Course Curriculum (in light of NEP 2020) for B. Tech.

In

Mechanical Engineering

(For students admitted in 2022-23 onwards)

National Institute of Technology
Arunachal Pradesh

P.O.: Jote, Dist.: Papumpare, Arunachal Pradesh, Pin–791113
www.nitap.ac.in

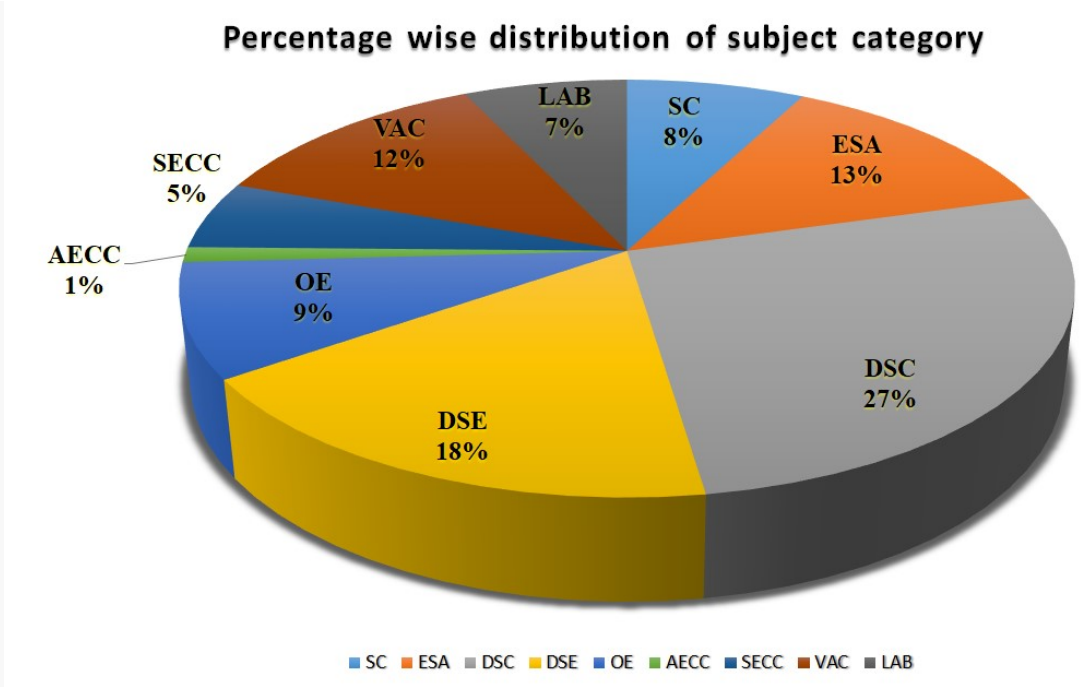
1.0 Semester wise Credit point distribution

Sl. No.	Year	Credit Point	
		ODD	EVEN
1	First	22	22
2	Second	21	21
3	Third	24	23
4	Fourth	20	17
Total Credit Point		**87**	**83**
		170	

1.1 Subject Category wise Credit point Distribution

Course Category	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Sem-VII	Sem-VIII	Total Credit Point
Science Core (SC)	7	3	3	-	-	-	-	-	**13**
Engineering Science and Arts (ESA)	8	14	-	-	-	-	-	-	**22**
Departmental Specific Core (DSC)	4	3	9	9	9	9	3	-	**46**
Departmental Specific Elective (DSE)	-	-	3	3	3	6	9	6	**30**
Open Elective (OE)	-	-	3	3	3	3	3	-	**15**
Ability Enhancement Compulsory Course (AECC)	-	-	-	-	1	-	1	-	**2**
Skill Enhancement Compulsory Course (SECC)	3	-	-	3	3	-	-	-	**9**
Value Added Course (VAC)	0	2	-	-	2	2	4	11	**21**
Laboratory (LAB)	-	-	3	3	3	3	-	-	**12**
Total Credit Point									**170**

1.2 Subject Category wise Credit point Distribution (in percentage)



2.0 Course Structure

Ist Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SC1-Engineering Mathematics-I	2	0	0	2
2	BS-1102	SC2-Engineering Chemistry	2	0	0	2
3	BS-1103	SC3-Engineering Physics	2	0	0	2
4	BT-1101	ESA1-Biology for Engineers	2	0	0	2
5	ME-1101	DSC1-Fundamentals of Mechanical Engineering	3	0	0	3
6	MH-1101	SECC1-Communication Skill	2	0	0	2
7	EE-1102	ESA2-Basic of Electrical and Electronics Engineering	2	0	0	2
8	CS-1102	ESA3-Coding Laboratory	0	0	4	2
9	EE-1103	ESA4-Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
10	BS-1104	SC4-Basic Science Laboratory-I	0	0	2	1
11	ME-1102	ESA5-Engineering Drawing	0	0	2	1

12	ME-1103	DSC2-Basic Mechanical Engineering Laboratory	0	0	2	1
13	MH-1102	SECC2-Language Laboratory	0	0	2	1
14	MH-1103	VAC1-NSS/NCC/Yoga (Audit Pass)	0	0	0	0
Contact Hours			15	0	14	
Total Credits						22
II[nd] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1201	SC5-Engineering Mathematics-II	2	0	0	2
2	CS-1201	ESA6-Programming and Data Structure	3	0	0	3
3	EC-1201	ESA7-Introduction to Digital engineering	2	0	0	2
4	MH-1201	ESA8-Introduction to Innovation and Creativity	2	0	0	2
5	ME-1201	ESA9-Engineering Mechanics	3	0	0	3
6	ME-1202	DSC3-Introduction to Machine Tools and Operation	3	0	0	3
7	ME-1203	ESA10-System Design	2	0	0	2
8	ME-1204	ESA11-Workshop Practice-I	0	0	2	1
9	ME-1205	VAC2-Do It Yourself (DIY)/Industry Exposure	0	0	0	1
10	BS-1202	SC6-Basic Science Laboratory-II	0	0	2	1
11	CS-1202	ESA12-Programming and Data Structure Laboratory	0	0	2	1
12	MH-1202	VAC3-Gandhian Technology	0	0	2	1
Contact Hours			17	0	8	
Total Credits						22
III[rd] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-2101	SC7-Engineering Mathematics-III	3	0	0	3
2	ME-2101	DSC4-Introduction to Thermodynamics	2	1	0	3
3	ME-2102	DSC5-Solid Mechanics	2	1	0	3
4	ME-2103	DSC6- Fluid Mechanics-I	2	1	0	3
5	ME-210A	DSE1- Material Science and Metallurgy	3	0	0	3
	ME-210B	DSE1- Sustainable Energy Conversion.				

6	YY-210X	OE1*.	3	0	0	3
7	ME-2104	Laboratory-I – Machine Drawing	0	0	2	1
8	ME-2105	Laboratory-II – Strength of Materials Laboratory	0	0	2	1
9	ME-2106	Laboratory-IIII – Workshop Practice -II	0	0	2	1
Contact Hours			15	3	6	
Total Credits						21
IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-2201	DSC7- Fluid Mechanics-II	2	1	0	3
2	ME-2202	DSC8 – Kinematics of Machinery	2	1	0	3
3	ME-2203	DSC9 –Manufacturing Processes-I	3	0	0	3
4	ME-220A	DSE2 –Numerical Methods in Engineering/ Continuum Mechanics	3	0	0	3
	ME-220B	DSE2 – Continuum Mechanics				
5	YY-220X	OE2*	3	0	0	3
6	MH-2201	SECC3-Entrepreneur Essential and Early Stage Start-up	3	0	0	3
7	ME-2204	Laboratory-IV – Fluid Mechanics and Machinery Laboratory	0	0	2	1
8	ME-2205	Laboratory-V – Kinematics of Machinery Laboratory	0	0	2	1
9	ME-2206	Laboratory-VI - Manufacturing ProcessesLaboratory	0	0	2	1
Contact Hours			16	2	6	
Total Credits						21
Vth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-3101	DSC10 –Applied Thermodynamics	3	0	0	3
2	ME-3102	DSC11 – Design of Machine Elements	3	0	0	3
3	ME-3103	DSC12 - Manufacturing Processes II	3	0	0	3
4	ME-310A	DSE3 - Dynamics of Machinery	3	0	0	3
5	YY-310X	OE3*	3	0	0	3
6	ME-3104	AECC1-Internship-I	0	0	0	1

7	MH-3101	SECC4-Engineering Economics	3	0	0	3
8	ME-3105	VAC4-Minor Project-I	0	0	4	2
9	ME-3106	Laboratory-VII–Thermal Laboratory-I	0	0	2	1
10	ME-3107	Laboratory-VIII - Workshop Practice II	0	0	2	1
11	ME-3108	Laboratory-IX–Theory of Machines Laboratory	0	0	2	1
Contact Hours			18	0	10	
Total Credits						24
VIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-3201	DSC13 - Heat Transfer	3	0	0	3
2	ME-3202	DSC14 - Industrial Engineering & Operations Research	3	0	0	3
3	ME-3203	DSC15–Machine Design	3	0	0	3
4	ME-320A	DSE4–Computational Fluid Dynamics	3	0	0	3
	ME-320B	DSE4– Finite Element Analysis				
	ME-320C	DSE4– Computer-Aided Design and Manufacturing				
5	ME-321A	DSE5 - Materials Characterization methods	3	0	0	3
	ME-321B	DSE5 - Automobile Engineering				
	ME-321C	DSE5 - Advanced Machine Tools and Operations				
	ME-321D	DSE5 - Refrigeration and Air-conditioning				
	ME-321E	DSE5 - Mechatronics and Automation				
6	YY-320X	OE4*	3	0	0	3
7	ME-3204	VAC5-Minor Project-II	0	0	4	2
8	ME-3205	Laboratory-X - Thermal Laboratory-II	0	0	2	1
9	ME-3206	Laboratory-XI–Design Practices	0	0	2	1
10	ME-3207	Laboratory-XII–Mechatronics and Automation Laboratory	0	0	2	1
Contact Hours			18	0	10	
Total Credits						23
VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-4101	DSC16-Product Design and Development	3	0	0	3

2	ME-410A	DSE6– Convective Heat Transfer	3	0	0	3
	ME-410B	DSE6– Mechanical Vibration				
	ME-410C	DSE6– IC Engines				
	ME-410D	DSE6– Nanotechnology				
	ME-410E	DSE6– Measurement and Control				
	ME-410F	DSE6– Viscous Fluid Flow				
3	ME-411A	DSE7 – Robotics	3	0	0	3
	ME-411B	DSE7 – Introduction to Aeronautics				
	ME-411C	DSE7 – Advanced Solid Mechanics				
	ME-411D	DSE7 – Renewable Energy				
	ME-411E	DSE7 – Composite Materials				
4	ME-412A	DSE8 –Gas Turbine Technology	3	0	0	3
	ME-412B	DSE8 –Principle of Tribology				
	ME-412C	DSE8 –Optimization Techniques				
	ME-412D	DSE8 –Gas Dynamics				
	ME-412E	DSE8 –Bio-materials				
5	YY-410X	OE5*	3	0	0	3
6	ME-4102	AECC2-Internship-II	0	0	0	1
7	ME-4103	VAC6-Major Project-I	0	0	8	4
Contact Hours			15	0	8	
Total Credits						20
VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-421A	DSE9 - Materials selection and Design	3	0	0	3
	ME-421B	DSE9 - Advanced Thermodynamics				
	ME-421C	DSE9 - Additive Manufacturing				
	ME-421D	DSE9 - Two-phase flow and heat transfer				
	ME-421E	DSE9 - Non-linear Vibration				

	ME-421F	DSE9 - SWAYAM Course				
2	ME-422A	DSE10 - Thermal Storage Systems	3	0	0	3
	ME-422B	DSE10 - Mathematical Modeling of Manufacturing Processes				
	ME-422C	DSE10 -Fuels and Combustion				
	ME-422D	DSE10 - Industry 4.0 and Machine Learning				
	ME-422E	DSE10 - Micro and Nano Manufacturing Processes				
	ME-422F	DSE10 - SWAYAM Course				
3	ME-4201	VAC7-Major Project-II	0	0	22	11
Contact Hours			6	0	22	
Total Credits						17

*The students have to choose a subject offered by other department.

3.0 List of Department specific electives

DSE1	DSE2	DSE3	DSE4	DSE5	DSE6	DSE7	DSE8	DSE9	DSE10
ME-210A	ME-220A	ME-310A	ME-320A	ME-321A	ME-410A	ME-411A	ME-412A	ME-421A	ME-422C
ME-210B	ME-220B	ME-310B	ME-320B	ME-321B	ME-410B	ME-411B	ME-412B	ME-421B	ME-422B
			ME-320C	ME-321C	ME-410C	ME-411C	ME-412C	ME-421C	ME-422C
				ME-321D	ME-410D	ME-411D	ME-412D	ME-421D	ME-422D
					ME-410E	ME-411E		ME-421E	ME-422E
					ME-410F			ME-421F	ME-422F

- **Students are urged to register for the electives given under DSE9 and DSE10 using the SWAYAM/NPTEL, etc. portal. Courses will be of completely student's choice and should be of at least of 12 weeks including tutorials which will be considered as 3 credit course.**

4.0 Open elective (offered by other departments)

- Students are free to choose any subjects of their interest offered as open electives by other department of the Institute.
- The total course has to be of 15 credits.
- During the beginning of the 3rd semester onwards, HoD, ME will notify the specific subject offered as an open elective for other departments.

Open Electives (Offered by ME Deptt. for other Departmental Students)

Sl No	Course Code	Course Title	L	T	P	C
1	ME-210X	OE1 – Fluids and Thermal Engineering	3	0	0	3
2	ME-220X	OE2 – Materials and Manufacturing Practices	3	0	0	3
3	ME-310X	OE3–Elements of Mechanical Design	3	0	0	3
4	ME-320X	OE4 – Robotics	3	0	0	3
5	ME-410X	OE5 – Mechatronics and Automation	3	0	0	3
Contact Hours			15	0	0	15
Total Credits						15

5.0 Internship

- Internship - I: Student will go for internship during summer vacation (after 4th semester) for a period of 4 weeks. The assessment will be done on 5th semester
- Internship - II: Student will go for internship during summer vacation (after 6th semester) for a period of 4 weeks. The assessment will be done on 7th semester

6.0 Institute Vision

To transform into an acclaimed institution of higher learning with creation of an impact on the north eastern region in terms of innovation and entrepreneurship.

7.0 Institute Mission

1. To generate new knowledge through state of the art academic program and research in multidisciplinary field.
2. To identify regional, Indian and global need to serve the society better.
3. To create an ambience to flourish new ideas, research and academic excellence to produce new leaders and innovators.
4. To collaborate with other academic, research institutes and industries for holistic growth of the students.

5. Utilization of available big resources to encourage entrepreneurship through formation of start-ups.

8.0 Departmental Vision

"To produce competent mechanical engineers for generation of state of the art technology, innovative products and challenging entrepreneurs for overall development of the society."

9.0 Departmental Mission

1. To impart quality education with holistic approach to cater the needs of Industry and society.
2. To develop state of the art laboratories and centre of excellence for teaching, research and innovation.
3. To encourage collaborative work in multidisciplinary field with Industries and other research Organizations.
4. To create an ambience for entrepreneurship development with special emphasis to resource utilization of North-East region.

10.0 Programme Outcomes (POs)

PO1	**Engineering Knowledge-** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis-** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of Solutions-** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems-** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool usage-** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society-** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability-** Understand the impact of the professional

	engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics-** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work-** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication-** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance-** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long Learning-** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

11.0 Program Educational Objectives (PEOs)

PEO1	Graduates will be able to apply technical knowledge and skills as Mechanical Engineers to provide the solutions for the industries and society.
PEO2	Graduates will be able to work in multidisciplinary environment developing complex mechanical systems.
PEO3	Encourage establishing own start-ups to become competent entrepreneur.

12.0 Program Specific Outcomes (PSOs)

PSO1	Ability to identify, formulate and solve engineering problems in three core streams of Mechanical Engineering, i.e. design engineering, thermal and fluids engineering and manufacturing engineering.
PSO2	Ability to prepare and execute the plan to manufacture components / assembly / processes and systems.
PSO3	Engage professionally and ethically in industries or as an entrepreneur by incorporating technological and managerial skills and build the attitude of developing new concepts on emerging fields and pursuing advanced education.

I[st] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SC1-Engineering Mathematics-I	2	0	0	2
2	BS-1102	SC2-Engineering Chemistry	2	0	0	2
3	BS-1103	SC3-Engineering Physics	2	0	0	2
4	BT-1101	ESA1-Biology for Engineers	2	0	0	2
5	ME-1101	DSC1-Fundamentals of Mechanical Engineering	3	0	0	3
6	MH-1101	SECC1-Communication Skill	2	0	0	2
7	EE-1102	ESA2-Basic of Electrical and Electronics Engineering	2	0	0	2
8	CS-1102	ESA3-Coding Laboratory	0	0	4	2
9	EE-1103	ESA4-Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
10	BS-1104	SC4-Basic Science Laboratory-I	0	0	2	1
11	ME-1102	ESA5-Engineering Drawing	0	0	2	1
12	ME-1103	DSC2-Basic Mechanical Engineering Laboratory	0	0	2	1
13	MH-1102	SECC2-Language Laboratory	0	0	2	1
14	MH-1103	VAC1-NSS/NCC/Yoga (Audit Pass)	0	0	0	0
Contact Hours			15	0	14	
Total Credits						22

Subject Code: Engineering Mathematics-I
Subject Name: BS 1101
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. Providing high quality education in pure and applied mathematics in order to prepare students for graduate studies or professional careers in mathematical sciences and related fields,
2. Imparting theoretical knowledge and to develop computing skill to the students in the area of science and technology,
3. Providing teaching and learning to make the students competent to their calculating ability, logical ability and decision-making ability,

4. Giving students theoretical knowledge of calculus, algebra and the practical applications in the various fields of science and engineering,
5. Apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate program in mathematics and other fields such as the field of quantitative /mathematical finance, mathematical computing, statistics and actuarial science.

B. Course Content:

Matrix Algebra: Basic concept of matrices & Determinant, Jacobi's theorem. Rank of a matrix, rank nullity theorem, Introduction to Vector space, Linear dependent and independent, System of homogeneous and non-homogeneous linear equations, Eigen values and Eigen vectors of a square matrix, Cayley-Hamilton theorem and its applications.

Differential Calculus: Higher order derivatives, Leibnitz's theorem and its application, Rolle's theorem and its application, Mean Value theorems–Lagrange & Cauchy and their application, Taylor's theorem and its application, Expansions of functions by Taylor's and Maclaurin's theorem. Partial Derivatives, Differential calculus for two variables.

Integral Calculus: Double and triple integrals and evaluation of area and volume, change of variables.

C. Text Books:

1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11th edition.
2. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 2014, 43rd edition.
3. Marsden J., Tromba A. J. and Weinstein A., Basic Multivariable Calculus, Springer, India, Private Ltd, 2009.

D. Reference Books:

1. Finney R. L. and Thomas G. B., Calculus and Analytical Geometry (Linear Algebra), Narosa Publishing House, 2021, 9th edition.
2. Hofmann K. M. and Kunze R., Linear Algebra, Prenticehall, 2015, 2nd Edition.
3. Bartle and Sherbart, Introduction to Real Analysis, Wiley, 2014, 4th Edition.
4. Apostol T. M., Calculus,Vol I and II, John Wiley and Sons Ltd;, 2007, 2nd Edition.
5. Stewart J., Transcendental Calculus, Cengage; 2014, 2nd edition.
6. Mappa S. K., Higher Algebra, Shrat book House, 2014.
7. Mappa S. K., Real Analysis, Shrat book House, 2013, 7th edition.
8. Wylie C. R. and Barrett L. C., Advanced Engineering Mathematics, McGraw Hill, 1995.

E. Course Outcomes:

1. Students will become more confident about their computing skill, logical skill and decision making skill,
2. Students will find various applications of calculus and algebra in the practical fields of science and engineering,

3. Students will become more competent to analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions,
4. Student will be able to explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validations.

Subject Code: Engineering Chemistry
Subject Name: BS 1102
Credit Point: 2 **(**L=2, T=0, P=0)

F. Course Objectives:

1. To enable the students to acquire knowledge about basic chemistry and its technology.
2. To understand applicability of chemistry for engineering purposes.
3. To make them apply the knowledge of chemistry for analysis, evaluation and design system components or processes related to chemistry.

G. Course Content:

Chemical thermo dynamics: first law, energy, enthalpy, Cp and Cv, second law, entropy, free energy, chemical kinetics: rate of elementary reactions, surface chemistry: surfactants and colloidal systems; electrochemistry: conductance, Kohlrausch's law, cell EMF.

Ligand, somerism, valence bond theory, valence shell electron pair repulsion theory, crystal field theory, molecular orbital theory, charge transfer transition, d-d transition, John-Teller effect, magnetic properties, bioinorganic chemistry.

Hybridization, inductive effect, resonance, hyper conjugation, carbocation, carbanion and free radicals, substitution and addition reactions, introduction to instrumental methods (IR, UV-vis, NMR and Mass-spectroscopy).

Polymers and materials: addition and condensation polymers, degree of polymerization, thermoplastic and thermosetting plastics, conducting polymers, nanomaterials and ceramics, nanocomposites, corrosion, explosive materials.

H. Text Books:

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic chemistry, Pearson education, New Delhi, 2010, 7^{th} Ed.
2. Rakshit P.C., Physical chemistry, Sarat book distributors, Kolkata, 2004, 7^{th} Ed.
3. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic chemistry: principles of structure and reactivity, Pearson Education, New Delhi, 2009, 4^{th} Ed..

I. Reference Books:

1. Ray B. C., Das S. N. and Biswas S., Engineering chemistry, New Central Book Agency, Kolkata, 2008.
2. Gowariker V. R, Viswanathan N. V and Sreedhar J., Polymer science, New Agency International, Kolkata, 2012.
3. Malik W. U., Tuli G. D. and Madan R. D., Selected topics in inorganic chemistry, S. Chand, New Delhi, 2012.
4. Ahluwalia V. K. and Parashar R. K., Organic reaction mechanisms,., Narosa publishing house, Kolkata, 2013, 4th Ed.

J. Course Outcomes:

1. Acquire basic knowledge in engineering chemistry.
2. Apply their knowledge for various technological and engineering issues.
3. Select appropriate analysis, evaluation and methods for interpret the concern results.

Subject Code: Engineering Physics
Subject Name: BS 1103
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. Imparting theoretical & practical knowledge to the students in the area of engineering physics.
2. Providing teaching and learning to make students acquainting with modern state-of-art of Engineering.
3. Injecting the future scope and the research direction in the field of Physics with specific specialization.
4. Making students competent to design & development of Engineering Physics.

B. Course Content:

Electricity and Magnetism:

Coulombs law in vector form, Electric field, Gauss's law (differential and integral form), Electric potential and energy, multipole expansion of electric potential, Boundary value problem (Poisson's Eqn. and Laplace's Eqn.). Dielectric, Polarization and Bound charges, Biot-Savart's law, Ampere's law (differential and integral form), Faraday's law of electromagnetic induction, Lenz's Law, Self and mutual Inductance, Maxwell'sfield equation in vacuum and matter.Wave solution of Electromagnetic waves.

Modern Physics and Quantum Mechanics:

Photo electric effect, Compton effect, Blackbody radiation (no derivations), Wave particle duality, two slit experiments, de-Broglie's hypothesis, Heisenberg's uncertainty principle,

concept of wave function and wave packet**,** phase velocity and group velocity, Formulation of quantum mechanics and basic postulates, physical interpretation of wave function, Schrodinger's wave equation, Steady state of Schrodinger's wave equation, One dimensional quantum problems:Free particle, particle in a box, particle in a step potential, harmonic oscillator.

C. Text Books:

1. Griffiths J. D, "Introduction to Electrodynamics," Pearson Education India Learning Private Limited, 2015, 4th Ed.
2. Griffiths J. D, "Introduction to Quantum Mechanics," Pearson Education, 2015, 2nd Ed.
3. Beise, A., Mahajan, S. and Choudhury S. R., "Concepts of Modern Physics," McGraw-Hill Education, 2017, 7th Ed.

D. Reference Books:

1. Krane K., "Modern Physics", Wiley, 2016.
2. Jackson, J. D. "Classical Electrodynamics", Wiley, 1998, 3rd Ed.
3. Feynman R. P., Leighton R. B. and Matthew S., "The Feynman Lectures on Physics Vol. 1 to Vol. 3" The New Millennium Edition, 2012.

E. Course Outcomes:

1. Demonstrate competency and understanding of the basic concepts found in physics.
2. Utilize the scientific method for formal investigation and to demonstrate competency with experimental methods that are used to discover and verify the concepts related to content knowledge.
3. Engineering applications capability to understand advanced topics in engineering. apply quantum mechanics to engineering phenomena
4. Identify formula and solve engineering problems.

Subject Code: BT1101
Subject Name: ESA1-Biology for Engineers
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. imparting knowledge on the origin of Earth and life forms on Earth, appreciating importance of biological diversity and understanding biomolecules being the main component of life.
2. understanding "Cell" – the basic UNIT in different life forms, and structure and function of different organelles in living organisms
3. imparting knowledge on nutrient uptake and assimilation, and metabolism in living organisms, providing knowledge on Bioenergetics of living cells, different organelles

involved in electron transport systems, nervous, digestive and immune systems in animals.

4. imparting knowledge on immunity of the body and various advanced applications derived out of the natural systems
5. imparting knowledge on DNA as a genetic material and various advanced technology derived out of it for variety of applications
6. imparting knowledge on interference of biological systems in various machines, structures, process and instrumentation
7. motivating young minds to utilise their interdisciplinary knowledge to become a thinker in innovation of effective ideas for solving problems related to biological systems

B. Course Content:

Origin of Life: theories of origin of life, Classification of various forms of life (virus, bacteria, fungi, plantae, Animalia)

Nutrients and Bioenergetics: Essential nutrients (carbohydrates proteins, lipids, nucleic acids, minerals, vitamins), Bioenergetics; basics of aerobic and anaerobic glycolysis and citric acid cycle.

Cell: Cell concept, prokaryotic and eukaryotic cell, cell organelles and their functions, Cell division: Mitosis and meiosis, Cancer biology

Immunology: Immune systems and cell types, applications of immunology: biosensors, nanoparticles.

Genes and Chromosomes: Principles of inheritance, Mendelian Genetics, Discovery of DNA as genetic material, DNA mutation and effects, Genetic engineering/Cloning and its applications

C. Text Books:

1. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; HiddePloegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon. Molecular Cell Biology (Ninth Edition). W. H. Freeman, 2020
2. J. L. Tymoczko, J. M. Berg and L. Stryer, Biochemistry, 8th Ed, W. H. Freeman & Co, 2015.
3. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Ed, Macmillan Worth, 2017.
4. N.A. Campbell, J.B. Reece, "Biology" Person Education, Inc& Dorling Kinderley Publishing, Inc, 2015
5. wen, Judith A., Jenni Punt, and Sharon A. Stranford. Kuby immunology. New York, NY, USA:: WH Freeman, 2013.
6. Niemeyer, Christof M., and Chad A. Mirkin, eds. Nanobiotechnology: concepts, applications and perspectives. Vol. 1. John Wiley & Sons, 2004.

