CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY

KANPUR

SYLLABUS

(B.Tech.)

MECHANICAL ENGINEERING
(w.e.f. 2024-25)

UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY

SCHOOL OF ENGINEERING & TECHNOLOGY

UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY

(SCHOOL OF ENGINEERING & TECHNOLOGY)

Vision

To achieve excellence in engineering education, empower students to be technically competent professionals and entrepreneurs with strong ethical values so as to significantly contribute as agents for universal development and societal transformation

Mission

To provide affordable quality education at par with global standards of academia and serve society with harmonious social diversity

To encourage new ideas and inculcate an entrepreneurial attitude amongst the students, and provide a robust research ecosystem

To practice and encourage high standards of professional ethics and accountability among students

Bachelor of Technology in Mechanical Engineering

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of basic science, mathematics and fundamentals of engineering with specialization to solve the complex problems of engineering.
PO2	**Problem analysis:** Identify and formulate for the analysis of the engineering problems considering the knowledge of engineering mathematics, natural and engineering sciences and review of the research articles and draw conclusion.
PO3	**Design/Development of solutions:** Demonstrate and develop the appropriate solutions of the complex level of mechanical engineering design based problems to meet the specified needs and overall sustainability of the processes, considering the necessary approaches of safety, health hazards, societal and environmental factors.
PO4	**Conduct investigations of complex problems:** Investigate, demonstrate and conduct the design based complex problems using research based knowledge and methodologies, experimental studies, subsequent analysis and interpretation of data to prepare the valid technical reports.
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 and demonstrate the impact of relevant professional engineering solutions and knowledge for the sustainable development of society and environment.
PO8	**Ethics:** Apply suitably the norms and responsibilities of engineering practices towards the commitment following the principles of engineering ethics.
PO9	**Individual and team work:** Work effectively as an individual or in diversified and multidisciplinary environments showing the team solidarity.
PO10	**Communication:** Ability to communicate efficiently with the engineering community, society and able to represent and explain the design documentation effectively with clear instructions.
PO11	**Project management and Finance:** Demonstrate the knowledge and principles of engineering, management, cost and feasibility studies for the desired projects as an individual, a member or leader in a team of multidisciplinary settings.
PO12	**Life-long learning:** Possess the attitude of lifelong independent learning as per the need of wider context of technological changes and can pursue higher education for careers in academics, research and development.

Program Specific Outcomes (PSOs)

PSO-1	Impart education and training of Mechanical Engineering to the students and to eventually make them competent and well qualified Mechanical Engineers
PSO-2	Provide best knowledge of the Mechanical Engineering to the students and nurture their creative talent by motivating them to work on various challenging problems of Mechanical Engineering
PSO-3	Acquire high end industry centric skills in the field of Mechanical Engineering
PSO-4	Knowledge of the software used in the field of Mechanical Engineering
PSO-5	To prepare Professional Engineer with ethical, social and moral values

Program Educational Outcomes (PEOs)

1. To make the students ready for successful career leading to higher education and /or in industry related domains of design, research and development, testing, and manufacturing.
2. To solve diverse real-life engineering problems equipped with a solid foundation in mathematical, scientific, and mechanical engineering principles.
3. To motivate and encourage the students to adopt professionalism, teamwork, leadership, communication skills, ethical approach.
4. To provide learning opportunity in a broad spectrum of multidisciplinary field.

Curricular Components

Category of courses	Credits offered
Basic Science Core	**27**
Engineering Science Core	**32**
Humanities and Social Science Core	**16**
Departmental Core	**66**
Departmental Electives	**12**
Open Electives	**09**
Projects and Seminars	**16**
Audit Courses	**02**
Total	**180**

Semester-wise Course Structure for
B. Tech. Mechanical Engineering Major (w.e.f. 2024-25)

Semester – wise breakup of courses

1st Year, Semester I

S. No.	Course Code	Course Title	L	T	P	Credits
1	MTHS101	Mathematics – I	3	1	0	4
2	PHYS101	Physics – I	3	1	3	5
3	CHMS101	Chemistry – I	3	1	3	5
4	TCAS101	Engineering Drawing	3	0	3	5
5	ESCS101	Basic Electrical & Electronics Engineering	3	1	3	5
6	UHVS101	Universal Human Values - I (SIP)				0
		Total	**15**	**4**	**12**	**24**

1st Year, Semester II

S. No.	Course Code	Course Title	L	T	P	Credits
1	MTHS102	Mathematics – II	3	1	0	4
2	PHYS102	Physics – II	3	1	3	5
3	HSSS101	Professional Communication	3	1	0	4
4	ISCS101	Programming & Computing (C & UNIX)	3	1	3	5
5	TCAS102	Workshop Practice & IDEA Lab	3	0	6	5
		Total	**15**	**4**	**12**	**23**

2nd Year, Semester III

S. No.	Course Code	Course Title	L	T	P	Credits
1	ESCS201	Engineering Mechanics	3	1	0	4
2	ESCS202	Basic Thermodynamics	3	1	0	4
3	MEES201	Basic Fluid Mechanics	3	0	2	4
4	MEES202	Kinematics of Machine	3	0	2	4
5	MEES203	Manufacturing Science	3	0	2	4
6	MTHS201	Mathematics - III	3	1	0	4
7	EVS S201	Environmental Science	2	0	0	2
8	SST S201	Summer Internship - I	0	0	2	2
		Total	**20**	**3**	**8**	**28**

2nd Year, Semester IV

S. No.	Course Code	Course Title	L	T	P	Credits
1	ESCS203	Introduction to Machine Learning	3	0	2	4
2	MEES204	Mechanical Design & Drawing	1	0	2	2
3	MEES205	Basic Solid Mechanics	3	0	0	3
4	MEES206	Material Science & Engineering	3	0	2	4
5	MEES207	Dynamics of Machine	3	0	2	4
6	MEES208	Material Removal & Manufacturing Process	3	0	2	4
7	HSSS201	Communication Practicum	1	0	2	3
8	UHVS201	Universal Human Values - II	3	0	0	3
		Total	**20**	**0**	**12**	**27**

3rd Year, Semester V

S. No.	Course Code	Course Title	L	T	P	Credits
1	MEES301	Heat Transfer & Mass Transfer	3	0	2	4
2	MEES302	Fluid Machinery System	3	0	2	4
3	MEES303	Energy Conversion System	3	0	0	3
4	MEES304	Measurements & Metrology	3	0	2	4
5	MEES305	Machine Design	3	0	0	3
6	HSSS302	Industrial Management	3	0	0	3
7	SSTS301	Summer Internship - II	0	0	2	2
8	SSMS301	Seminar	0	0	2	2
		Total	18	0	10	25

3rd Year, Semester VI

S. No.	Course Code	Course Title	L	T	P	Credits
1	MEES306	Computer Aided Design	3	0	2	4
2	MEES307	Refrigeration & Air-Conditioning	3	0	2	4
3	MEES308	I. C. Engine	3	0	2	4
4	HSS S301	Engineering Economics	3	0	0	3
5	MEE S5XX	Program Electives - I	3	0	0	3
6		Open Electives - I	3	0	0	3
		Total	**18**	**1**	**4**	**21**

4th Year, Semester VII

S. No.	Course Code	Course Title	L	T	P	Credits
1	MEES401	Computer Aided Manufacturing	3	0	2	4
2	MEES402	Material Additive & Manufacturing Process	3	0	0	3
3	MEES5XX	Program Electives – II	3	0	0	3
4		Open Electives – II	3	0	0	3
5	SSTS401	Summer Training	0	0	4	2
6	PRTS401	Project - I	0	0	8	4
		Total	**12**	**0**	**14**	**19**

4th Year, Semester VIII

S. No.	Course Code	Course Title	L	T	P	Credits
1	MEE S5XX	Program Electives - III	3	0	0	3
2	MEE S5XX	Program Electives - IV	3	0	0	3
3		Open Electives – III	3	0	0	3
4	PRT S402	Project - II	0	0	8	4
		Total	**9**	**0**	**10**	**13**

Total Credits – 180

Legends

L = Lecture

T= Tutorial

P= Practical/Presentation/Project

C= Credit

Note:

- Total No. of Lectures in each course should in the range of 40 to 45 per semester if per week three lectures are allotted.

Program Elective (PE) Courses or MOOCs:

Sr. No.	Course Code	Course Title	SEM	L	T	P	Credits
1	MEE S501	Mechanical Vibrations	VI	3	0	0	3
2	MEE S502	Production & operation management	VI	3	0	0	3
3	MEE S503	Power Plant Engg.	VI	3	0	0	3
4	MEE S504	Thermal Turbo Machines	VI	3	0	0	3
1	MEE S511	Gas Dynamics & Jet Propulsion	VII	3	0	0	3
2	MEE S512	Design Thinking and Product Innovation	VII	3	0	0	3
3	MEE S513	Advance Manufacturing Processes	VII	3	0	0	3
4	MEE S514	Automation and Robotics	VII	3	0	0	3
1	MEE S521	Operation Research	VIII	3	0	0	3
2	MEE S522	Automobile Engineering	VIII	3	0	0	3
3	MEE S523	Machine Tool Design	VIII	3	0	0	3
4	MEE S524	Advance Solid Mechanics	VIII	3	0	0	3
5	MEE S525	Advance Fluid Mechanics	VIII	3	0	0	3
6	MEE S526	Product Design and Manufacturing	VIII	3	0	0	3
7	MEE S527	Advanced Engineering Materials	VIII	3	0	0	3
8	MEE S528	Unconventional Machining Processes	VIII	3	0	0	3
		Total Credits					**12**

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Open Electives (OE) Courses from MEE department/MOOCs:

Sr. No.	Course Code	Course Title	SEM	L	T	P	Credits
1	MEE S531	Robotics	VI	3	0	0	3
2	MEE S532	Design and Manufacturing of Composites	VI	3	0	0	3
3	MEE S533	Renewable Energy Technology	VI	3	0	0	3
1	MEE S541	Total Quality Management	VII	3	0	0	3
2	MEE S542	Optimization Method in Engineering	VII	3	0	0	3
3	MEE S543	Oil Hydraulics and Pneumatics	VII	3	0	0	3
1	MEE S551	Finite Element Methods	VIII	3	0	0	3
2	MEE S552	Computational Fluid Dynamics	VIII	3	0	0	3
3	MEE S553	Non Destructive Testing	VIII	3	0	0	3
4	MEE S554	Control System	VIII	3	0	0	3
		Total Credits					**09**

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Bridge Courses for Exit or / Skills-Enhancement Courses For Exit (Mechanical Engineering):

- **02-Months internship for 6 Credits.**

OR

- **Two courses mentioned below of 4 to 6 credits**.

A. After First Year: UG Certificate (Engg. - ITI Level).

- The candidate should pass the following two additional courses (ITI Level)

OR

- Any two suitable skill based courses to qualify for UG Certificate (Engg.- ITI Level).

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	ME-159	Heating, Ventilation and Air Conditioning (HVAC)	2	0	2	3
2.	Skill Enhancement	ME-160	Machinist	2	0	2	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

B. After Second Year: UG Certificate (Engg. - Diploma Level).

- The candidate should pass the following two additional courses (Diploma Level)

OR

- Any two suitable skill-based courses to qualify for Diploma.

1) MOOC Course 1 as recommended by department
2) MOOC Course 2 as recommended by department

C. After Third Year: UG Certificate (Engg. - Degree Level).

- **The candidate should pass following additional courses (Degree Level)**

OR

- Any two suitable skill based courses to qualify for B. Voc.

1) MOOC Course 1 as recommended by department
2) MOOC Course 2 as recommended by department

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Minor Degree (MD) from other Department

a) For holistic development of the students and as per NEP S2020 and AICTE guideline, the students may earn additional 18-20 credits through the minor degree courses offered by different departments of the University from Semester IV to VIII. The Minor Degrees offered by different departments will be the state-of-the-art courses that make the student competent in his/her discipline to meet the additional global challenges.

b) The choice of MD will be optional in the sense that if the student does not opt for MD, he/she can complete his/her B.Tech. Program with a minimum of 175 – 180 credits. However, if a student opts for the additional 18 - 20 credits through minor degree courses, he/she will get B.Tech. Degree with Minor in (**Mechanical Engineering**).

In the present credit structure, a student will have to choose inter-minor courses in total, and an additional 18 - 20 credits can be earned during the entire period of the B. Tech. Program. If a student is not willing to opt for a minor degree, he/she may opt for intra minor courses to complete the overall 175-180 credits.

A-Department of Mechanical Engineering: Minor Degree (MD) in Mechanical Engineering (For Other Departments)

B. Tech. students from other Departments may get a Minor degree in Mechanical Engineering by completing 20 credit courses from the list courses listed below.

