1.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Total Quality Management

Course Code: A105918

Semester: Open Elective Group

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the dimensions of product quality or service quality for the same.
CO2	Understand the Quality Expert's philosophies/ contributions in Quality Management.
CO3	Develop the Pareto chart to prioritize the defects.
CO4	Illustrate the four levels of benchmarking and/ or enlist and brief seven step benchmarking model.

CO5	Examine the dimensions of product quality or service quality for the same.

Course Content

Module I [15 Hours]

Quality and Total Quality Management, Excellence im manufacturing/service, factors of excellence, relevance of TQM. benefits of TQM.

Concept and definition of quality, total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models,

Just-in-time (JIT): Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation, Role of JIT in lean manufacturing.

Module II [12 Hours]

Customer Satisfaction: data collection and complaint, redressal mechanism.

Planning Process: Policy development and implementation, plan formulation and implementation.

Process Management: Factors affecting process management, Quality function development (QFD), and quality assurance system.

Total Employees Involvement (TEI): Empowering employees: team building, quality circles, reward and Recognition, education and training, Suggestion schemes.

Module III [10 Hours]

Problems solving Defining problem, Problem identification and solving process, QC tools.

Benchmarking definition, concept, process and types of benchmarking.

Module IV [10 Hours]

Quality Systems: Concept of quality system standards: relevance and origin of ISO 9000, Benefits, Elements of ISO 9001, ISO 9002, ISO 9003.

Advanced techniques of TQM: Design of experiments: failure mode effect analysis: Taguchi methods

References Books:

1. Raju, S. (2008) *Total Quality Management.* Tata McGrawHill.
2. Zairi, M.(1991). *TQM for Engineers.*Woodhead Publishing.
3. Hradeskym, J.L. (1944).*Total Quality Management Handbook.* Tata McGrawHill
4. Dalela, S. (1999). *ISO 9000 quality System.* StandardPublishers Distributers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	2	3	2	3	2	1	2	1	-	3	2	3
CO2	2	1	2	1	2	1	2	1	-	1	-	1	2	1	2
CO3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	2	3	2	3	2	3	2	1	2	3	2	-	3	2	3
CO5	1	2	1	2	1	2	1	2	1	2	1	1	2	1	2
Average	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.8**	**1.4**	**1.25**	**1.8**	**1.25**	**1**	**2.2**	**1.4**	**2.2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Management Information System
Course Code: A105920
Semester: Open Elective Group

L T P

Credits: 03 **3 0 0**

Course Outcomes:

CO	Statement
CO1	Understand the basic concepts and technologies used in the field of management information systems.
CO2	Differentiate the processes of developing and implementing information systems.
CO3	Illustrate the role of the ethical, social, and security issues of information systems.
CO4	Comprehend the role of information systems in organizations, the strategic management processes, with the implications for the management.

Course Content

Module I [8 Hours]

INTRODUCTION: Organization and management, Management classification and Functions, Organizational structure, scalar point, span of control, Unity of command. Organizational systems, Open and Closed system, Application of systems concept to an organization, Information system, characteristics of MIS.

Module II [8 Hours]

INFORMATION SYSTEM AND CONTROL: Definition of information, Components of Information system, Evolution of Information systems Technology – The First generation, The Second generation, The Third generation, The fourth generation and Information systems today, Computer Hardware, A sample program, Data Representation, File processing and database processing. Case studies. Enterprise Information systems – Applications and goals. Information system control.

Module III [8 Hours]

DECISION MAKING: Phases in Decision making process, Behavioral models of decision maker classical Economic model, Administrative Model. Methods for decisions among alternatives, optimization techniques, pay off matrices, decision trees, Utility and Inference curves, statistical Technologies, Minicase studies.

Module IV [8 Hours]

DECISION SUPPORT SYSTEMS: Characteristic of DSS, classes of DSS, Expert system cases, computer based decision support system, developing and implementing application system – life cycle approach, [prototyping approach, Quality assurance and evaluation of Information systems. Future development and Impact of Information Technology on organization and Society.

Reference Books:-

1. Mudrick, R.G., Ross, J.E. &Clagget, J.R. (1971). *Information systems for Modern Management*.Prentice Hall.
2. Davis, G.B.& Olson, M.H. (1985). *Management Information systems*.TataMcGrawHill.
3. Lucas, H.C. (1983). *Information systems for management.*TataMcGrawHill.
4. Kanter, J. (1983). *Jerome,Management Information System*.Prentice Hall.
5. Davis, G.B. &Olson, M.H.(1985). *Management Information System*.TataMcGraw-Hill Inc.
6. Kroenke, D.M.&Hatch, R.(1993). *Management Information System*.Tata McGraw-Hill Publishing Co.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	2	3	2	3	2	3	2	-	1	-	2	3	2	3
CO2	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
CO3	1	1	1	1	1	1	1	1	2	1	2	1	1	1	1
CO4	2	3	2	3	2	3	2	-	2	1	2	2	3	2	3
Average	**2**	**1.75**	**2**	**1.75**	**2**	**1.75**	**2**	**1.3**	**2**	**1**	**2**	**1.5**	**2.25**	**1.5**	**2.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Operation Management
Course Code: 105945
Semester: Open Elective Group