D. Reference Books:

1. Nruno Antonny, Catherine Rabouille. Cell Organlles, Current Opinion in Cell Biology, Elsevier, 2017
2. Joel B. Hagen. Five Kingdoms, More or Less: Robert Whittaker and the Broad Classification of Organisms, BioScience, Oxford Academic, 2012
3. Pascal Maguin,Luciano A. Marraffini, From the discovery of DNA to current tools for DNA editing, JEM, 2021

E. **Course Outcomes:**

4. Students will understand the characteristics of living organisms; appreciate the importance of diversity of life and their interaction with the environment.
5. Students will be able to explain the interrelationship between biomolecules and the living system, and influences of biomolecules upon the structure and function of intracellular components.
6. Students will have a broad knowledge on Bioenergetics of living cells; and a brief on important biological systems of animal.
7. Students will learn different functions of cell organelles, cell types and various positive and negative functional implications, development of new tools and kits from the knowledge of natural system.
8. Students will learn the basis of inheritance and introduction to technological aspects and varied applications and advanced tools to tackle medical complications
9. Students will learn the interference of biological systems in various machines, structures, process and instrumentation
10. Students will develop keen interest in applying basic engineering skills to solving problems related to biological systems through their concepts in biology

Subject Code: ME-1101
Subject Name: Fundamentals of Mechanical Engineering
Credit Point: 3 **(**L=3, T=0, P=0)

F. Course Objectives:

1. Understand basic definitions and terminology.
2. Students get a basic idea of Thermodynamics, Fluid Mechanics, Strength of Material and Manufacturing processes**.**

G. Course Content:

Thermodynamics: Introduction, concepts of systems and control volumes, properties of a system, state and equilibrium, processes and cycles, quasi-static process, reversible &

irreversible processes and cycles, temperature and Zeroth law of thermodynamics, concepts of heat and work transfer, introduction to1st and 2ndlaws of thermodynamics and their applications.

Fluid Mechanics: Properties of fluid-mass and weight density, specific gravity, specific volume, viscosity and Newton's law of viscosity, types of fluid, surface tension and capillarity, Pascal's law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement, Bernoulli's equation-velocity and flow measurement, introduction to fluid machineries, classification of pumps and turbines.

Strength of Materials: Concept of stress and strain-Hook's law, Poisson's ratio, elastic and plastic deformation, normal stress, shear stress, bearing stress, normal strain, shearing strain, principal stresses, Mohr's circle, relation of Young's modulus, modulus of rigidity and bulk modulus, theories of failure and applications.

Manufacturing Technology: Classification and types of materials, types of casting, patterns, pattern materials and allowances, classification and application of welding, brazing and soldering process, various metal forming techniques.

H. Text Books:

7. Nag P K., Engineering Thermodynamics, Tata McGraw Hill Publisher, 2017, 6th Edition.
8. Som S K., Biswas G. and Chakraborty S., Introduction to Fluid Mechanics & Fluid Machines, McGraw Hill Education India, 2017, 3rd Edition.
9. Shames I H., Introduction to Solid Mechanics, Prentice Hall, 2015, 3rd Edition.
10. Rao P N., Manufacturing Technology: Foundry, Forming and Welding, Volume I, Tata McGraw Hill, 2018, 5th Edition.
11. Timoshenko S. P. and Young D. H., Elements of Strength of Materials, East West, 2003, 5th Edition.
12. Srinath L. S., Strength of Materials, Macmillan publishers India, 2000, 1st Edition.

I. Reference Books:

1. Ghosh A. and Mallik A K., Manufacturing Science, Wiley Eastern, 2010, 2nd Edition.
2. Cengel Y A. and Boles M A., Thermodynamics, An Engineering Approach, McGraw Hill Education, 2017, 8th Edition.
3. Beer F P., Johnston E R., Dewolf J T., Mazurek D F., Sanghi S., Mechanics of Materials, McGraw Hill, 2020, 8th Edition.

J. Course Outcomes:

1. Understand the basic concepts of thermodynamics, fluid mechanics, strength of materials and manufacturing technology.
2. Describe the physics of thermodynamics, fluid mechanics, strength of materials and manufacturing technology.
3. Solve the fundamental problems related to thermodynamics, fluid mechanics, strength of materials and manufacturing technology.

Subject Code: MH-1101
Subject Name: Communication skills
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. To increase the student's ability to improve and utilize the skills necessary to be competent communicator.
2. To enhance the students' linguistic understanding of his or her own communication behaviour.
3. To improve the students' communication skills in both social and professional contexts.
4. To enhance language proficiency and thereby the employability of budding engineers and technologists.

B. Course Content:

Fundamentals of Communication-Concept and Meaning, Process of Communication, Communication Channels, Importance of Communication, Role of Cross-cultural Communication, Communication Cycle, Objectives and Barriers of Communication(linguistic and semantic, psychological, physical, mechanical, cultural), Importance of Audience and Purpose, Types of Communication, Styles of Communication, Verbal and Nonverbal Communication, Comparing General Communication and Technical Communication, Role of Communication in Technology, Persuasive Skills, Negotiation Skills, Language Skills (listening, speaking, reading, writing),Listening-Types of Listening, Writing-Writing Formal Letters, Résumés, Reports, User Manuals, Emails and Blogs, Essentials of Grammar- Sentence Formation, Common Errors and Misappropriations, Note Making, Oral and Poster Presentation Skills, Interview Skills and Etiquette, Language Usage in Social Media.

C. Text Books:

1. Salaria, R.S. and Kul Bhushun Kumar, Effective Communication Skills, Khanna Publishing, 2022.
2. Edwards, Vanessa Van. Cues: Master the Secret Language of Charismatic Communication, Penguin, 2022.
3. Kumar, Sanjay and PushpLata, Communication Skills: Workbook, Oxford University Press (OUP), 2018.
4. Mitra, Barun K. Personality Development and Soft Skills, Oxford University Press (OUP), 2016.

D. Reference Books:

1. Kumar, Sanjay and Pushpa Lata, English Language and Communication Skills for Engineers (as per AICTE Syllabus), Oxford University Press (OUP), 2018.

2. Raman, Meenakshi and Sangeeta Sharma,Technical Communication: Principles and Practice, Oxford University Press (OUP), 2017.
3. Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, Jan Svartvik. A Comprehensive Grammar of the English Language, Pearson Education India, 2010.

E. Course Outcomes:

1. Display competence in oral, written, and visual communication.
2. Apply communication theories in various speech acts.
3. Practice the effective way of communication with good personality traits and etiquette.
4. Understand the process of communication and its effect on giving and receiving information.

Subject Code: EE-1102
Subject Name: Basic of Electrical and Electronics Engineering
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. Course Content:

Network Theorems: Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Superposition, Thevenin's, Norton's & Maximum power transfer theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC & AC sources.

Coupled circuits: Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modelling of coupled circuits, Solution of problems.

AC Fundamentals: RMS Values, Average Values, Peak Factor, Crest Factor, Resonance. Power in purely resistive, inductive, capacitive, RL, RC and RLC Circuits.
Number Systems: Decimal, Binary, Octal, Hexadecimal systems, conversion of a number from one base to another, complements of number systems and its addition and subtraction, Introduction to logic gates.

Boolean Algebra: Theorems and operations, Boolean expressions and truth tables, Duality and inversion, multiplying out and factoring expressions, Exclusive-OR and equivalence operations, Positive and negative logic.

C. Text Books:

1. Theraja B. L., Theraja A.K., A Textbook of Electrical Technology Vol 1, Shree Hari Publications, 2021.
2. Morris Mano M., Digital Logic and Computer Design, Pearson Education India, First Edition, 2016.

D. Reference Books:

1. Kumar Anand, Fundamentals of Digital Circuits, Prentice Hall, 3rd Edition, 2014.
2. Salivahanan.S.,PravinKumar.S., Digital Electronics, VikasPubliashing House, First Edition, 2011.

E. Course Outcomes:

1. Describe different type of networks, sources and signals with examples.
2. Explain different network theorems, coupled circuit and tools for solution of networks.
3. Apply network theorems and different tools to solve network problems.
4. Select suitable techniques of network analysis for efficient solution.
5. Estimate parameters of two-port networks.
6. Design filter circuits.

Subject Code: CS-1102
Subject Name: Coding Laboratory
Credit Point: 2 **(**L=0, T=0, P=4)

A. Course Objectives:

1. The student will gain a thorough understanding of the fundamentals of C programming.
2. A student can code, compile and test C programs.
3. Could take Systems programming or Advanced C programming course.
4. Although this course does not deal with object-oriented programming methodology, it will assist the student build the required foundations to undertake a course in OOP.

B. Course Content:

Introduction: The von Neumann architecture, machine language, assembly language, high level programming languages, compiler, interpreter, loader, linker, text editors, operating systems, flowchart.

C Fundamentals: Introduction to C, Data types, Constants and variable declaration, Scope, Storage classes, Data input and output functions, Sample programs.

Operators & Expressions: Arithmetic, Relational, Logical, Bitwise operators, Conditional, Assignment, Library functions.

Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the operator, goto statement.

Decision making & branching: while statement, do-while statement, for statement.

Array: Declaration, Initialization and processing One-dimension array, Two-dimension array and multi dimension array and their operations.

String & pointer: String: Operation on String without using library function and using library function. Pointer: Declaration of pointer variables, accessing the variable by using pointer, pointer increment and decrement operator, pointer and array

Functions: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by reference, Recursive function. Pointer to function.

Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure. Nested structure, structure & functions, Pointer & structure, Unions, Enum.

File management system: Advantage of using file, Open, close, read, write in the files, Operation on files.

Dynamic memory Allocation: use of malloc, calloc, realloc, free. Library functions, Implementation of Linked list and their various operations.

The pre-processor: macro statements.

C. Text Books:

1. Kerninghan and Ritchie, The 'C' programming language, 2nd Edition, Pearson, 2008.
2. Yashavant P. Kanetkar, Let Us C: Authentic guide to C programming language, 15th edition, BPB, 2021.
3. Balaguruswamy, Programming In ANSI C, 8th Edition, Tata McGraw-Hill Education, 2019

D. Reference Books:

1. Zed A. Shaw, Learn C the Hard Way: Pratical Exercises on Computational Subjects You Keep Avoiding (Like C), 2015.
2. Deepali Srivastava and S.K Srivastava, C in Depth, BPB Publication, 2017.
3. Griffiths David and Dawn Griffiths, Head First C, A Brain Friendly Guide, 2012.
4. Grey Perry and Dean Miller, C Programming Absolute Beginner's Guide, 3rd Edition, 2013.

E. Course Outcomes:

1. Understand the basic terminology used in computerprogramming.
2. Write, compile and debug programs in C language in different operatingsystems.
3. Design programs involving decision structures, loops andfunctions.
4. Use and apply the dynamics of memory by the use of pointers in engineering applications.
5. Use and apply the differences between structure oriented and function oriented

programming in programming applications.

Subject Code: EE-1103
Subject Name: Basic of Electrical and Electronics Engineering Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. Course Content:
List of Practical:

1. V-I Characteristics of Carbon and Tungsten filament lamp.
2. V-I Characteristics of Fluorescence Lamp.
3. V-I Characteristics of RLC Series Circuit.
4. V-I Characteristics of RLC Parallel Circuit.
5. Verification of truth tables of different logic and universal gates.
6. Implementation of logic gates with the help of universal gates.

C. Text Books:

1. Theraja B. L., Theraja A.K., A Textbook of Electrical Technology Vol 1, Shree Hari Publications, 2021.
2. Morris Mano M., Digital Logic and Computer Design, Pearson Education India, First Edition, 2016.

D. Reference Books:

3. Kumar Anand, Fundamentals of Digital Circuits, Prentice Hall, 3rd Edition, 2014.
4. Salivahanan.S.,PravinKumar.S., Digital Electronics, VikasPubliashing House, First Edition, 2011.

E. Course Outcomes:

1. Describe different type of networks, sources and signals with examples.
2. Explain different network theorems, coupled circuit and tools for solution of networks.
3. Apply network theorems and different tools to solve network problems.

4. Select suitable techniques of network analysis for efficient solution.
5. Estimate parameters of two-port networks.
6. Design of filter circuits.

Subject Code: BS-1104
Subject Name: Basic Science Laboratory - I
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Imparting practical knowledge to the students in the area of engineering physics.
2. Student will have exposure to various experimental skills which is very essential for an engineering student.
3. To gain practical knowledge by applying the experimental methods to correlate with the physics theory.
4. To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.
5. To learn the usage of various areas of physics like electricity and magnetism systems for various measurements.

B. Course Content:

List of the experiments are as follows:

1. Determination of Planck's constant using photocell.
2. Verification of Stefan's radiation law.
3. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
4. Verification of Biot-Savart's law.
5. Charging and discharging of capacitor using RC circuit
6. Hall Effect.
7. To determine e/m ratio

C. Reference Books:

1. Arora C. L., "Practical Physics", S. Chand Publications, 2010.
2. Squires G. L., "Practical Physics", Cambridge University Press, 2014.

D. Course Outcomes:

1. Apply the various procedures and techniques for the experiments.
2. Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.
3. Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.

Subject Code: ME-1102
Subject Name: Engineering Drawing
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic Auto Cad skills.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

B. Course Content:

Indian standards: Sheet layout, type of lines and their representations, scales.

Principles of orthographic projection (multi view drawing): 1st and 3rd angle projection.

Projections: Points, lines, surfaces and solids.

Projection of sections and intersections of solids: Isometric projection.

Use of drafting software

C. Reference Books:

1. Dhananjay, A. J., "Engineering Drawing", TMH, 2017, 1st Ed.
2. Bhatt, N.D. and Panchal, V.M., "Engineering Drawing", Charotar Publishing House Pvt. Ltd, 2014, 43rd Ed.
3. Venugopal, K. and Prabhu,V. R., "Engineering Graphics", New Age International Pvt. Ltd, 2018, 15th Ed.

D. Course Outcomes:

1. Understand orthographic projections and sections.
2. Basic understanding of Indian standards of Engineering drawing.
3. Develop engineering drawings by projection techniques.
4. Utilise AutoCAD towards developments of drawings.

Subject Code: ME-1103
Subject Name: Basic Mechanical Engineering Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To understand the physical significance of different apparatus.
2. To understand laboratory techniques including the proper use of different apparatus

B. Course Content:

Study of various parts of engine, pumps and refrigerator, Measurement of temperature & pressure, Determine the velocity using Pitot tube, Verify the Bernoulli's principle, Determine the flow rate using Venturimeter and Orificemeter, Data acquisition system and its applications, Universal Testing Machine (UTM) - tensile & compression test, Hardness test- Rockwell, Brinell, Vicker's test, Impact test, Metallurgical/Optical microscope applications & Surface Roughness measurement and Use of software in various Mechanical Engineering applications.

C. Reference Books:

1. Nag P.K., Engineering Thermodynamics, Tata McGraw Hill Publisher, 2017, 6th Edition.
2. Som S K., Biswas G. and Chakraborty S., Introduction to Fluid Mechanics & Fluid Machines, McGraw Hill Education India, 2017, 3rd Edition.
3. Shames I H., Introduction to Solid Mechanics, Prentice Hall, 2015, 3rd Edition.
4. Rao P N., Manufacturing Technology: Foundry, Forming and Welding, Volume I, Tata McGraw Hill, 2018, 5th Edition.

D. Course Outcomes:

1. Practice the use of different apparatus for measuring temperature, pressure, velocity, flow rate and surface roughness.
2. Estimate different mechanical properties of materials.
3. Use of different software packages and their applications in Mechanical Engineering.

Subject Code: MH-1102
Subject Name: Language Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
2. To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
3. To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
4. To improve the fluency of students in spoken English and neutralize their mother tongue influence
5. To train students to use language appropriately for public speaking and interviews

B. Course Content:

Basics of Phonetics, Speech Sounds – Vowels and Consonants, Word Stress and Rhythm, Accent, Intonation, Phonetics Drills, Developing Effective Listening Skills- Listening Comprehension Drills, Speaking - Conversations, Dialogues, and Debates, Role Play, Situational Dialogues, Expressions in Various Situations, Making Requests and Seeking

Permissions, Formal Presentations. Telephone Etiquette, Building Advanced Vocabulary and English Grammar Exercises.

C. Text Books:

1. Words Worth English Language Software
2. Kumar, Rajesh, English Language Communication Skills: Lab Manual Cum Workbook with CD, Cengage Learning India, 2014

D. Reference Books:

1. Jones, Daniel. English Pronouncing Dictionary, Cambridge University Press, 2011.
2. Bansal, R. K. & J. B. Harrison. Spoken English with CD, Orient Blackswan, 2013.

E. Course Outcomes:

1. Understand of nuances of English language through audio - visual experience and group activities.
2. Reach the neutral intelligibility.
3. Attain the clarity and confidence to enhance their employability skills.
4. Express themselves fluently and appropriately in social and professional contexts.

IInd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1201	SC5-Engineering Mathematics-II	2	0	0	2
2	CS-1201	ESA6-Programming and Data Structure	3	0	0	3
3	EC-1201	ESA7-Introduction to Digital engineering	2	0	0	2
4	MH-1201	ESA8-Introduction to Innovation and Creativity	2	0	0	2
5	ME-1201	ESA9-Engineering Mechanics	3	0	0	3
6	ME-1202	DSC3-Introduction to Machine Tools and Operation	3	0	0	3
7	ME-1203	ESA10-System Design	2	0	0	2
8	ME-1204	ESA11-Workshop Practice-I	0	0	2	1
9	ME-1205	VAC2-Do It Yourself (DIY)/Industry Exposure	0	0	0	1
10	BA-1202	SC6-Basic Science Laboratory-II	0	0	2	1
11	CS-1202	ESA12-Programming and Data Structure Laboratory	0	0	2	1
12	MH-1202	VAC3-Gandhian Technology	0	0	2	1
Contact Hours			17	0	8	
Total Credits						22

Subject Code: BS-1201
Subject Name: Engineering Mathematics-II
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. Imparting theoretical knowledge to the students about three and more dimensional objects in space and to improve their capability of visualizing of objects in space.
2. Making student competent enough to construct a differential equation/mathematical modeling for every real life situation with its solution.
3. Giving students theoretical knowledge of vectors with the flavor of calculus.
4. Introduce the concepts of Laplace and Fourier transforms and its application to the solution of differential equations (ode & pde) to the students.

B. Course Content:

Vector Calculus: Basics of vector calculus, Line integral, Surface integral and Volume integral, Path independence, Fundamental theorem of Calculus, Green's, Gauss' and Stokes' theorems (without proofs) and their simple applications.

Ordinary Differential Equations: First order ODEs, Higher order linear differential equation with constant coefficients, Euler's homogeneous equation, Series solutions of linear differential equations with variable coefficients (Ordinary point).

Partial Differential Equations: Basic of PDEs (order, degree, Linear, Non-Linear, homogeneous, non-homogeneous), Classification of 2nd Order PDEs; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, D'Alembert method, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates).

C. Text Books:

1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11th Edition.
2. Ross S. L., Ordinary Differential Equation, Wiley and Sons Ltd., 2010, 3rd Edition.
3. Farlow S. J., Partial Differential Equation for Scientists and Engineers, Dover Publications, 1993, 1st Edition.

D. Reference Books:

1. Boyce and Diprima R. C., Elementary Differential Equations and Boundary value Problems, Wiley publications, 2009, 9th Edition.
2. Sneddon I. N., Elements of Partial Differential Equations, Dover Publications Inc., 2013, 2nd Edition.
3. Alan Jeffrey, Advanced Engineering Mathematics, Academic Press, 2001, 1st Edition.
4. Earl Coddington, Norman Levinson, Introduction to Ordinary Differential Equations McGraw Hill Education; 2017, 1st Edition.

E. Course Outcomes:

1. Students will have strong visualizing capability in their mind about any object.
2. Students are so trained that they will recognize various real life situation/problem and able to solve them by constructing a differential equation/ mathematical model.
3. Students will be able to find the Laplace representation as transforms of functions of one/two variables.

Subject Code: CS - 1201
Subject Name: Programming and Data Structure
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Designing principles of algorithms and data structures

2. Learning efficiency and scaling of algorithms
3. Learning essential algorithms in computing
4. Understanding generic data structures for common problems

B. Course Content:

Performance of algorithms: Basic concepts, Mathematical Background, Complexity Analysis, space and time complexity, asymptotic notations, Types of Date Structure.

Linear Data Structures: Arrays: one dimensional, multi-dimensional, Sparse Matrix, Elementary Operations

Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching

Queues: Simple queue, circular queue, de-queue, elementary operations and applications.

Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation

Non-Linear Data Structures: Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, red-black tree, B-tree, B+ tree, m-way Search tree, other operations and applications of trees

Graphs: representation, Adjacency list, graph traversal, path matrix, connected components, topological sort, Spanning tree, BFS, DFS.

Sorting and Searching:
Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, insertion sort, selection sort, radix sort, Searching: linear and binary search, Hashing: hash tables, hash functions, and open addressing.

File structures: Introduction, data file types, file organization, file access methods.

C. Text Books:

1. Lipschutz S., Data Structure, McGraw Hill Education, 2014.
2. Deshpande P.S., Kakde O.G., C & Data Structures, Charles River Media, 2004.
3. Balagurusamy E., Data Structures Using C, McGraw Hill Education, 2017.
4. Srivastava S.K., Srivastava D., Data Structures through C in Depth, BPB Publications, 2004.

D. Reference Books:

1. Drozdek A., Data Structures and Algorithms in C++, Cengage Learning, 2012.
2. Radhakrishnan M., Srinivasan V., Data Structures Using C, BPB Publications, 2008.
3. Gupta P., Aggarwal V., Varshney M., Data Structure Using C, Laxmi Publications, 2011.
4. Aho A.V., Hopperoft J.E., UIlman J.D., Data Structures and Algorithms, Pearson, 1998.
5. Tanenbaum A.M., Data Structures using C, Pearson Education, 2009.
6. Agarwal A., Data structure Through C, Cyber Tech Publications, 2005.
7. Bandyopadhyay S.K., Data Structures Using C, Pearson Education India, 2009.
8. Thareja R., Data Structures Using C, Oxford University Press, 2011.

E. Course Outcomes:

1. Assess performance efficiency of sequential algorithms.
2. Design data structures to enable algorithms and design sequential algorithms for performance.
3. Implement designing algorithms and corresponding data structures using object oriented programming languages.
4. Demonstrate deployment of essential data structures such as lists, stacks, queues, and trees.

Subject Code: EC-1201
Subject Name: Introduction to Digital Engineering
Credit Value: 2 (L = 2, T = 0, P = 0)

A. Course Objectives

The objective of the course is:

- Understand different digital technology used in everyday life.
- Work with electrical circuits in cascaded form and implementation in real world.

B. Course Content

Introduction- What is *digital* (analog vs. digital)? What is *technology*? History of Computing/Internet

Hardware – from electricity to hardware to software

Binary Arithmetic- Boolean Logic

Computer Architecture- Quantum computing

IoT - Introduction to principles and uses- BIG DATA - Introduction to principles and uses

VR/AR - Introduction to principles and uses

AI - Introduction to principles and uses

Blockchain - Introduction to principles and uses

Databases and mySQL queries

Networking Protocols

Introduction to Data Analytics, Machine Learning, Security, Quantum Technology and Cyber Physical System (CPS)

Careers in Digital Technologies

Ethics and the Future of Computing

Model based analysis; Data driven analysis

C. Text Books

1. B. Marr, "Tech Trends in Practice: The 25 Technologies that are Driving the 4th Industrial Revolution", Wiley, 2020.

D. Reference Books

1. A. Goel, “Computer Fundamentals”, Pearson, 2010.

E. Course Outcomes

At the end of the course, a student will be able to:

1. Understand basic fundamentals of different digital techniques
2. Understand the fundamentals of AI, Blockchain and its use
3. Understand different network protocols.

Subject Code: MH-1201
Subject Name: Introduction to Innovation and Creativity
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:

1. To involve themselves in the innovation and creative activities
2. Starting innovative practices in their entrepreneurial activities.
3. Developing their skills on the traits that they want to carry forward.
4. Starting activities based on the search of new ideas.

B. Course Content:

Introduction to innovation and creativity, opportunity identification: the search for new idea, entrepreneurial imagination and creativity, The role of creative thinking, Components of creativity, Indication of creativity, Developing your creativity, the creative thinking process, Two approaches to creative problem-solving, the most common idea killers, Arenas in which people are creative, the creative climate, Innovation and entrepreneur, the innovation process, types of innovation, Proof of Concept(PoC), product development, the major misconceptions of innovation, principles of innovation, Methods to initiate ventures, creating new ventures: new-new approach & new-old approach, ways to develop personal creativity: recognise relationships, develop a functional perspective, use your brains, and eliminate muddling mind –sets, design thinking, design innovation, technological innovation and designing entrepreneurship, creative design. Case study on startup / unicon.

C. Text Books:

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice CengageLearning, 2017.
2. Cynthia, L. Greene, Entrepreneurship Ideas in Action. Thomson Asia Pvt.Ltd.,Singapore, 2004.

D. Reference Books:

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing, 2015.
2. Timmons, Jerry A., and Spinelli, Stephen,. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill, 2009.

3. Hisrich, Entrepreneurship, TataMcGraw Hill, NewDelhi, 2001.

E. Course Outcomes:

1. Start their venture more scientifically.
2. Start their venture by linking with the all the stakeholders.
3. Enable to identify various opportunity mapping
4. Explore many possibility of generating new idea leading to enterprise.

Subject Code: ME-1201
Subject Name: Engineering Mechanics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Ability to utilise scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Ability to apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Student gets a basic idea of Centre of gravity, moment of inertia, mass moment of inertia, friction.

B. Course Content:

Forces and Moments: Force, moment and couple, wrench, equivalent force and moment, forces in space equilibrium, FBD, general equations of equilibrium-Lami's theorem, analysis of forces in truss and frames, brief introduction to vector approach.

Friction: Introduction to dry friction, laws of friction, friction of simple machines, inclined planes, screw jacks, clutch, and collar pivot bearing (uniform wear and uniform pressure assumptions).

Centre of gravity and moment of inertia: Centre of gravity, volume and composite bodies, area moment of inertia and mass moment of inertia for plane figures and bodies.

Virtual work and energy method: Virtual displacement; principle of virtual work; applications of virtual work principle to machines.

Kinematics of particle: Introduction, rectilinear motion, plane curvilinear motion, rectangular coordinates (x-y), normal and tangential coordinates (r-θ).

Kinetics of particle: Review of force, mass, acceleration, work and energy, impulse, momentum, linear impulse and linear momentum, angular impulse and angular momentum, impact, central-force and motion, and relative motion,

Kinetics of system of particles: Introduction, generalized Newton's second law, work-energy, impulse-momentum, conservation of energy and momentum, steady mass flow, variable mass.

Plane kinematics of rigid bodies: Introduction, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes.

Plane kinetics of rigid bodies: Introduction, general equation of motion, translation, fixed axis rotation, general plane motion, work energy relations, acceleration from work-energy, virtual work, impulse-momentum equation.

C. Text Books:

1. Timoshenko S and Young D.H., "Engineering Mechanics", MGH, 2017, 5th Ed.
2. Beer and Johnston, "Vector Mechanics for Engineers: Statics and Dynamics", TMGH, 2012, 10th Ed.

D. Reference Books:

1. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 1: Statics", Wiley, 2017, 8th Ed.
2. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 2: Dynamics", Wiley, 2006, 5th Ed.
3. Shames, I. H. and Rao,G. K., "Engineering Mechanics: Statics and Dynamics'", Pearson 2006, 4thEd.
4. Nelson A., "Engineering Mechanics: Statics and Dynamics", TMGH, 2017, 1st Ed.

E. Course Outcomes:

1. Basic understanding of different type of forces, moments and resolving them.
2. Evaluation of centre of gravity, moment of inertia and mass moment of inertia for various figures & bodies.
3. Apply principles of kinematics, kinetics and effects of friction for solving problems.

Subject Code: ME-1202
Subject Name: Introduction to Machine Tools and Operation
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Classify the general purpose machine tools of common use.
2. Distinguish the construction and operations of various machine tools.
3. Understand the different cutting tool materials.
4. Describe the different operations performed on machine tools.

B. Course Content:

Introduction: classification of machine tools and metal removal processes, manufacturing and machining, basic working principle, configuration, specification and classification of machine tools.

Machinability: concept of machinability and its improvement, cutting tool materials of common use, advanced cutting tool materials, Tool life equation.

Machine Tools& operations: lathe, drilling, shaping, planning, slotting, milling, grinding, broaching, gear hobbing, lapping, honing, super finishing, operation and tool layout in semiautomatic and automatic lathes, Numerical Control, Computer Numeric Control, Flexible Manufacturing System, Computer Integrated Manufacturing.

Introduction to Non-traditional machining: water jet machining, abrasive water jet machining, ultrasonic machining, chemical machining, electro-chemical machining, electric discharge machining, electric-discharge grinding, electro-chemical honing, laser beam machining, ion beam machining.

Introduction to advanced manufacturing technologies: Basics of agile manufacturing, lean manufacturing, rapid prototyping, 3D manufacturing.