S. No.	Course Code	Course Title	SEM	L	T	P	Credits
1	ESC S201	Engineering Mechanics	III	3	0	0	3
2	ESC S202	Applied Thermodynamics	III	3	0	0	3
3	MEE S201	Basic Fluid Mechanics	III	3	0	2	4
4	MEE S202	Kinematics of Machine	III	3	0	2	4
5	MEE S203	Manufacturing Science	III	3	0	2	4
6	MEE S204	Mechanical Design & Drawing	IV	1	0	2	2
7	MEE S205	Basic Solid Mechanics	IV	3	0	0	3
8	MEE S206	Material Science & Engineering	IV	3	0	2	4
9	MEE S207	Dynamics of Machine	IV	3	0	2	4
10	MEE S208	Material removal & Manufacturing Process	IV	3	0	2	4
11	MEE S301	Heat Transfer & Mass Transfer	V	3	0	2	4
12	MEE S302	Fluid Machinery System	V	3	0	2	4
13	MEE S303	Energy Conversion System	V	3	0	0	3
14	MEE S304	Measurements & Metrology	V	3	0	2	4
15	MEE S305	Machine Design	V	3	0	0	3
16	MEE S306	Computer Aided design	VI	3	0	2	4
17	MEE S307	Refrigeration & Air-Conditioning	VI	3	0	2	4
18	MEE S308	I. C. Engine	VI	3	1	0	4
19	MEE S401	Computer Aided Manufacturing	VII	3	0	2	4
20	MEE S402	Material Additive & Manufacturing Process	VII	3	0	0	3
		Total 20 credit Required for MD					**20**

B-Department of Mechanical Engineering:

Minor Degree (MD)
in
Manufacturing Science & Engineering (For other Department students or a student of Mech. Engg. Deptt. may opt)

B.Tech. students from other Departments may get a Minor degree in Manufacturing Science & Engineering by completing 20 credit courses from the list courses listed below.

or

A student of Mech. Engg. Department may opt for B. Tech. With Minor Degree or B. Tech. (Hons.) Degree by completing in 20 more credit courses from courses listed in the following list as part of regular B. Tech. Programme.

S. No.	Course Code	Course Title	SEM	L	T	P	Credits
1	MEE S203	Manufacturing Science-I	III	3	0	2	4
2	MEE S208	Material removal & Manufacturing Process	IV	3	0	2	4
3	MEE S502	Production & Operation Management	VI	3	1	0	4
4	MEE S531	Robotics	VI	3	0	0	3
5	MEE S532	Design and Manufacturing of Composites	VI	3	0	0	3
6	MEE S401	Computer Aided Manufacturing	VII	3	0	2	4
7	MEE S402	Material Additive & Manufacturing Process	VII	3	0	0	3
8	MEE S513	Advance Manufacturing Processes	VII	3	1	0	4
9	MEE S514	Automation & Robotics	VII	3	1	0	4
10	MEE S526	Product Design & Manufacturing	VIII	3	1	0	4
11	MEE S528	Unconventional Machining Processes	VIII	3	1	0	4
12	MEE S553	Non-Destructive Testing	VIII	3	0	0	3
	Total 20 credit Required for MD or **B. Tech. (Hons.) Degree**						**20**

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Detailed Syllabus

(For First year)

Course Code: **CHMS101** **Breakup: 3 – 0 – 2 – 5**
Course Name: **Chemistry – I**

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the concept related to atoms and molecules, chemical bonding coordinate compounds and its applications
CO2	Concept of chemical kinetics, electrochemistry, photochemistry and their applications
CO3	Understand the concept of spectroscopy and its applications in various fields
CO4	Understand the basics of stereochemistry, organic reactions and its mechanism for various types of reactions
CO5	Various experiments helps the student to learn the basics of experiments to apply in day today life as well as in industry

Course Details:

UNIT-I - Atoms and Molecules: Need for wave mechanical picture of atomic structure [Photoelectric effect, de Broglie concept of matter waves], Derivation of schrodinger wave equation [as an example particle moving in unidimensional potential well]

Chemical Bonding- Orbital concepts in bonding, V.B. and M.O. theory, M.O. diagrams, Intermolecular interactions.

UNIT-II - Reaction Dynamics: Order, Molecularity, Rate law, integrated rate equations, Methods of determining of order of reaction, Complex reaction kinetics- chain reactions and reversible reactions in detail, Catalysis and enzyme catalysis

UNIT-III - Electrochemistry: Arrhenius theory of electrolytic dissociation, Transport number, Kohlrausch's law, Solubility product, Redox reaction, Electrochemical and concentration cells.

UNIT-IV- Stereochemistry: Introduction, Chirality, Enantiomers, Dia-stereomers, Projection formula of a tetrahedral carbon, Geometrical isomerism, Conformers

UNIT- V- Spectroscopic Techniques: General introduction to IR, NMR and Mass spectroscopy

UNIT-VI - Organic Reactions: Introduction, Electron displacement effects, Organic intermediates, Types of reactions [addition, elimination and substitution reactions]

UNIT-VII - Photochemistry: Photoexcitation of organic molecules, Jablonski diagram, Laws of photochemistry and quantum yield, Some examples of photochemical reactions, Chemistry of vision and other applications of photochemistry.

UNIT-VIII - Transition Metal Chemistry: Stucture of coordination compounds corresponding to coordination number up to 6, Tpes of ligands, Isomerism [geometrical, optical, ionization, linkage and coordination], Theories of bonding in coordination compounds- crystal field theory, Valence bond theory, Chelation.

UNIT-IX - Laboratory Practical Classes:

Text Books and References:

Physical Chemistry-

1. Physical Chemistry, P. Atkins and J De Paul, International student edition , 8th edition, Oxford University Press, (2006)
2. Principles of physical chemistry, B. R. Puri, L.R. Sharma and M.S. Pathania,

ShobanLalNagin Chand and Co., Jalandhar, 43 edition, Vishal Publishing ***Co***. (2017)

Organic Chemistry-

1. Organic Chemistry, R. T. Morrison and R.N. Boyd, 6th edition, Prentice hall of India (P) Ltd. New Delhi (2016)
2. A Textbook of Organic Chemistry, ArunBahl and B.S. Bahl, S., 22th edition, S.Chand Publishers, New Delhi (2019)

3.Inorganic Chemistry-

1. Concise Inorganic chemistry, J.D. Lee, 5th edition, (1997).
2. Inorganic Chemistry, J.E. Huyee, E.A. Keiter and R.L. Keiter. 4th edition, Prentice Hall, Upper Saddle River,(2017)

Engineering Chemistry-

1. Engineering chemistry , ShashiChawala, DhanpatRai& Co.(2013)
2. Engineering chemistry , P. C.Jain and Monika Jain. 16th edition,DhanpatRai Publishing Company (2015)

Chemistry Lab- I

Course Details:

Exp. 01. To estimate the strength of the given unknown solution of Mohr's salt (Ferrousammonium sulphate ($FeSO_4(NH_4)_2SO_4.6H_2O$) using $KMnO_4$ solution as an intermediate.

Exp. 02. To prepare a sample of p-nitroacetanilide.

Exp. 03. To prepare a sample of Aspirin.

Exp. 04. Preparation of Tris (Thiourea) Copper (I) sulphate.

Exp. 05. Preparation of Hexamine Nickel (II) chloride $[Ni(NH_3)_6]Cl_2$.

Exp. 06. Estimation of commercial caustic soda: Determination of the amounts of sodium carbonate and sodium hydroxide present together in the given commercial caustic soda.

Exp. 07. Estimation of calcium ions present in tap water.

Exp. 08. To determine the partition coefficient of acetic acid between n-butanol and water.

Exp. 09. To study the photochemical reduction of a ferric salt (Blue printing).

Exp. 10. To determine the viscosity of a given liquid (30% sugar solution) at room temperature using Ostwald's viscometer.

Exp. 11. To separate Ag(I), Hg (I) and Pb (II) ions by paper chromatography and calculate their RF values.

Exp. 12. Understanding reaction kinetics and calculating the rate and order of a reaction.

Exp.13. To study the kinetics of methyl acetate hydrolysis catalyzed by .5N HCl Solution.

Course Code: **ESCS101** **Breakup: 3 – 0 – 2 – 5**
Course Name: **Basic Electrical & Electronics Engineering**

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Predict the behavior of any electrical and magnetic circuits
CO2	Formulate and solve complex AC, DC circuits
CO3	Realize the requirement of transformers in transmission and distribution of electric power and other applications
CO4	Have knowledge of some basic electronic components and circuits
CO5	Understand the basics of diode and transistor circuits
CO6	Understand the working of some I C based circuits
CO7	Study logic gates and their usage in digital circuits

Course Details:

Unit – I

Sinusoidal steady state circuit analysis, voltage, current, sinusoidal & phaser presentation single phase AC circuit – behavior of resistance, inductance & capacitance & their combination, impedance concept of power, power factor. Series & parallel resonance – band width & quality factor. Three phase circuits – phase voltage & current, line & phase quantities, phasor diagram, balanced & unbalanced loads, Measurement of R, L, and C.

Unit –II

Network Theory: Network theorems – Thevenin's, Norton, maximum power transfer theorem, star delta transformation, circuit theory concept – mesh & nodal analysis.

Unit – III

Magnetic circuit concepts: self inductance , magnetic coupling analysis of single tuned & double tuned circuit involving mutual inductance , introduction to transformer.

Unit – IV

Basic Instruments, electrical measurement – measurement of voltage , current , power & energy, voltmeters & ammeter , wattmeter , energy meter , three phase power measurement , electronics instrument – multimeter, CRO(analog & digital),An overview of voltage regulator.

Unit – V

Introduction to basic electronics devices – junction diode, BJT, amplifier, op-amps & instrumentation amplifier with mathematical operation.

Number System: Introduction to binary, octal, decimal & hexadecimal systems, representation of negative numbers, 1's, 2's, 9's, 10's complement and their arithmetic.

Text Books and References:

1. Edward Hughe "Electrical and Electronic Technology", 10th Edition, Pearson Education Asia, 2019.
2. P. Kothari, I J Nagrath, "Electric Machines", 5th Edition, Tata McGraw Hill, 2017.
3. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007.
4. A Textbook of Electrical Technology - Volume I (Basic Electrical Engineering)

23Rev Ed Edition, S. Chand Publishing.2020
5. S. K. Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.
6. Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Limited, 2nd Edition, 2003.
7. David Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.
8. Michael Tooley A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

Basic Electrical & Electronics Engineering Lab Course Details:

1. Familiarization with the Electronic Instruments.
2. Familiarization with electronic components and Bread board.
3. To verify the Thevenin theorem.
4. To verify the Superposition theorem.
5. Measurement of voltage and frequency with CRO.
6. To study half wave rectifier.
7. To study full wave bridge rectifier.
8. To study full wave bridge rectifier with filter.
9. To study and verify the truth table of different logic gates using digital IC.
10. To study different type of transformer and there operation.
11. To study basic wiring and design a switchboard/extension board.
12. To study the polarity test of a single phase transformer.
13. To study the open & short circuit test of a transformer and calibration losses.
14. To study the load test and efficiency of a single phase transformer.

Course Code: **MTHS101** **Breakup: 3 – 1 – 0 – 4**
Course Name: **Mathematics-I**

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Test the convergence & divergence of infinite series
CO2	Understand concepts of limit, continuity and differentiability of function of two variables
CO3	Find the maxima and minima of multivariable functions
CO4	Evaluate multiple integrals, concepts of beta & gamma functions
CO5	Apply the concepts of gradient, divergence and curl to formulate engineering problems

Course Details:

Unit I

Applications of integrals: Areas between curves, Methods of finding volume: Slicing, solids of revolution , Cylindrical shell , Lengths of plane curves, Areas of Surface of revolution, Moments and Center of mass, Work, Fluid pressure and Forces . Trapezoidal and Simpson rule, Improper integrals.

Unit II

Sequences: Definition, Monotonic sequences, Bounded sequences, Convergent and

Divergent Sequences**.**

Series: Infinite series, Oscillating and Geometric series, their Convergence, Divergence. Tests of Convergence: n^{th} Term test of divergence, Integral test, Comparison Test, Limit Comparison test, Ratio test (Delambert), n^{th} root test (Cauchy root test), Alternating series, Absolute and conditional convergence..

Power Series: Power series and its convergence, Radius and interval of convergence, Term by term differentiation , Term by term integration, Product of power series, Taylor and Maclaurin series , convergence of Taylor series, Error estimates ,Taylor's Theorem with remainder .