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Comprehend the major concepts in the functional areas of accounting, marketing, finance, and management.
CO2	Evaluate the legal, social, and economic environments of business.
CO3	Understand the global environment of business.
CO4	Apply the concepts of Functional Strategies, Gross Domestic Product (GDP) and World Class Manufacturing

Course Content

Module-I

Introduction: Functional subsystem of an Organisation, Definition of Operation Management, System Concept of Production, Types of Production System, Strategic Management- Corporate Strategies, Generic Competitive Strategies, Functional Strategies, Gross Domestic Product (GDP) and its impact, World Class Manufacturing [10]

Module-II

Line Balancing: Concept of mass Production system, objective of Assembly Line balancing, Rank Positional Weight Method, The COMSOAL Algorithm, Model for Assembly Line Balancing- Integer Programming Model to minimize the number of work Station and model to minimize the balancing Delay, Stochastic Assembly, Line Assembly [10]

Module-III

Maintenance, Planning & Control: Objectives of Maintenance, Types of maintenance, basic reasons for replacement, Replacement problems, Determination of maintenance crew size using Analytical Queuing Model, Total Productive Maintenance: Objectives, Waste elimination, Equipment maintenance Technique, Benefits, Pillers of TPM. [10]

Module-IV

Just in Time Manufacturing, Computer Integrated Manufacturing, Total Quality management, ISO 9000 series, Poke a Yoke, Kaizen, Business Process Re-engineering, Supply chain Management, Lean Manufacturing [10]

References Books:

1. Adam,E.E.& Ebert, R.J. (2004). *Production and Operation Management*.Prentice Hall of India.
2. Paneerselvam,R. (2005). *Production and Operation Management*. Prentice Hall of India

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	1	2	1	2	1	-	1	2	1	2	1
CO2	2	1	2	1	2	1	2	1	2	1	1	1	2	1	2
CO3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	2	1	2	2	2	1	2	1	2	1	-	2	1	2	1
Average	**1.5**	**1.25**	**1.5**	**1.5**	**1.5**	**1.25**	**1.5**	**1.25**	**1.5**	**1**	**1**	**1.5**	**1.25**	**1.5**	**1.25**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Industrial Engineering

Course Code: 105946

Semester: Open Elective Group

L T P

Credits: 03 **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Illustrate the need for optimization of resources and its applications
CO2	Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
CO3	Validate the concept of value analysis and its relevance.
CO4	Differentiate the various concepts which are involved in method study and understanding of work content in different situations.
CO5	Comprehend the different aspects of work system design and facilities design pertinent to manufacturing industries.

Course Content

Module - I [12 Hours]

Linear Programming: Graphical Method, Primal and Dual problem, simplex method, Transportation and assignment problems, Queuing theory-poission's and exponential service time, single server and multi server models

Module – II [6 Hours]

Network analysis including PERT & CPM. Productivity: Importance, Productivity ratio, Productivity measurement, Productivity index

Module – III [12 Hours]

Forecasting: Methods – moving average, exponential smoothing, Regression analysis, coefficient of co-relation, Delphi, Market survey, Facilities Planning: Site location, facilities layout, work place design, working conditions – noise illumination etc

Module – IV [10 Hours]

Motion study – Principles of Motion – economy, Time Study – standard time, Production Planning & Control: Aggregate Planning, Sequencing, Line balancing, Flow control, Dispatching, expendiating Gantt chart. Line of balance, Learning curve.

Reference Books:

1. Hillier, F.S. & Liberman, G.J.(1967).*Introduction of Operations Research*.Holden. San Francisco.
2. Giggs, J. L.(1981).*Production Systems: Planning & Control*.John Wiley.

3. Barnes,R. M.(1971).*Motion & Time Study*.John Wiley & Sons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	1	2	1	2	1	2	1	2	1	2	1	-	1	2	1
CO2	2	1	2	1	2	1	2	1	2	-	2	1	2	1	2
CO3	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1
CO4	2	1	2	2	1	2	2	1	2	2	1	1	2	1	2
C05	2	1	2	2	1	2	2	1	2	2	1	1	2	1	2
Average	**1.6**	**1.2**	**1.6**	**1.6**	**1.2**	**1.6**	**1.6**	**1.2**	**1.6**	**2**	**1.2**	**1**	**1.6**	**1.2**	**1.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Total Number of Courses	**60**
Number of Theory Courses	**42**
Number of Practical Courses	18
Total Number of Credits	**186**

Annexure-4

ACADEMIC INSTRUCTIONS

Attendance Requirements

A student shall have to attend 75% of the scheduled periods in each course in a semester; otherwise he / she shall not be allowed to appear in that course in the University examination and shall be detained in the course(s). The University may condone attendance shortage in special circumstances (as specified by the Guru Kashi University authorities). A student detained in the course(s) would be allowed to appear in the subsequent university examination(s) only on having completed the attendance in the program, when the program is offered in a regular semester(s) or otherwise as per the rules.

Assessment of a course

Each course shall be assessed out of 100 marks. The distribution of these 100 marks is given in subsequent sub sections (as applicable).

	Internal (40)						External (60)	Total
Components	**Attendance**	**Assignment**			**MST1**	**MST2**	**ETE**	
		A1	A2	A3				
Weightage	5	5	5	5	30	30	60	
Average Weightage	5	5			30		40	100

Passing Criteria

The students have to pass both in internal and external examinations. The minimum passing marks to clear in examination is 40% of the total marks.