C. Text Books:

1. Rao P. N, Manufacturing Technology, Volume II, Tata McGraw Hill, 2008.
2. Chattopadhyay A. B, Machining and Machine Tools, Wiley, 2011.
3. Shaw M. C, Metal Cutting Principles, MIT Press, 2004.
4. Lal G. K, Introduction to Machining Science, New Age International Pvt. Ltd., 2007.
5. Pandey P. C. and Shan H. S., Modern Machining Processes, McGraw Hill Education, 2019.

D. Reference Books:

1. Choudhury, S. K. H., Choudhury, A. K. H., Roy, N., "Elements of Workshop Technology-Vol-1", Media Promoters & Publishers Pvt ltd, 2008.
2. Begeman, M. L. and Amstead, B. H., "Manufacturing Process", Wiley, 1987, 8th Ed.
3. Chapman, W. A. J. and Arnold E., "Workshop Technology, Vol. I, II & III", CRC press, Prentice Hall, 2005, 2004 and 1995, 5th, 4th and 3rd Ed.

E. Course Outcomes:

1. Identify the general purpose machine tools of common use.
2. Recognize the construction and operations of various machine tools.
3. Distinguish the different cutting tool materials.
4. Classify the different operations performed on machine tools.

Subject Code: ME-1203
Subject Name: System Design

Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Understand the basic concept of system engineering.
2. Describe the various system engineering stages.
3. Understand the system development process.
4. Knowing the system management concept.

B. Course Content:

Introduction: Basic concept of system level input & output with qualities, properties, characteristics, functions, behaviors & performances

System Engineering Major Process flow (Concepts of Interdisciplinary design, integration, complex systems and life cycles

System Engineering Stages: Analysis of base level Requirement and appropriate Management; Functional Analytics, Interpretation and Allocation of inference; Design Synthesis; Systems Analysis and Control; Verification; Conclusion

System Engineering Types (concept of product system, service system, enterprise system and system of systems)

Systems engineering responsibilities: Management and monitoring of all installed systems and infrastructure; Installation, configuration, testing and maintaining operating systems, application software and system management tools; Ensure the highest levels of quality standards on systems and infrastructure.

System Engineering Skill (for analysis, problem solving, and conflict resolution)**:** Communication skill**;** Interpersonal skill**;** Project management skill**;** Governance skills

System Development Process: Life cycle Planning and Life Cycle integration**;** System Development Life Cycle Phasing (planning, analysis, design, development, testing, implementation, and maintenance)**;** Industrial System Engineering (Quality Function Deployment, Product Planning, Design Planning, Production & Operational Planning, Planning for Quality Control & Assurance, Whole Value chain concept)

System Engineering Management: Management of complex systems over their life cycles

C. Text Books:

1. Kossiakoff Alexander, "Systems engineering principles and practice".

D. Reference Books:

1. INCOSE, "Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities".

2. Sage P Andrew and Rouse B William, "Handbook of Systems Engineering and Management".
3. Moore Alan, SteineRick r, and Friedenthal Sanford "A Practical Guide to SysML: The Systems Modelling Language".

E. Course Outcomes:

1. Identify the general purpose machine tools of common use.
2. Recognize the construction and operations of various machine tools.
3. Distinguish the different cutting tool materials.
4. Classify the different operations performed on machine tools.

Subject Code: ME-1204
Subject Name: Workshop Practice-I
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Students able to understand different tool &equipment for work shop practice.
2. Students acquire skills for the preparation of different Carpentry/fitting/welding models.
3. Students able to understand the safety precaution in the workshop
4. Student acquires skills of Application orientated tasks.

B. Course Content:

Introduction and demonstration: Introduction to various shops/ sections and workshop layouts,safety norms to be followed in a workshop should be conveyed to students.

Carpentry shop: Introduction of tools and operations, types of woods & their applications, types of carpentry hardware and their uses, carpentry joints, carpentry operations such as marking, sawing, planning, chiselling, grooving, boring, joining, types of woods and carpentry hardware.

Fitting shop: Introduction of tools and operations, types of marking tools and their uses, types of fitting cutting tool and their uses, fitting operations such as chipping, filing, scraping, grinding, sawing, marking, drilling, tapping.

Metal joining shop: Introduction of tools, types of welding joint, arc welding, gas welding and gas cutting.

Machine shop: Introduction of machine tools and operations, demonstrations of basic machine tools like lathe, shaper, drilling, milling machine and CNC with basic operations and uses.

List of workshop practices:

a. Hands on practice and job making in carpentry.

b. Hands on practice and job making in fitting.
c. Hands on practice and job making in welding.
d. Demonstrate the operations of machine shop.

C. Text Books:

1. Choudhury Hajra S.K., Choudhury Hajra A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology Vol. I & II", Media promoters and publishers private limited, Mumbai, 2008 and 2010.
2. Raghuvanshi B.S., "Workshop Technology Vol. I & II", Dhanpath Rai & Sons, 2017.
3. Bawa H S., "Workshop Practices", Tata McGraw-Hill, 2009.

D. Reference Books:

1. John K.C., "Mechanical Workshop Practice", PHI, 2010, 2nd Ed.
2. Kannaiah P. and Narayana K.L., "Workshop Manual, Scitech publishers", 2009. 2nd Ed.

E. Course Outcomes:

1. Study and practice on machine tools and their operation.
2. Select the appropriate tools required for specific operation.
3. Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding.
4. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping.

Subject Code: BS 1202
Subject Name: Engineering Chemistry Lab
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To enable the students to acquire knowledge about chemistry practical and its technological importance towards research works.
2. To understand applicability of chemistry for engineering and research purposes.
3. To make them apply the knowledge of fundamental chemistry for design system components or processes and researches considering the public health and safety, and the cultural, societal, and environmental considerations.

B. <u>List of Experiments:</u>

1. Determination of the concentration of NaOH solution.
2. Standardization of $KMnO_4$ solution by Mohr's salt.
3. Estimation of hardness of water using EDTA titration.
4. Conductometric titration for
   - Determination of the strength of a given HCl solution by titration against a standard NaOH solution.
   - Analysis of a mixture of strong and weak acid by strong base.
5. Estimation of available chlorine in bleaching powder.

6. Determination of pH value of the solution by digital pH meter and pH paper.

C. Reference Books:

1. Rao M. V. B., Laboratory Mannual for Engineering and Physical Chemistry, Studium Press (India) PVT. Ltd. 2013.
2. Israel V. A., Vogel's Qualitative Inorganic Analysis, Publisher: Pearson Education Limited, ISBN: 9780582218666, 0582218667

D. Course Outcomes:

After studying this course, students will be able to

1. an ability to function on research areas in multidisciplinary subjects.
2. design economically, environmental friendly and new methods of synthesisfor various needful products.
3. a knowledge of titration for various kinds of acid-base for new experimental aspects.

Subject Code: CS-1202
Subject Name: Multimedia and Web Design
Credit Point: 3 **(**L=1, T=0, P=4)

A. Course Objectives:

1. Students will understand multimedia in respect to many application including business, schools, home, education, and virtual reality.
2. Students will understand the hardware and software needed to create projects using creativity and organization to create them.
3. Student will develop multimedia skills understanding the principal players of individual players in multimedia teams in developing projects.
4. Students will learn the cost involved in multimedia planning, designing, and producing.

B. Course Content:

Coding Basics: Intro to HTML Syntax: The HTML, head, title, & body tags, Headings, paragraphs, & lists, The strong &em tags, The doctype, The lang attribute, The meta tag & the unicode character set, Coding Links: Absolute & Relative URLs, Anchor tags &hrefs, Linking to other websites, Linking to pages within a website, Opening a link in a new browser window/tab, Adding Images, The break tag, The image tag & source attribute, Using the width, height, & alt attributes, Using horizontal rules

Intro to Cascading Style Sheets (CSS): CSS Class Selectors The class attribute CSS class selectors The span tag CSS opacity Div Tags, ID Selectors, & Basic Page Formatting Dividing up content with the div tag Assigning IDs to divs Setting width & max-width CSS background-color Adding padding inside a div Centering content CSS borders CSS

shorthand & the DRY principle Using Browser Developer Tools Opening the DevTools in Chrome Editing HTML in the DevTools Elements panel Enabling, disabling, & editing CSS in the DevTools Using DevTools to fine-tune your CSS Hexadecimal shorthand HTML5 Semantic Elements & Validating HTML The outline algorithm The header, nav, aside, & footer elements Understanding articles & sections The main element The figure &figcaption elements Checking for errors: validating your code

Basics of web-programming Programming: Client-side scripting: JAVASCRIPT, Overview of Java, JAVA Applet

PHP: Concept of PHP, features of PHP, other equivalent tools – JSP, PHP Including PHP in web page, **Data types, Variables,** Operator precedence Built In Functions., **String Manipulation Functions, Time & Date Functions, Arrays, Conditional statements, Loops, User Defined Functions,** Global Variables, Elements of $_SERVER, PHP Forms, Text Files, Other Features: PHP File Upload, Cookies, Sessions (start, modify and destroy), Error Handling

C. Text Books:

1. Richardson T., and Thies C., Multimedia Web Design and Development, Mercury Learning and Information, 2013.
2. Steinmetz R., Multimedia: Computing Communications & Applications, Pearson Education India, 2002.

D. Reference Books:

1. Xavier C, "Web Technology & Design New Age Publication.
2. Andleigh K. Prabhat., Thakrar K., Multimedia Systems Design, 2015, 1st Edition, Pearson.
3. Maidasani Dinesh., Multimedia Applications and Web Designing, Laxmi Publications, 2008.

E. Course Outcomes:

1. Ability to develop proficiency in Webpage Development and website management
2. Ability to develop proficiency in creating dynamic Web Interface
3. Ability to write server and client sides scripts and manage websites
4. Ability to design a web page using Image, Audio and Video editing tools
5. Ability to understand the basic concepts of Open Source Standards and Open Source software.

Subject Code: MH-1202
Subject Name: Gandhian Philosophy and Technology
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. To understand the life style and significance of M. K. Gandhi in modern world
2. To introduce Gandhian Thought as an academic discipline to students
3. To convey the importance of Gandhian Values in different walks of life
4. To create awareness about the significance of Gandhian Thought for Academics and life in general, in students and common stakeholder through workshop and related activities done by Gandhi Study Center.

B. Course Content:

Ethics in Gandhian Thought : Socio- Political and Economic Thoughts of Gandhiji, Gandhian methods for Global Peace, Gandhian Development, Mahatma Gandhi's Perspectives on Technology. Participating practical oriented activities done by GSC/ Technology-attributes/innovation/activities of Gandhian way of life styles/Gandhian economics,Indian cottage industry and its improvement, Inclusive growth and through sustainable development

C. Text Books:

1. Gandhi, Gopal krishna, Mohandas Karamchand Gandhi: Restless as Mercury, My Life as a Young Man, Aleph Book Company, 2021.
2. Beitzel, Terry and et al. Reflections on Mahatma Gandhi: The Global Perspectives, Rawat Publications, India, 2021.
3. Gandhi, M.K. The story of my experiments with truth (an autobiography),Navajivan Publishing House, 1927.

D. Reference Books:

1. Awasthi, R.K. Technological Transformation and Relevance of Gandhi in Modern India, IJSW online, Retrieved May 2022.
2. Talwar, Sushant. Mahatma and machines: Understanding Gandhi's thoughts on modern technology, https://www.timesnownews.com/, 2019.
3. Kothari,L. S. Science and Technology in India: What Can We Learn From Gandhi?, Source: International Seminar on Gandhi And The Twenty First Century, (January 30-February 4, 1998) New Delhi- Wardha.
4. Ram K.Vepa, New Technology: A Gandhian Concept, Gandhi Book House New Delhi, 1975.

E. Course Outcomes:

1. Understand how a simple thought changes the world
2. Identify the various barriers and challenges faced in India and try to solve from Gandhian perspectives
3. Dedicate your ideas to poor people and transform technology among people
4. Aware of the economic and social equality and relationship with peace

IIIrd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**

1	BS-2101	SC7-Engineering Mathematics-III	3	0	0	3
2	ME-2101	DSC4-Introduction to Thermodynamics	2	1	0	3
3	ME-2102	DSC5-Solid Mechanics	2	1	0	3
4	ME-2103	DSC6- Fluid Mechanics-I	2	1	0	3
5	ME-210A	DSE1- Material Science and Metallurgy	3	0	0	3
	ME-210B	DSE1- Sustainable Energy conversion.				
6	YY-210X	OE1*	3	0	0	3
7	ME-2104	Laboratory-I – Machine Drawing	0	0	2	1
8	ME-2105	Laboratory-II – Strength of MaterialsLaboratory	0	0	2	1
9	ME-2106	Laboratory-IIII – Workshop Practice -II	0	0	2	1
Contact Hours			15	3	6	
Total Credits						21

Subject Code: Engineering Mathematics-III
Subject Name: BS 2101
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Imparting theoretical knowledge and practical application to the students in the area of Stochastic Process,
2. Introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of stochastic processes,
3. Providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical frame work for evaluating study designs and results,
4. Injecting future scope and the research directions in the field of stochastic process.

B. Course Content:

Probability: Random Experiment, Sample space; Events; Probability of events, Frequency Definition of probability; Axiomatic definition of probability; Finite sample spaces, Probability of Non-disjoint events (Theorems). Conditional probability; General Multiplication Theorem; Independent events; Bayes'theorem and related problems.

Random variables: Probability mass function; Probability density function and distribution function. Distributions: Binomial, Poisson, Uniform, Exponential, Normal, t and $\chi 2$. Expectation and Variance (t and $\chi 2$ excluded); Moment generating function; Transformation of random variables (One variable); Central limit theorem (Statement only).

Basic Statistics: Measures of Central tendency: Moments, skew-ness and Kurtosis – Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression– Rank correlation.

Statistics: Population; Sample; Statistic; Estimation of parameters (consistent and unbiased); Sampling distribution of sample mean and sample variance (proof notrequired).

Estimation: Maximum likelihood estimate of statistical parameters (Binomial,Poissonand Normal distribution). Interval estimation (Normal distribution). Testing of hypothesis and $\chi 2$ goodness of fit.

C. Text Books:

1. Rohatgi V. K. and Saleh A. K. Md E., An Introduction to Probability and Statistics, Willy, 2008, 2nd edition.
2. Gupta S. C., & Kapoor V. K., Fundamental of Mathematical Statistics, Sultan Chand &Sons, 2014.

D. Reference Books:

1. Ross S. M., Introduction to Probability Models, Academic Press, 2014, 14th edition.
2. Cramer H., Random Variables and Probability Distributions, Cambridge University Press, 2014, Revised Ed.
3. Spiegel M. R., Probability and Statistics, McGraw-Hill, 2017, 3rd Edition.
4. Mayer P. L., Introductory Probability and Statistical Applications, Oxford & IBH, 1970, 2nd Ed.
5. Feller W., An Introduction to Probability Theory and Its applications, Vol I, Jon Willy and Sons, 2008, 3rd Edition.
6. Chung K. L., A course of Probability Theory, Academic Press, 2000, 3rd Edition.

E. Course Outcomes:

1. Students will add new interactive activities to fill gaps that we have identified by analyzing student log data and by gathering input from other college professors on where students typically have difficulties.
2. Students will add new simulation-style activities to the course in Inference and Probability, students will be able to take up prospective research assignments.

Subject Code: ME-2101
Subject Name: Introduction to Thermodynamics

Credit Point: 3 **(**L=2, T=1, P=0)

A. Course Objectives:

1. Understand basic definitions and terminology.
2. Identify special definitions from the thermodynamics point of view.
3. Discover why and how natural processes occur only in unidirectional way.
4. Understand the concept of property and how it defines the state thermodynamic.
5. Identify the change of state results in a process.
6. Determine why processes are required to build cycles.
7. Recognize the differences between work producing and work consuming cycles.

B. Course Content:

Fundamental concepts: Review of fundamental concepts:systems, properties, state, thermodynamic processes and cycles, Zeroth law of thermodynamics, heat and work transfer.

First law of thermodynamics: First law applied to closed and open systems, internal energy, enthalpy, specific heats, perpetual motion machine of first kind (PMMI), steady flow energy equation (SFEE), application of SFEE to various engineering systems.

Second law of thermodynamics: Statements of the second law of thermodynamics and their equivalence, reversibility and irreversibility, Carnot cycle, Carnot theorem, absolute thermodynamic temperature scale,Clausiustheorem and inequality, entropy principle, entropy changes during various processes, concept of third law of thermodynamics, availability.

Properties of pure substances: P-V, P-T, T-s and h-s diagrams of a pure substance, sensible heat, latent heat, saturation temperature, dryness fraction, steam table, Mollier diagram,

Properties of ideal gases and their mixtures: Gases-equation of state of an ideal gas, thermodynamic property relations, specific heats, internal energy, enthalpy change of ideal gases,equation of state of real gases, principle of corresponding state, compressibility factor.

Thermodynamic cycles: Rankine cycle, Otto, Diesel, Dual, Brayton cycle etc.

List of workshop practices:

a. Hands on practice and job making in carpentry.
b. Hands on practice and job making in fitting.
c. Hands on practice and job making in welding.
d. Demonstrate the operations of machine shop.

C. Text Books:

1. Cengel, Y. A., Boles, M. A., "Thermodynamics, An Engineering Approach", McGraw Hill Education, 2017, 8th Ed.

2. Nag, P. K., "Engineering Thermodynamics", McGraw Hill, 2017, 6th Ed.

D. Reference Books:

1. Sonntag, R. E., Borgnakke, C., Wylen, G. J. V., "Fundamentals of Thermodynamics", John Wiley, 2012, 6th Ed.

E. Course Outcomes:

1. Understand of the first and second laws of thermodynamics and their application to a wide range of systems working with pure substance and gaseous mixtures.
2. 2. Analyse the work and heat interactions associated with a prescribed process, path, and to perform a first law analysis of a flow and non flow process.
3. 3. Evaluate entropy changes in a wide range of processes and determine the reversibility and irreversibility of a process from such calculations.
4. 4. Apply pressure-temperature diagrams, volume-temperature and pressure-volume phase diagrams and the steam tables for the analysis of engineering devices and systems.

Subject Code: ME-2102
Subject Name: Solid Mechanics
Credit Point: 3 **(**L=2, T=1, P=0)

A. Course Objectives:

1. To establish an understanding of the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behavior.
2. To understand and apply for evaluation of stress and deformation in simple geometries such as bars, beams, shafts, for various types of load conditions.
3. To build the necessary theoretical background to be utilized in design courses.

B. Course Content:

Introduction and concept of stress: Load, stress, principle of St.Venant, principle of superposition, strain, Hooke's law, modulus of elasticity, stress-strain diagrams, working stress, factor of safety, strain energy in tension and compression, resilience, impact loads.

Analysis of axially loaded members: Composite bars in tension and compression, temperature stresses in composite rods, concept of statically indeterminate problems. shear stress, complimentary shear stress, shear strain, modulus of rigidity, Poisson's ratio, bulk modulus, relationship between elastic constants.

Biaxial state of stress: Analysis of biaxial stress. plane stress, principal plane, principal stress, Mohr's circle for biaxial stress, stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

Biaxial state of strain: Two dimensional state of strain, principal strains, Mohr's circle for strain, calculation of principal stresses from principal strains, strain Rossette.

Shear force and bending moment diagrams: Shear force and bending moment, types of load and types of support, support reactions, relationship between bending moment and shear force, point of inflection, shear force and bending moment diagrams.

Analysis of beams for bending: Theory of simple bending of initially straight beams, pure bending, bending stresses, shear stresses in bending, distribution of normal and shear stress, composite beams.

Deflection of beams: Differential equation of the elastic line, slope and deflection of beams by integration method and area - moment method, Castigliano's theorems.

Torsion: Torsion in solid and hollow circular shafts, twisting moment, strain energy in shear and torsion, strength of solid and hollow circular shafts, strength of shafts in combined bending and twisting.

Pressure vessels: Stresses in thin and thick cylinders, longitudinal stress, compound cylinders.

Introduction to buckling of columns: Classification of columns, Euler's theory, crippling stress.

C. Text Books:

1. Shames, I. H., "Introduction to Solid Mechanics", Prentice Hall , 2015, 3rd Ed.
2. Ryder, G. H., "Strength of Materials", Macmillan Press, 1969, 3rd Ed.
3. Beer and Johnston, "Mechanics of Materials", McGraw Hill, 2017, 7th Ed.
4. Srinath L. S., Strength of Materials, McMillan Publishers India, 2000.
5. Timoshenko S., Elements of Strength of Materials, East West Publisher, 2003, 5th Ed.

D. Reference Books:

1. Beer and Johnson, Mechanics of Materials, McGraw Hill, 2017, 7th Ed.

E. Course Outcomes:

1. Have the basic concepts on various loadings and their effects on different elements.
2. Be able to analyse simple geometries subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
3. Be able to evaluate strain and deformation that will result due to internal stress developed under simple load conditions.
4. Be able to apply the knowledge in designing machine parts and structures to prevent failure.

Subject Code: ME-2103
Subject Name: Fluid Mechanics I

Credit Point: 3 **(**L=2, T=1, P=0)

A. Course Objectives:

1. Illustrate the properties of fluids and the applications of fluid mechanics.
2. Understand the fundamental of kinematics and dynamics of fluid flows and the governing non-dimensional parameters of a fluid element.
3. Apply the concepts of mass, momentum and energy conservation to flows.
4. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
5. Solve simplified problems analytically.

B. Course Content:

Review of fundamentals: Introductory concepts, properties and classification of fluids, basic hydrostatic equation, measurement of pressure, forces on submerged plane and curved surfaces, buoyancy and stability.

Kinematics of fluids: Streamline, pathline, streakline, scalar and vector fields, flow field and description of fluid motions, deformation of fluid element.

Conservation equations: integral and differential formulations - conservation of mass, conservation of momentum and conservation of energy; Bernoulli equation, stream function, velocity potential and vorticity, Euler equation.

Principles of physical similarity and dimensional analysis: Introduction, concept and type of physical similarity, applications of dynamic similarity, dimensional analysis.

Some incompressible viscous flows: Reynolds experiment, plane Poiseuille flow, Hagen Poiseuilleflow, Couetteflow, losses in pipes, friction factors, hydraulic diameter, pipes in series and parallel.

Flow measurement devices: Pilot tube, venturi meter, orifice meter, orifice and mouthpieces, pitot static tube.

Boundary layer concept: Introduction to laminar boundary layer for flow over a flat plate – boundary layer thickness, displacement and momentum thickness.

C. Text Books:

1. Som, S. K.,.Biswas, G and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", TMH, 2017, 3rd Ed.
2. Munson, B. R., Young, D. F., Okiish, T. H., "Fundamental of Fluid Mechanics", Wiley, 2012, 7th Ed.
3. Cengel Y. A. and Cimbala J. M., Fluid Mechanics: Fundamentals and applications, McGraw, 2019, 4^{th} Ed.

D. Reference Books:

1. White, F. M., "Fluid Mechanics", TMH, 2014, 8th Ed.
2. Fox, R. W., McDonald, A. T., Pritchard, P. J., "Introduction to Fluid Mechanics", 2003, 6th Ed.

E. Course Outcomes:

1. Understand the basics of fluid statics, kinematics and dynamics.
2. Describe the fundamentals of incompressible viscous flow, various flow measurement devices and boundary layer concepts.
3. Analyse fluid flow problems with the applications of mass and momentum.
4. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters.

Subject Code: ME-210A
Subject Name: Material Science and Metallurgy
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between microstructure, properties and processing.
3. Have the experimental skills for a professional career or graduate study in materials.
4. Design and selections of materials for specific application.

B. Course Content:

Introduction: Material science, definition and its importance in relation to mechanical engineering, application of various materials in mechanical engineering.

Crystallography: Crystal lattice, seven crystal system and fourteen bravis lattices, relationship between atomic diameter and lattice parameter in SC, BCC, FCC, HCP crystals,coordination numbers, atomic packing factor and voids in above mentioned crystals,introduction to defects in crystal: point defect, line defect.

Alloys and phase diagram: Types of alloys, solid solutions, substitutional and interstitial solid solutions, factors affecting solid solubility (Hume Rothary rules), Gibbs phase rule, Lever rule.

Binary phase diagram: Isomorphous, eutectic, peritectic, eutectoid and peritectoid system, equilibrium in above binary phase diagrams,iron carbon equilibrium phase diagram and micro structure in plain carbon steel, non-equilibrium solidification in plain carbon steel, transformation curves – time-temperature-transformation (TTT) curves, continuous cooling transformation (CCT) curves.

Heat treatment: Various heat treatment processes– annealing,recovery, recrystallization and grain growth, normalizing, hardening, tempering, martempering, austempering, concept of hardenability, factors affecting it hardenability, surface hardening of steel, carburizing, cyaniding, nitriding, flame hardening and induction hardening etc.

Ferrous alloys: Classification and properties of ferrous alloys, plain carbon steel, medium carbon steel, high carbon steel, different alloy steel and cast iron,properties.

Non-Ferrous alloys: Properties, compositions and uses of most commonly used non-ferrous alloys such as Al, Mg, Cu, Ti, Zn alloys etc. alloys**.**

Introduction to advanced materials: Smart materials (shape memory alloys, magneto rheological fluid, electro rheological fluids, piezo electric materials, magneto rheological elastomers), composite materials, functionally graded composite materials, nano materials, biomaterials.

C. Text Books:

1. Smith, W., "Foundations of Materials Science and Engineering", McGraw Hill, 2009, 5th Ed.
2. Callister, W. D., "Material science and Engineering and Introduction", Wiley, 2016, 5th Ed.

D. Reference Books:

1. Raghavan, V., "Materials Science and Engineering", PHI, 2015, 6th Ed.

E. Course Outcomes:

1. Recognize the various metals and define their crystal structure.
2. Select materials; design the heat treatment for specific needs.
3. Classify the heat treatment to the microstructure and mechanical properties of industrial alloys.
4. Describe the processing condition of alloys based on phase diagram.

Subject Code: ME-210B
Subject Name: Sustainable Energy Conversion
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the different energy resources like conventional and non-conventional sources of energy.
2. To learn about energy conversion systems like bio-energy conversion, biomethanation technology, Thermochemical Conversion, gasification, pyrolysis etc.
3. To know about various sustainable energies

B. Course Content:

Energy resources: Conventional and non-conventional sources of energy, basics of solar, wind, bio, hydro, tidal, ocean, thermal and other renewable energy sources.

Energy conversion systems: Conversion routes, direct and indirect way of energy conversion, electricity generation, distribution and use, basic of solar thermal conversion, technology of selective coating, fundamentals of flat plate collector and evacuated collector, basics of wind energy conversion,wind machine, wind electric generator, wind pump,basics of photovoltaic conversion technology and PV systems, basics of bio-energy conversion, bio-methanation technology, thermochemical conversion through pyrolysis, gasification and esterification, bio oil, application of ocean thermal gradient and geothermal gradient for power generation, basics of hydropower, tidal and wave power, basics of hydrogen fuel, fundamentals of fuel cells, basics of fusion power.

C. Text Books:

1. Rao Ashok, "Sustainable Energy Conversion for Electricity and Coproducts: Principles, Technologies and Equipment", Wiley, 2015.

D. Reference Books:

1. Capareda Sergio, Introduction to Biomass Energy Conversions, CRC Press, 2013, 1st Ed.

E. Course Outcomes:

1. Various conventional and non-conventional energy resources.
2. Various conversion methods-direct and indirect ways, bio-energy conversion, biomethanation technology, Thermochemical Conversion.
3. Gasification and Esterification, power generation.

Subject Code: ME-2104
Subject Name: Laboratory I- Machine Drawing
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic Auto CAD skills.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

B. Course Content:

Review of orthographic projections and sectioning.
IS/ISO codes,limits, tolerances and fits, surface finish,symbols for weldments, process flow, electrical and instrumentation units.
Assembly and part drawings of simple assemblies and subassemblies of machine parts such as couplings, clutches, bearings, gear assemblies.
I.C. engine components, valves, machine tools, etc. introduction to solid modellers,
A drawing project on reverse engineering.

Use of drawing software.