Unit III

Vector Calculus: Vector valued functions, Arc length and Unit Tangent vector, Curvature, Torsion and TNB frame**.**

Partial Derivatives: Function of two or more variables (Limit, Continuity, Differentiability , Taylors Theorem) , Partial derivatives, Chain Rule, Partial Derivatives of higher orders, , Maxima and Minima and Saddle Point, Lagrange Multipliers, Exact differential, Jacobian, Leibnitz Theorem.

Directional derivatives, Gradient Vectors, Divergence and Curl, Tangent planes.

Unit III

Multiple Integrals: Double and triple integral, Change of order, Change of variables, Application to area and volume, Dirichlet integral and applications.

Line, surface integrals, Path independence, Statement and problems of Green's, Stoke's and Gauss divergence theorems (without proof).

Text Books and References :

1. G.B.Thomas and R.L.Finney : Calculus and Analytical Geometry, Ninth Edition 2010.
2. B.S. Grewal, Engineering Mathematics, Khanna Publishers, 2004.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005.

Course Code: PHYS101 **Breakup: 3 – 1 – 3 – 5**
Course Name: Physics-I

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the behaviour of Physical bodies
CO2	Understand the basic concepts related to the motion of all the objects around us in our daily life
CO3	Gain the foundation for applications in various applied fields in science and technology
CO4	Understand the concepts of vectors, laws of motion, momentum, energy, rotational motion, central force field, gravitation, collision and special theory of relativity
CO5	Empower the students to develop the skill of organizing the theoretical knowledge and experimental observations into a coherent understanding

Course Details:

Unit-I: Newton's laws and their applications, Friction, conservative forces and potentials,

Work energy theorem, conservation of energy and linear momentum, variable mass system

(rocket), impulse, system of particles and collision, Elementary rigid body kinematics, rotation motion, moment of inertia, and Gyroscopic motion.

Unit-II: Rigid body motion, angular momentum, fundamental of classical mechanics, Lagrangian and Hamiltonian formulation.

Unit-III: Motion in non-inertial frames, fractious forces, special theory of relativity, central forces, Gravitation motion under central forces and Kepler's Laws.

Unit-IV: Simple harmonic motion (SHM), small oscillations and resonance; Wave particle duality, de-Broglie matter's waves, Phase and group velocities, Davisson-Germer experiment, Heisenberg uncertainty principle and its applications.

Unit-V: Wave function and its significance, Schrödinger equations (time dependent and independent), Schrödinger's wave equation for particle in one dimensional box, diffraction of X-rays by crystal planes, Bragg's spectrometer, Compton's effect.

Text Books and References:

1. Vector Analysis by M. R. Spiegel, Schaum's Outlines, 2021
2. Introduction to Mechanics: R. D. Kleppner and J. Kolenkow, Cambridge University Press, 2nd edition, 2014
3. A textbook of Mechanics by J. C. Upadhyay, Ram Prasas Publications; 1st edition, 2017
4. Mechanics by D. S. Mathur, S. Chand; New edition, 2000
5. Theory & Problems of Theoretical Mechanics by M. R. Spiegel, Schaum's Outline Series, 2017
6. Introduction to Special Theory of Relativity by Robert Resnick, Wiley, 1st edition 2007.
7. Concept of physics (Part-I) by H. C. Verma, Bharti Bhawan Publisher, 2022.
8. Quantum Mechanics by L.I. Schiff, McGraw-Hill Education (India) Pvt Limited, 2017.
9. A Textbook of Quantum Mechanics by P.M. Mathews and K. Venkatesan, McGraw-Hill Education (India) Pvt Limited,2010.
10. Introduction to Quantum Mechanics by D.J. Griffiths, 3E, Cambridge University Press, 2018.

Physics Lab-I

Course Details:

1. Graphical Analysis (Ref. UIET Laboratory Manual)
2. Trajectory of projectile (Ref. UIET Laboratory Manual) Apparatus Used (Trajectory Apparatus, Metal Balls, Channels, Vernier Callipers, Carbon & Graph Paper)
3. Moment of Inertia of Bicycle wheel (Ref. Book by K. K. Dey, B. N. Dutta)

   Apparatus Used (Bicycle Wheel, Masses, Thread, Stopwatch, Meter Scale, Vernier Callipers)
4. Spring Oscillations (Ref. UIET Laboratory Manual)

   Apparatus Used (Spring Oscillation Apparatus, Stop Watch, Masses)
5. Coupled Pendulum (Ref. UIET Laboratory Manual)

Apparatus Used (Coupled Pendulum Setup, Stop Watch, Scale)

6. Bifilar Suspension System (Ref. UIET Laboratory Manual)

   Apparatus Used (Bifilar Suspension System Setup, Stop Watch, Masses)

7. Frequency of AC Mains by Melde's Method (Ref. Book by K. K. Dey, B. N. Dutta)

   Apparatus Used (Electrical Vibrator, String, Pulley, Small Pan, Weight Box & Physical Balance)

8. Kater's(Reversible) Pendulum (Ref. Book by K. K. Dey, B. N.

   Dutta) Apparatus Used (Kater's Pendulum, Stop Watch)

9. Inertia Table (Ref. Book by K. K. Dey, B. N. Dutta)

   Apparatus Used (Inertia Table, Stop Watch, VernierCallipers, Split Disc, Balancing Weights, and Given Body(Disc)

Course Code: **TCAS101** **Breakup: 2 – 1 – 3 – 5**
Course Name: **Engineering Drawing**

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the basics of engineering graphics
CO2	Develop skills to prepare basic engineering drawings
CO3	Understand the concept of projection and acquire visualization skills
CO4	Gain imaginative skills to understand section of solids and developments of surfaces

Course Details:

UNIT - I: Introduction- Drawing instruments and their uses, BIS conventions, lettering dimensioning and free hand practicing. Polygons-Construction of Regular Polygons using given length of a side; Ellipse-General method and Oblong Methods for Construction of ellipse; Scales-Plain, Vernier and Diagonal Scales.
UNIT – II: Introduction to Orthographic Projections; Projections of Points; Projections of Straight Lines parallel to both planes; Projections of Straight Lines-Parallel to one and inclined to other plane.
UNIT – III: Projections of Planes; Regular Planes Perpendicular / Parallel to one Reference Plane and inclined to other Reference Plane; inclined to both the Reference Planes.
UNIT – IV: Projections of Solids-Prisms, Pyramids, Cylinders and Cones with the axis inclined to one Plane.
UNIT – V: Conversion of Isometric Views to Orthographic Views. Conversion of Orthographic Views to Isometric Projections and Views.

Introduction to computer graphics: Some problems on above topics on computer graphics.

Text Books and References:

1. Narayana,K.L. & Kannaiah,P. "Engg.Graphics". Tata McGraw Hill, New Delhi (2012).
2. Bhatt,N.D. (2014) "Elementary Engg. Drawing" Charotar Book stall. Anand.
3. Lakshminarayanan, V and VaishWannar, R. S. "Engg.Graphics".Jain Brothers, New Delhi (2006).

4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
5. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

Course Code: TCAS102 **Breakup: 2 – 1 – 3 – 5**
Course Name: Workshop Practice & IDEA Lab

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	To Study on different machine tools and their operations.
CO-2	Basic knowledge of casting processes and their applications.
CO-3	Recognize the different types metal forming process and their operations.
CO-4	Introduction to basic fabrication processes such as welding
CO-5	To study on Modern trends in manufacturing, Unconventional machining Processes and Automation
CO6	Demonstrate the ability to design, prototype, and test electronic systems using measurement instruments, embedded platforms, and fabrication techniques

Course Details: Historical perspectives; Classification of Manufacturing process.

Unit – I Machining: Basic principles of lathe machine & operations performed on it. Basic description of machines & operations of shaper-planer, drilling, milling, grinding Unconventional machining processes, Machine tools.
Unit –II Casting Processes: Pattern & allowances, Moulding sands & its desirable properties. Mould making with the use of a core Gating system, Casting defects & remedies, Cupola furnace, Die-casting & its uses.
Unit – III Metal forming: Basic metal forming operations & uses of such as-forging, rolling, wire& tube drawing/making & extrusion, & its products/applications, presswork & die & punch assembly, cutting & forming, its application; Hot working vs Cold working;
Unit – IV Powder metallurgy: powder metallurgy process &its applications, plastic-products manufacturing, galvanizing & electroplating.
Unit – V Welding: Importance & basic concepts of welding, classification of welding processes, Gas welding, types of flames, Electric arc welding. Resistance welding, Soldering & brazing and its uses, Modern trends in manufacturing, Automation, Introduction to NC/ CNC /DNC, FMS, CAD/CAM, CIM and factory of future
Unit-VI IDEA Lab: Familiarization and use of basic electronic measurement instruments- DSO, Signal and function generator. Bench power supply. Circuit prototyping, 3D printing, Arduino programming.

Text Books and References:

1. Chapman,W A J & Arnold ,E "Workshop Technology,1972 ; vol. I,II&III" Viva Low Priced Student Edition.
2. Raghuwanshi,B S "Workshop Technology ,2015; vol. I&II" DhanpatRai& Sons
3. Chaudhary, Hajra "Elements of Workshop Technology, 2008 ; vol. I&II" Media Promoters & Publishers.

Workshop Practice Lab

Course Details:

1. Foundry (1 turn)
2. Welding (3 turns)
   a. Gas Welding (1 turn)
   b. Arc Welding (2 turns)
      (i). Lap Joint (1 turn)
      (ii) Butt Joint (1 turn)
3. M/C Shop (4 Turns)
4. Fitting & Sheet Metal Work (1 turn+1 turn)
5. Carpentry Shop(1 turn)
6. Black-smithy shop(1 turn)
7. Machining of 3D geometry on soft material such as soft wood or modelling wax.
8. 2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
9. Schematic and PCB layout design of a suitable circuit and fabrication.
10. Embedded programming using Arduino and/or Raspberry Pi.
11. Discussion and implementation of a mini project.

Course Code: MTHS102 **Breakup: 3 – 1 – 0 – 4**
Course Name: Mathematics-II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Solve the consistent system of linear equations
CO2	Determine the power series expansion of a given function
CO3	Solve arbitrary order linear differential equations with constant coefficients
CO4	Apply Laplace transforms to solve physical problems arising in engineering
CO5	Find eigen values, eigen vectors &diagonalize a matrix
CO6	Understand concept of vector space & linear transformation

Course Details:

Unit-I- Linear Algebra
Matrices, Elementary row and column operations, Echelon form, Rank of matrix, Determinants. Vector spaces, Linear dependence and Independence, Linear transforms and matrices, Consistency of linear system of equations and their solution, Special matrices: Symmetric, Hermtionetc, Characteristic equation, Cayley-Hamilton theorem(statement only), Eigen values and eigen vectors, Diagonalisation .

Unit-II- First order differential Equations :
Seperable, Exact Differential Equation ,Integrating Factors, Linear differential equations with constant coefficients, Homogeneous linear differential equations, Bernouille Equation, Simultaneous linear differential equations, Differential equations of first order but not first degree, Claiurat's equation, Homogeneous linear differential

equations of second order with constant coefficients, Complex root case, Differential operators, Euler-Cauchy equation Existence and uniqueness, Wronskain, Nonhomogeneous equations,
Solution by undetermined coefficients, solution by variation of parameters.
Series solution: Strum-Liouvilleproblems , Ordinary differential equations of 2^{nd} order with variable coefficients (Frobenius Method), Orthogonal polynomials, Bessel functions .

Unit-III: Laplace Transform

Laplace transform, Existence Theorem, Laplace transform of derivatives and integrals, Inverse Laplace transform, Unit step function, Dirac Delta function, Laplace transform of periodic functions, Convolution Theorem, Applications to solve simple linear and simultaneous differential equations.

Text Books and Reference :

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, KhanPublishers,2005.
3. C. Ray Wylie & Louis C. Barrett, Advanced Engineering Mathematics, Tata McGraw- Hill Publishing Company Ltd. 2003.
4. G.F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Ltd. 1981.

Course Code: PHYS102 **Breakup: 3 – 1 – 3 – 5**
Course Name: Physics-II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	understand the vector integration which they can apply in electricity and magnetism
CO2	Understand the concepts of wave optics such as the phenomena of interference, diffraction and polarization of light
CO3	Understand the concepts of electrostatics, magnetostatics, electromagnetic induction, Maxwell's equations and electromagnetic waves
CO4	Apply the concepts of physics in the engineering courses

Course Details:
Unit-I: Vector analysis: scalars, vectors, vector differentiation, gradient, divergence and curl, vector, integration, Gauss divergence and Stoke's theorem, co-ordinate systems (spherical polar & cylindrical), Electrostatics: electric fields, potentials, Gauss's law, electric dipoles and multipoles, polarization, bound charges, linear dielectrics and force on dielectrics, electric displacement, boundary condition of E and D, work and energy of electrostatics, Laplace's equation and uniqueness theorem, image theory.
Unit-II: Motion of charge in electric and magnetic field, Magnetostatics: current density, magnetic fields, Ampére's law, Faraday's law, magnetic potential, magnetic polarization,

bound current, magnetic properties of materials (para, dia and ferro), boundary condition of B and H, basic idea of superconductor.