C. Text Books:

1. Bhatt, N. D., "Machine Drawing", Charotar Book Stall, Anand, 2014, 53rd Ed.
2. Sidheswar, N., Kanniah, P., Sastry, V. V. S., "Machine Drawing", Tata McGraw Hill, 2001, 1st Ed.
3. SP 46: 1988 Engineering Drawing Practice for School & Colleges, Bureau of Indian Standards.

D. Course Outcomes:

1. Learn basic understanding on development of manufacturing drawings.
2. Understand tolerance and symbols used for different operations and fit.
3. Development of part and assembly drawings of different mechanical systems.
4. Utilisation of engineering tools for development of solid models.

Subject Code: ME-2105
Subject Name: Laboratory II- Strength of Materials Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To understand the procedure of doing different tests like hardness, compression, torsion, tension and impact in various materials
2. To impart knowledge about the testing of columns and beams and behavior of materials.

B. Course Content:

List of the experiments are as follows:

a. To obtain the stress-strain curve by performing the tensile test for both ductile and brittle material in Universal Testing Machine (UTM).
b. Determination of hardness of a material using Brinell hardness testing machine, Rockwell hardness testing machine, Vickers hardness testing machine.
c. Determination of toughness of a material using Impact testing machine.
d. Determination of twisting moment of a material using Digital torsion testing machine.
e. Beam bending and deflection of beam with various boundary conditions.
f. Column buckling.

C. Reference Books:

1. Capareda Sergio, Introduction to Biomass Energy Conversions, CRC Press, 2013, 1st Ed.

D. Course Outcomes:

1. Describe the behavior of materials upon normal external loads.
2. Predict the behavior of the material under impact conditions.
3. Recognize the mechanical behavior of materials**.**

Subject Code: ME-2106
Subject Name: Laboratory III-Workshop Practice - II
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Demonstrate laboratory techniques including the proper use of relevant instruments for measurement of various physical quantities.
2. Preparation of different kinds of test specimen and studying their properties.

B. Course Content:

List of Experiments:

a. Sample preparation.
b. Metallographic study using metallurgical/optical microscope.
c. Surface roughness measurement.
d. Calibration of micrometer and vernier calliper using slip gauges.
e. Measurement of the diameter and height of a given specimen using the micrometer.
f. Use of different angle measuring instruments.
g. Measurement of screw thread parameters using grove micrometer.
h. Checking the flatness of granite surface plate using spirit level.
i. Measurement of different elements of gear.

C. Text Books:

1. Rao, P. N., "Manufacturing Technology: Foundry, Forming and Welding, Volume I", Tata McGraw Hill, 2018, 5th Ed.
2. Holman, J. P., "Experimental Methods for Engineers", McGraw Hill Education, 2017, 7th Ed.

D. Course Outcomes:

1. Use various measuring instruments.
2. Measure different elements of gear and parameters like diameter, height angle etc.
3. Analyse the different surface properties.

IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-2201	DSC7- Fluid Mechanics-II	2	1	0	3
2	ME-2202	DSC8 – Kinematics of Machinery	2	1	0	3
3	ME-2203	DSC9 –Manufacturing Processes-I	3	0	0	3
4	ME-220A	DSE2 –Numerical Methods in Engineering/ Continuum Mechanics	3	0	0	3

	ME-220B	DSE2 – Continuum Mechanics				
5	YY-220X	OE2*	3	0	0	3
6	MH-2201	SECC3-Entrepreneur Essential and Early Stage Start-up	3	0	0	3
7	ME-2204	Laboratory-IV – Fluid Mechanics and Machinery Laboratory	0	0	2	1
8	ME-2205	Laboratory-V – Kinematics of Machinery Laboratory	0	0	2	1
9	ME-2206	Laboratory-VI - Manufacturing ProcessesLaboratory	0	0	2	1
Contact Hours			16	2	6	
Total Credits						21

Subject Code: ME-2201
Subject Name: Fluid Mechanics-II
Credit Point: 3 **(**L=2, T=1, P=0)

A. Course Objectives:

1. Understand the concepts of boundary layers, its related equations and also the mechanics of viscous flow about immersed boundaries.
2. Apply the basic law of thermodynamics to a steady flow in a conduit to derive the general one dimensional flow equation.
3. Recognize the isentropic flow and normal shock to some flow systems such as discharge of air from tanks and nozzle configurations.
4. Formulate a general treatment of the common forms of turbomachines, covering basic fluid dynamics and thermodynamics of flow through passages and over surface with fundamental governing equations.
5. Describe the basic characteristics of radial and axial pumps, turbines and fans with different kinds of working medium.

B. Course Content:

Boundary layer flows: Boundary layer equations, Blasius solution, momentum-integral equation of boundary layer, separation of boundary layer, turbulent flat plate boundary layers.

Forces on submerged bodies: Drag and lift on a stationary body by flowing fluid, streamlined and bluff body, terminal velocity of a body, lift on an aerofoil.

Compressible flow: Introduction, thermodynamic relations of perfect gases, speed of sound, pressure field due to a moving source, basic equations, flow through nozzles, stagnation and sonic properties, normal shock waves, oblique shock.

Turbomachines: Euler-equation for turbo-machines,impact of free jets,impulse momentum principle, force exerted by the jet on stationary flat and curved plate, hinged plate, moving plate and moving curve/vanes, impulse turbine - Pelton wheel,reaction turbine- Francis turbine, propeller turbine, centrifugal pump, performance parameters and characteristics of pumps and turbines, cavitation, net positive suction head (NPSH), positive displacement pumps.

C. Text Books:

1. Som, S. K.,. Biswas, G and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", TMH, 2017, 3rd Ed.
2. Munson, B. R., Young, D. F., Okiish, T. H., "Fundamental of Fluid Mechanics", Wiley, 2012, 7th Ed.
3. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachines, ButterworthHeinemann, 2005, 5th Ed.
4. Oosthuizen, P.H. and Carscallen,W.E., Compressible Fluid Flow, McGraw-Hill, 2003, 1st Ed.

D. Reference Books:

1. White, F. M., "Fluid Mechanics", TMH, 2014, 8th Ed.
2. Fox, R. W., McDonald, A. T., Pritchard, P. J., "Introduction to Fluid Mechanics", Wiley, 2003, 6th Ed.

E. Course Outcomes:

1. Understand the concepts of viscous boundary layers, boundary layer equations, Blasius solution, momentum integral equation to determine integral thicknesses, wall shear stresses, and skin friction coefficients.
2. Describe the principles and applications of turbomachinery in modern industry and apply the principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, fans, and turbines.
3. Evaluate the mechanics of viscous flow about immersed boundaries, as it relates to flow separation, wakes, profile drag, drag coefficients and the determination of drag forces exerted on such bodies.
4. Apply the compressible flow analysis to a pipe flow and compute the pressure losses due to friction, area change in the system and assess the performance of the system.

Subject Code: ME-2202
Subject Name: Kinematics of Machinery
Credit Point: 3 **(**L=2, T=1, P=0)

A. Course Objectives:

1. To learn different mechanism of machine.
2. To learn different working principle of various types of gears, brakes, cams.
3. To learn how to draw velocity and acceleration diagram for kinematics pairs.

B. Course Content:

Machine and mechanism: Definition, mechanism and machine, link, kinematic pair, degrees of freedom, kinematic chain, various types of joints, degrees of freedom for plain mechanism, inversion, different types of kinematic chain and their inversions,Kutzbachcriteria and Grublercriteria.

Velocity and acceleration in mechanism: Analysis of reciprocating engine mechanism and four bar mechanism, relative velocity method, velocity and acceleration in four bar, slider crank mechanism, instantaneous center method, Kennedy‘s theorem, mechanical advantage, Coriolli‘sacceleration component, synthesis of mechanism, pantograph, Scott-Russel indicator diagram.

Mechanism Synthesis: Graphical methods of synthesis, relative pole and inversion methods, Chebychev spacing for precision positions, Freudenstein’s equation applicable to four bar linkages.

Brakes &dynamometers: Classification of brakes, analysis of simple block, band and internal expanding shoe brake, braking of a vehicle,absorption and transmission dynamometers, prony brake, rope brake dynamometer, belt transmission, torsion dynamometer.

Cams: Introduction, types of followers, cam profile nomenclature, various types of motion of the follower-uniform motion, simple harmonic, uniform acceleration and retardation, cycloidal, cam profile construction for various types of followers.

Gear and gear trains: Gear terminology and definitions, analysis of mechanism trains,simple train, compound train, reverted train, epicyclic train and their applications.

C. Text Books:

1. Shigley, J. E., Vicker, J. J., “Theory of Machines and Mechanisms”, MGH, 2014, 4th Ed.
2. Rao, J. S., “Mechanism and Machine Theory”, Newage publishers, 2010, 2nd Ed.

D. Reference Books:

1. Rattan, S. S., “Theory of Machine”, TMGH, 2017, 4th Ed.

E. Course Outcomes:

1. Have basic knowledge on kinematics of various mechanisms to obtain specific motion in machine.
2. Have basic understanding of working principle of different types of gears, brakes, cams.
3. Solve and evaluate kinematic parameters with the help of velocity and acceleration diagram for kinematics pairs.

4. Use of computerized tools for kinematic analysis of mechanisms.

Subject Code: ME-2203
Subject Name: Manufacturing Processes-I
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Identify the various manufacturing processes.
2. To understand the fundamentals of casting, welding, metal forming and powder metallurgy.
3. Examine the various manufacturing methods encountered in engineering practice.
4. Analyze the effect of process variables to manufacture defect free products.

B. Course Content:

Casting: Introduction, patterns, pattern materials, allowances, types of pattern, sand casting, green and dry sand casting process, types of sand, moulding sand and its properties, moulding sand composition, use of cores, core material, core prints, special moulding processes, die casting process, investment casting process, injection moulding, continuous casting process, vacuum-sealed casting process, plaster mould casting, casting defects and testing's, causes and remedies of defects.

Welding: Classification and application of welding, brazing and soldering process, principles and applications of various welding processes: gas welding, types of flames, shielded material, inert gas welding, tungsten arc welding, submerged arc welding, resistance welding, thermit welding, friction stir welding, high frequency welding, newer welding techniques, laser welding, plasma welding, ultrasonic welding, electron beam welding, various welding defects and testing's.

Metal Forming: Elastic and plastic deformation, concept of strain hardening, hot and cold working processes, various metal forming techniques; rolling, forging, extrusion, wire and tube drawing. Machines and equipment for metal forming processes. Sheet metal forming: shearing, blanking, piercing, bending, stretch forming, metal spinning, and shear spinning, deep drawing, forming defects and testing, swaging, high energy rate forming, explosive forming, electromagnetic forming, electro-hydraulic forming, hydro forming.

Powder Metallurgy: Introduction to powder metallurgy, production of metal powders, compaction and sintering processes, secondary and finishing operations, economics, advantages and applications of powder metallurgy.

C. Text Books:

1. Rao P. N, "Manufacturing Technology: Foundry, Forming and Welding, Volume I", Tata McGraw Hill, 2018, 5th Ed.

2. Ghosh A, Mallik A. K, "Manufacturing Science", Wiley Eastern, 2010, 2nd Ed.

D. Reference Books:

1. Kalpakjian S, Schmid S. R, "Manufacturing Processes for Engineering Materials", Pearson education, 2009, 5th Ed.
2. Dieter G. E, Mechanical Metallurgy, TMH, 2017, 3rd Ed.

E. Course Outcomes:

1. Describe the various manufacturing processes.
2. Interpret casting, welding, metal forming and powder metallurgy techniques.
3. Classify the various manufacturing methods encountered in engineering practice.
4. Evaluate the effect of process variables to manufacture defect free products.

Subject Code: ME-220A
Subject Name: Numerical Methods in Engineering
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Introducing the basic concepts of round off error, truncation error, to derive and apply some fundamental algorithms for solving scientific and engineering problems: roots of nonlinear equations, systems of linear equations, interpolation, numerical differentiation and integration etc.
2. Application of computer oriented numerical methods which has become an integral part of the life of all the modern engineers and scientists.
3. Injecting future scope and the research directions in the field of numerical methods.

B. Course Content:

Introduction: Mathematical modelling and engineering problem solving, approximation and round off errors, truncation errors and Taylor series.

Roots of equations: Bracketing methods-graphical method, bisection method, Newton-Raphson method, Secant method, roots of polynomials, case studies on mechanical engineering problems.

Linear algebraic equations: Solution of linear simultaneous algebraic equations by Gauss elimination and Gauss-Siedel iteration methods, case studies on mechanical engineering problems.

Numerical differentiation and integration: Finite difference method: backward, forward and central difference relations and their uses in numerical differentiation and integration, application of different relations in the solution of partial differential equations.

Ordinary differential equations: Numerical solution by Euler method, Runge-Kutta method, systems of equations, case studies on mechanical engineering problems.

C. Text Books:

1. Kreyzig E., Advanced Engineering Mathematics, Wiley, 2016, 9th Edition.
2. Jain M K., Iyengar S R K. and Jain R K., Numerical Methods for Scientific and Engineering Computation, New Age International Pvt Ltd, 1996,3rd Edition.
3. Atkinson K E., An Introduction to Numerical Analysis, John Wiley & Sons; 1989, 2nd Edition.

D. Reference Books:

1. Rajaraman V., Computer Oriented Numerical Methods, PHI Learning Private Limited, 2018, 4th Edition.
2. Chapra S C.,Canale R P., Numerical Methods for Engineers, McGraw-Hill Education, 2016, 7th Edition.
3. Saha S R., Numerical Analysis with Algorithm and Programming, CRC Press, 2016, 1st Edition.

E. Course Outcomes:

1. Students will be skilled to do numerical analysis, which is the study of algorithms for solving problems related to mechanical engineering.
2. Students will learn to develop computer program for case study part of all sections.
3. Students will be substantially prepared to take up prospective research assignments.

Subject Code: ME-220B
Subject Name: Continuum Mechanics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the physics of Continuum Mechanics.
2. To interpret the difference equation applied in Continuum Mechanics.

B. Course Content:

Introduction to tensors: vectors and second order tensors; tensor operation; properties of tensors; invariants, Eigenvalues and Eigenvectors of second order tensors; tensor fields; differentiation of tensors; divergence, stokes and localization theorems.; kinematics of deformation: continuum hypothesis; deformation mapping; material (Lagrangian) and spatial (Eulerian) field descriptions; length, area and volume elements in deformed configuration; material and spatial time derivatives - velocity and acceleration; linearized kinematics; balance laws: conservation of mass; balance of linear and angular momentum - cauchy stress tensor, state of stress; spatial and material forms of balance laws - concept of first and second Piola-Kirchoff stress tensors; conservation of energy; continuum thermodynamics: basic laws of thermodynamics; energy equation; entropy; Clausius-Duhem inequality. constitutive equations: material frame-indifference; objective stress and stress-rates; material symmetry; constitutive relations for hyperelastic solids, generalized Hooke's law; simple fluids; Navier-Stokes equation.

C. Text Books:

1. Jog, C. S., Continuum Mechanics: Foundations and Applications of Mechanics, Volume-I, Cambridge university press, 2015, Third edition.
2. Tadmor, E. B., Miller, R. E., and Elliot, R. S., Continuum Mechanics and Thermodynamics: From Fundamental Concepts to Governing Equations, Cambridge University Press, 2012.

D. Reference Books:

1. Lai, W. M., Rubin, D., and Krempl, E., Introduction to Continuum Mechanics, Butterworth-Heinemann, 2015, 4th edition.

E. Course Outcomes:

1. Understand the physics of Continuum Mechanics.
2. Interpret the difference equation applied in Continuum Mechanics.

Subject Code: ME-2204
Subject Name: Laboratory-IV – Fluid Mechanics and Machinery Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To provide practical knowledge in verification of principles of fluid flow and Bernoulli's theorem.
2. To impart knowledge in measuring pressure, discharge and velocity of fluid flow.
3. To provide practice in estimating friction losses.
4. To impart training to use various flow measuring devices for making engineering judgment.
5. To know the impact of jet on different surfaces.
6. To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head.

B. Course Content:

List of experiments

a. Metacentric height apparatus.
b. Flow rate measurement using Venturimeter and Orifice meter.
c. Determination of flow velocity using Pitot tube.
d. Determination of discharge coefficient of notches.
e. Determination of friction factor as a function of Reynolds number in pipe flow.
f. Impact of jet on flat and curved surfaces.
g. Performance characteristics of Pelton wheel, Francis and Kaplan turbine.
h. Performance characteristics of pumps.

C. Course Outcomes:

1. Identify various fluid flow measuring apparatus.
2. Understand working principles of various fluid flow measuring instruments.
3. Calculate the friction and measure the frictional losses in fluid flow.
4. Understanding the working principles of hydraulic turbine, pump.
5. Evaluate the impact of jet on different surfaces.

Subject Code: ME-2205
Subject Name: Kinematics of Machinery Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Enhancing the knowledge of students on the different mechanisms, and develop position, velocity and acceleration relations.

B. Course Content:

List of experiments

a. Velocity analysis of four bar mechanism.
b. Velocity analysis of slider crank mechanism.
c. Acceleration analysis of four bar mechanism.
d. To draw displacement diagram, velocity diagram and acceleration diagram of cam follower.
e. To draw a cam profile.
f. Study of Ackerman's Steering Gear Mechanism.
g. To study various types of gears – Helical, cross helical worm, bevel gear.
h. To study various types of gear trains – simple, compound, reverted, epicyclic and differential.

C. Course Outcomes:

1. Understand basic concepts on different mechanisms.

Subject Code: ME-2206
Subject Name: Manufacturing Process Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Acquire skills of the various manufacturing processes.
2. Acquire practical knowledge of casting, welding, metal forming and powder metallurgy processes.
3. Examine the various manufacturing methods encountered in engineering practice.
4. Analyse the effect of process variables to manufacture defect free products

B. Course Content:

List of experiments

a. Perform metal casting for both ferrous and non-ferrous metals.
b. To perform joining of two metals using gas welding and arc welding.
c. To join thin metal sheets using resistance welding.
d. Sieve analysis test of sand/powder and its specification.
e. To find the distribution of sand grains using a set of sieves and to find the average grain fineness number.
f. To find the friability value and the moldability index of the compacted moulding sand.
g. To find the green compression strength of the given specimen at different percentage of clay and moisture.

C. Reference Books:

1. Rao P. N, "Manufacturing Technology: Foundry, Forming and Welding, Volume I", Tata McGraw Hill, 2018, 5th Ed.

2. Ghosh A, Mallik A. K, "Manufacturing Science", Wiley Eastern, 2010, 2nd Ed.

D. Course Outcomes:

1. Use the various manufacturing processes as per requirement and application.
2. Select casting, welding, metal forming and powder metallurgy processes as and when required.
3. Interpret the various manufacturing methods encountered in engineering practice.
4. Choose appropriate process variables to manufacture defect free products.

Vth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-3101	DSC10 –Applied Thermodynamics	3	0	0	3
2	ME-3102	DSC11 – Design of Machine Elements	3	0	0	3
3	ME-3103	DSC12 - Manufacturing Processes II	3	0	0	3
4	ME-310A	DSE3 - Dynamics of Machinery	3	0	0	3
5	YY-310X	OE3*	3	0	0	3
6	ME-3104	AECC1-Internship-I	0	0	0	1
7	MH-3101	SECC4-Engineering Economics	3	0	0	3
8	ME-3105	VAC4-Minor Project-I	0	0	4	2
9	ME-3106	Laboratory-VII–Thermal Laboratory-I	0	0	2	1
10	ME-3107	Laboratory-VIII - Workshop Practice II	0	0	2	1
11	ME-3108	Laboratory-IX–Theory of Machines Laboratory	0	0	2	1
Contact Hours			18	0	10	
Total Credits						24

Subject Code: ME-3101
Subject Name: Applied Thermodynamics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To learn about various vapour power cycles, cogeneration, steam generators, steam turbines etc.
2. To study about, refrigeration cycles, air conditioning and refrigeration, properties of dry and wet air and the principles of psychrometry.

3. To understand about air compressors, IC engines etc.

B. Course Content:

Vapour power cycles: Rankine cycle, cycle with superheat, reheat and regeneration and intercooling.

Gas power cycles: Otto, Diesel and Dual cycles , air standard Brayton cycle, cycle with superheat, reheat and regeneration and intercooling, combined gas and vapour power cycles.

Refrigeration: Vapour compresion refrigeration cycles, vapour absorption refrigeration cycles, refrigerants and their properties, air refrigeration.

Psychometry: Properties of dry and wet air, use of psychometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.

Reciprocating air compressors: Staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Analysis of steam turbines: Velocity and pressure compounding of steam turbines.

IC Engines: SI and CI engines, two stroke and four stroke engines, performance parameters, modern fuel ignition systems, combustion in SI and CI engines.

C. Text Books:

1. Cengel Yunus A. and Boles, "Engineering Thermodynamics", Tata McGraw-HillPublishing Co. Ltd, 2017, 8th Ed.
2. Eastop T.D and McConkey A., "Applied Thermodynamics and engineering", 2010, 5th Ed.

D. Reference Books:

1. Jones, J. B. and Duggan, R. E., "Engineering Thermodynamics", Prentice-Hall of India, 1996.
2. Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 1999.
3. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., , "Fundamentals of Thermodynamics", John Wiley and Sons, 2003, 6th Edition.
4. Nag, P.K, "Engineering Thermodynamics", Tata McGraw-Hill Publishing Co. Ltd, 1995.

E. Course Outcomes:

1. Various practical power cycles, heat pump cycles, refrigeration cycles etc.
2. They will be able to analyze energy conversion in various thermal devices such as nozzles, diffusers, steam turbines and reciprocating compressors
3. They will be able to understand air compressors, IC engines and their working.

Subject Code: ME-3102
Subject Name: Design of Machine Elements

Credit Point: 3 [L = 3, T = 0, P =0]

A. Course Objectives: The course is design to meet with the following objectives:
1. To teach the students the basic steps forming the design process and demonstrating the fact that design problems are open-ended, require creativity and involve iterative solutions.
2. To teach the students design methodologies and simple stresses & applicability of factor of safety. 3. Will be able to design machine elements based on strength and stiffness.

B. Course Content:
Basics of Machine design: Introduction to Mechanical Design, overview of design and manufacturing procedure, engineering materials, load-stress-strain analysis in machine parts, deflection and stiffness in machine elements.

Design for Strength: Design for static loading, stress concentration, failures theories from static loading, Introduction to fatigue load, fatigue failure analysis and design, failure theories for fluctuating stress.

Design of Permanent Joints: Riveted joints, welded joints, design of Non-Permanent Joints: screws, fasteners and bolted joints, keys, knuckle and cotter joints.

Design of shaft and shaft components: Design of shaft for static loading and fluctuating loads: pure torsion, simple bending, combined bending and torsion, combined bending, torsion and axial loads.

Design of shaft couplings: Muff couplings, rigid flange couplings, flexible couplings: bush-pin type. Design of mechanical springs: stresses and deflection of helical springs, closed and open coiled tension and compression springs and their ends, design of helical springs for static and fatigue loading. design of leaf springs, design of clutches and brakes and design of belts.

C.Text Books:
1. Norton, L. R., "Machine Design an Integrated Approach", 5th Ed., Pearson Education Asia, 2018.
2. Shigley, J. E., Mischke, C. R., "Mechanical Engineering Design", 9th Ed., Mcgraw Hill, 2018.
3. Bhandari, V. B., "Design of Machine Elements", 4th Ed., McGraw-Hill, 2017.

D. Course Outcomes: Upon completion of the subjects, students:
1. Will have knowledge on design philosophy, design considerations for machine component design, design principals, material properties, engineering materials, standard and codes.
2. Will have basic understanding machine elements subjected to simple stresses for different loading conditions and theories of failure.
3. Will be able to apply knowledge in design of temporary joint e.g. cotter joint, knuckle joint, keys, bolted& coupling and permanent joints e.g. riveted and welded joints subjected to static load.
4. Will be able to design of machine components like shafts based on strength and stiffness, various springs and power screws.
5. Use of computerized tools for 3D design of machine elements.

Subject Code: ME-3103
Subject Name: Manufacturing Processes-II
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the concept and basic mechanics of metal cutting.
2. To understand the effect of different process parameters during machining.
3. To understand the concept of non-conventional machining.
4. To understand the basic concepts of additive manufacturing processes.

B. Course Content:

Machining and Machinability: Classification of metal removal processes, concepts of machining and machinability and its improvement,, mechanism of chip formation, orthogonal and oblique cutting, geometry of single point cutting tools, conversion of tool angles from one system to another, use of chip breakers in machining.

Mechanics of machining: Machining forces and Merchant's circle diagram (MCD), analytical and experimental determination of cutting forces, dynamometers for measuring cutting forces, cutting temperature-causes and effects, assessment and control, cutting fluid application, failure of cutting tools and tool life, cutting tool materials for common use, advanced cutting tool materials, estimation of machining time.

Non-conventional machining: Classification of non-conventional machining based on source of energy, abrasive jet machining, water jet and abrasive water jet machining, ultrasonic machining, chemical machining, electro chemical machining, electro discharge machining, electron beam and laser beam machining, ion beam machining.

Introduction to micro and nano machining techniques: Electro chemical discharge machining, electro chemical grinding, electro chemical honing.

Additive manufacturing: Introduction and working principle of AM techniques like vat photo-polymerization AM process, material jetting AM processes, binder jetting AM processes, extrusion based AM processes, sheet lamination AM processes, powder bed fusion AM processes.

Introduction to Industry 4.0: Introduction, core idea of industry 4.0, origin concept of industry 4.0, industry 4.0 production system, current state of industry 4.0, main concepts and components of industry 4.0.

Introduction to machine learning: Learning problems: perspectives and issues, concept learning

C. Text Books:

1. Bhattacharyya A, Metal Cutting: Theory and Practice, New Central.
2. Pandey P.C and Shan H.S, Modern Machining Processes, Tata McGraw Hill, 2017.
3. Rao P. N, Manufacturing Technology: Volume II, Tata McGraw Hill, 2008
4. Ghosh A and Mallik A. K, Manufacturing Science, Wiley Eastern, 1986.
5. Kalpakjian S and Schmid S. R, Manufacturing Processes for Engineering Materials, Pearson education, 2009.
6. Chattopadhyay A. B, Machining and Machine Tools, Wiley, 2011.
7. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
8. Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0.

D. Reference Books:

1. Lal G. K, Introduction to Machining Science, New Age International Pvt. Ltd., 2007.
2. Shaw M. C, Metal Cutting Principles, MIT Press, 2004.
3. Mishra P. K, Non-conventional Machining, Narosa Publishing House, 1997.
4. Bandyopadhyay A., Bose S., Additive Manufacturing, CRC Press, Taylor & Francis group, 2020, 2nd edition.
5. Paul C. P., Junoop A. N., Additive Manufacturing: Principles, Technologies and Applications, McGraw Hill, 2021.
6. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

E. Course Outcomes:

1. Demonstrate the concept and mechanics of metal cutting.
2. Choose effectively the different process parameters during machining.
3. Identify and apply the concept of non-conventional machining.
4. Describe and practice the basic concepts of additive manufacturing processes.

Subject Code: ME-310A
Subject Name: Dynamics of Machinery
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To equip the student with fundamental knowledge of dynamics of machines so that student can appreciate problems of dynamic force balance, transmissibility of forces, isolation of systems, vibrations.
2. Develop understanding of dynamic balancing, flywheel analysis, gyroscopic forces and Moments.

3. Develop knowledge of analytical and graphical methods for calculating balancing of rotary and reciprocating masses.
4. Develop understanding of vibrations and its significance on engineering design.

B. Course Content:

Static force analysis: Inertia force of piston cylinder considering friction and orientation of the piston cylinder arrangement.

Dynamic Force Analysis of Machines: Flywheel: Turning moment diagram for engines and speed fluctuation; power smoothening by flywheels. Governor: Difference between flywheel and governor, Watt governor, Porter governor, analysis, effect of friction, Proell governor, Hartnell governor, controlling force, sensitivity, stability, hunting, isochronism, effort and power of a governor. Gyroscope: Gyroscopic effect- gyroscopes and their uses.