Unit-III: Displacement current, Maxwell's equations for free space and matter (dielectric and conductor), Electromagnetic waves, Poynting vector.

Unit-IV: Origin the refractive index, Interference: division of wave-front and division of amplitude; diffraction: Fraunhoffer, Grating, Resolving power (grating, prism, telescope and microscope); polarization: Phenomena of double refraction, Nicol prism, optical activity Production and analysis of plane, circular and elliptical polarized light, Frenels theory of optical activities and Polarimeters.

Unit-V: Fiber optics and photonics: Fundamental ideas about optical fiber, types of fibers, Total Internal Reflection (TIR), critical angle, acceptance angle and application, basic principal of Laser and Holography and fundamental ideas about photonics.

Text Books and References

1. Optics: Ajoy Ghatak
2. A textbook of OPTICS: Subrahmanyam, Brijlal and Avadhanulu
3. Electrodynamics: David J. Griffith
4. Classical electrodynamics: J. D. Jackson
5. Modern Physics: Author Beiser
6. Photonic Crystals: J. D. Joannopoulos, R. D. Meade, and R. D. Winn

Physics Lab-II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Gain practical knowledge about electricity and magnetism and measurements such as resistance, voltage, current etc
CO2	Gain experimental knowledge of interference, diffraction and polarization of light and measurement of the wavelengths of the monochromatic light with the help of Newton's ring experiment, Fresnel's biprism experiment, etc.
CO3	Understand concept of semiconductor through the four probe the experiment physics
CO4	Gain knowledge about the various optical devices: prism, grating, spectrometer.
CO5	Understand the basic concept of modern physics through the determination of Planck's constant

Course Details:

1. Newton's Ring (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Traveling Microscope, Support for Glass Plate inclined at 45^0 to the Vertical, Short Focus Convex Lens, Sodium Lamp, Plano Convex Lens, An Optically Plane Glass Plate)
2. Prism Spectrometer (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Spectrometer, Glass Prism, Reading Lens, Mercury Lamp)

3. Plane Transmission Grating (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Spectrometer, Diffraction Grating, Mercury Lamp)
4. Ballistic Galvanometer (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Ballistic Galvanometer, Morse key, Damping key, Condenser, Rheostat, Volt Meter, Storage Battery, Connection Wires)
5. Carey Foster's Bridge (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Carey Foster's Bridge, Laclanche cell, Resistance Box, Galvanometer, Plug Key, Copper Strip)
6. Fresnel's Biprism (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Sodium Lamp, Biprism, Convex Lens, Optical Bench with Four Uprights)
7. Variation of Magnetic Field (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Stewart and Gee type Tangent Galvanometer, Storage Battery, Commutator, Ammeter, Rheostat, One way Plug Key, Connection Wires)
8. Polarimeter (Ref. Book by K. K. Dey, B. N. Dutta) Apparatus Used (Sodium Lamp, Polarimeter, Physical Balance)

Course Code: ISCS101 **Breakup: 3 – 1 – 3 – 5**
Course Name: Programming & Computing(C & UNIX)

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Recollect various programming constructs and to develop C programs
CO2	Understand the fundamentals of C programming
CO3	Choose the right data representation formats based on the requirements of the problem
CO4	Implement different Operations on arrays, functions, pointers, structures, unions and files

Course Details:

Basic concepts of Computers, Basic UNIX Concepts and Vi– Editor, Introduction to C: Basic Programming concepts, Program structure in C, Variables and Constants, Data types, Conditional statements, control statements, Functions, Arrays, Structures, Introduction to pointers, and Introduction to File Systems.

Text Books and References:

1. Programming in C, Schaum Series, 3rd edition, BPB Publication, Byron S. Gottfried
2. The 'C' Programming, Denis Ritchi, Second edition, PHI, 1988
3. Mastering C, Venugopal, Second edition, TMH, 2006
4. Let Us C, YashavantKanetkar, 18th Edition, BPB, 2021
5. Programming in ANSI C, Balaguruswami, Eighth Edition, TMH, 2019

Computer Programming Lab:

Learning OS Commands

Practice of all Internal and External DOS Commands, Writing simple batch programs, Exposure to Windows environment, Practice of UNIX commands and Vi editor, Writing

simple shell script

C Programming:

Practicing programs to get exposure to basic data types,algebraic expressions, Conditional statements, Input Output Formatting, Control structures, arrays, functions, structures, pointers and basic file handling.

Course Code: HSSS101 Breakup: 3 – 1 – 0 – 4
Course Name: Professional Communication

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Enhance their communication skills for tackling the professional challenges of a diverse workplace
CO2	Learn effective writing skills and be able to write clear technical reports
CO3	Improve their verbal and non-verbal communication
CO4	Be fluent orally in the use of the nuances of the English language
CO5	Learn good interpersonal skills and be proficient with the soft skills required for national and global placements

Course Details:

Unit 1: Basics of Technical Communication: Technical Communication: features; Distinction between General and Technical communication; Language as a tool of communication; Levels of communication: Interpersonal, Organizational, Mass communication; the flow of Communication: Downward, Upward, Lateral or Horizontal (Peer group); Barriers to Communication.

Unit 2: Constituents of Technical Written Communication: Word formation, Prefix and Suffix; Synonyms and Antonyms; Homophones; One Word Substitution; Technical Terms; Paragraph Development: Techniques and Methods -Inductive, Deductive, Spatial, Linear, Chronological etc; The Art of Condensation- various steps.

Unit 3: Forms of Technical Communication: Business Letters: Sales and Credit letters; Letter of Enquiry; Letter of Quotation, Order, Claim and Adjustment Letters; Memos, Notices, Circulars; Job application and Resumes. Reports: Types; Significance; Structure, Style & Writing of Reports. Technical Proposal; Parts; Types; Writing of Proposal; Significance.

Unit 4: Presentation Strategies: Defining Purpose; Audience & Locale; Organizing Contents; Preparing Outline; Audio-visual Aids; Nuances of Delivery; Body Language; Space; Setting Nuances of Voice Dynamics; Time- Dimension.

Unit 5: Value- Based Text Readings: Following essays form the suggested text book with emphasis on Mechanics of writing,

(i) The Language of Literature and Science by A.Huxley
(ii) Man and Nature by J.Bronowski
(iii) The Mother of the Sciences by A.J.Bahm

(iv) Humanistic and Scientific Approaches to Human Activity by Moody E. Prior
(v) The Effect of Scientific Temper on Man by Bertrand Russell.

Text Books and References:

1. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, OxfordUniv. Press, New Delhi.
2. Technical Communication – Principles and Practices by Meenakshi Raman &Sangeeta Sharma, Oxford Univ. Press 2007, New Delhi.
3. Effective Technical Communication by Barun K. Mitra, OxfordUniv. Press, 2006, New Delhi
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., New Delhi.
5. How to Build Better Vocabulary by M.Rosen Blum, Bloomsbury Pub. London.
6. Word Power Made Easy by Norman Lewis, W.R.Goyal Pub. & Distributors; Delhi.
7. Developing Communication Skills by Krishna Mohan, MeeraBanerji-Macmillan India Ltd. Delhi.
8. Manual of Practical Communication by L.U.B. Pandey & R.P. Singh; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, Delhi.

(For Second year)

Course Code: MTHS201 **Breakup: 3 – 1 – 0 – 4**
Course Name: Mathematics - III

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Obtain the Fourier series expansion of a given function
CO2	Apply Fourier transform for solving Boundary Value Problems
CO3	Determine the solution of linear partial differential equations (PDE) by variable Lagrange's method & some nonlinear PDEs
CO4	Understand and use of complex variable & analyticity
CO5	Expand a function of Laurent series
CO6	Evaluation of real integrals using residues

Course Details:

Unit – I : Function of a Complex variable

Complex numbers- power and roots, limits, continuity and derivative of functions of complex variable, Analytic functions, Cauchy-Reimann equations, Harmonic function, Harmonic conjugate of analytic function and methods of finding it, Complex Exponential, Trigonometric, Hyperbolic and Logarithm function.

Unit – II : Complex Integration

Line integral in complex plane(definite and indefinite), Cauchy's Integral theorem, Cauchy's Integral formula, Derivatives of analytic functions, Cauchy's Inequality, Liouville's theorem, Morera's theorem, Power series representation of analytic function and radius of convergence,Taylor's and Laurent's series, singularities, Residue theorem, Evaluation of real

integrals, Improper Integrals of rational functions, Fourier integrals.

Unit – III: Fourier Series

Periodic functions, Trignometric series, Fourier series of period 2π , Eulers formulae, Functions having arbitrary period, Change of interval, Even and odd functions, Half range sine and cosine series, Complex fourier series, Fourier Integrals, Fourier Sine and Cosine Transform.

Unit – IV: Partial Differential Equations

Solution of first order partial differential equations-Linear and nonlinear (Charpit's method), Linear partial differential equations with constant coefficients of second order and their classifications - parabolic, elliptic and hyperbolic with illustrative examples. Methods of finding solutions using seperation of variables method. Wave and Heat equations upto two dimension

Unit – V: Probability and Statistics

Basics of probability, Bayes theorem, Random variables, Probability and density fuctions, Binomial, Poisson and Normal distributions.

Text Books and Reference:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2005.
2. B.S. Grewal, Higher Engineering Mathematics, KhanPublishers, 2005.

Course Code: ESCS201 **Breakup: 3 – 1 – 0 – 4**

Course Name: Engineering Mechanics

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Determine the resultant force and moment for a given system of forces
CO-2	Determine the Centre of Gravity and Moment of Inertia of surfaces and solids
CO-3	Determine the shear force, Bending moment of beams and analyze the trusses and problems related to frictions
CO-4	Determine the stresses in beam for pure bending and effect of torsion in shafts
CO-5	Calculate the motion characteristics of a body subjected to a given force system

Course Details:

General Coplanar force systems: Basis concepts, Law of motions, principle of transmissibility of forces, Transfer of a force to parallel position, Resultant of a force system, simplest resultant of two dimensional concurrent & non concurrent force systems, free body diagrams, equilibrium & its equations, applications.

Trusses &Cables: Introductions, simple truss & solutions of simple truss, method of joints & method of sections.

Friction: Introduction, Laws of coulomb friction, equilibrium of bodies involving dry friction, belt friction, applications.

Centre of gravity, centroid, Moment of Inertia: Centroid of plane, curve, area , volume & composite bodies, moment of inertia of plane area, parallel axis theorem, perpendicular axis theorem, principal moment inertia, mass moment of inertia of circular ring, disc, cylinder, sphere and cone about their axis of symmetry.

Beams: Introductions, shear force and bending moment, differential equations for equilibrium, shear force & bending moments diagrams for statically determinate beams.

Kinematics of rigid body: Introduction, plane motion of rigid bodies, velocity & acceleration under translation & rotational motion, Relative velocity, projectile motion.

Kinetics of rigid bodies: Introduction, force, mass & acceleration, work & energy, impulse & momentum, D'Alembert principles & dynamic equilibrium. Virtual work.

Text Books and Reference:

1. Beer F.P. &Johnston, F.R. "Mechanics for Engineers" 11th edition 2017, McGraw Hill.
2. Shames, I.H. "Engg. Mechanics" 4thedition2005, P H I.
3. Meriam, J. L. "Statics" 7th edition 2011, J. Wiley.
4. Meriam, J. L. "Dynamics" 7th edition 2011, J. Wiley.

Course Code: ESCS202 **Breakup: 3 – 1 – 0 – 4**
Course Name: Basic Thermodynamics

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	Analyze the types of thermodynamic systems, heat and work interactions
CO-2	Apply knowledge of laws of thermodynamic to practical systems
CO-3	Understand the concept of energy, entropy and equilibrium
CO-4	Able to calculate the efficiency of systems, cycles
CO-5	Understand the concept of different cycles needed for power, refrigeration

Course Details:

Fundamental concepts: System, Property, Work and Heat interactions.
Zeroth law: Zeroth law of thermodynamics, Temperature & its measurement & scales.
First law: Thermodynamic processes, calculation of work in various processes, non-flow work & flow work. Joule's experiment, First law of thermodynamics applied to open systems, study flow system and their analysis. Applications to closed systems and flow processes. Analysis of unsteady processes. Limitations of first law of thermodynamics, PMM1.Thermodynamics properties of fluids.
Second law: Devices converting heat to work, Thermal reservoir, heat engines efficiency, Devices converting work to heat, heat pump, refrigerator, COP, Reversed heat engine, Kelvin Planck statements, Clausius statement, reversible& irreversible processes, Carnot cycle ,PMM2, Entropy , Availability , equilibrium Criterion , Maxwell Relations Thermodynamics relations , Clapeyron equation , Gibb's Phase rule.
Properties of steam & thermodynamic cycles: pure substance, properties of steam, Phase Diagram, Power &Refrigeration cycles, Psychometry. Adiabatic flame temperature, Equilibrium conversion, Statistical definition of entropy Kinetic theory of Ideal Gases.

Text Books& References:

1. Yunus A. Cengel , Michael A. Boles , 2014, 8th Edition, Thermodynamics: An Engineering Approach, McGraw-Hill Education.
2. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India

3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

Course Code: MEES201 **Breakup: 3 – 0 – 2 – 4**
Course Name: Basic Fluid Mechanics

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Understanding to State the Newton's law of viscosity and Explainthe mechanics of fluids at rest and in motion by observing the fluid phenomena
CO-2	Understanding to State the Newton's law of viscosity and Explainthe mechanics of fluids at rest and in motion by observing the fluid phenomena
CO-3	Applying to Derive Euler's Equation of motion and Deduce Bernoulli's equation.
CO-4	Applying and Analyzing to Compute force of buoyancy on a partially or fully submerged body and Analyzethe Examine energy losses in pipe transitions and sketch energy gradient lines.
CO-5	Understanding the basics of rate equations under steady and unsteady heat and mass transfer

Course Details:

UNIT – I: Fluid statics: Dimensions and units: physical properties of fluids- specific gravity, viscosity, and surface tension - vapour pressure and their influence on fluid motion- atmospheric, gauge and vacuum pressures – measurement of pressure- Piezometer, U-tube and differential manometers.
UNIT – II: Fluid kinematics: Stream line, path line and streak lines and stream tube, classification of flows steady & unsteady, uniform & non-uniform, laminar & turbulent, rotational & irrotational flows-equation of continuity for one dimensional flow and three-dimensional flows. Fluid dynamics: Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend.
UNIT – III: Boundary Layer Concepts: Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers (No derivation) boundary layer in transition, separation of boundary layer, submerged objects – drag and lift. Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line. Measurement of flow: Pitot tube, venturi meter, and orifice meter, Flow nozzle.

Text Book and References:

1. Agarwal, "Fluid Mechanics & Machinery", TMH, 2010.
2. Som, S.K. & Biswas,G. " Introduction to Fluid Mechanics & Machins "TMH, 2012.
3. Bansal R.K. "A Text Book Of Fluid Mechanics & Hydraulic Machines" Laxmi Publications (p) Ltd. 2019.
4. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.

Basic Fluid Mechanics Labs-

Minimum Eight experiments are to be conducted from the following:

1. To verify the momentum equation using the experimental set-up on impact of jet.
2. To determine the coefficient of discharge of an orifice of a given shape. Also to determine the coefficient of velocity and the coefficient of contraction of the orifice mouth piece.
3. To calibrate an orifice meter and study the variation of the co-efficient of discharge with the Reynolds number.
4. To calibrate a Venturimeter and study the variation of the co-efficient of discharge with the Reynolds number.
5. To calibrate a bend meter and study the variation of the co-efficient of discharge with the Reynolds number. .
6. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
7. To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
8. To study the variation of friction factor, _f' for turbulent flow in commercial pipes.
9. To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.
10. To determine Meta-centric height of a given ship model.
11. To determine the head loss for a sudden enlargement
12. To determine the head loss for a sudden Contraction

Course Code: MEES202 **Breakup: 3 – 0 – 2 – 4**
Course Name: Kinematics of Machine

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Identify link, pair, chain, joints and inversions of mechanisms.
CO-2	Construct the velocity and acceleration diagrams for different mechanisms
CO-3	Understand Cam profile generation and their applications
CO-4	Learn the concept of gear and gear train and various automotive transmissions.
CO-5	Understand balancing of different machines

Course Details:

Introduction: Links-Types, Kinematic Pairs-Classification, constraints-types, Degree of freedom of planar mechanism. Inversions of four bar chain, slider crank chain and double slider crank chain. Mechanism Diagram & inversion. Mobility & Range of Movements. Displacement, Velocity & Acceleration analysis of planar linkages. Dimensional synthesis for motion, Function& path generation. Dynamic force analysis, Cam profile Synthsis, flywheel, Inertia forces & Balancing for Rotating & Reciprocating Machines.

Text Book and References:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East West Pvt. Ltd, New Delhi, 1988.

Kinematics of Machine Lab-

1. Study of simple linkage models/mechanisms
2. Study of inversions of four bar linkage
3. Study of inversions of single/double slider crank mechanisms
4. Study of paucellier mechanism
5. Study of Hart Mechanism
6. Study of Grass-Hopper Mechaism
7. Study of Watt Mechanism
8. Study of Tchebicheff Mechanism

Course Code: MEES203 **Breakup: 3 – 0 – 2 – 4**
Course Name: MANUFACTURING SCIENCE

Course Assessment methods: Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory & Practical Examination.

Course Objectives: This course introduces manufacturing processes that are used in industry to manufacture products that are widely used in daily life. Students can compare the existing technologies used in casting, shaping, forming, and property enhancing, joining and assembly process.

Course outcomes (CO): The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO-1	Able to understand the fundamentals and analysis of Forging and rolling processes.
CO-2	Knowledge of wire drawing, extrusion, sheet metal working, and unconventional metal forming process.
CO-3	Know about principles, working and applications of various types of welding processes and their thermodynamic and metallurgical aspects.
CO-4	Able to understand pattern allowances, molding sand properties, elements of mold and various casting processes.
CO-5	Understand the mechanics of metal cutting, tool geometry, tool life and economics of metal cutting.
CO-6	Able to understand the concept of grinding wheel designation and various grinding process.

Course Details:

UNIT-I: Introduction:- Importance of manufacturing, economic & technological considerations in manufacturing, classification of manufacturing processes, materials & manufacturing processes for common items.

Metal forming processes:- Elastic & plastic deformation, Yield 's criteria. Hot & cold working. Analysis of forging process for slab and disc. Work required for forging. Hand, power & drop Forging. Analysis of Rolling Process. Analysis of Wire/strip drawing, Tube drawing, Extrusion and its application. Defects in metal forming processes.

Sheet metal working:- Presses and their classification Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, Blanking & piercing. Compound & progressive dies. Flat-face & Inclined-face punches and load calculation. Analysis of forming process like cup/deep drawing. Bending & spring-back.

Unconventional metal forming processes:- Unconventional metal forming or High Energy Rate Forming (HERF) processes — explosive forming, electromagnetic, electro-hydraulic forming.

UNIT-II Welding: - Survey of welding and allied processes. Gas welding and cutting, process and equipment. Arc welding: Power sources and consumables. TIG & MIG processes and their parameters. Resistance welding - spot, seam projection etc. Other welding processes — atomic hydrogen, submerged arc, electroslag, friction. Soldering & Brazing. Thermodynamic and Metallurgical aspects in welding. Shrinkage/residual stress in welds. Defects in welds and their remedies. Weld decay in Heat affected zone (HAZ).

UNIT-III Casting (Foundry):- Basic principle & survey of casting processes. Types of patterns and allowances. Types and properties of molding sand, sand testing. Design considerations for elements of mould— Gate, Riser, Runner & Core. Solidification of casting. Sand casting— defects, remedies. Cupola furnace. Other casting processes— Die Casting, Centrifugal casting, Investment casting, Continuous casting and CO2 casting etc.

UNIT-IV Metal Cutting:- Mechanics of metal cutting. Geometry of tool and nomenclature. ASA system. Orthogonal/ Oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces & power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Dynamometer. Economics of metal cutting.

Grinding: Grinding wheels, abrasives (bonds & cutting action). Grinding wheel specification. Wear of grinding wheel— dressing & truing, Surface, and cylindrical grinding. Center less grinding.

EXPERIMENTS

Minimum eight experiments are to be conducted from the following:

1. Design and Pattern making
2. Making a mould (with core) and casting.
3. Study & operation of hand & power forging.
4. Press work experiment such as blanking/piercing, washer, making etc.
5. Wire drawing/extrusion on soft material.
6. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine
7. Bolt (thread) making on Lathe machine
8. Gear cutting on milling machine
9. Machining a block on shaper machine
10. Study of different types of tools and its materials
11. Experiment on tool wear and tool life
12. Experiments on welding (Gas, Arc & resistance)
13. Experiment on unconventional machining.

Text & Reference Books

1. Manufacturing Science -Ghosh and Mallik (EWP)
2. Manufacturing Engineering & Technology- Kalpakjian (Pearson)
3. Materials and Manufacturing - Paul Degarmo. (TMH)
4. Manufacturing Technology – Foundry, Forming and Welding- P. N. Rao (TMH).
5. Manufacturing Technology: Metal Cutting & Machine Tools- P. N. Rao (TMH)
6. Advanced Machining Process - VK Jain (Allied Publisher)
7. Fundamentals of Metal Cutting & Machine Tools – Juneja & Shekhon (New Age International)
8. Manufacturing Processes Vol I – H. S. Shan (Pearson)
9. Fundamental of Modern Manufacturing – M. P. Groover (PHI)
10. Production Engineering Science - P.C. Pandey (Standard publisher)
11. Production Technology - R.K. Jain (Khanna publication)
12. Production Engineering – P. C. Sharma (S. Chand)
13. Workshop Technology Vol1-B. S. Raghubanshi (Dhanpat Rai and Sons)
14. Workshop Technology Vol-II-B. S. Raghubanshi (Dhanpat Rai and Sons)

Course Code: EVSS201 **Breakup: 2 – 0 – 0 – 2**
Course Name: Environmental Science

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the concepts and definitions associated with ecosystems, environmental pollution and its causes
CO2	Gain knowledge to analyse problems and suggest alternatives and new methods to manage natural resources
CO3	Understand how to Redesign, Recreate & Restore the ecosystems
CO4	Understand the legal aspects and the role of government in environment protection

Course Details:

UNIT-I

Scope and Importance of environmental studies, Need for public awareness, Segments of environment, biodiversities: Genetic diversity, Species diversity, Ecosystem diversity, Landscape diversity, Causes of pollution and detrimental effects.

UNIT-II

Eco systems- Types of systems, energy flow in an ecosystem, Balanced ecosystem, Human activities- Food, shelter, economic and social security, Effects of human activities on environment- Agriculture, housing, Industry, mining and transportation activities, Basics of Environmental Impact Assessment, Sustainable Development.

UNIT-III

Types of natural resources: Water resources-Availability and quality aspects, Water borne diseases, Fluoride problems in portable water, Mineral resources, Food resources, Land resources, Forest Wealth, Material cycles- Carbon, Nitrogen and Sulphur cycle.

UNIT-IV

Energy- Different types of energy (Renewable and Non-renewable), Convectional and non-conventional energy-sources Electromagnetic radiation, Hydro Electric, Fossil fuel based, Nuclear, Solar, Biomass and Bio-gas, Hydrogen as an alternative future source of energy

UNIT-V

Environmental pollution and their effects, Water pollution, Land pollution, Noise pollution, public Health aspects, Air pollution. Current environmental issues of importance and their impact on environment: Population Growth, Climate change and global warming effect, Urbanization, Automobile pollution, Acid rain, Ozone layer depletion.

UNIT-VI

Preventive measures and control of pollution, Air and Water pollution control, Sold waste management, Case studies.

UNIT-VII

Role of Government in environment protection, Legal Aspects, Initiatives and protection Acts, public awareness, Initiatives by Non-governmental Organizations (NGOs), Role of IT services, Disaster management.

UNIT-VIII

Field work/ Activities/ Visit

Text and References Books:

1. Environmental Studies- Benny Joseph, TATA Mcgaw Hill publication.
2. Environmental Studies- Dr. D.L. Manjunath, pearson Education.
3. Environmental Studies- R. Rajgopalan, Oxford publication.
4. Environmental Science and Technology- M. Anji Reddy, BS publication.
5. Principles of Environmental Science and Engineering- P. VenugopalanRao, Prentice Hall of India.
6. Environmental Science and Engineering- Meenakshi, Prentice Hall of India.