Balancing: Dynamics of rotating Bodies; unbalance effects and balancing of inertia forces; field balancing and balancing machines, dynamics of reciprocating machines with single slider; unbalance in single cylinder engine mechanisms, unbalance in multi-cylinder engines -in-line, v-twin and radial engines; balancing techniques.

Vibration: Vibration of mechanical systems; types of vibration; lumped parameter models; linearization of system elements; degrees of freedom; types of restoration` and dissipation mechanisms; types of excitation, free un-damped vibration of single degree of freedom systems; determination of natural frequency; equivalent inertia and stiffness; energy method; phase plane representation, forced vibration with harmonic excitation; un-damped systems and resonance; viscously damped systems; frequency response characteristics and phase lag; systems with base excitation; transmissibility and vibration isolation; whirling of shafts and critical speed, vibration of two and multi degree of freedom systems; concept of normal mode; free vibration problems and determination of natural frequencies; forced, vibration analysis; vibration absorbers; approximate methods -Dunkerley's method and Holzer method, free vibration of elastic bodies; longitudinal vibration of bars; transverse vibration of beams; torsional vibration of shaft; approximate methods - Rayleigh's method and Rayleigh-Ritz method.

C. Text Books:

1. Uicker, J. J., Pennock, G. R. and Shigley, J. E.,Theory of Machines and Mechanisms, Oxford International Student edition, 2014, 3rd Ed.
2. Rattan, S. S., Theory of Machines, TMH, 2014, 4th Ed.
3. Thomson, W. T. and Dahleh, M. D., Theory of vibration with applications, Pearson, 2015, 5th Ed.

D. Reference Books:

1. Balachandran, B., Magrab, E. B., Vibrations, Cengage Learning, 2009, 2nd Ed.
2. Kelly, S. G., Fundamentals of Mechanical Vibrations, TMH, 2000, 2nd Ed.

E. Course Outcomes:

1. Basic understanding of dynamics in plane motion with force equilibriums.

2. Analyse slider crank and other mechanisms based on learnt techniques.
3. Understand basic principles of different rotating dynamic bodies.
4. Understand how to determine the natural frequencies of continuous systems and analyse stability of various systems.

Subject Code: MH-3101
Subject Name: Engineering Economics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Learn the fundamentals of Engineering Economics
2. Understand and use of Economic concepts in making business decision
3. Use economic information to manage the organization
4. Use economic tools with respect to acceptance or rejection of investment proposals
5. Know the current issues relating to economic environment

B. Course Content:

Basics of Economics: Basic Concepts, Scope, Importance and definitions, Relevant to Managerial Economics-Factors Influencing Managerial Decision — Managerial economics and other disciplines, Relation between Science, Engineering, Technology and Economics Demand Analysis : Managerial Decisions-Meaning- Types—Determinants, Demand Functions, Demand Elasticity, Demand Forecasting Methods, Accuracy of Forecasting Cost concept :Costs Concepts-Accounting Cost and Economic Cost determinants of Cost, Cost — Output Relationship ,Break Even Analysis- Meaning, Assumption, Uses and Limitation, Break Even Point (BEP)- Meaning, Determinants of Break Even Point- Break Even Charts, linear approach (Simple numerical problems to be solved).Market Structure and Product Pricing :Perfect and Imperfect Market Structures. Conditions of Perfect Competition. Price of a Product under demand and supply forces. Equilibrium Price. Pricing under Monopoly and Monopolistic Competition. Pricing under Oligopoly. Kinked Demand Curve. Discriminating Prices. Inflation, Business cycle, National income: Inflation- meaning, feature, Types, causes, Effects of Inflation, Measures to Control Inflation. Business Cycle - Features of Business Cycle, Causes of Business Cycle, Types of Business Cycle, Theories of Business Cycle, Impacts/Effects of Business Cycle, Measures to Control Business cycle, National Income & Current Issues- Concepts of National Income, Factors Determining Level (Size) of National Income, Methods of Measurement of National Income, Choice of Methods of National Income, Importance of Measurement of National Income, Difficulties in Measuring National Income.

C. Text Books:

1. Park, S. Chan, Fundamentals of Engineering Economics, , Pearson , New York, 2019, 4th Edition.
2. Yates, J.K. Engineering Economics, CRC Press, Boca Raton, 2016, 1st Edition.
3. Brajesh Kumar, Zahid A.Khan, Arshad N. Siddiquee, Mustufa H. Abidi , Principles of

Engineering Economics with Applications, Cambridge University Press; 2018, 2nd edition.

4. Singh Seema, Economics for Engineering Students, I.K. International Publishing House Delhi, 2014, 2nd Edition

D. Reference Books:

1. Panneer Selvam, Engineering Economics, NewDelhi, PHI Learning Private Limited, 2013, 2nd Edition.
2. Pravin Kumar, Fundamentals of Engineering Economics, New Delhi, John and Wiley, 2012.
3. *Gupta, G.S. Managerial Economics*, *Joel Dean*, *Englewood Cliffs*, *N.J.*: *Prentice-*. Hall, 2011
4. Diwedi, D.N., Managerial Economics, New Delhi, Pearson Education India,2012.
5. Varshney, S.C., Managerial Economics, New Delhi Sultan Chand & Sons, 2010

E. Course Outcomes:

1. Learn the fundamentals of Engineering Economics.
2. Understand and use of Economic concepts in making business decision.
3. Use economic information to manage the organization.
4. Use economic tools with respect to acceptance or rejection of investment proposals.
5. Know the recent trends relating to economic environment.

Subject Code: ME-3106
Subject Name: Thermal Laboratory-I
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To understand the basic internal combustion engine performance, brake power, indicated power, friction power and volumetric efficiency of I.C. engines.
2. To develop an idea of fuel properties and their variation with temperature, determination of kinematic viscosity and calorific value of fuel.

B. Course Content:

List of Experiments:

a. Determination of Viscosity, Calorific value, Flash points and Fire points, Aniline point of liquid fuels.
b. Study the working principle of Two-Stroke internal combustion engines.
c. Study the working principle of Four-Stroke internal combustion engines.
d. Determine the performance characteristics of engines
e. Determine COP of Heat Pump.
f. Determine the FAD of air compressor.

C. Reference Books:

1. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill, 2017, 4th Ed.

D. Course Outcomes:

1. Explain the complete operation of 2 stroke and 4 stroke I.C engines and its performance evaluation.
2. Calculate viscosity, flash points, fire points, aniline point and calorific value of fuel.

Subject Code: ME-3107
Subject Name: Workshop Practice II
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To identify and distinguish the particle size of a given sand sample.
2. To calculate the average grain fineness number by sieving/ screening.
3. To analyse the friability value and moldability index of the molding sand.
4. Demonstrate laboratory techniques including the proper use of relevant instruments for measurement of various physical quantities.

B. Course Content:

List of Experiments:

a. Sieve analysis test of sand/powder and its specification.
b. To find the distribution of sand grains using a set of sieves and to find the average grain fineness number.
c. To find the friability value and the moldability index of the compacted moulding sand.
d. To find the green compression strength of the given specimen at different percentage of clay and moisture.
e. Study the mechanism and formation of different types of chips during machining.
f. Measure the cutting force using dynamometers during operations in lathe, drilling and milling.
g. To measure the surface roughness of various machined surfaces using surface roughness tester.

C. Reference Books:

1. Rao, P. N., Manufacturing Technology: Foundry, Forming and Welding, Volume I", Tata McGraw Hill, 2018, 5th Ed.
2. Holman, J. P., Experimental Methods for Engineers, McGraw Hill Education, 2017, 7th Ed.

D. Course Outcomes:

1. Know basic principles of identification of particle grain size and the average grain fineness number by sieving/ screening technique.
2. Analyse the friability and moldability index of the molding sand.
3. Identify the various methods of measurement of cutting force and surface roughness

during machining.

Subject Code: ME-3108
Subject Name: Theory of Machines Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To provide basic concept of kinematics and kinetics of machine elements
2. To study basics of power transmission.
3. To Study the essentiality of balancing.
4. To study the different types of vibration and to understand critical speed of shaft.
5. To acquaint with working principles of CAM Mechanism.

B. Course Content:

List of Experiments:

1. Gyroscope.
2. Jump speed of a cam
3. Whirling speed of a shaft.
4. Vibration.
5. Balancing.
6. Governor.

C. Reference Books:

1. Bevan Thomas., Theory of Machines, CBS Publishers and Distributors, 2005, 3rd Edition.
2. Rattan.S.S, Theory of Machines, Tata McGraw -Hill Publishers, New Delhi, 2009.
3. Uicker J John., Pennock R Gordon, Shigley E Joseph., Theory of Machines and Mechanism, Oxford university Press, 2014.

D. Course Outcomes:

1. Understand the basics of Machines and Mechanisms.
2. Understand the Terminology and types associated with vibration in machine elements
3. Identify and select the appropriate power transmission mechanisms.
4. Construct CAM profile for the specific follower motion
5. Analyze and apply the knowledge of these machines, mechanisms and related terminologies in mechanical engineering science in maintaining sustainable environment and its impact on society.

VIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-3201	DSC13 - Heat Transfer	3	0	0	3

2	ME-3202	DSC14 - Industrial Engineering & Operations Research	3	0	0	3
3	ME-3203	DSC15–Machine Design	3	0	0	3
4	ME-320A	DSE4–Computational Fluid Dynamics	3	0	0	3
	ME-320B	DSE4– Finite Element Analysis				
	ME-320C	DSE4– Computer-Aided Design and Manufacturing				
5	ME-321A	DSE5 - Materials Characterization methods	3	0	0	3
	ME-321B	DSE5 - Automobile Engineering				
	ME-321C	DSE5 - Advanced Machine Tools and Operations				
	ME-321D	DSE5 - Refrigeration and Air-conditioning				
	ME-321E	DSE5 - Mechatronics and Automation				
6	YY-320X	OE4*	3	0	0	3
7	ME-3204	VAC5-Minor Project-II	0	0	4	2
8	ME-3205	Laboratory-X - Thermal Laboratory-II	0	0	2	1
9	ME-3206	Laboratory-XI–Design Practices	0	0	2	1
10	ME-3207	Laboratory-XII–Mechatronics and Automation Laboratory	0	0	2	1
Contact Hours			18	0	10	
Total Credits						23

Subject Code: ME-3201
Subject Name: Heat Transfer
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To introduce a basic study of the phenomena of heat and mass transfer.
2. To develop methodologies for solving a wide variety of practical engineering problems.
3. To design a knowledgeable based problem requiring the formulations of solid conduction and fluid convection.
4. To develop basic understanding of two phase flow heat transfer.

B. Course Content:

Introduction: Typical heat transfer situations, modes of heat transfer, introduction to laws, some heat transfer parameters.

Conduction: Fourier's law and thermal conductivity, equation of heat conduction, boundary conditions and initial conditions, one dimensional steady state situations – plane wall, cylinder, sphere, concept of thermal resistance, concept of overall heat transfer coefficient, critical radius, heat generation, fin analysis, uniform cross section, two dimensional steady heat conduction, transient conduction-lumped capacitance model, one dimensional transient conduction – analytical solutions.

Forced convection: Concepts of fluid mechanics, differential equation of convection, laminar flow and heat transfer in circular pipe, thermal entrance region, turbulent flow heat transfer, heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy, flow across a cylinder and sphere, flow across banks of tubes.

Natural convection: Introduction, differential equations, vertical plate, horizontal cylinder, horizontal plate.

Heat exchangers: Types of heat exchangers, LMTD-NTU approach – parallel and counter-flow arrangements.

Boiling and condensation: Dimensionless parameters, boiling modes, correlations, forced convection, laminar film condensation on a vertical plate.

C. Text Books:

1. Cengel A.Younis, Heat Transfer: A Practical Approach, McGraw Hill, 2002, 2nd Ed.
2. Incropera, F. P., Dewitt, D. P., Bergman, T. L., Introduction to Heat Transfer, John Wiley & Sons, 2006, 5th Ed.

D. Reference Books:

1. Bejan, A., Convection Heat Transfer, John Wiley, 2006, 3rd Ed.
2. Ozisik, M. N., Heat Conduction, John Wiley & Sons, 2012, 3rd Ed.

E. Course Outcomes:

1. Define the different modes of heat transfer and basic laws of heat as well as mass transfer.
2. Understand the fundamentals of convective heat transfer process.
3. Calculate the consequences of heat transfer in thermal analyses of engineering systems.
4. Solve problems involving steady and transient heat conduction in simple geometries.
5. Analyse heat exchanger performance and effectiveness as well as boiling heat transfer.

Subject Code: ME-3202
Subject Name: Industrial Engineering & Operations Research
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms.
2. To develop skills necessary to effectively analyze and synthesize the many inter-relationships inherent in complex socio-economic productive systems.
3. To gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.

B. Course Content:

Introduction: Concept of industrial engineering, its role & applications, work study: time & motion study, method study , principles of motion economy, workplace layout, stopwatch time study, SIMO chart, man-machine chart, Therbligs, PMTS, MTM, work sampling.

Organisation: Organisation structures, types, principles of organization structures, features of various ownerships, company formations, its management and finance, public limited & private limited company.

Material Management: Functions of material management, Inventories- its types, Just In Time (JIT), MRP, concept of EOQ & EBQ, simple EOQ model with and without stock outs, simple EOQ model with varying demand and production, P- type & Q- type of inventory policies, selective inventory control like ABC, VED, SDE techniques etc.

Production Planning &Control: Functions and role, value analysis, exponential smoothing constant and moving average method in demand and production forecasting, break even analysis.

Metrology and Quality Management: Introduction to engineering metrology: Linear, angular and rotational measurement comparators, screw threads and gear measurement, strain gauge and surface finish measurement, quality v/s reliability, quality maintenance and quality assurance, SQC technique, acceptance sampling, concept of TQM, ISO standards.

Plant Layout: Location factors, principles and design, types of layout, tools & technique.

Plant Maintenance: Break down, scheduled and preventive maintenance, steps in preventive maintenance, online maintenance, TPM concept.

Operational Research: concept of OR, methods of OR, concept of optimization, linear programming, simplex method transportation problem, queuing theory. decision theory, integer programming, revised simplex method, network techniques (PERT & CPM), theory of games, simulation.

C. Text Books:

1. Ralph M. Barnes, ‘Motion and Time Study: Design and measurement of work', Wiley, 1980, 7th Ed.

2. M. Mahajan, 'Industrial Engineering and Production Management' Dhanpat Rai and Co., 2015.
3. H. A. Taha, 'Operations Research- An Introduction', Prentice Hall of India, 1997.

D. Reference Books:

1. S. N. Chary, Problems & Solutions in Production and Operations Management, TMH, 1995.

E. Course Outcomes:

1. Identify the core features of the operations and production management function at the operational and strategic levels.
2. Identify and observe the operational research models from the description of a real system.
3. Illustrate the mathematical tools that are needed to solve optimization problems.

Subject Code: ME-3203
Subject Name: Machine Design
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the design and analysis of clutches, brakes and fly wheels.
2. To determine the forces on different type of gears for power transmission.
3. To determine the different forces acting on bearings and understanding selection of bearings.

B. Course Content:

Design of Clutches, Brakes and Flywheels: Brakes and clutches need and functioning, design of disc and cone type of clutches for uniform pressure and wear. Design of internal expanding and external contracting brakes, band type of brakes, cone and disk brakes. Flywheel: coefficient of fluctuation of speeds, fluctuation of energy, energy stored in flywheel, stresses in flywheel ring and arms.

Design of gear: Gears types and application and gear terminology, law of gearing-conjugate action and interference in gears, analysis of forces on spur, and helical gears, bending and contact stress in gear tooth Lewis equation for design, dynamic loading and wear-buckingham equations for design, force analysis on bevel and worm gears, design approach for bevel gears-equivalent tooth, design of fixed ratio gearbox general design procedure.

Sliding and Journal Bearing: Types of lubrication, hydro static and dynamic lubrication, Petroff's equation and the bearing characteristic number, lubrication regimes-boundary and film lubrication, hydro dynamic bearings-pressure distribution-eccentricity and minimum film thickness Reynolds equation and use of bearing design charts, heat generation and thermal equilibrium.

Rolling Contact Bearing: Types of ball bearing, thrust ball bearing, types of roller bearing, selection of radial ball bearing, bearing life, selection of roller bearings, dynamic equivalent load for roller contact bearing under constant and variable loading, reliability of bearing. selection of rolling contact bearing.

Design of IC Engine Components: General design consideration, design of cylinder, cylinder liner, cylinder head, pistons, connecting rod and crank shaft.

Reliability analysis in Design.

C. Text Books:

1. Norton, L. R, Machine Design, Pearson Education Asia, 2018, 5th Ed.
2. Spotts, M. F. and Shoup, T. E., Design of Machine Elements, Pearson Hall, 2006, 8th Ed.
3. Shigley, J. E. and Mischke. C. R., Mechanical Engineering Design, McGraw Hill 2014, 10th Ed.
4. Bhandari, V. B., Design of Machine Elements, McGraw-Hill, 2017, 4th Ed.

D. Reference Books:

1. Juvinal, R. C. and Marshek, K. M., "Fundamentals of Machine Component Design" John Wiley Publication, 2016, 5th Ed.

E. Data Book:

1. "Design Data: Data Book of Engineers", PSG College of Technology, Coimbatore, 2012.
2. S.Md.Jalaludeen, "Design Data Hand Book –Mechanical & Automobile", Anuradha Agencies Kumbakonam, 2016, 3rd Ed.
3. Maitra, G.M. and Prasad, L.V., "Handbook of Mechanical Design", McGraw-Hill Inc, 1985.
4. Mahadevan, K. and Balaveera, K. Reddy, "Design Data Handbook for Mechanical Engineering", CBS Publishers, 2013, 4th Ed.

F. Course Outcomes:

1. Define the different modes of heat transfer and basic laws of heat as well as mass transfer.
2. Understand the fundamentals of convective heat transfer process.
3. Calculate the consequences of heat transfer in thermal analyses of engineering systems.
4. Solve problems involving steady and transient heat conduction in simple geometries.
5. Analyse heat exchanger performance and effectiveness as well as boiling heat transfer.

Subject Code: ME-320A
Subject Name: Computational Fluid Dynamics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems.
2. Provide the essential numerical background for solving the partial differential equations governing the fluid flow.

B. Course Content:

Introduction to computational fluid dynamics and principles of conservation: Continuity equation, Navier stokes equation, energy equation and general structure of conservation equations.

Classification of partial differential equations and physical behaviour: Mathematical classification of partial differential equation, illustrative examples of elliptic, parabolic and hyperbolic equations, physical examples of elliptic, parabolic and hyperbolic partial differential equations.

Approximate solutions of differential equations: Error minimization principles, functional involving higher order derivatives, approximate solution of differential equations through variation formulation, boundary conditions in the variation form: primary and secondary variables, essential and natural boundary conditions, approximate solutions of differential equations, properties of variation form, weighted residual approach: trial function and weighting function, requirement of trial function and weighting function, least square method, point collocation method, Galerkin's method, Rayleigh-Ritz method.

Fundamentals of discretization: Discretization principles: pre-processing, solution, post-processing, finite element method, 3 finite difference method, well posed boundary value problem, possible types of boundary conditions, conservativeness, boundedness, transportiveness, finite volume method (FVM), illustrative examples: 1-d steady state heat conduction without and with constant source term.

Finite volume method: Some conceptual basics and illustrations through 1-d steady state diffusion problems: physical consistency, overall balance, FV discretization of a 1-d steady state diffusion type problem, composite material with position dependent thermal conductivity, four basic rules for FV discretization of 1-d steady state diffusion type problem, source term linearization, implementation of boundary conditions.

Discretization of unsteady state problems: 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme.

Finite volume discretization of 2-d unsteady state diffusion type problems: FVM for 2-D unsteady state diffusion problems, solution of linear algebraic equation- basic numerical methods, direct method, tri-diagonal matrix algorithm, TDMA and other iterative methods.

C. Text Books:

1. Chung, T. J., Computational Fluid Dynamics, Cambridge University Press, 2014, 2nd Ed.
2. Anderson J. D. (Jr)., Computational Fluid Dynamics: The basic with applications, McGraw Hill Education, 2017.

D. Reference Books:

1. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, CRC Press 2017.
2. Versteeg, H. K., Malalasekera, W., An Introduction to Computational Fluid Dynamics, PHI, 2007, 2nd Ed.
3. Ferziger, J. H. and Peric, M., Computational Methods for Fluid Dynamics, Springer, 2002, 3rd Ed.

E. Course Outcomes:

1. Understand the basic concepts and its solution for aerodynamic flow.
2. Define and setup flow problems within CFD context.
3. Solve Navier-Stokes equations with proper initial and boundary conditions.
4. Use CFD software to model relevant engineering flow problems and analyse the results.

Subject Code: ME-320B
Subject Name: Finite Element Analysis
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To learn the theory and characteristics of finite elements that represent engineering problems.
2. To learn and apply finite element solutions to structural, thermal, dynamic problem.
3. To develop the knowledge and skills needed to effectively evaluate finite element analyses.

B. Course Content:

Introduction: Continuous and discrete systems (discussion on differential equations, matrix algebra)

Energy methods: Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames.

Finite elements for two-dimensions: Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates, Iso-parameteric mapping, numerical integration, assembly procedure, solution techniques.

Applications: Plane elasticity, heat conduction, potential flow and Transient problems, computer implementation.

C. Text Books:

1. Logan D L., A first course in the finite element method, Cengage Learning India Private Limited, 2012, 5th Edition.
2. Reddy J.N, Introduction to Finite Element Method, McGraw Hill, 2020, 4th Edition.
3. Dixit US, Finite Element Methods for Engineers, Cengage Learning, 2009.
4. Seshu P., Textbook of Finite Element Analysis, PHI Learning, 2003.

D. Reference Books:

1. Fish J. and Belytschko T., A first course in finite elements, Wiley, 2007, 1st Edition.
2. Desail Abel, Introduction To The Finite Element Method A Numerical Method For Engineering Analysis, CBS, 2005.
3. BatheK J., Finite element procedures, Prentice Hall, Indian edition, 2006, 1st Edition.

E. Course Outcomes:

1. Apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence.
2. Analyze linear 1D problems like bars and trusses; 2D structural problems using CST element and analyse the axi-symmetric problems with triangular elements.
3. Solve linear 2D structural beams and frames problems; 1Dheatconduction and convection heat transfer problems.
4. Evaluate the Eigen values and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity.

Subject Code: ME-320C
Subject Name: Computer Aided Design and Manufacturing
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To introduce the students to the basic tools of Computer Aided Design (CAD).
2. To be able to perform all 2D and 3D designs using CAD package.
3. To introduce the students to the standard terminologies, design and operational characteristics of Numerical Control (NC) and Computer Numerical Controlled (CNC) machines.
4. To prepare the students to be an effective user of a CAD/CAM system.

B. Course Content:

Introduction: Fundamentals of CAD, automation, design process, application of computers for design, benefits of CAD, computer configuration for CAD applications.

Geometric modeling: 3D wire frame modelling, wire frame entities and their definitions, interpolation and approximation of curves, concept of parametric and non-parametric representation of curves, curve fitting techniques, cubic spline, Bezier and B-spline.

Surface modelling: Algebraic and geometric form, parametric space of surface, blending functions, cylindrical surface, ruled surface, composite surface, Bezier surface, B-spline

surface, solid modelling, cell composition, constructive solid geometry, boundary representations.

NC/CNC control production systems: NC control, elements of NC system, NC part programming, methods of NC part programming, manual part programming, computer assisted part programming, CNC programming, adaptive control systems, machining centers.

Computer Aided Manufacturing: Computer aided process planning, manufacturing resource planning, flexible manufacturing system and computer aided quality control and computer integrated manufacturing.

C. Text Books:

1. Ibrahim Z., CAD/CAM: Theory and Practice, TMH.
2. Rao P. N., CAD/CAM: Principles and Applications, TMH.
3. Groover M.P and Zimmers E., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall.
4. Alavala C. R., CAD/CAM: Concepts and applications, PHI Learning Pvt. Ltd., 2008.

D. Reference Books:

1. Valentino V. James and Goldenberg Joseph, Introduction to Computer Numerical Control, Prentice Hall, Englewood Cliff, New Jersey, 2012, 5th Edition.
2. Gibbs David and Crandall Thomas, CNC Machining and Programming: An Introduction, Industrial Press Inc., 2003.
3. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.

E. Course Outcomes:

1. Recognize the geometric transformation techniques in CAD.
2. Distinguish NC, CNC and DNC systems and understand the basic principles of CAM, FMS and CIM.
3. Apply mathematical tools to represent curves and surfaces for engineering applications.
4. Develop manual and APT part programs for various profiles and test the program through simulation.

Subject Code: ME-321A
Subject Name: Materials Characterization Methods
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To provide an introduction to materials characterization and its importance.
2. To discuss different types of characterization techniques and their uses.
3. To understand crystal structure using diffraction methods.

4. To describe the properties and behaviour of x-rays and their use in materials characterization.
5. To describe the operation and use of a SEM, FESEM and TEM.

B. Course Content:

Introduction: Need of material characterization and available techniques.

Optical Microscopy: Optical microscope, basic principles and components, different examination modes (bright field illumination, oblique illumination, dark field illumination, phase contrast, polarised light, hot stage, interference techniques), stereomicroscopy, photo-microscopy, colour metallography, specimen preparation, applications.

Electron Microscopy: Interaction of electrons with solids, scanning electron microscopy,transmission electron microscopy and specimen preparation techniques, field emission scanning electron microscopy, energy dispersive spectroscopy, wavelength dispersive spectroscopy.

Diffraction Methods: Fundamental crystallography, generation and detection of X-rays, diffraction of X-rays, X-ray diffraction techniques, electron diffraction.

Surface Analysis: Atomic force microscopy, scanning tunnelling microscopy, X-ray photoelectron spectroscopy.

Spectroscopy: Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transforms infrared spectroscopy, Raman spectroscopy, XRD.

Thermal Analysis: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetry, thermo mechanical analysis and dilatometry.

C. Text Books:

1. Lin Li, Kumar A, Zhang S, Materials Characterization Techniques, CRC Press, 2008.
2. Cullity B. D, Stock R. S, Elements of X-ray Diffraction, Prentice Hall, 2001.
3. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, 2001.
4. Tyagi A. K., Roy M., Kulshreshtha S. K, Banerjee S, Advanced Techniques for Materials Characterization, Materials Science Foundations, Volume 49-51, 2009.
5. Wendlandt W. W, Thermal Analysis, John Wiley & Sons, 1986.

D. Reference Books:

1. Wachtman J. B, Kalman Z. H, Characterization of Materials, Butterworth-Heinemann, 1993.

E. Course Outcomes:

1. Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials.
2. Choose appropriate electron microscopy techniques to investigate microstructure of materials at high resolution.

3. Use appropriate spectroscopic technique to measure vibrational/electronic transitions to estimate parameters like energy band gap, elemental concentration.
4. Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.

Subject Code: ME-321B
Subject Name: Automobile Engineering
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Introduction to engineering analysis of the automobile and its sub-systems.
2. Application of engineering principles to automotive design.
3. Acquaintance with modelling and analysis methods.
4. Acquaintance with the automotive industry and its terminology.

B. Course Content:

Introduction: Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act. Power for Propulsion Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves. Breaking systems, hydraulic breaking system, breaking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

Transmission Systems: Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheel and four wheel drives. Hotchkiss and torque tube drives.

Gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission. Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

Front wheel Geometry and steering systems: Camber, castor, kingpin inclination, toe-in and toe-out, centre point steering condition for true rolling, components of steering mechanism, power steering.

Electrical system of an automobile: Starting system, charging system, ignition system, other electrical system. Electrical vehicles: History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

C. Text Books:

1. Gupta S.K., A text book of Automobile Engineering, , S. Chand, 2020, 2nd Edition.
2. Heitner J., Automobile Mechanics, , CBS Publishers & Distributers, 2nd Edition.

D. Reference Books:

1. Crouse W.H. and Anglin D.L., Automotive Mechanics, , TMH, 2017, 10th Edition.

E. Course Outcomes:

1. Demonstrate the vehicle construction, chassis, lubrication system and cooling system in automobile, 3-way catalytic converter.
2. Identify the wheels, tyres, steering gear box, suspension system-telescopic, and leaf spring.
3. Describe the principles and working of Carburettors, CRDI, MPFI, electronic fuel injection system and Ignition system.
4. Differentiate between clutch, gear box, rear axle drives, fluid flywheel, and torque converter.
5. Appraise the recent trends in alternate fuels and automobile safety system.

Subject Code: ME-321C
Subject Name: Advanced Machine Tools and Operation
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Classify the various abrasives and the abrasive processes.
2. Differentiate the superfinishing processes and their applications.
3. Understand the different screw threads and gear manufacturing methods.
4. Explain the various non-conventional machining techniques.

B. Course Content:

Abrasive Processes: Basic principle, purpose and application of grinding, abrasive particles, wheel designation, selection of wheels and their conditioning, classification of grinding machines and their uses.

Superfinishing processes: Honing, lapping and superfinishing processes, tools and abrasives used, process parameters and their control.

Screw threads and gear manufacturing methods: Production of screw threads by machining, rolling and grinding, manufacturing of gears.

Non-conventional machining: Review of abrasive jet machining, ultrasonic machining, water jet and abrasive water jet machining, chemical machining, electro chemical

machining, electro discharge machining, electro chemical discharge grinding, electro chemical honing electron beam and laser beam machining.

C. Text Books:

1. Rao P. N, Manufacturing Technology, Volume II, Tata McGraw Hill, 2008.
2. Chattopadhyay A. B, Machining and Machine Tools, Wiley, 2011.
3. Shaw M. C, Metal Cutting Principles, MIT Press, 2004.
4. Kalpakjian S, Schmid S. R, Manufacturing Processes for Engineering Materials, Pearson Education, 2009, 5th Ed.
5. Pandey P.C and Shan H.S, Modern Machining Processes, Tata McGraw Hill, 2017.

D. Reference Books:

1. Begeman, M. L. and Amstead, B. H., Manufacturing Process, Wiley, 1987, 8th Edition.
2. Chapman, W. A. J. and Arnold E., Workshop Technology, Vol. I, II & III, CRC press, Prentice Hall, 2001, 2005 and 1995, 5th, 4th and 3rd editions.

E. Course Outcomes:

1. Describe the various abrasives and the abrasive processes.
2. Distinguish the superfinishing processes and their applications.
3. Compare the different screw threads and gear manufacturing methods.
4. Define the various non-conventional machining techniques.

Subject Code: ME-321D
Subject Name: Refrigeration and Air Conditioning
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using p-h charts and/ or refrigerant property tables.
3. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
4. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

B. Course Content:

Introduction: Brief history and need of refrigeration and air conditioning, methods of producing cooling, ton of refrigeration, coefficient of performance, types and application of refrigeration and air condensing systems.

Refrigerants: Classification, nomenclature, desirable properties, secondary refrigerants, future industrial refrigerants.

Air refrigeration: Reversed Carnot cycle and its limitation, Bell-Coleman cycle, aircraft refrigeration, working and analysis of simple; bootstrap; reduced ambient and regenerative air refrigeration systems.

Vapour compression Refrigerating (VCR) system: Reverse Carnot cycle and its limitations, simple VCR system and its performance analysis, factors affecting the performance of cycle, actual cycle, compound compression system, multiple evaporators system, cascade refrigeration system.

Vapour absorption system: Desirable characteristics of refrigerant, selection of pair, practical H2O -NH3 cycle, LiBr – H2O system and its working, electrolux refrigeration system. Refrigeration system components: Compressors-reciprocating and axial, condensers and evaporators, expansion devices.

Psychometry: Air properties and psychometric chart, sensible heating, sensible cooling, humidification, dehumidification and their combinations, bypass factor, sensible heat ratio, comfort, psychometric calculations for cooling, evaporative cooling.

Summer and winter air conditioning: Simple summer air conditioning process, room sensible heat factor, coil sensible heat factor, ADP, winter air conditioning, comfort zone, clothing. Load analysis: Internal heat gain, system heat gain, break-up of ventilation load and effective sensible heat factor, cooling load and heating load estimation.

C. Text Books:

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill, 2017, 3rd Ed.
2. Stoecker W. F. and Jones J.W., Refrigeration and Air Conditioning, Tata McGraw-Hill, 2014, 2nd Ed.

D. Reference Books:

1. Dossat, R. J., Principles of Refrigeration, Pearson Education, 2002, 4th Ed.

E. Course Outcomes:

1. Define the fundamental principles and applications of refrigeration and air conditioning system.
2. Explain the properties, applications and environmental issues of different refrigerants.
3. Calculate cooling capacity and coefficient of performance of air refrigeration system, VCRS and VA.

Subject Code: ME-321E
Subject Name: Mechatronics and Automation
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Generate conceptual design for mechatronics systems based on potential customer requirements.
2. Selection of appropriate sensors and transducers and devise an instrumentation system for collecting information about processes, control systems.
3. Design a control system for effective functioning of mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers.
4. Selection of appropriate actuators for physical systems.
5. Study design of robot as case study

B. Course Content:

Introduction: Introduction to mechatronics, need and applications, philosophy and approach; systems and design: Mechatronic approach, integrated product design, modeling, analysis and simulation, man machine interface, role of mechatronics in automation, manufacturing and product development.

Sensors and transducers: Characteristics, classification, working principles, development in transducer technology, opto-electronics shaft encoders, strain, velocity, acceleration, LVDT, temperature sensors, vision system, etc.

Drives and Actuators: Hydraulic and pneumatic drives, electrical actuators such as servo motor and stepper motor, drive circuits, open and closed loop control; embedded systems: hardware structure, software design and communication, programmable logic devices, automatic control and real time control systems;

Smart Materials: Shape memory alloy, piezoelectric and magnetostrictive actuators, microsensors, microactuators.

Hydraulic and Pneumatic Systems: Introduction to hydraulic systems, hydraulic pumps, control valves, pressure relief valves, graphical representation of hydraulic and pneumatic elements, design of hydraulic circuit, introduction to Pneumatic systems, compressors, air treatment and pressure regulation, actuators, pneumatic controllers, application of pneumatic systems

CNC Programming and Industrial Robotics: CNC programming fundamentals, CNC machines and part programming, CNC programming- drilling, milling, turning operations

Application: Case studies based on the application of mechatronics in manufacturing, machine diagnostics, road vehicles and medical technology, bionics and avionics. industrial robotics, types of industrial robots, classification based on work envelope, generations configurations and control loops, co-ordinate systems, need for robot, basic parts and functions, specifications.

C. Text Books:

1. Bolton, W., Mechatronics, Electronic control systems in mechanical and electrical engineering, , Pearson Education, 2011, 5th edition.

2. Alcaiatore, G.D., Michel B. H., Introduction to Mechatronics and Measuring Systems, , Mc. Graw Hill International, 2006, 3rd edition.
3. Robert H. B., The Mechatronics Handbook, , CRC Press, 2007, 2nd edition.

D. Reference Books:

1. Stenersons, J., Fundamentals of Programmable Logic Controllers Sensors and Communications, , Pearson Education, 2004, 3rd edition.
2. Kuttan K. A., Introduction to Mechatronics, Oxford University Press, 2007.

E. Course Outcomes:

1. Will be able to identify the need of mechatronics and integrated product design procedure and role of mechatronics in various engineering fields.
2. Will have basic understanding of various types of sensors and transducers including modelling
3. Will study and select appropriate actuators and drivers along with design of control system and modeling.
4. Will have case studies and design of robotic systems and application of mechatronic in system design.

Subject Code: ME-3205
Subject Name: Thermal Laboratory-II
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. Define the fundamental concepts to students in the area of heat transfer and its applications.
2. Recognize the practical significance of various parameters involved in different modes of heat transfer.
3. To demonstrate and develop understanding among the students about the basic working principles of refrigeration and air conditioning with hands-on experience and demonstrates the basics of psychometry.

B. Course Content:

List of Experiments:

1. Thermal conductivity through composite wall.
2. Thermal conductivities of various fluids.
3. Free and forced convection.
4. Parallel flow, counter flow, shell and tube heat exchanger.
5. Stefan-Boltzmann setup.
6. Vapour compression refrigeration system.
7. Vapour absorption refrigeration system.
8. Air conditioning system.

C. Reference Books:

1. Incropera, F. P., Dewitt, D. P., Bergman, T. L., Introduction to Heat Transfer, John Wiley & Sons, 2006, 5th Ed.
2. Arora, C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill, 2017, 3rd Ed.

D. Course Outcomes:

1. Conduct experiments on conduction, convection and radiation of heat; collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures
2. Determine thermal properties and performance of heat exchanger.
3. Knowledge of refrigerant compressors, evaporator, condenser, and expansion devices used in vapour compression refrigeration system.
4. Understand the principles and applications of vapour compression, vapour absorption refrigeration systems and basics of psychometry.

Subject Code: ME-3206
Subject Name: Design Practices
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To acquire a skill of design, drafting and analysis of permanent and non-permanent joints by using design software
2. To acquire a skill of design, drafting and analysis of bearings and gears using design software and comparing with analytical results.
3. To acquire skill of design, drafting and analysis of IC engine parts using design software and comparing with analytical results.

B. Course Content:

List of Experiments:

1. Design and Analysis of Mechanical components using AutoCAD/Solid works/CATIA/ANSYS.
2. Design and analysis of Permanent joints (Riveted Joints, Welded Joints).
3. Design and Analysis of temporary joints (Knuckle joints, Cotter joints, Nut and bolts).
4. Design and Analysis of shafts, couplings and springs.
5. Design and Analysis of bearings.
6. Design and Analysis of Gears.
7. Design of IC engine parts (Cluthes, Fly Wheels, Connecting Rods, Crank Shafts, Pistons, Cylinders and Cylinder heads.

C. Reference Books:

1. Shigley, J. E. and Mischke. C. R., "Mechanical Engineering Design", Mcgraw Hill, 2014, 10th Ed.

D. Course Outcomes:

1. Develop skill to apply knowledge of design software for design of permanent and non-permanent joints, shaft and springs.
2. Define and construct the Mechanical Engineering parts and components which include gears, bearings, IC engine parts along with their assembly drawing and analysis.

Subject Code: ME-3207
Subject Name: Mechatronics and Automation Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

1. To encourage interdisciplinary research and industry driven innovation in the cutting edge areas of mechatronics and automation.
2. The laboratory is designed to assist the students in the development of "hands-on" skills with an emphasis on mechatronics systems.

B. Course Content:

List of Experiments:

1. Study and demonstration of Mechatronics system and its components like sensors and Actuators.
2. Automatic actuation of single acting cylinder using PLC
3. Automatic actuation of double acting cylinder using PLC
4. Controlling the single acting cylinder using push button switch
5. Controlling double acting cylinder using push button switch
6. Actuation of single acting cylinder using on delay timer
7. Demonstration of Cartesian/ cylindrical/ spherical robot
8. Demonstration of Automated guided Vehicles.

C. Reference Books:

1. Bolton, "Mechatronics", Prentice Hall, 2008
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Prentice Hall, 2008, 5th Edition.
3. Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2012.

D. Course Outcomes:

1. Explain the uses and working of different actuators in the industrial automation.
2. Describe role of different mechanical components and their working in the automation system

3. Compare different sensors and actuators and select proper one for a typical industry application
4. Describe study basic robot co-ordinate configurations and Automated guided Vehicles.

VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-4101	DSC16-Product Design and Development	3	0	0	3
2	ME-410A	DSE6– Convective Heat Transfer	3	0	0	3
	ME-410B	DSE6– Mechanical Vibration				
	ME-410C	DSE6– IC Engines				
	ME-410D	DSE6– Nanotechnology				
	ME-410E	DSE6– Measurement and Control				
	ME-410F	DSE6– Viscous Fluid Flow				
3	ME-411A	DSE7 – Robotics	3	0	0	3
	ME-411B	DSE7 – Introduction to Aeronautics				
	ME-411C	DSE7 – Advanced Solid Mechanics				
	ME-411D	DSE7 – Renewable Energy				
	ME-411E	DSE7 – Composite Materials				
4	ME-412A	DSE8 –Gas Turbine Technology	3	0	0	3
	ME-412B	DSE8 –Principle of Tribology				
	ME-412C	DSE8 –Optimization Techniques				
	ME-412D	DSE8 –Gas Dynamics				
	ME-412E	DSE8 –Bio-materials				
5	YY-410X	OE5*	3	0	0	3
6	ME-4102	AECC2-Internship-II	0	0	0	1
7	ME-4103	VAC6-Major Project-I	0	0	8	4
Contact Hours			15	0	8	
Total Credits						20

Subject Code: ME-4101
Subject Name: Product Design and Development
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To study the basic concepts of product design and development process.
2. To expose the students to different design principles like designing for function, production, maintenance, packaging etc.
3. To study the applicability of product design and development in industrial applications including product specifications, concept development, design for prototyping and manufacturing.

B. Course Content:

Introduction: Product design definition and evolution, product design morphology, product life cycle, product policy of an organization, selection of a profitable product, product design process, product analysis.

Product design: Flow charting, creativity techniques, translating customer needs, product development process.

Value engineering in product design: Advantages, applications in product design, problem identification and selection, functional analysis, functional analysis system techniques (FAST), case studies.

Product design tools: Quality function development (QFD), computer aided design, robust design, design for excellence, design for manufacturing, design for assembly, ergonomics in product design.

Product costing: Elements of product cost, life cycle costing, material selection, metals and alloys, plastics, ceramics, rubber.

Design for manufacturing and assembly: Guidelines, product design for manual assembly, design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc., rapid prototyping, needs, advantages, working principle of stereo lithography, laminated object manufacturing, selective laser sintering.

C. Text Books:

1. Eppinger S and Ulrich K, Product design and development, McGraw Hill Higher Education, 2015.
2. Magrab E. B, Gupta S. K, McCluskey F. P and Sandborn P, Integrated product and process design and development: The product realization process, CRC Press, 2009.

3. Ulrich K. T, Steven D. E, Product Design & Development, Tata McGraw Hill, New Delhi, 2003.

D. Reference Books:

1. Boothroyd G, Product design for manufacturing and assembly: Computer Aided Design, 26 (7), pp 505-520, 1994.
2. Hollins B and Pugh S, Successful Product Design, Butter Worths, London.
3. Bralla J G, Handbook of Product Design for Manufacture, McGraw Hill, New York.

E. Course Outcomes:

1. Describe an engineering design and development process.
2. Employ engineering, scientific and mathematical principles to execute a design from concept to finished product.
3. Choose an appropriate standardization method for product and develop methods to minimize the cost.
4. Explain product design for manufacturing and manual assembly.

Subject Code: ME-410A
Subject Name: Convective Heat Transfer
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. This is one of the major courses for post graduate students which will help to understand the flow of fluids and heat transfer.
2. The focus of the course is a central theme of modern applied mathematics. Based on mathematical concepts of gradient, divergence, vorticity and tensor, the basic properties normally ascribed to fluids such as density, compressibility and dynamic viscosity will be introduced.
3. Then general equations, including continuous equation, momentum equation and energy equation are derived.
4. Therefore the course is used to model a vast range of physical phenomena and plays a vital role in science and engineering.

B. Course Content:

Introduction: Continuity, momentum and energy differential equations in different coordinate systems, boundary layer approximations/scaling analysis.

Laminar external flow and heat transfer: Blasius solution for flat plate, pressure gradient flow, von Karman-Pohlhausen method for flows with pressure gradient integral solutions for flow over an isothermal flat plate, flat plate with constant heat flux.

Laminar internal flow and heat transfer: Fully developed forced convection in pipes with different wall boundary conditions- Hagen Poiseuille flow, plane Poiseuille flow, and Couette flow, Graetz solution for forced convection in the thermal entrance region of ducts and channels.

Natural convection heat transfer: Governing equations for natural convection, Boussinesq approximation, dimensional analysis, similarity solutions for laminar flow past a vertical plate with constant wall temperature and heat flux conditions.

Turbulent convection: Governing equations for averaged turbulent flow field (RANS), eddy viscosity and eddy thermal diffusivity, turbulence models, turbulent flow and heat transfer across flat plate and circular tube.

C. Text Books:

1. Kays, W., Crawford, M. and Weigand, B., Convective Heat and Mass Transfer, McGraw Hill Education, 2017, 4th Edition.
2. Burmeister, C., L., Convective Heat Transfer, John Wiley and Sons, 1993, 2nd Edition.
3. Bejan, A., Convection Heat Transfer, John Wiley, 2006, 3rd Edition.

D. Course Outcomes:

1. To be able to solve industry oriented problems.
2. Understand the concept of fluid and the models of fluid flow and heat transfer for flow over external surfaces and duct of different cross-sections.
3. Understand the basic physical meaning of general equations.
4. To be able to derive the equation for viscous flow, including laminar flow and turbulent flow.

Subject Code: ME-410B
Subject Name: Mechanical Vibration
Credit Point: 3 [L = 3, T = 0, P = 0]

A. Course Objectives: The course is designed to meet with the following objectives:

1. Introduction to mathematical models of problems in free and forced vibrations using Newton's second law or energy principles,
2. Determine a complete solution to the modelled mechanical vibration problems.
3. Correlate results from the mathematical model to physical characteristics of the actual system.
4. Design of a mechanical system using fundamental principles of vibration.

B. Course Content:

Introduction: Causes and effects of vibration, classification of vibrating system, discrete and continuous systems, degrees of freedom, identification of variables and parameters, linear and nonlinear systems, physical models, schematic models and mathematical models.

Free Vibration Analysis: Formulation of equation of motion: De-Alembert's method, Energy method, Newton's method and Rayleigh methods, differential equations of motion for first order and second order linear systems, undamped free vibration response, damped free vibration response, Eigen values and Eigen vectors, normal modes and mode superposition problem formulation and response calculation.

Forced Vibration analysis: Response to harmonic excitations, solution of differential equation of motion, vector approach, complex frequency response, magnification factor resonance, rotating/reciprocating unbalances, force transmissibility, motion transmissibility, vehicular suspension, vibration measuring instruments, problems on forced vibration.

Two degree of freedom systems: Introduction, formulation of equation of motion, equilibrium method, Lagrangian method, problem formulation of equations of motion.

Multi degree of freedom systems: Introduction , formulation of equations of motion, free vibration response, natural modes and mode shapes, orthogonally of model vectors, normalization of model vectors, decoupling of modes, model analysis, mode superposition technique, free vibration response through model analysis, forced vibration analysis through model analysis, model damping, Rayleigh's damping, introduction to experimental model analysis.

Vibration Analysis of Continuous systems: Introduction to continuous systems, exact and approximate solutions, free vibrations of bars and shafts, free vibrations of beams, forced vibrations of continuous systems and approximate methods for continuous systems.

C. Text Books:

1. Meirovich, L., Elements of Vibration Analysis, 2nd Ed., McGraw-Hill, 2014.
2. Rao, S.S, Mechanical Vibrations, 6th Ed., Pearson Education, 2018.
3. Thomson, W.T., Theory of Vibration, 5th Ed., Pearson Education, 2002.

D. Reference Books:

1. Clarence W. de Silva, "Vibration: Fundamentals and Practice", 2nd Ed., CRC Press, 2006.

E. Course Outcomes: Upon completion of the subject, students should have the knowledge of:

1. Construct the governing differential equation and able to solve for the motion and the natural frequency of damped and undamped system.
2. Formulate any periodic function in terms of a series of simple harmonic motions using Fourier series analysis.
3. Solve for the motion and the natural frequency for forced vibration of a single degree of freedom damped or undamped system.
4. Obtain the complete solution for the motion of a single degree of freedom vibratory system (damped or undamped) that is subjected to non-periodic forcing functions.
5. Acquire design parameters and indicate methods of solution for a complicated vibratory problem.

Subject Code: ME-410C
Subject Name: IC Engines
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To learn about various parts associated with IC engines.
2. To understand the basics of IC engines.
3. To understand combustion principles, parameters and variables affecting IC engines.
4. To learn about various systems used in IC engines and the types of IC engine required for various applications.
5. To learn about emission and its control.

B. Course Content:

Introduction: Engines, classifications & construction of ic engines, engine performance parameters, review of air-standard cycles, fuel-air cycles, actual cycles and their analysis, si and ci engine fuels, alternate fuels.

Carburetion: Factors affecting carburetion, air-fuel mixtures, the simple carburettor, essential parts of modern carburetors, calculation of air fuel ratio, working of various carburettors.

Combustion in S.I. Engines: Stages, flame propagation, factors influencing the flame speed, rate of pressure rise, ignition delay, knocking .

Fuel Injection and Mixing: Air and solid injection, fuel feed pump, injection pumps, fuel injector,nozzles, injection in si engine, mechanical and pneumatic governor, spray characteristics, swirl, squish and tumble, electronic fuel injection system, mpfi, injection timing.

Ignition system: Introduction, classification, components of ignition system, modern ignition systems.

Combustion in C.I. Engines: Stages, injection delay, factors influencing the delay, knocking, effect of variables on knocking.

Cooling and Lubrication System: Introduction, need and type of cooling system, air and liquid cooling, thermosyphon, pressure cooling, engine friction, function and mechanism of lubrication, lubrication systems, properties of lubricant.

Supercharging and Turbocharging: Supercharging, methods of supercharging, turbocharging, charge cooling.

Nonconventional Engines: CRDI engine, dual fuel and multi fuel engines, free piston engines, wankel and stirling engines, vcr engine, PFI and GDI engines.

Measurement and Testing: Tests for friction power, indicated power, brake power, fuel consumption, air consumption.

Emissions and Control: Introduction, emission norms, engine emissions, emission control methods.

C. Text Books:

1. V. Ganesan, Internal Combustion Engines, Tata McGraw-Hill, 2017, 4th Ed.
2. Pulkrabek W, Engineering Fundamentals of IC engine, Pearson, 2003, 2nd Ed.

D. Reference Books:

1. C.R. Fergusan and A.T. Kirkpatrick, Internal Combustion Engines, John Wiley & Sons, 2001, 2nd Ed.
2. R. Stone, Internal Combustion Engines, The Macmillan Press Limited, 2012, 4th Ed.
3. Heywood John, IC Engine Fundamentals, Mcgraw Hill, 1988.

E. Course Outcomes:

1. Demonstrate the basics of IC engines and how different parameters influence the operational characteristics of IC Engines.
2. Understand Ignition and combustion in SI, CI and non-conventional engines.
3. Calculate difference performance parameters.
4. Analyse the exhaust emission and learn about its control strategies.

Subject Code: ME-410D
Subject Name: Nanotechnology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Demonstrate a working knowledge of nanoscience/nanotechnology principles and applications
2. Explain the nanoscale paradigm in terms of properties at the nanoscale dimension.

B. Course Content:

Introduction: Importance of Nano-technology, Emergence of Nano-Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

Zero Dimensional Nano-structures: Nano particles through homogenous nucleation; Growth of nuclei, synthesis of metallic Nano particles, Nano particles through heterogeneous nucleation; Fundamentals of heterogeneous nucleation and synthesis of nano particles using micro emulsions and Aerosol.

One Dimensional Nano-structures: Nano wires and nano rods, Spontaneous growth: Evaporation and condensation growth, vapor-liquid-solid growth, stress induced recrystallization. Template based synthesis: Electrochemical deposition, Electro-phoretic deposition. Electrospinning and Lithography.

Two dimensional nano-structures: Fundamentals of film growth. Physical vapour Depostion(PVD): Ebvaporation molecular beam epitaxy (MBE), Sputtering, Comparison of Evaporation and sputtering. Chemical Vapour Deposition (CVD): Typical chemical reactions, Reaction kinetics, transportant phenomena, CVD methods, diamond films by CVD. **Thin films**: Atomic layer deposition (ALD), Electrochemical deposition (ECD), Sol-Gel films.

Special Nano Materials: Carbon fullerence and nano tubes: carbon fullerness, formation, properties and applications. Carbon nano tubes: formation and applications.

C. Text Books:

1. Hornyak G.L., Dutta J., Tibbals H.F., Rao A.K., Introduction to Nanoscience, CRC Press, 2008.
2. Cao Guozhong, Nano structures and Nano materials: Synthesis, properties and applications, Imperial College press, 2004.

D. Reference Books:

1. Lindsay S.M., Introduction to Nanoscience, Oxford, 2009

E. Course Outcomes:

1. Understood the basic concept of nanotechnology.
2. Apply key concepts in materials science, chemistry, physics, biology, and engineering to the field of nanotechnology.
3. Identify societal and technology issues that may impede the adoption of nanotechnology.

Subject Code: ME-410E
Subject Name: Measurement and Control
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To explain basic concepts and definitions of measurement and control.
2. To explain the measurement of different physical quantities.
3. To explain the control systems and related mathematical formulation.

B. Course Content:

Introduction to measurement: Generalized measurement system, standards, and types of signals, static performance characteristics, dynamic performance, general model, zero order,

first order: step response and frequency response, second order: step response and frequency response.

Analysis of uncertainties: Error classification, systematic and random errors, statistical analysis of data, propagation and expression of uncertainties.

Measurement of physical quantities: Linear and angular displacement, velocity, force, torque, strain, viscosity, pressure, flow rate and temperature.

Introduction to control systems: Classification of control system. Open loop and closed loop systems.

Mathematical modeling of control systems: Concept of transfer function, block diagram algebra, transient and steady state analysis of first and second order system. Time Domain specifications, step response of second order system, steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs.

C. Text Books:

1. Doebelin E.O., Manik D.N., Measurement Systems, McGraw-Hill International, 2019, 7th Ed.
2. Holman, J. P., Experimental Methods for Engineers, McGraw-Hill Company, 2017, 7th Ed.
3. Kumar, D. S., Mechanical Measurements and Control, Metropolitan Book Co. (P) Ltd, 2015, 5th Ed.

D. Reference Books:

1. Nelson A., Engineering Mechanics: Statics and Dynamics, TMGH, 2017, 1st Ed.
2. Backwith, T. G., Marangoni, R. D. and Lienhard, J. H., Mechanical Measurements, Addison Wesley, 1993, 5th Ed.
3. Dally, J. W., Riley, W. F. and McConnell, K. G., Instrumentation for engineering measurements, John Wiley & Sons, 1993, 2nd Ed.

E. Course Outcomes:

1. Understand basics of measurement regarding different physical quantity and control system.
2. Explain the accuracy of measuring instruments.
3. Analyse calibration of measuring instruments.
4. Evaluate control system for mechanical components.

Subject Code: ME-410F
Subject Name: Viscous Fluid Flow
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the physics of viscous fluid flow.
2. To explain different equations involved in viscous fluid flow.
3. To formulate the numerical methods required in viscous fluid flow.

B. Course Content:

Preliminary concepts; Conservation of mass, momentum and energy; Exact solutions of the viscous flow equations: Couette flows, Poiseuille flow through ducts, unsteady duct flows; Laminar boundary-layers: integral analysis and similarity solutions; Laminar free shear flows: jet, wake, and plume; Stability of laminar flows; Turbulent flow: fundamentals, Reynolds-averaged equations, velocity profile in wall-bounded flows, turbulent flow in pipes and channels, turbulent free-shear flows (jet, wake, and plume); Turbulence modelling: zero, one, and two equation models of turbulence; Numerical methods.

C. Text Books:

1. Frank M White, Viscous Fluid Flow, McGraw-Hill, 1991.
2. Schlichting and Gersten, Boundary-Layer Theory, Springer-Verlag, 2000.
3. F S Sherman, Viscous Flow, McGraw-Hill, 1990.

D. Course Outcomes:

1. Understand the physics of viscous fluid flow.
2. Evaluate different equations involved in viscous fluid flow.
3. Formulate the numerical methods required in viscous fluid flow.

Subject Code: ME-411A
Subject Name: Robotics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To explain the basic principles of Robotic technology, configurations, control and applications of Robots.
2. To explain the basic concept Coordinate Frames, Mapping and Transforms.
3. To describe the concept of Robot kinematics and dynamics.
4. To choose the appropriate Sensor and vision system for a robot for a given application.
5. To understand the motion planning and control trajectory of the robot.

B. Course Content:

Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.

Coordinate Frames, Mapping and Transforms: Coordinate Frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices, mechanical structure and notations, description of links and joints,

kinematic modeling of the manipulator, Denavit-Hartenberg notation, kinematic relationship between adjacent links, manipulator transformation matrix.