Course Code: SSTS201 **Breakup: 0 – 0 – 2 – 2**
Course Name: Summer Internship – I (or Mini project)

Course Details:

First-year students are required to undertake a four-week summer internship after completion of two semesters. This internship aims to provide practical experience in the application of engineering principles. Upon completion of the training, students must submit a formal report and their certificate of completion to the department, followed by a professional presentation summarizing their internship experience.

6-8 Weeks practical training in a reputed industry/organization is to be undertaken during summer after completing six semesters of study. The student will submit detailed report and give presentation on training.

Course Outcomes (CO): Upon successful completion of this seminar, students will be able to:

CO1	Articulate the objectives, activities, and outcomes of their internship experience
CO2	Analyze the relevance of their internship work to their academic curriculum and future career goals
CO3	CO3 Develop and deliver a clear, concise, and professional presentation summarizing their internship
CO4	Engage in constructive self-reflection and peer feedback regarding practical industry exposure
CO5	Identify key learning

The seminar will typically involve:

- Pre-Seminar Preparation: Students will prepare a detailed report and a presentation.
- Oral Presentation: Each student will deliver a presentation to their peers and faculty.
- Question & Answer Session: A dedicated time for questions and discussion following each presentation.
- Feedback: Constructive feedback will be provided by faculty and peers.
- Internship Seminar Topics / Content Guidelines

The seminar presentation should cover the following aspects of the internship:

- Introduction to the Organization:
- Internship Details:
- Project/Work Undertaken:
- Problem Statement/Objective
- Methodology/Approach
- Activities Performed
- Challenges Faced & Solutions
- Results/Outcomes
- Learning Outcomes & Impact:
  - Technical Skills Gained/Enhanced
  - Soft Skills Developed
  - Application of Classroom Knowledge
  - Insights into Industry
  - Career Relevance
- Conclusion & Recommendations

Presentation Guidelines

- 8-10 minutes presentation + 2-3 minutes Q&A.

Course Code: ESCS203 **Breakup: 3 – 0 – 2 – 4**
Course Name: Introduction to Machine Learning

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand core ML concepts and implement regression models
CO2	Apply logistic regression and evaluate classification models.
CO3	Explain neural networks and build basic deep learning models.
CO4	Use unsupervised learning and dimensionality reduction techniques
CO5	Execute the ML pipeline with model tuning and deployment basics
CO6	Develop ML models using Python tools with ethical awareness

Course Details:

UNIT I: Introduction to Machine Learning and Supervised Learning

Definition and types of machine learning, applications in engineering, components of ML systems, data characteristics, training and testing concepts, linear regression with single and multiple variables, cost function, gradient descent, normal equation, feature scaling, polynomial regression, underfitting and overfitting, introduction to ML tools.

UNIT II: Classification and Logistic Regression

Classification vs regression, logistic regression, sigmoid function, decision boundaries, cost function, regularization, multiclass classification, model evaluation using confusion matrix, ROC curve, precision, recall, and F1-score.

UNIT III: Neural Networks and Deep Learning

Artificial neurons, neural network architecture, activation functions, forward and backpropagation (conceptual), loss functions, introduction to deep learning, implementation basics using Keras and TensorFlow, ethical concerns.

UNIT IV: Unsupervised Learning and Dimensionality Reduction

Unsupervised learning concepts, k-means clustering, number of clusters, hierarchical clustering, PCA for dimensionality reduction, visualization of data, anomaly detection, association rule learning (introductory).

UNIT V: ML Workflow and Model Optimization

ML workflow stages, EDA, feature engineering, train-validation-test splits, cross-validation, model selection, bias-variance tradeoff, hyperparameter tuning, introduction to ensemble methods, basics of deployment and MLOps.

UNIT VI: Python Tools for Machine Learning

Introduction to Python using Google Colab, basic use of NumPy, Pandas, Matplotlib, Scikit-learn, implementation of regression and classification models, model evaluation, working on a real-world mini project, ethical considerations.

Text and Reference Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media.
3. Tom M. Mitchell, Machine Learning, McGraw-Hill Education.
4. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.
5. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning, Springer.

Course Code: MEES204 **Breakup: 1 – 0 – 2 – 2**
Course Name: Mechanical Design & Drawing

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	The Fundamentals of engineering drawing and represent various pictorial views to Orthographic views.
CO-2	Gain knowledge Working drawings Machine elements
CO-3	Gain knowledge on Keys and cotter joints Riveted joints Couplings
CO-4	Assembly drawings-Engine parts : Stuffing box Assembly drawings : Connecting rod and eccentric
CO-5	Assembly drawings: Screw Assembly drawings: Machine vice and tailstock Assembly drawings Rams-bottom Safety Valve, feed check valve

Course Details:

Review of engineering graphics, IS&ISO codes, Free hand sketching of Part Drawing & Dimensioning. Fits & Tolerances, Surface Finish, Design of Simple machine elements; (Threaded fasteners, locking arrangements, Guides) of some assemblies. Design of joints; riveted, welded & cotter. Design of keys. Shaft and Couplings Assembly drawing & part list. Computer aided drafting of machine components. Valves etc. A drawing Project on reverse engineering.

Text Books and References:

1. Lakshminarayanan ,v. &Mathur ,M.L., 2016 ," A Text Book of Machine Drawing". Jain Brothers, N. Delhi.
2. Siddheswar ,N. ,Kannaiah, P.&Sastry V.V.S. " Machine Drawing", 2017; TMH,N.Delhi.
3. Bhandari, V.B. "Design of Machine Elements, 4th edition 2017; TMH.N.Delhi.
4. Shigley&Mische,"Mechanical Engg. Design", 2002; McGraw Hill.

Mechanical Design & Drawing Lab-

1 Drawing sheet (1 sheet)-Introduction:Scales, Type of lines, section line, dimensioning.
2 Drawing sheet-(1 sheet)-Orthographic projection in first & third angle of machine elements
3 Drawing sheet-(2 sheet)- Screwed fasteners
4 Drawing sheet-(1 sheet)- Keys & cotters and pin joints
5 Drawing sheet-(1 sheet)- Shaft couplings
6 Drawing sheet-(1 sheet)- Riveted joints
7 Drawing sheet-(3 sheet)- Assembly drawing

Course Code: MEES205 **Breakup: 3 – 0 – 0 – 3**
Course Name: Basic Solid Mechanics

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Analyze the behavior of the solid bodies subjected to various types of loading
CO-2	Apply knowledge of materials and structural elements to the analysis of simple structures
CO-3	Compute the slope & deflection, bending stresses and shear stresses on a beam.
CO-4	Calculate torsional shear stress in shaft and buckling on the column
CO-5	Apply the concept of principal stresses and theories of failure to determine stresses on a 2-D element.
CO-6	Utilize the concepts of SFD & BMD, torsion and principal stresses to solve combined loading application based problems.

Course Details:

Introduction: Stresses & strains, elastic constants, **Compound Stress & Strains:** Introduction, State of plane stress, principal stress and strain, Mohr's circle, Modelling of supports & equilibrium of forces / moments, Principles of mechanics , Axially loaded members & pressure vessels , Force

analysis of slender members (BMD & SFD) . Stress at a point. Mohr circle, Strain at a point. 1-D material behavior, Equationsm of elasticity, Torsion of shafts & tubes. Bending of beams with symmetric cross – section, Combined stresses, Yield criterion. Deflections in bending. Deflection of indeterminate systems by energy methods Concept of elastic instability. Thin cylinder & spheres, Thick Cyllinder, Helical & leaf spring, columns& struts.

Text Books and Reference:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Course Code: MEES206 **Breakup: 3 – 0 – 2 – 4**
Course Name: Material Science and Engineering

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Know the structure crystalline solid, crystal imperfections and defects
CO-2	Understand the phase diagrams and comprehend the phase transformations in of materials
CO-3	Understand the process of heat treatment
CO-4	Understand the electrical, magnetic and optical properties of important materials
CO-5	Appreciate the properties of rubber, plastic, ceramic and other important materials for different engineering applications

Course Details:

Structuring of crystelline solids , liquids and glass, imperfectionsin crystals , multiphase structures , phase change , mechanical behaviour , tensile properties , plastic properties , creep , fracture electric and magnetic properties , magnetic materials for applications , heat treatment process , effect of alloying elements on the properties of cabon steel , general properties, composition and uses of alloys of alluminium copper , nickel and bearing materials ., Chemical properties—Corrosion and oxidation , cutting tool and die materials , spring alloys , introduction to rubber , plastic , ceramic and refractory materials , Smart materials

Text Book and References:

1. W. D. Callister, 2006, Materials Science and Engineering-An Introduction, 6th Edition, Wiley India.
2. V. Raghavan, Material Science and Engineering, Prentice Hall of India Private Limited, 1999.
3. U. C. Jindal, Engineering Materials and Metallurgy, Pearson, 2011.
4. Kenneth G. Budinski and Michael K. Budinski, Engineering Materials, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002

Materials and Mechanical Metallurgy Lab

Course Details:

1. Strength testing of a given mild-steel specimen on UTM.
2. Impact testing on impact testing machine like Charpy, Izod.
3. Hardness testing of a given specimen using Rockwell &Vicker's/Brinell testing.
4. To the study of Microstructure of Low, Medium & High carbon steels.
5. To the study of Microstructure Cast Irons. (Grey cast Iron & White cast Iron).
6. Torsion test on mild steel rods
7. Hardness tests (Brinell and Rockwell tests)
8. To study the behaviour of given specimen subjected to pure bending and to determine the Young"s modulus of elasticity and modulus of rupture (bending).
9. Fatigue testing on fatigue testing machine.
10. Creep testing on creep testing machine
11. Deflection of beam experiment
12. Torsion testing of a rod on torsion testing machine
13. To determine the compression test and determine the ultimate compressive strength for a specimen

Course Code: MEES207 **Breakup: 3 – 0 – 2 – 4**
Course Name: Dynamics of Machines

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Identify the problems associated with unbalance in machines.
CO-2	Realize the requirement of frictional devices
CO-3	Identify the type of governors most suited for various applications.
CO-4	Understand the challenges posed by vibration

Course Details:

UNIT-I

Static & Dynamic Force Analysis

Static equilibrium of two/three force members, Static equilibrium of member with two forces and torque, Static force analysis of linkages, D'Alembert's principle, Equivalent offset inertia force, Dynamic force analysis of four link mechanism and slider crank mechanism, Dynamically equivalent system

Turning Moment & Flywheel

Engine force analysis-Piston and crank effort, Turning moment on crankshaft, Turning moment diagrams-single cylinder double acting steam engine, four stroke IC engine and multi-cylinder steam engine, Fluctuation of energy, Flywheel and its design

UNIT-II

Governors

Terminology, Centrifugal governors-Watt governor, Dead weight governors-Porter &Proell governor, Spring controlled governor-Hartnell governor, Sensitivity, Stability,

Hunting, Isochronism, Effort and Power of governor

Gyroscopic Motion

Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes & automobiles

UNIT-III

Balancing of Machines

Static and dynamic balancing, Balancing of several masses rotating in the same plane and different planes, Balancing of primary and secondary forces in reciprocating engine, Partial balancing of two cylinder locomotives, Variation of tractive force, swaying couple, hammer blow, Balancing of two cylinder in-line engines

UNIT-IV

Friction

Laws of friction, Efficiency on inclined plane, Screw friction, Screw jack, Efficiency, Friction in journal bearing-friction circle, Pivots and collar friction-Flat and conical pivot bearing, Flat collar bearing

Clutches, Bakes & Dynamometers

Single and multiple disc friction clutches, Cone clutch, Brakes-types, Single and double shoe brake, Simple and differential Band brake, Band and Block brake, Absorption and transmission dynamometers, Prony brake and rope brake dynamometers

Text Books and Reference:

1. Theory of Machines, 3rd edition 2009, Thomas Bevan; CBS Publication.
2. Theory of Machines and Mechanisms, 3rd edition 2017, Shigley; Oxford University Press-New Delhi.
3. Theory of Machines and Mechanisms, 2nd edition 1988, Ghosh & Mallik; East West Press.
4. Mechanism and Machine Theory, 2nd edition 2007, J. S. Rao & Dukkipati; New Age International Publication.
5. Theory of Machines, 4th edition 2017, S.S. Rattan; McGraw Hill.
6. Theory of Machines – R.K. Bansal (Laxmi)
7. Schaum's Outlines Series of "Mechanical Vibration", 1996, S. Kelly; McGraw Hill

EXPERIMENTS-

Minimum Eight experiments are to be conducted from the following

1. Experiments on simple and dead weight governor
2. Experiment on spring controlled governor
3. Experiment on gyroscope
4. Experiment on critical speed of shaft
5. Experiment on longitudinal vibration
6. Experiment on transverse vibration
7. Experiment on static/dynamic balancing
8. Experiment on Gear trains
9. Experiment on Gears tooth profile, interference etc.
10. Study of simple linkage models/mechanisms

11. Study of inversions of four bar linkage
12. Study of inversions of single/double slider crank mechanisms
13. Experiment on Brake
14. Experiment on clutches/dynamometers

Course Code: MEES208 **Breakup: 3 – 0 – 2 – 4**
Course Name: Material removal manufacturing Process

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Understand the concept of state of stress, strain, and significance of compatibility conditions.
CO-2	Understand The concept of energy methods for solving problems.
CO-3	Understand the theory of bending of curved bars for solving problems.
CO-4	Learn the underlying theory of unsymmetrical bending and concept of shear centre

Course Details:

Unit I-

Metal Cutting: Mechanics of metal cutting. Geometry of tool and nomenclature.ASA system orthogonal vs. oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces, power required for turning, milling and drilling. Cutting fluids/lubricants.Tool materials. Tool wear and tool life. Machinability. Force measurement. Economics of metal cutting.

Grinding & super finishing

(i) Grinding: Grinding wheels, abrasive & bonds, cutting action. Grinding wheel specification. Grinding wheel wear - attritions wear, fracture wear. Dressing and Truing. Max chip thickness and grinding criteria. Surface and cylindrical grinding. Centerless grinding.

(ii) Super finishing: Honing, lapping, and polishing.

Unit II-

Machine Tools: (i) Lathe: Principle, construction, types, operations, Turret / capstan, semi / Automatic, Tool layout; (ii) Shaper, slotter, planer: Construction, operations & drives; (iii) Milling: Construction, Milling cutters, up & down milling. Dividing head & indexing. Various types of milling cutters; (iv) Drilling and boring: Drilling, boring, reaming tools. Geometry of twist drills.

Unit III-

Limitations of conventional manufacturing process and need of unconventional Manufacturing processes. Mechanical processes such as Ultrasonic machining, Abrasive Jet Machining: Principle, Application, Advantages and disadvantages, Variables in AJM, Water Jet Machining- Jet Cutting equipment, Principle, advantages, Practical Application;

Unit IV-

Electro Discharge Machining: mechanism of material removal ,EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish, Tool Material, Dielectric fluid, Application limitation, Laser Beam Machining: Lasing process and principle, population inversion, Principle of Ruby laser, Nd: YAG Laser and CO2 Laser, Power control of laser output, Application and Electron Beam Machining: Basic principle, Controlling parameters and focal distance, Application. Plasma Arc Machining: generation of Plasma, Equipment's.

Text & Reference Books:

1. Modern machining processes, 2017, P.C. Pandey and H.S.Shan; McGraw hill.
2. Nontraditional Manufacturing Processes", 2019, G.F. Benedict, CRC Press.
3. Nontraditional and Hybrid Machining Processes, 2005, H. Abdel and G. El-Hofy; McGraw-Hill Professional.

Material removal manufacturing Process Lab

Any 8 experiments out of the following:

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe Machine.
2. Taper turning operation on lathe.
3. Bolt (thread) making on Lathe machine.
4. Tool grinding (to provide tool angles) on tool- grinder machine.
5. Gear cutting on Milling machine.
6. Machining a block on shaper machine.
7. Finishing of a surface on surface- grinding machine.
8. Drilling holes on drilling machine and study of twist-drill.
9. Study of different types of tools and its angles & materials.
10. Experiment on tool wear and tool life.
11. Gas welding of a lap joint.
12. Arc welding of a lap/butt joint.
13. Resistance spot welding of two thin metallic sheets.
14. Experiment on Electro discharge machining.

Course Code: HSSS201 **Breakup: 1 – 0 – 2 – 3**
Course Name: Communication Practicum

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the nuances of English language for enhancing presentation skills
CO2	Speak in standard English with clarity and fluency and to write business messages professionally
CO3	Speak and communicate clearly in different professional contexts which would improve their chances of employability
CO4	Understand the importance of ethical practices in their professional life

Course Details:

Unit 1- Presentation techniques Meaning and importance of presentation technique Presentation skills required for business organization: Negotiation, Persuasion & Time management Types of business presentations- meetings, seminars, conferences

Unit 2- Oral presentations Effective oral delivery- Phonetics Interviews, Group discussions, debates, speeches Listening skills, Reading skills

Unit 3- Written communication Style and tone of writing business messages and documents Persuasive, sales and goodwill messages, delivering bad news Writing e-mails and short messages, Resume writing

Unit 4 – Non Verbal communication Nonverbal communication techniques Business manners, ethics and personality development Power point presentations

Text and Reference Books:

1. Bove`e, Thill and Schatzman, Business Communication Today, Pearson Education (Singapore), (2003)
2. H. Dan O'Hair, James S. O'Rourke and Mary John O'Hair, Business Communication-a framework of success", South Western College Publishing, (2001)
3. Raymond V. Lesikar, Marie E. Flatley, Basic Business Communication, Tata McGraw Hill Publishing Company Ltd., (2002)

Course Code: UHVS201 **Breakup: 3 – 0 – 0 – 3**
Course Name: Universal Human Values - II

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.
CO2	Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.
CO3	Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society.
CO4	Understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.
CO5	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

Course Details:

UNIT I: Course Introduction Need, Basic Guidelines, Content and Process for Value Education Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness

and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II: Understanding Harmony in the Human Being Harmony in Myself Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

UNIT III: Understanding Harmony in the Family and Society Harmony in Human-Human Relationship Understanding harmony in the Family- the basic unit of human interaction , Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals, Visualizing a universal harmonious order in societyUndivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family!.

UNIT IV: Understanding Harmony in the Nature and Existence Whole existence as Co-existence Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

UNIT V: Implications of the above Holistic Understanding of Harmony on Professional Ethics Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers, b) At the level of society: as mutually enriching institutions and organizations.

Text and Reference Books:

1. R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics – Teachers Manual, 2nd Revised Edition, Excel Books, New Delhi, 2019
3. http://www.uhv.org.in/) containing: Video of Faculty Development Program (Teachers' Orientation Programme), Presentation (PPTs) material for use in lectures and practice sessions Audio-visual material for use in the practice sessions
4. A Nagaraj, 1999, Jïvana Vidyã Ek Parichaya, Jïvana Vidyã Prakãsåna, Amarkantak.
5. A Nagaraj, 1999, Vyavahãrvãdï. Samãjashãstra, Jïvana Vidyã Prakãsåna, Amarkantak.
6. A Nagaraj, 2001, Ãvartansïla Arthasãstra, Jïvana Vidyã Prakãsåna, Amarkantak.
7. A Nagaraj, 2003, Mãnava Vyavahãra Darsåna, Jïvana Vidyã Prakãsåna, Amarkantak.
8. A Nagaraj, 1998, Samãdhãnãtmak Bhoutikvãd, Jïvana Vidyã Prakãsåna, Amarkantak.
9. A N Tripathy, 2003, Human Values, New Age International Publishers.

10. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Class notes Co., Lucknow. Reprinted 2008.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. D H Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
13. E F Schumacher, 1973, Small is Beautiful: A Study of Economics as if People Mattered, Blond and Briggs, Britain.
14. E G Seebauer and Robert L. Berry, 2000, Fundamentals of Ethics for Scientists and Engineers, Oxford University Press.
15. FAO, 2011, Global Food Losses and Food Waste – Extent, Causes and Prevention, ISBN 978-92-5-107205-9, Rome.
16. M Fukuoka, 1984, The One-straw Revolution: An Introduction to Natural Farming, Published (in India) by Friends Rural Centre, Rasulia.
17. Illich, 1974, Energy and Equity, The Trinity Press, Worcester, and Harper Collins, USA.
18. King Jigme Khesar of Bhutan, 2010, Royal Address at the Kolkata University Convocation, Kolkata (October 5, 2010).
19. M Govindrajran, S Natrajan and V S Senthil Kumar, 2004, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
20. M K Gandhi, 1939, Hind Swaraj, Navjivan Publishing House, Ahmedabad.
21. P L Dhar, R R Gaur, 1990, Science and Humanism, Commonwealth Publishers.
22. S Palekar, 2000, How to Practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
23. S George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991.

Relevant Websites, CDs and Documentaries

1. Universal Human Values website, http://www.uhv.org.in/
2. AKTU Value Education website, http://aktu.uhv.org.in/
3. Story of Stuff website, http://www.storyofstuff.com/
4. Al Gore, An Inconvenient Truth, 2006, Paramount Classics, USA
5. Charlie Chaplin, Modern Times, United Artists, USA
6. IIT Delhi, Modern Technology – The Untold Story
7. Anand Gandhi, Right Here Right Now, 2003, Cyclewala Production

(Detailed Syllabus - 3rd Year)

Course Code: MEES301 **Breakup: 3 – 0 – 2 – 4**
Course Name: Heat Transfer & Mass Transfer

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Understand the concepts of Basic Heat Transfer mechanisms and their applications
CO-2	Understand and Solve heat transfer by conduction in solids for steady state and transient conditions.
CO-3	Understand the effect of thermal conductivity on heat transfer mechanisms
CO-4	Explain and solve heat transfer by forced and natural convection
CO-5	Discuss and solve heat transfer problems of convection using dimensional analysis
CO-6	Analyze the performance of heat exchange equipment's.

Course Details:

UNIT-I

Introduction to Heat Transfer

Concepts of the mechanisms of heat flows; Conduction, convection and radiation; Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism

Conduction

One-dimensional general differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems; Initial and boundary conditions.

Steady State one-dimensional Heat conduction

Composite Systems in rectangular, cylindrical and spherical coordinates without energy generation; Thermal resistance concept; Analogy between heat and electricity flow; Thermal contact resistance;

Critical thickness of insulation. Concept of overall heat transfer coefficients.

UNIT-II

Fins Heat transfer from extended surfaces, Fins of uniform cross-sectional area; Errors of measurement of temperature in thermometer wells

Natural Convection

Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates and cylinders, and sphere; Combined free and forced convection.

UNIT-III

Forced Convection

Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Empirical heat transfer relations; Flow inside ducts; Relation between fluid friction and heat transfer.

Condensation and Boiling

Introduction to condensation phenomena; Heat transfer relations for laminar film, condensation on vertical surfaces and on outside & inside of a horizontal tube, Heat pipes; Boiling modes, pool boiling

Heat Exchanger

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

UNIT-IV

Thermal Radiation

Basic radiation concepts; Radiation properties of surfaces; Black body radiation Planck's law, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; Gray body; Shape factor; Black- body radiation; Radiation exchange between diffuse non black bodies in an enclosure; Radiation shields; Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation

Unit V:

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

Mass Transfer-Rate Equations, Mass Diffusion in Binary Mixtures, Evaporation in a Column, Forced Convective Mass Transfer, Heat and Mass Transfer Analogies.

Text Books and Reference:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J. P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F. P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. P.K. Nag, Heat & Mass Transfer, 2018.
5. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002

Heat Transfer Lab

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following

1. Conduction: Composite wall experiment
2. Conduction: Composite cylinder experiment
3. Convection: Pool Boiling experiment
4. Convection: Experiment on heat transfer from tube-natural convection
5. Convection: Heat pipe experiment
6. Convection: Heat transfer through fin natural convection
7. Convection: Heat transfer through tube/fin-forced convection
8. Any experiment on Stefan's Law on radiation determination of emissivity etc.
9. Any experiment on solar collector etc.
10. Heat exchanger-Parallel flow experiment
11. Heat exchanger-counter flow experiment

Course Code: MEES302 **Breakup: 3 – 0 – 2 – 4**
Course Name: Fluid Machinery System

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Analyze the principles of jet propulsion and impact forces.
CO-2	Evaluate the performance and design of impulse and reaction turbines.
CO-3	Apply dimensional analysis and similarity principles to fluid machinery.
CO-4	Describe the operation and characteristics of centrifugal and reciprocating pumps.
CO-5	Explain the function and application of various hydraulic systems.