Kinematic Modeling of Robots: Position analysis – direct and inverse kinematic models of robotic manipulators, various examples. Velocity analysis–Jacobian matrix.

Dynamics of Robots Modeling of Robots: Dynamic analysis of the manipulator robot, Lagrange-Euler dynamic formulation, static force analysis, transformation of force and moment.

Robotic Sensors and Vision: Sensors in robotics, architecture of robotic vision systems, image acquisition, components of vision, system, image representation, image processing.

Motion Planning and Control: Basics of trajectory planning, Cartesian space trajectory, basics of control, block diagram, Laplace transform, PID control, trajectory planning - position, velocity and force control.

C. Text Books:

1. Craig J.J., Introduction to Robotics: Mechanics and Control, Pearson Education International, 2004, 3rd edition.
2. Spong M.W., and Vidyasagar M., Robot Dynamics and Control, Wiley, 2008.
3. Schilling R.J., Fundamentals of Robotics Analysis and Control, Prentice Hall of India, 1990.

D. Reference Books:

1. Fu K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
2. Saha S.K., Introduction to Robotics, McGraw Hill, 2014, 2nd edition.

E. Course Outcomes:

1. Have basic knowledge on various components of robotic system.
2. Develop suitable model for forward and inverse kinematics of robot manipulators.
3. Analyse forces in links and joints of a robot.
4. Model for trajectory planning and control mechanism of robot.

Subject Code: ME-411B
Subject Name: Introduction to Aeronautics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To understand the basic physics of aeronautics.
2. To study factors affecting aircraft performance.
3. To study the propulsion of an aircraft.

B. Course Content:

Introduction: History of aircraft flight; classification of aircraft, fixed and rotary wing aircraft; anatomy of the aircraft – fuselage, wings, horizontal and vertical stabilizers, landing gear, monoplane and biplane configurations.

Standard atmosphere: Definition of standard atmosphere, geometric, absolute, geo-potential altitudes, pressure, temperature and density altitudes.

Aerodynamics: Wind tunnels and their application, measurement of airspeed,airfoils and wings; airfoil nomenclature, lift, drag and moment coefficients, infinite and finite wings, critical mach number, induced drag, swept wings, high-lift devices.

Aircraft performance: Drag polar, cruising, climbing, and gliding flight; range and endurance; takeoff and landing flights; turning performance and V-n diagram.

Stability and control: Definition of stability and control, moments on the airplane, stick-fixed and stick-free stability, control surfaces, static and dynamic stability, longitudinal and lateral stability.

Propulsion: Aircraft propulsion – piston-prop, turbojet, turboprop, turbofan, turbo-shaft and ramjet engines; general thrust equation, propulsive efficiency; two and three spool configurations; elements of rocket propulsion.

Airplane structure: Structural elements, fuselage construction, monocoque, semi-monocoque and truss type constriction, choice of materials, stress-strain diagram.

Special topics: Airplanes of the future, hypersonic vehicles, basics of space flight, rocket propulsion.

C. Text Books:

1. Anderson, J. D. Introduction to Flight, Tata McGraw-Hill, 2007, Fifth Edition.
2. Shevell, R. A., Fundamentals of Flight, Pearson Education, 1989.
3. Clancy, L. J., Aerodynamics, Himalayan Books, 1996.

D. Reference Books:

1. Hull, D. G. Fundamentals of Airplane Flight Mechanics, Springer, 2010.
2. Newman, D. Interactive Aerospace Engineering and Design, McGraw-Hill, 2002.
3. S. A. Brandt, S. A., Stiles, R. J., Bertin, J. J. and Whitford, R. Introduction to Aeronautics: A Design Perspective, AIAA Education series, 2004.
4. Kermode, A. C., Mechanics of Flight, Longman, 1996.
5. Hill, P. G. and Peterson, C. R. C. Mechanics and Thermodynamics of Propulsion, Addison Wesley, 1965.

E. Course Outcomes:

1. Understand the basic physics involved in aeronautics.
2. Understand the various parameters and factors involved in operation of an aircraft.
3. Understand the processes involved in jet propulsion.

Subject Code: ME-411C
Subject Name: Advanced Solid Mechanics
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To establish an understanding of the fundamental concepts of mechanics ofdeformable solids; including static equilibrium, geometry of deformation, andmaterial constitutive behaviour.
2. To provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
3. To discuss 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.
4. To build the necessary theoretical background for further structural analysis and design courses.

B. Course Content:

Analysis of stress and strain: Three dimensional stresses in arbitrary plane, principal stresses, stress invariants, Mohr's circle for 3-d state of stress, octahedral stresses, state of pure shear, differential equations of equilibrium and compatibility conditions, plane stress. analysis of strain, state of strain at a point, strain invariant, principal strains, plane state of strain.

Energy Methods: Strain Energy, strain-energy density, elastic strain energy for normal stresses, elastic strain energy for shearing stresses, strain energy for a general state of stress, Castiglione's theorem, deflections by Castiglione's theorem, statically indeterminate structures.

Bending of Beams: Bending of symmetric and unsymmetrical straight beams, effect of shear stresses, curved beams, shear center and shear flow, shear stresses in thin walled sections, thick curved bars. stresses in thick and thin walled cylinders, composite tubes, rotating disks and cylinders.

Theory of Columns and Introduction to elasticity: Euler's buckling load, beam column equations. strain measurement techniques using strain gages, characteristics, instrumentations, principles of photo-elasticity.

C. Text Books:

1. L. S. Srinath, Advanced Mechanics of Solids, TMH Publishing Co. Ltd., New Delhi, 2003, 2nd Edition.
2. R. G. Budynas, Advanced Strength and Applied Stress Analysis, McGraw Hill Publishing Co, 1999, 2nd Edition.
3. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, John Willey and Sons Inc, 1993, 5th Edition.

D. Reference Books:

1. S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, McGraw Hill Publishing Co. 1970, 3rd Edition.
2. P. Raymond, Solid Mechanics for Engineering, John Willey & Sons, 2001, 1st Edition.
3. J. W. Dally and W. F. Riley, Experimental Stress Analysis, McGraw Hill Publishing Co., New York, 1991, 3rd Edition.

E. Course Outcomes:

1. Understand the concepts and principles applied to members under various loadings and the effects of these loadings.
2. 2. Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
3. 3. Analyze columns and pressure vessels under various loadings.

Subject Code: ME-411D
Subject Name: Renewable Energy
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand about energy systems and renewable energy resources.
2. To learn about scientific examination of the energy field with emphasis on alternative energy sources and their technology and application.

B. Course Content:

Introduction: Various non-conventional energy resources, potential of renewable energy sources, global as well as Indian scenario.

Solar energy: Solar radiation, measurement of solar radiation, solar thermal collector-flat plate and concentrating collector, solar applications, fundamentals of photo voltaic conversion, solar cells, solar PVS.

Wind energy: Principles of wind energy conversion, wind energy generators and its performance, wind energy storage, applications, hybrid systems.

Energy from bio-mass: Biomass, biogas, bio-mass conversion technologies, different types of bio gas plants, digesters, thermal gasification of biomass, ethanol production, bio diesel production and economics.

OTEC, tidal and wave, geothermal, hydel energy and hydrogen energy: Tidal energy, wave energy, ocean thermal energy conversion, open and closed OTEC cycles, hydro power energy, small hydro turbines, geothermal energy sources, production and storage of hydrogen energy, transport, applications, power plant and environmental issues, energy storage.

MHD power generation: Principles of MHD power generation, open and closed cycle systems.

Energy storage: Fuel cell.

C. Text Books:

1. Boyle, Godfrey, Renewable Energy, Oxford University Press, 2004, 2nd edition.
2. Schaeffer, John, Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaiam, 2007.

D. Reference Books:

1. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A., Energy and the Environment, John Wiley, 2006, 2nd Edition.
2. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, McGarw-Hill.

E. Course Outcomes:

1. Explain the main sources of energy and their primary applications.
2. Understand the energy sources and scientific concepts/principles behind them.
3. Analyse the effects of using energy sources on environment and climate.
4. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the impact on the environment.
5. Identify primary renewable energy resources and suitable technologies acting upon it.

Subject Code: ME-411E
Subject Name: Composite Materials
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To teach students the basic concepts involved in fiber reinforced composites and their applications in engineering.
2. Develop an understanding of the linear elastic analysis of composite materials.
3. Understand the concepts of anisotropic material behaviour and the analysis of laminated plates.
4. To undertake a design project involving application of fibre reinforced laminates.

B. Course Content:

Composites: Fundamentals of composites and structures, need for composites, classification of composites, classical lamination theory, matrix materials, reinforcement materials, applications of various types of composites, fibre production techniques for glass, carbon and ceramic fibre.

Metal matrix composites: Characteristics of MMC, limitations of MMC, rule of mixtures, processing of MMC, powder metallurgy processes, diffusion bonding, stir casting, squeeze casting, in-situ reactions, interface, measurement of interface properties, applications of MMC in aerospace, automotive industries.

Ceramic matrix composite & special composites: Need for ceramic matrix composites, toughening mechanism, processing, sintering, hot pressing, cold isostatic pressing (CIP), hot isostatic pressing (HIP), applications of CMC in aerospace and automotive industries, carbon composites, advantages of carbon matrix, limitations of carbon matrix and carbon fibre, chemical vapour deposition of carbon on carbon fibre perform, sol-gel technique.

Interface &failure analysis: Interphase, mechanisms of bonding, measurements of interface bonding strength, yielding, particle/fibre fracture, interface de-cohesion/de-bonding, elastic stress analysis of composite material, fatigue strength improvement techniques, stress concentration around cut outs in composite laminates, stability of composite laminate plates and shells, hybrid materials, applications.

C. Text Books:

1. Hull and T. W. Clyne, An Introduction to Composite Materials, Cambridge Solid State Science Series.
2. K. K. Chawla, Composite Material: Science and Engineering, Springer, 1998, 2nd Edition.
3. T. W. Clyne & P. J. Withers, An Introduction to Metal Matrix Composites, Cambridge University Press, 1993.
4. R. M. Jones, Mechanics of Composite Materials, Taylor and Francis.

D. Reference Books:

1. S. W. Tsai, Mechanics of Composite Materials, MGH, 2nd edition.
2. K. Kaw, Mechanics of Composite Materials, CRC Press, 2nd edition.
3. R. Bunsell and J. Renard, Fundamentals of Fibre Reinforced Composite Materials.

E. Course Outcomes:

1. Understand the concept of various composite materials.
2. Evaluate mechanical properties of composite materials.
3. Explain different manufacturing techniques for composites.
4. Analyze fibre-reinforced composites for mechanical properties.

Subject Code: ME-412A
Subject Name: Gas Turbine Technology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. This course is designed to have an advanced understanding of the theory and operation of gas turbine engines.
2. To apply thermodynamic principles to calculate parameters such as pressure and temperature in Gas Turbine Engines as used in aircraft.

B. Course Content:

Fundamentals of Turbo Machines: Classification, applications, isentropic flow, energy transfer, efficiency, static and stagnation conditions, continuity equation, euler's flow through variable cross sectional area, unsteady flow in turbo machine.

Review of Fundamentals: Thermodynamic concepts, isentropic conditions, Mach number and area – velocity relation, dynamic pressure, normal shock relations for perfect gas, supersonic flow, oblique shock waves.

Gas Turbine Cycles: Simple gas turbine cycle– single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, component losses, stage and overall efficiency, polytropic efficiency.

Aircraft Propulsion Cycles: Propulsive devices viz., turbojet, turboprop and turbofan engines; performance analysis-thrust equation, specific thrust, specific fuel consumption; propulsive, thermal and overall efficiencies, bypass ratio, ideal and actual t-s diagrams of aircraft engines.

Centrifugal compressors: Elements of compressor stage, velocity triangles and efficiencies, blade passage design, diffuser and pressure recovery, slip factor, compressor performance - stall and surge, performance characteristics.

Axial Flow Compressors: Flow analysis, work and velocity triangles, efficiencies, thermodynamic analysis, stage pressure rise, degree of reaction, stage loading, free and forced vortex blades, effect of axial velocity and incidence on velocity triangles, Performance characteristics.

Axial Flow Gas Turbines: Work done; velocity triangles and efficiencies; thermodynamic flow analysis, degree of reaction, free-vortex blades, blade angles for variable degree of reaction, matching of compressor and turbine.

Gas Turbine Cooling: Effect of high gas temperature, methods of cooling-internal and external, convective, film, impingement and transpiration cooling.

Radial Flow Gas Turbines: Work done; velocity triangles and efficiencies.

C. Text Books:

1. R. D. Flack, Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2005.
2. H. I. H Saravanamuttoo, G. F. C. Rogers and H. Cohen, *Gas Turbine Theory,* Pearson, 2003.

D. Reference Books:

1. F.El-Sayed, Fundamentals of Aircraft and Rocket Propulsion, Springer-Verlag, London, 2016.
2. V. Ganesan, Gas Turbines, Tata McGraw Hill, 2003.

E. Course Outcomes:

1. Describe the fundamentals of turbo machines as well as flow in turbo machines.
2. Analyse the conditions and concepts of gas dynamics at different levels.
3. Apply the thermodynamics of aircraft propulsion systems, air compressor and gas turbines.
4. Calculate velocity triangles, work done etc. for flow in gas turbine and air compressors.

Subject Code: ME-412B
Subject Name: Principle of Tribology
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To provide the students with the fundamental concepts and principles of tribology.
2. Emphasis on the design, selection and performance of lubricated components such as pistons, bearings, gears etc.
3. To understand the concepts of friction and wear and to deal with surface properties, contact mechanics in the field of Industrial Tribology.

B. Course Content:

Introduction: Introduction to tribology, history of tribology, interdisciplinary approach, economic benefits.

Friction: Causes of friction, adhesion theory, abrasive theory, junction growth theory, laws of rolling friction, friction instability.

Wear: Wear mechanisms, adhesive wear, abrasive wear, corrosive wear, fretting wear, wear analysis.

Lubrication and lubricants: Importance of lubrication, boundary lubrication, mixed lubrication, full fluid film lubrication, types and properties of lubricants, lubricants additives.

Fluid film lubrication: Concept of fluid mechanics, equation of continuity and motion, generalized Reynolds equation with compressible and incompressible lubricants.

Application of tribology: Rolling contact bearings, gears, journal bearings, finite bearings.

C. Text Books:

1. Halling J, Principles of Tribology, The Macmillan Press Ltd., London, 1975.
2. Dowson D, History of Tribology, Longman London, 1979.
3. Ludema K. C, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press, 2010.

D. Reference Books:

1. Stachowiak G. N, Batchelor A. W. and Stachowick G. B, Experimental methods in Tribology, Tribology series 44, Editor D. Dowson, 2004.
2. Michael M. Khonsari, Applied Tribology (Bearing Design and Lubrication), John Wiley & Sons, 2001.
3. Edwards K. S. & McKee R. B, Fundamentals of Mechanical Component Design, McGraw Hill Inc., 1991.

E. Course Outcomes:

1. Understand basic principles of tribology.
2. Apply the theories of friction, wear and lubrication to predict frictional behaviour of commonly encountered sliding interfaces.
3. Differentiate the features of rough surface and liquid lubricants.
4. Anticipate the latest research on new topics in tribology including its application to nanoscale devices and biological systems.

Subject Code: ME-412C
Subject Name: Optimization Techniques
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Learn the fundamentals of engineering optimization (minimization and maximization of objective function).
2. Formulate problem using linear, dynamic programming, game theory and queuing models.
3. Design of mathematical models for quantitative analysis of problems in industry.

B. Course Content:

Introduction: Concept of optimization, classification of optimization, problems.

Linear programming: Examples of linear programming problems, formulation simplex methods variable with upper bounds, principleduality, dual simplex method, sensitivity analysis, revised simplex procedure, solution of the transportation problem, network minimization, shortest route problem, maximal two problem, representation of networks.

Queuing theory: Queuing model, poison and exponential distributions, queues with combined arrivals and departures, random and series queues.

Unconstrained optimization: Maximization and minimization of convex functions, necessary and sufficient conditions for local minima, speed and order of convergence, unibariate search, steepest and desent methods, metcher reeves method, conjugate gradient method.

Constrained optimization: Necessary and sufficient condition, equality constraints, inequality constraints, kuhn – tucker conditions, gradient projection method, penalty function methods, cutting plane methods of sibel directions.

C. Text Books:

1. Rao S.S., Optimization Theory &Applications, Wiley Eastern, 2000.
2. Deb. K, Optimization for Engineering Design, Prentice Hall of India, 2002.
3. Reklaitis G.V., Ravindram A., Ragsdell K.M., Engineering Optimization Methods and Application, Wiley, 2001.

D. Reference Books:

1. Verma, A. P,. Operation Research, S. K. Kataria and Sons, 2007.
2. Vora, N. D, Quantitative techniques, Tata Mc-Graw Hill, 2006.

E. Course Outcomes:

1. Recall the theoretical foundations of various issues related to linear programming modelling to formulate real-world problems as a L P model.
2. Explain the theoretical workings of the graphical, simplex and analytical methods for making effective decision on variables so as to optimize the objective function.
3. Identify appropriate optimization method to solve complex problems involved in various industries.

Subject Code: ME-412D
Subject Name: Gas Dynamics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the physics of Gas Dynamics.
2. To understand supersonic flow.
3. To study flow in ducts and wind tunnels.

B. Course Content:

Concepts from thermodynamics; The basic equations of fluid motion; One-dimensional gas dynamics; Isentropic conditions, speed of sound, Mach number, area velocity relations, normal shock relations for a perfect gas, Fanno and Rayleigh flow, one-dimensional wave motion, the shock tube; Waves in supersonic flow: oblique shock waves, supersonic flow over a wedge, Mach lines, piston analogy, supersonic compression by turning, supersonic expansion by turning, the Prandtl-Meyer function, reflection and intersection of oblique

shocks, Mach reflection, shock expansion theory, thin aerofoil theory; Flow in ducts and wind tunnels: area relation, nozzle flow, normal shock recovery, effects of second throat, wind tunnel pressure ratio, supersonic wind tunnels; Small perturbation theory; The method of characteristics; Methods of measurement; Elements of hypersonic flow

C. Text Books:

1. H. W. Liepmann and A. Roshko, Elements of Gas Dynamics, John Wiley, 1960.
2. J. D. Anderson, Modern Compressible Flow, McGraw Hill, 1989.
3. B. K. Hodge and C. Koenig, Compressible Fluid Dynamics (with P.C. applications), PH, 1995.

D. Reference Books:

1. H. Shapiro, The Dynamics and Thermodynamics of Compressible Flow, Ronald Press, 1954.
2. R. D. Zucker and O. Biblarz, Fundamentals of Gas Dynamics, Wiley, 2002

E. Course Outcomes:

1. Understand the physics of Gas dynamics.
2. Understand the behavior of flow in case of supersonic condition.
3. Understand the flow behavior in ducts and wind tunnels.

Subject Code: ME-412E
Subject Name: Bio-Materials
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Learn the characteristics and classifications of biomaterials.
2. Understand the significance of metals, ceramics and the nanomaterials as biomaterials.
3. Understand the concept of biocompatibility and the methods for biomaterials testing.

B. Course Content:

Biomaterials and properties: Introduction to biomaterials and requirements for biomaterial, classification of biomaterials: metallic, ceramic, synthetic and natural polymers, properties of biomaterials: bulk properties and surface properties.

Metallic and ceramic materials: Metallic implants - stainless steels, Co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

Polymeric implant materials: Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, bio polymers: collagen, elastin

and chitin, medical textiles, materials for ophthalmology: contact lens, intraocular lens, membranes for plasma separation and blood oxygenation, electro spinning: a new approach.

Testing of biomaterials: Biocompatibility, blood compatibility and tissue compatibility tests, toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, in-vitro and in-vivo testing, sterilization of implants and devices, ETO, gamma radiation, autoclaving, effects of sterilization.

C. Text Books:

1. Bhatt S. V, Biomaterials, Narosa Publishing House, 2005, 2nd Edition.
2. Ramakrishna S, Ramalingam M, Kumar T. S. S, and Soboyejo W. O, Biomaterials: A Nano Approach, CRC Press, 2010.

D. Reference Books:

1. Kutz M, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003.
2. Enderle J, Bronzino J. D, Blanchard S. M, Introduction to Biomedical Engineering, Elsevier, 2005.
3. Park J.B, Biomaterials Science and Engineering, Plenum Press, 1984.
4. Saini S, Singh Y, Arora P, Arora V and Jain K, Implant biomaterials: A comprehensive review, World Journal of Clinical Cases, 2015.

E. Course Outcomes:

1. Analyze different types of biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.
2. Identify significant gap required to overcome challenges and further development in metallic, ceramic and polymericbiomaterials.
3. Understand the biocompatibility and testing standards applied for biomaterials**.**

VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ME-421A	DSE9 - Materials selection and Design	3	0	0	3
	ME-421B	DSE9 - Advanced Thermodynamics				
	ME-421C	DSE9 - Additive Manufacturing				
	ME-421D	DSE9 - Two-phase flow and heat transfer				
	ME-421E	DSE9 - Non-linear Vibration				
	ME-421F	DSE9 - SWAYAM Course				
2	ME-422A	DSE10 - Thermal Storage Systems	3	0	0	3
	ME-422B	DSE10 - Mathematical Modeling of Manufacturing Processes				

	ME-422C	DSE10 -Fuels and Combustion				
	ME-422D	DSE10 - Industry 4.0 and Machine Learning				
	ME-422E	DSE10 - Micro and Nano Manufacturing Processes				
	ME-422F	DSE10 - SWAYAM Course				
3	ME-4201	VAC7-Major Project-II	0	0	22	11
Contact Hours			6	0	22	
Total Credits						17

Subject Code: ME-421A
Subject Name: Materials selection and Design
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To apply systematic approach to the selection of metals, ceramics, polymers and composites required for mechanical design.
2. To familiarize the students with material properties and materials fabrication processes and an approach for selecting a process capable of producing a component possessing the size, shape, properties and cost dictated by the design.
3. To teach students how to deal with multiple constraints and conflicting objectives including realistic constraints involving the economics, environment, manufacturability and sustainability.

B. Course Content:

Material Selection in Design: Introduction, relation of materials selection to design, general criteria for selection, performance characteristics of materials, materials selection process, design process and materials selection, types of design, material property chart, material performance indices, materials selection procedure, structural index, economics of materials, recycling and materials selection.

Manufacturing Considerations in Design: Surface finish, texture, standardization, interchangeable manufacturing, selective assembly, selection of materials based on mechanical properties — preferred numbers, limits, fits and tolerances, types of fits and tolerances,geometric tolerance, types of form and position tolerances, tolerance and manufacturing methods, selection of fits.

Materials in Design: Design for brittle fracture, plane strain fracture toughness, fatigue failure, design criteria, fatigue parameters, infinite, safe life and damage tolerance design , fatigue life prediction, corrosion resistance, forms of corrosion, corrosion prevention, design

against wear, types of wear, wear prevention, designing with plastics, design for stiffness, time dependent part performance.

Engineering materials and their properties: Material property charts, strategy for material selection, materials selection involving multiple constraints and/or conflicting objectives, hybrid materials, bio-inspired materials, the material life-cycle and environment-friendly selection.

Integrated computational materials engineering: New frontiers in systems design of materials, material processes and process selection, failure analysis and materials selection for durability, aesthetics and industrial design.

C. Text Books:

1. Dieter George E, Engineering Design, Tata McGraw-Hill education, 1991.
2. Michael F Ashby, Materials selection in Machine Design, Butterworth and Heinemann, 2010.

D. Reference Books:

1. Charles J A and Crane F A A, Selection and Use of Engineering Materials, Elsevier, 2013.
2. Bhandari V B, Design of Machine Elements, Tata McGraw-Hill Education, 2010, 3rd edition.
3. Mangonan P L, The Principles of Materials Selection for Engineering Design, Prentice Hall, 1999.
4. ASM Handbook : Materials Selection and Design, Volume 20, Taylor and Francis,1997.
5. Mahmoud M Farag, Materials and Process Selection for Engineering Design, CRC Press, 2013.

E. Course Outcomes:

1. Apply and integrate knowledge of Materials Science and Engineering (structure, properties, processing and performance) to solve problems related to materials selection and design.
2. Demonstrate an understanding of the methodologies used in materials design.
3. Construct a translation table for problems involving either multiple constraints or conflicting objectives, and systematically identify candidate materials.

Subject Code: ME-421B
Subject Name: Advanced Thermodynamics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To learn about thermodynamic relations, exergy, non-reactive gas mixtures in advanced level.
2. To understand the practical applications of the concepts of thermodynamics.
3. To deal with advanced thermodynamic problems in the practical fields.

B. Course Content:

Review of basic thermodynamics: First & second laws, concept of entropy and entropy generation, entropy balance for closed & open systems; concept of exergy & irreversibility, exergy analyses of open and closed system

Thermodynamic property relations: Maxwell relations; relations involving enthalpy, internal energy and entropy; Mayer relation, Clausius-Clapeyron equation, Joule-Thompson experiment.

Properties of gas mixtures: Multi-component and multi-phase systems, equations of states and properties of ideal and real gas mixtures, change in entropy in mixing.

Irreversible thermodynamics: Finite time thermodynamic principle, Optimization of various thermodynamic systems, Principles of entropy generation minimization.

Thermodynamics of reactive systems: Combustion and thermochemistry, reactant and product mixtures, adiabatic flame temperature, chemical equilibrium, equilibrium products of combustion.

Chemical Kinetics: Global versus elementary reactions, elementary reaction rates, rates of reaction for multistep mechanisms.

Flames: Types of flames, simplified analyses of premixed & diffusion flames, factors influencing flame velocity and thickness, quenching, flammability and ignition, flame stabilization.

C. Text Books:

1. Adrian Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons, 2016, 4th Edition.
2. Stephen R. Turns, An Introduction to Combustion: Concepts & Applications, McGraw-Hill Education, 2012, 3rd Edition.

D. Reference Books:

1. Michael J. Moran & Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, 2010, 6th Edition.
2. Kenneth K. Kuo, Principles of Combustion, Wiley India Pvt. Ltd, 2012, 2nd Edition.

E. Course Outcomes:

1. Understand the basic principles of advanced thermodynamics.
2. Apply the exergy concepts in entropy generation.

3. Create pressure, volume and temperature relationships for mixtures of ideal and perfect gases.
4. Identify the latest direct energy conversion systems and also know about statistical thermodynamics.

Subject Code: ME-421C
Subject Name: Additive Manufacturing
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Understand the working principle of various additive manufacturing techniques.
2. Interpret various rapid prototyping techniques and their applications.
3. Understand the basic concepts in reverse engineering

B. Course Content:

Introduction to Additive Manufacturing (AM): Introduction to AM, AM evolution, distinctionbetween AM & CNC machining, steps in AM, classification of AM processes, advantages ofAM and types of materials for AM.

Vat photo-polymerization AM processes: Stereolithography (SL), materials, processmodeling, SL resin curing process, SL scan patterns, micro-stereolithography, mask projectionprocesses, two-photon vat photo-polymerization, process benefits and drawbacks,applications of vat photo-polymerization, case studies.

Material jetting AM processes: Evolution of printing as an additive manufacturing process,materials, process benefits and drawbacks, applications of material jetting processes,binder jetting AM processes: materials, process benefits and drawbacks, researchachievements in printing deposition, technical challenges in printing, applications of binderjetting processes.

Extrusion based AM processes: Fused deposition modelling (FDM), principles, materials,process modelling, plotting and path control, bio-extrusion, contour crafting, process benefitsand drawbacks, applications of extrusion based processes, case studies.

Sheet lamination AM processes: Bonding mechanisms, materials, laminated objectmanufacturing (LOM), ultrasonic consolidation (UC), gluing, thermal bonding, LOM and UCapplications, case studies.

Powder bed fusion AM processes: Selective laser sintering (SLS), materials, powder fusionmechanism and powder handling, process modelling, SLS metal and ceramic part creation,electron beam melting (EBM), applications of powder bedfusion processes, case studies.

Rapid prototyping with allied technologies: Introduction to rapid manufacturing (RM), RM of polymeric objects, direct and indirect routes for RM of metallic & ceramic objects, advancement in RM (Synergistic integration of hybrid processes and multiple technologies).

Computational aspects of additive manufacturing (AM): Introduction to STL format, pre & post-processing of STL files, various slicing methods, various area-filling methods, overview of the algorithms for slicing and area-filling, emerging trends,an overview of mathematical modelling of AM processes: thermal cycle, residual stress, single bead and multi bead formation in cladding based AM processes.

Reverse engineering (RE): Introduction to RE, digitizing methods, 3D reconstruction, design for AM (build orientation, topology optimization, conformal cooling channels).

C. Text Books:

1. Gibson I, Rosen D, and Stucker B, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, New York, 2015, 2nd edition.
2. Liou F. W, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press, Taylor and Francis Group, 2007.
3. Pham D, Dimov S. S, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London, 2001.
4. Kai C. C, Fai L. K, 3D Printing and Additive Manufacturing: Principles & Applications, World Scientific, 2015, 4th edition.

D. Reference Books:

1. Venuvinod P. K and Weiyin M, Rapid Prototyping: Laser-based and Other Technologies, Springer, 2004.
2. Pham D. T, Dimoy S. S, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer, 2001.
3. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley& Sons, 2006.
4. Bandyopadhyay A, Bose S, Additive Manufacturing, CRC Press, Taylor &Francis Group, 2020, 2nd edition.
5. Paul C. P, Junoop A. N, Additive Manufacturing: Principles, Technologies and Applications, McGrawHill, 2021.

E. Course Outcomes:

1. Describe the importance of additive manufacturing.
2. Select the suitable AM technique for manufacturing a component.
3. Explain the preprocessing and post processing requirements in AM.
4. Explain the process of reverse engineering.

Subject Code: ME-421D
Subject Name: Two-phase flow and heat transfer
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To provide a rudimentary exposure to the thermo-fluid transport phenomena in one of the simplest multiphase systems: two-phase.
2. To formulate and solve problems associated with two-phase flow phenomena.
3. Design heat transfer equipment in which phase change (boiling or condensation) takes place.

B. Course Content:

Introduction: Basic definitions; review of one-dimensional conservation equations in single phase flows; governing equations for homogeneous; pressure gradient components; flow patternsmaps for horizontal and vertical systems; simplified treatment of stratified, bubbly, slug and annular flows, pressure drop in twophase flow, brief discussion on critical flow.

Basic flow models: Homogeneous flow model, pressure gradient, twophase friction factor for laminar flow and turbulent flow, two phase viscosity, modeling of two phase flow.

Boiling: Evaporation, nucleate boiling, convective boiling; bubble formation and limiting volume; boiling map; nucleation and dynamics of single bubbles, critical boiling conditions; static and dynamic instabilities;empirical correlations in two phase flow, critical heat flux and interfacial phenomena, Rohsenow correlation for nucleate boiling, pool and boiling crisis.

Condensation: Types of condensation, Nusselt theory, deviations from Nusselt theory, practical equations, condensation of flowing vapors; introduction to boiling and condensation in small passages.

C. Text Books:

1. Ghiaasiaan, S. M., Two-Phase flow, Boiling, and Condensation, Cambridge University Press, 2017, 2nd edition.
2. Brennen, C.E., "Fundamentals of Multiphase Flow", Cambridge University Press, 2009, 1st edition.

D. Reference Books:

1. Collier, J. G. and Thome, J. R., "Convective Boiling and Condensation", Oxford University Press, 1996, 3rd edition.
2. Tong, L. S. and Tang, Y. S., "Boiling Heat Transfer and Two-Phase Flow", CRC Press, 1997, 2nd edition.

E. Course Outcomes:

1. Describe the most important phenomena and principles of two-phase flow in engineering applications.
2. Apply the basic two-phase models and flow pattern maps to calculate the pressure drops of two-phase flow at various conditions.
3. Apply the models of critical flow and flooding to analyze limiting flow of engineering processes.
4. Explain the main points of boiling and condensation, heat transfer, and their enhancement methods.
5. Describe the concept boiling crisis (e.g., DNB - departure from nucleate boiling, and dryout) and its modelling.

Subject Code: ME-421E
Subject Name: Non-liner vibration
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. Understand the basic concept of non-linear vibration.
2. Apply the knowledge of non-linear vibration in real applications.

B. Course Content:

Introduction: Linear and nonlinear systems, conservative and non-conservative systems; potential well, Phase planes, types of forces and responses, fixed points, periodic, quasi-periodic and chaotic responses; Local and global stability; commonly observed nonlinear phenomena: multiple response, bifurcations, jump phenomena.

Development of nonlinear governing equation of motion of Mechanical systems: Linearization techniques, ordering techniques; commonly used nonlinear equations: Duffing equation, Van der Pol's oscillator, Mathieu's and Hill's equations.

Analytical solution methods: Harmonic balance, perturbation techniques (Linstedt-Poincare', method of Multiple Scales, Averaging – Krylov-BogoliubovMitropolsky), incremental harmonic balance, modified Lindstedt Poincare' techniques.

Stability and bifurcation analysis: static and dynamic bifurcations of fixed point and periodic response, different routes to chaotic response (period doubling, torus break down, attractor merging etc.), crisis.

Numerical techniques: time response, phase portrait, FFT, Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos; Lyapunov exponents and their determination, basin of attraction: point to point mapping and cell to cell mapping, fractal dimension.

Application: Single degree of freedom systems: Free vibration-Duffing's oscillator; primary, secondary-and multiple- resonances; Forced oscillations: Van der Pol's oscillator; parametric excitation: Mathieu's and Hill's equations, Floquet theory; effects of damping and nonlinearity, multi degree of freedom and continuous systems.

C. Text Books:

1. Nayfeh, A. H., and Mook, D. T., Nonlinear Oscillations, Wiley-Interscience, 1979.
2. Hayashi, C. Nonlinear Oscillations in Physical Systems, McGraw-Hill, 1964.
3. Evan-Ivanowski, R. M., Resonance Oscillations in Mechanical Systems, Elsevier, 1976.
4. Nayfeh, A. H., and Balachandran, B., Applied Nonlinear Dynamics, Wiley, 1995.

D. Reference Books:

1. Seydel, R., From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis, Elsevier, 1988.
2. Moon, F. C., Chaotic & Fractal Dynamics: An Introduction for Applied Scientists and Engineers, Wiley, 1992.
3. Rao, J. S., Advanced Theory of Vibration: Nonlinear Vibration and Onedimensional Structures, New Age International, 1992.

E. Course Outcomes:

1. Understand the basic concept of non-linear vibration.
2. Apply the knowledge of non-linear vibration in real applications.

Subject Code: ME-422A
Subject Name: Thermal Storage Systems
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To impart knowledge on various energy storage systems.
2. To make the student understand about various techniques of energy storage.
3. To learn about energy management and storage systems

B. Course Content:

Introduction to energy storage for power systems, Role of energy storage systems and its applications.Overview of energy storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical. Efficiency of energy storage systems.Electrical energy storage: Batteries, Super capacitors, Superconducting Magnetic Energy Storage (SMES), charging methodologies, SoC, SoH estimation techniques. Hydrogen production and storage, fuel cells.Mobile storage system: electric vehicle, G2V, V2G.Hybrid Energy storage systems, Storage for renewable energy systems: Solar energy, Wind energy, Pumped hydro energy, fuel cells. Energy storage in Micro-grid and Smart grid. Energy Management with storage systems, Battery SCADA, Increase of energy conversion efficiencies by introducing energy storage**.**

C. Text Books:

1. A. R. Pendse, Energy Storage Science and Technology, SBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011.
2. A.G.Ter-Gazarian, Energy Storage for Power Systems, The Institution of Engineering and Technology (IET) Publication, UK, 2011, 2nd Edition.

D. Reference Books:

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt, Energy Storage in Power Systems, Wiley Publication, 2016.

E. Course Outcomes:

1. Discuss the scientific principles underpinning the operation of energy storage systems.
2. Resolve the intermittency of renewable energy sources such as solar and wind by utilising problem solving skills in energy storage engineering and grid integration.
3. Work with a team to apply energy storage knowledge to develop and conduct a project.

Subject Code: ME-422B
Subject Name: Mathematical Modeling of Manufacturing Processes
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To provide basic concept of Material processing.
2. To be familiar with different microstructural properties and residual stresses of manufacturing process.
3. To get the overview of Mathematical modelling and solution methods.

B. Course Content:

Introduction to Manufacturing processes: Materials processing; types and properties of engineered materials; evaluation of properties of manufactured products; statistical and data-driven modelling approach; overview of mathematical modelling, types of mathematical models and methods to solve the same.

Physics of manufacturing processes: Solid-state deformation (elasticity and plasticity) and residual stresses; solid-state phase transformation and recrystallization; melting and solidification; coupled systems

Conventional machining: Orthogonal cutting; tool geometry; chip formation; force components; heat generation; tool life; mathematical modelling approach; solution of problems; introduction to discretetime linear and non-linear models. non-conventional machining; principal and mechanism of different processes; parametric analysis of heat transfer, material removal, and surface finish.

Metal forming: Mechanics of bulk metal forming; mechanics of sheet metal forming; heat transfer and deformation; welding; fusion welding; welding-heat source modelling, temperature distribution, effect of surface- active elements, modes of metal transfer in welding; solid-state welding; solidification and microstructure; residual stress and distortion.

Casting and powder metallurgy: Cooling and solidification; principle of powder metallurgy; coating and additive manufacturing; principle of surface and coating technology; principle and development of additive manufacturing technologies.

Heat treatment: Fundamentals of heat treatment; evaluation of microstructure properties and residual stress of different manufacturing processes.

Micro/nanoscale manufacturing: Down-scaling of conventional manufacturing processes, change of properties, micro-to-nano manufacturing; packaging, finishing, micro joining and nano joining, micro casting, micro forming, micromachining. processing of non-metallic

materials; principle of plastic processing and shaping of plastics, processing of non-metallic bio-materials; principle of glass and ceramics processing and shaping of glass and ceramics.

C. Text Books:

1. Rao C L and Deshpande P A, "Modelling of Engineering Materials", Ane Books Pvt. Ltd., New Delhi, India, 2010
2. Ghosh A, Mallik K A, "Manufacturing Science" East-West Press Pvt Ltd., 2010, 2nd Edition.

D. Reference Books:

1. Brandt. D A, Warner J C "Metallurgy Fundamentals" Goodheart-Willcox, 2009.
2. Zhang J and Jung Y G, "Additive Manufacturing: Materials, Processes, Quantification and Applications", Elsevier, 2018.

E. Course Outcomes:

1. Understand the fundamentals of manufacturing processes, mathematical models and their solutions.
2. Understand unconventional and conventional machining, their discrete-time linear, non-linear models and solutions.
3. Understand the fundamental of heat treatment, micro / nano manufacturing and processing of non-metallic materials.
4. Analyze the mechanism of forming and heat transfer in welding.
5. Apply the principles of casting, powder metallurgy, coating and additive Manufacturing.

Subject Code: ME-422C
Subject Name: Fuels and Combustion
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Solid, liquid and gaseous fuel properties, analysis, process and handling
2. Stoichiometry relations
3. The combustion processes
4. Features of different types of burners
5. About emissions

B. Course Content:

Classification of coal, analysis and properties of coal, oxidation of coal, hydrogenation of coal, agro fuels, solid fuel handling. Classification of petroleum products, Handling and storage of petroleum products, Refining and other conversion processes, property and testing of petroleum products, other liquid fuels. Types of gaseous fuels, natural gases, methane from coal mines, manufactured gases, producer gas, water gas, blast furnace gas, refinery gas, LPG, cleaning and purification of gaseous fuels. Stoichiometry relations, theoretical and minimum air required for complete combustion, calculation of dry flue gases, exhaust gas

analysis, flue gas analysis. Principles of combustion, rapid methods of combustion, flame propagation, various methods of flame stabilization. Basic features of burner, types of solid, liquid and gaseous fuel burners, recuperative and regenerative burners, Pulverised fuel furnaces–fixed, entrained, and fluidized bed systems. Emissions, Emission index, corrected concentrations, control of emissions for premixed and non-premixed combustion.

C. Text Books:

1. Stephen Turns, an Introduction to Combustion: Concepts and Applications, MGH, 2017.

D. Reference Books:

1. Sarkar S., Fuels and combustion, Universities Press, 2009, 3rd Edition.
2. Sharma and Chander Mohan, Fuels and combustion, Tata Mc Graw Hill, 1984.
3. Joshua Phillips H., Fuels, solid, liquid and gaseous – Their analysis and valuation, General Books, 2010.

E. Course Outcomes:

1. Differentiate between various fuels
2. Analyse exhaust and flue gases
3. Understand design considerations of burners
4. Control of emissions in combustion.

Subject Code: ME-422D
Subject Name: Industry 4.0 and Machine Learning
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To know about the necessity of industry 4.0 for manufacturing industries.
2. Understand the advances in robotics to implement in manufacturing and assembly.
3. Understand the need for machine learning for various problem solving.
4. To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning.lid, liquid and gaseous fuel properties, analysis, process and handling

B. Course Content:

Introduction to industry 4.0: Introduction, core idea of industry 4.0, origin concept of industry 4.0, industry 4.0 production system, current state of industry 4.0, main concepts and components of industry 4.0, state of the art, supportive technologies, proposed framework for industry 4.0.

Advances in robotics in the era of industry 4.0: Introduction, recent technological components of robots, advanced sensor technologies, internet of robotic things, cloud robotics and cognitive architecture for cyber-physical robotics, industrial robotic applications in manufacturing, maintenance and assembly.

Introduction to machine learning: Learning problems: perspectives and issues, concept learning, version spaces and candidate eliminations, inductive bias, decision tree learning, representation, algorithm, heuristic space search.

Supervised learning: Basic methods: distance-based methods, nearest-neighbors, decision trees, naive bayes, linear models: linear regression, logistic regression, generalized linear models, support vector machines, nonlinearity and kernel methods, beyond binary classification, multi-class/structured outputs, ranking.

Unsupervised learning: Clustering: K-means/Kernel K-means, dimensionality reduction: PCA and kernel PCA, matrix factorization and matrix completion, generative models (mixture models and latent factor models).

C. Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

D. Reference Books:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.
2. Klaus Schwab, The Fourth Industrial Revolution.
3. Ibrahim Garbie, Sustainability in Manufacturing Enterprises: Concepts, Analyses and Assessments for Industry 4.0.
4. Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
5. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2009.

E. Course Outcomes:

1. Explain the importance and necessity of industry 4.0.
2. Describe the applications of robotics in the manufacturing industry.
3. Discuss the decision tree algorithm and identity and overcome the problem of overfitting.
4. Differentiate between supervised and unsupervised machine learning approaches.

Subject Code: ME-422E
Subject Name: Micro and Nano Manufacturing Processes
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To give awareness of different techniques used in micro and nanomanufacturing processes.
2. To give in-depth idea of the conventional techniques used in micro machining.
3. To introduce non-conventional micro-nano manufacturing and finishing approaches.
4. To introduce micro and nanofabrication techniques and their applications.

B. Course Content:

Introduction: Basic elements of molecular dynamics modelling, design and requirements forstate-of-the-art cutting process simulations, capabilities for nanoscale materialremoval process analysis, advances and recent developments in material removal processsimulation.

Ductile mode cutting of brittle materials: Mechanism of ductile mode cutting of brittle materials, the chip formation in cutting of brittle materials, machined surfaces in relation to chip formation mode.

Diamond tools in micromachining: Diamond technology, preparation of substrate, modified HFCVD process, nucleation and diamond growth, deposition on complex substrates, diamond micromachining.

Conventional processes: Introduction, micro-turning, micro-drilling, micro-milling, product quality in micromachining, micro and nano grinding, nanogrinding tools.

Non-conventional processes: Introduction, fundamentals of lasers, laser microfabrication, Laser nanofabrication.

Evaluation of subsurface damage in nano and micromachining: Destructive evaluation technologies, non-destructive evaluation technologies.

Micro and nano finishing processes: Need for nano finishing, magnetic abrasive finishing, magnetorheological finish, elastic emission finishing, magnetic float polishing, ion beam finishing.

Micro joining: Challenges, micro resistance welding, ultrasonic welding, micro TIG, applications.

C. Text Books:

1. J. Paulo Davim, Mark J. Jackson, Nano and Micro-machining,John Wiley & Sons, 2013.
2. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
3. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining, CRC Press, 2006.
4. Nitaigour Premch and Mahalik, Micro-manufacturing and Nanotechnology, 2006.

D. Reference Books:

1. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.
2. Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
3. Kapil Gupta, Micro and Precision Manufacturing, Springer, 2017.

E. Course Outcomes:

1. Differentiate between the various traditional/non- traditional micro and nano machining methods.
2. Explain the various micro forming/welding techniques.
3. Explain the various nano finishing techniques.
4. Explain the various nanofinishing techniques used in industries.

OPEN ELECTIVES

(Offered by ME Deptt. for other Departmental Students)

Sl No	Course Code	Course Title	L	T	P	C
1	ME-210X	OE1 – Fluids and Thermal Engineering	3	0	0	3
2	ME-220X	OE2 – Materials and Manufacturing Practices	3	0	0	3
3	ME-310X	OE3–Elements of Mechanical Design	3	0	0	3
4	ME-320X	OE4 – Robotics	3	0	0	3
5	ME-410X	OE5 – Mechatronics and Automation	3	0	0	3
Contact Hours			15	0	0	15
Total Credits						15

Subject Code: ME-210X
Subject Name: Fluids and Thermal Engineering
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To impart knowledge on basics of thermodynamics, fluid mechanics and heat transfer.

2. To make the student familiar with applications of thermodynamics, fluid mechanics and heat transfer.

B. Course Content:

Integrated development of the fundamental principles of thermodynamics, fluid mechanics, and heat transfer, with applications.

Focuses on the first and second laws of thermodynamics, mass conservation, and momentum conservation, for both closed and open systems.

Entropy generation and its influence on the performance of engineering systems. Introduction to dimensionless numbers.

Introduction to heat transfer: conduction, convection, and radiation. Steady-state and transient conduction. Finned surfaces. The heat equation and the lumped capacitance model. Coupled and uncoupled fluid models.

Hydrostatics. Inviscid flow analysis and Bernoulli equation. Navier-Stokes equation and its solutions. Viscous internal flows, head losses, and turbulence. Introduction to pipe flows and Moody chart.

C. Text Books:

1. Cengel, Y. A., Boles, M. A., "Thermodynamics, An Engineering Approach", McGraw Hill Education, 2017, 8th Ed.
2. Cengel A.Younis, Heat Transfer: A Practical Approach, McGraw Hill, 2002, 2nd Ed.
3. Som, S. K.,.Biswas, G and Chakraborty, S., "Introduction to Fluid Mechanics and Fluid Machines", 2017, TMH, 3rd Ed.

D. Reference Books:

1. Nag, P. K., "Engineering Thermodynamics", McGraw Hill, 2017, 6th Ed.
2. Incropera, F. P., Dewitt, D. P., Bergman, T. L., Introduction to Heat Transfer, John Wiley & Sons, 2006, 5th Ed.
3. Munson, B. R., Young, D. F., Okiish, T. H., "Fundamental of Fluid Mechanics", Wiley, 2012, 7th Ed.

E. Course Outcomes:

1. Various thermodynamic systems, processes, cycles, work and heat interactions, path and point functions etc., The first and second laws of thermodynamics and their application to closed and open systems. Phase diagram, steam tables, Mollier diagram etc.
2. Basics of fluid mechanics, buoyancy, concepts of boundary layer, velocity profile, dimensional analysis
3. Basics of heat transfer-conduction, convection and radiation.

Subject Code: ME-220X
Subject Name: Materials and Manufacturing Practices
Credit Point: 3 [L = 3, T = 0, P = 0]

A. Course Objectives:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between microstructure, properties and manufacturing processes.
3. Understand the different manufacturing processes and their applications.
4. Examine the various manufacturing processes encountered in engineering practice.

B. Course Content:

Introduction: **M**aterial science, definition and its importance in relation to engineeringapplication, classification and properties of ferrous alloys, different alloy steel and cast iron, properties, compositions and uses of most commonly used non-ferrous alloys such as Al, Mg, Cu, Ti, Zn alloys etc.

Alloys and Phase diagram: Types of alloys, solid solutions, substitutional and interstitial solid solutions, factors affecting solid solubility (Hume Rothary rules), Gibbs phase rule, Lever rule, iron carbon equilibrium phase diagram and micro structure in plain carbon steel.

Effect of manufacturing processes on materials: Growth of crystal structure in materials, relation between crystal structure and properties of materials, recrystallization temperature and its effects, defects in crystal: point defect, line defect and its effect on properties.

Manufacturing practices: conventional manufacturing practices involving lathe, drilling and milling machine tools, applications of casting, injection moulding, metal forming, powder metallurgy and welding processes, principles of 3D printing technology and its application, effect of various process parameters in controlling the quality and quantity of manufactured products.

C. Text Books:

1. Smith, W., "Foundations of Materials Science and Engineering", McGraw Hill, 2009, 5th Ed.
2. Callister, W. D., "Material science and Engineering and Introduction", Wiley, 2016, 5th Ed.
3. Ghosh A, Mallik A. K, "Manufacturing Science", , Wiley Eastern, 2010, 2nd Ed..
4. Rao P. N, Manufacturing Technology, Volume II, Tata McGraw Hill, 2008.
5. Gibson I, Rosen D. W., Stucker B, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 20152nd Ed.

D. Reference Books:

1. Raghavan, V., "Materials Science and Engineering", PHI, 2015, 6th Ed..
2. Kalpakjian S, Schmid S. R, "Manufacturing Processes for Engineering Materials", Pearson Education, 2009, 5th Ed.
3. Kai C. C., Fai L. K., 3D Printing and Additive Manufacturing: Principles & Applications, World Scientific, 2015, 4th Ed.

E. Course Outcomes:
1. Identify the various materials and their properties and applications.
2. Interpret casting, welding, metal forming and powder metallurgy techniques.
3. Classify the various manufacturing methods encountered in engineering practice.
4. Evaluate the effect of process variables to manufacture defect free products.

Subject Code: ME-310X
Subject Name: Elements of Mechanical Design
Credit Point: 3 [L = 3, T = 0, P = 0]

A. Course Objectives:
1. To introduce design concepts and procedures necessary to design and/or select a machine component in terms of geometry and materials.
2. To introduce the concept of tribology and accordingly assist in selecting type of roller or ball bearing.

B. Course Content:
Design for variable loading - fatigue strength and design; design of shafts.

Design of bolts and Power Screws.

Theory of friction drives. Design and selection of belt drives; Design of clutches. Design of Gears: spur and worm gears, Contact and bending fatigue strength, Gear accuracy.

Tribology: Lubricant theories, Design of Journal bearings, Selection of ball and roller bearings.

C. Text Books:
1. Bhandari, Design of Machine Elements, 3rd edition McGraw-Hill Education, 2010.

D. Reference Books:
1. R. G. Budynas, K. J. Nisbett, Mechanical Engineering Design, McGraw-Hill Higher Education, 2014, 10th edition.
2. R. L. Norton, Machine Design, Prentice Hall, 2013, 5th edition.
3. C. S. Sharma and K. Purohit, Design of Machine Elements, Prentice Hall, 2008.
4. P. C. Gope, Machine Design: Fundamentals and Applications, Prentice Hall India, 2011.

E. Course Outcome:
1. Analyze the stresses in machine elements and structural members under various loads
2. Apply multidimensional failure criteria in the analysis and design of machine components
3. Design power transmission systems involving belts, clutches, gears
4. Determine the fatigue life of shafts, gears and bearings under varying loads

Subject Code: ME-320X
Subject Name: Robotics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:
1. To explain the basic principles of Robotic technology, configurations, control and applications of Robots.
2. To explain the basic concept Coordinate Frames, Mapping and Transforms.
3. To describe the concept of Robot kinematics and dynamics.
4. To choose the appropriate Sensor and vision system for a robot for a given application.
5. To understand the motion planning and control trajectory of the robot.

B. Course Content:
Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.

Coordinate Frames, Mapping and Transforms: Coordinate Frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices, mechanical structure and notations, description of links and joints, kinematic modeling of the manipulator, Denavit-Hartenberg notation, kinematic relationship between adjacent links, manipulator transformation matrix.

Kinematic Modeling of Robots: Position analysis – direct and inverse kinematic models of robotic manipulators, various examples. Velocity analysis–Jacobian matrix.

Dynamics of Robots Modeling of Robots: Dynamic analysis of the manipulator robot, Lagrange-Euler dynamic formulation, static force analysis, transformation of force and moment.

Robotic Sensors and Vision: Sensors in robotics, architecture of robotic vision systems, image acquisition, components of vision, system, image representation, image processing.

Motion Planning and Control: Basics of trajectory planning, Cartesian space trajectory, basics of control, block diagram, Laplace transform, PID control, trajectory planning - position, velocity and force control.

C. Text Books:

1. Craig J.J., Introduction to Robotics: Mechanics and Control, Pearson Education International, 2004, 3rd edition.
2. Spong M.W., and Vidyasagar M., Robot Dynamics and Control, Wiley, 2008.
3. Schilling R.J., Fundamentals of Robotics Analysis and Control, Prentice Hall of India, 1990.

D. Reference Books:

1. Fu K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
2. Saha S.K., Introduction to Robotics, McGraw Hill, 2014, 2nd edition.

E. Course Outcomes:

1. Have basic knowledge on various components of robotic system.
2. Develop suitable model for forward and inverse kinematics of robot manipulators.
3. Analyse forces in links and joints of a robot.
4. Model for trajectory planning and control mechanism of robot.

Subject Code: ME-410X
Subject Name: Mechatronics and Automation
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

1. Generate conceptual design for mechatronics systems based on potential customer requirements.
2. Selection of appropriate sensors and transducers and devise an instrumentation system for collecting information about processes, control systems.
3. Design a control system for effective functioning of mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers.
4. Selection of appropriate actuators for physical systems.
5. Study design of robot as case study

B. Course Content:

Introduction: Introduction to mechatronics, need and applications, philosophy and approach; systems and design: Mechatronic approach, integrated product design, modeling, analysis and simulation, man machine interface, role of mechatronics in automation, manufacturing and product development.

Sensors and transducers: Characteristics, classification, working principles, development in transducer technology, opto-electronics shaft encoders, strain, velocity, acceleration, LVDT, temperature sensors, vision system, etc.

Drives and Actuators: Hydraulic and pneumatic drives, electrical actuators such as servo motor and stepper motor, drive circuits, open and closed loop control; embedded systems: hardware structure, software design and communication, programmable logic devices, automatic control and real time control systems;

Smart Materials: Shape memory alloy, piezoelectric and magnetostrictive actuators, microsensors, microactuators.

Hydraulic and Pneumatic Systems: Introduction to hydraulic systems, hydraulic pumps, control valves, pressure relief valves, graphical representation of hydraulic and pneumatic elements, design of hydraulic circuit, introduction to Pneumatic systems, compressors, air treatment and pressure regulation, actuators, pneumatic controllers, application of pneumatic systems

CNC Programming and Industrial Robotics: CNC programming fundamentals, CNC machines and part programming, CNC programming- drilling, milling, turning operations

Application: Case studies based on the application of mechatronics in manufacturing, machine diagnostics, road vehicles and medical technology, bionics and avionics. industrial robotics, types of industrial robots, classification based on work envelope, generations configurations and control loops, co-ordinate systems, need for robot, basic parts and functions, specifications.

C. Text Books:

1. Bolton, W., Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education, 2011, 5th edition.
2. Alcaiatore, G.D., Michel B. H., Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill International, 2006, 3rd edition.
3. Robert H. B., The Mechatronics Handbook, , CRC Press, 2007, 2nd edition.

D. Reference Books:

1. Stenersons, J., Fundamentals of Programmable Logic Controllers Sensors and Communications, Pearson Education, 2004, 3rd Ed.
2. Kuttan K. A., Introduction to Mechatronics, Oxford University Press, 2007.

E. Course Outcomes:

1. Will be able to identify the need of mechatronics and integrated product design procedure and role of mechatronics in various engineering fields.
2. Will have basic understanding of various types of sensors and transducers including modelling
3. Will study and select appropriate actuators and drivers along with design of control system and modelling.
4. Will have case studies and design of robotic systems and application of mechatronic in system design