Course Details:

Unit I: Impact of Free Jets: Impulse–Momentum Principle, Jet Impingement- on a Stationary Flat Plate, Inclined Plate and a Hinged Plate, at the Center of a Stationary Vane, on a Moving Flat Plate, Inclined Plate, A Moving Vane and a Series of Vanes, Jet Striking Tangentially at the tip of a Stationary Vane and Moving Vane (s), Jet Propulsion of Ships. Problems.
Unit II: Impulse Turbines: Classification–Impulse and Reaction Turbines, Water Wheels, Component Parts, Construction, Operation and Governing Mechanism of a Pelton Wheel, Work Done, Effective Head, Available Head and Efficiency of a Pelton Wheel, Design Aspects, Speed Ratio, Flow Ratio, Jet Ratio, Number of Jets, Number of Buckets and Working Proportions, Performance Characteristics, Governing of Impulse Turbines. Problems
Unit III: Francis Turbines: Component Parts, Construction and Operation of a Francis Turbine, Governing Mechanism, Work Done by the Turbine Runner, Working Proportions and Design Parameters, Slow, Medium and Fast Runners, Degree of Reaction, Inward/Outward Flow Reaction Turbines, Performance Characteristics, Problems.
Unit IV: Propeller and Kaplan Turbines: Component Parts, Construction and Operation of a Propeller, Kaplan Turbine, Differences Between the Francis and Kaplan Turbines, Draft Tube-Its Function and Different Forms, Performance Characteristics, Governing of Reaction Turbine, Introduction to New Types of Turbine, Deriaz (Diagonal), Bulb, Tubular Turbines, Problems.
Unit V: Dimensional Analysis and Model Similitude: Dimensional Homogeneity, Rayleigh's Method and Buckingham's Π-Theorem, Model Studies And Similitude, Dimensionless Numbers and their Significance. Unit Quantities, Specific Speed and Model Relationships for Turbines, Scale Effect, Cavitations–Its Causes, Harmful Effects and Prevention, Thomas Cavitation Factor, Permissible Installation Height, Problems.
Unit VI: Centrifugal Pumps: Classification, Velocity Vector Diagrams and Work Done, Manometric Efficiency, Vane Shape, Head Capacity Relationship and Pump Losses, Pressure Rise in Impeller, Minimum Starting Speed, Design Considerations, Multi-Stage Pumps. Similarity Relations and Specific Speed, Net Positive Suction Head, Cavitation and Maximum Suction Lift, Performance Characteristics. Brief Introduction to Axial Flow, Mixed Flow and Submersible Pumps, Problems.
Unit VII: Reciprocating Pumps: Construction and Operational Details, Discharge Coefficient, Volumetric Efficiency and Slip, Work and Power Input, Effect of Acceleration and Frictionon Indicator Diagram (Pressure– Stroke Length Plot), Separation, Air Vessels and their Utility, Rate of Flow into or From the Air Vessel, Maximum Speed of the Rotating Crank, Characteristic Curves, Centrifugal Vs Reciprocating Pumps, Brief Introduction to Screw, Gear, Vane and Radial Piston Pumps, Problems.
Unit VIII: Hydraulic Systems: Function, Construction and Operation of Hydraulic Accumulator, Hydraulic Intensifier, Hydraulic Crane, Hydraulic Lift and Hydraulic Press, Fluid Coupling and Torque Converter, Hydraulic Ram, Problems.

Text Books:

1. Som S.K. And Biswas, G-Introduction To Fluid Mechanics And Fluid Machines, Tata Mcgraw-Hill, New Delhi.
2. Agrawal S.K.-Fluid Mechanics and Machinery, Tata Mcgraw-Hill, New Delhi.
3. Kumar, D.S.-Fluid Mechanics and Fluid Power Engineering, Kataria & Sons Publishers, New Delhi.
4. Bansal R.K.-Fluid Mechanics and Hydraulic Machines, Laxmi Publications (P) Ltd., NewDelhi. 5. Ramamrutham S., Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi.

FLUID MACHINES LAB The Following Practical Exercises are to be carried out:

1. Performance Characteristic Tests on Pelton Wheel (Load Test & Best Speed)
2. Performance Characteristic Tests on Francis Turbine (Load Test & Best Gate Opening). 3. Performance Characteristic Tests on Kaplan Turbine (Load Test & Best Gate, Vane Angle Opening).
4. Performance Characteristic Tests on Single Stage, Multi Stage Centrifugal Pumps at Constant Speed & at Variable Speed. Actual & Predicted Curves.
5. Performance Characteristic Tests on Self-Priming Pump, Jet Pump, Airlift Pump And Deep Well Pump.
6. Performance Characteristic Tests on Axial Flow Pump.
7. Performance Characteristic Tests on Hydraulic Ram.
8. Vibration Measurement and Computer Aided Fault Diagnosis of a Centrifugal/ Self-Priming /Gear/Reciprocating Pump.
9. Performance Characteristic Tests on Reciprocating Pump at Constant Speed and at Variable Speed.
10. Performance Characteristic Tests on Gear Pump.
11. Performance Characteristic Tests on Screw Pump.

Course Code: MEES303 **Breakup: 3 – 0 – 0 – 3**
Course Name: Energy Conversion System

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Apply thermodynamics cycles for steam power plant
CO-2	Apply thermodynamics cycles for steam engine
CO-3	Evaluate the performance of steam turbines
CO-4	Apply thermodynamics cycles for gas power plant and Evaluate the performance of gas turbines
CO-5	Understand functions of the components of nuclear power plant.

Course Details:

Unit-I

Steam power plant: Rankine cycle, General layout of steam power plant, Power plant

boilers. Types of boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizes and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds

Unit –II

Steam Turbines and Steam engine

Working & classification of Steam engine, Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine.

Unit –III

Gas turbine power plant: Brayton cycle Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant

Unit –IV

Nuclear power plant: Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants.

Text Books and References:

1. Thermodynamics and Energy Systems Analysis, 2012, Borel and Favrat; CRC Press.
2. Gas turbine Theory & Practice, 1996, Cohen & Rogers; Addison Wesley Long man.
3. Basic and Applied Thermodynamics, 2nd edition 2017, P.K. Nag; McGraw hill.
4. Power Plant Engineering, 4th edition 2017, P K Nag; McGraw hill.
5. Applied Thermodynamics for Engineering Technologists, 5th edition 1993; Eastop&McConkey.

Course Code: MEES304 **Breakup: 3 – 0 – 2 – 4**
Course Name: Measurements & Metrology

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	To apply Principles of Linear and Angular Measurement
CO-2	To analyze Instrument Performance and Data
CO-3	To Select and Use Transducers for Specific Applications
CO-4	To Measure Pressure, Flow, and Temperature Accurately
CO-5	To Determine Speed, Force, and Torque

Course Details:

UNIT-I

Introduction to measurement and measuring instruments, Generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration, concept of error, sources of error, statistical analysis of errors.

Sensors and Transducers- Types of sensors, types of transducers and their characteristics

Signal transmission and processing, Devices and systems, Signal Display & Recording Devices

UNIT-II

Time related measurements- Counters, stroboscope, frequency measurement by direct comparison, Measurement of displacement, Measurement of pressure, Gravitational, directing acting, elastic and indirect type pressure transducers, Strain measurement, Types of strain gauges and their working, strain gauge circuits, temperature compensation, Measurements of force and torque, Different types of load cells, elastic transducers, pneumatic& hydraulic systems, Temperature measurement Thermometers, bimetallic thermocouples, thermistors and pyrometers

UNIT-III

Standards of linear measurement, line and end standards. Limits, fits and tolerances. Interchangeability and standardization, Linear and angular measurements devices and systems Comparators: Sigma, Johansson‘s Microkrator, Limit gauges classification, Taylor‘s Principle of Gauge Design

UNIT-IV

Metrology-II

Measurement of geometric forms like straightness, flatness, roundness, Tool makers microscope, profile project autocollimator, Principle and use of interferometry, optical flat, Measurement of screw threads and gears, Surface texture: quantitative evaluation of surface roughness and its measurement. Measurement and Inspection, Dimensional inspection–Tolerance, Limit gauging, comparators, Surface roughness, Feature inspection

Text Books and References:

1. Mechanical Measurement, published 2012, Jain, R.K ; Khanna Publishers.
2. Mechanical Measurements and Control, 1979, Kumar D.S.; Metropolitan book company, Pvt. Ltd., N. Delhi.
3. Engineering Metrology - Hume K.J. (MacDonald and Co. 1963)
5. Engineering Metrology- Gupta, I.C. (DhanpatRai& Sons, New Delhi, 1994)
7. Measurement Systems, Application Design, 5th edition 2004, Doeblein E.O; McGraw Hill.

Metrology & Measurement lab

Minimum 8 out of following:

1. Study & working of simple measuring instruments-Vernier calipers, micrometer, tachometer.
2. Measurement of effective diameter of a screw thread using 3 wire methods.
3. Measurement of angle using sine-bar & slip gauges, Study of limit gauges.
4. Study & angular measurement using level protector.
5. Adjustment of spark plug gap using feeler gauges.
6. Study of dial indicator & its constructional details.
7. Use of dial indicator to check a shape run use.

8. Study and understanding of limits, fits & Tolerances.
9. Study of Pressure & Temperature measuring equipment.
10. Strain gauge measurement.
11. Speed measurement using stroboscope.

Course Code: MEES305 **Breakup: 3 – 0 – 0 – 3**
Course Name: Machine Design

Course outcome (CO): At the end of the course, the will be able to:

CO-1	To Select Materials and Understand Design Considerations
CO-2	To Design Components for Static and Dynamic Loads
CO-3	To Analyze and Design Joints and Power Transmission Elements
CO-4	To Design Springs and Power Screws.
CO-5	To Design Gears and Gearboxes

Course Details:

UNIT-I

Introduction: Definition, Methods, standards in design, considerations in design. **Selection of materials:** Importance, Classification of Engineering Materials, different kind of steels & cast irons, steel designation, Materials for components subjected to creep, static and fatigue loads, Importance of ceramics, plastics & rubbers for Engineering applications, ASTM testing methods.

UNIT-II

Design for static load: Modes of failure, Factor of safety, stress-strain relationship, principal stresses, theories of failure. **Design for dynamic loads:** types, effect w.r.t. static loads, stress concentration, Fluctuating / alternating stresses, fatigue failure, endurance limit, design for finite & infinite life, Soderberg & Goodman criteria, design for fatigue, creep and fracture, design for contact stresses and residual stresses

UNIT-III

Joints**:** Riveted joints, failure of rivets, welded joint, screwed joints, eccentric loading of above joints, and design for fatigue loading, Shaft, keys & coupling: Design against static and fatigue loads, strength & rigidity design, Selection of square & flat keys & splines, rigid & flexible couplings.

UNIT-IV

Mechanical springs: Design of Helical and leaf springs, against static & fatigue loading. **Design analysis of Power Screws:** Form of threads, square threads, trapezoidal threads, stresses in screw, design of screw jack.

UNIT-V

Design of Gears: Design of Spur, Helical, Bevel and Worm Gears, Design of Gear Box, Layout Diagram, Speed Diagram, Fixing Number of Teeth And Module Of Gears.

Text Books and Reference:

1. V. B. Bhandari, Design of Machine Elements, TMH. 2020
2. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
3. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
4. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
5. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
6. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Course Code: HSSS302 **Breakup: 3 – 0 – 0 – 3**
Course Name: Industrial Management

Course outcomes (CO): At the end of the course, the student will be able to:

CO1	Understand the concepts related to business and demonstrate the roles, skills and functions of management
CO2	Understand how the industrial company can be organized and managed
CO3	Understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities
CO4	Express leadership and entrepreneurial attributes through various case studies

Course Details:

Introduction to Industrial management, Brief history of industries in India, Brief definition of management, organization and administration. Characteristics of management, Principle of management, Function of management like, planning, organization, direction, co-ordination etc.

Level of management, skills of management, inter relation between skills and levels of management, scientific management, Introduction to Schools of Management thoughts, introduction to organization, study of basic type of organization for ex. Line and staff organization, project organization, metrics organization, Informal organization, Introduction to industrial Psychology, Motivation theory and study of Maxlow, Need, Hierarchy Theory, Planned Location, Planned Layout. Study of different forms of layout like line layout, process layout, product layout, combinational layout, sixth position layout etc.

Objective of planned layout, introduction to material management, scope of material management, study of inventory control method, introduction to different types of inventory control techniques, introduction to work study, motion study etc, introduction to conflict management.

Text Book and References:

1. Industrial Engineering , 2007, Khanna O.P; DhanpatRai&Co.

2. Industrial Engineering and Management, 2017, S. C. Shrma and T.R. Banga; Khanna Book Publishing Co. (P) Ltd.
3. Industrial Management, 2018, M. Mahajan; DhanpatRai& Co.

Course Code: SSTS301 **Breakup: 0 – 0 – 4 – 2**
Course Name: Summer Internship - II

Course Details:
First-year students are required to undertake a four-week summer internship after completion of two semesters. This internship aims to provide practical experience in the application of engineering principles. Upon completion of the training, students must submit a formal report and their certificate of completion to the department, followed by a professional presentation summarizing their internship experience.
6-8 Weeks practical training in a reputed industry/organization is to be undertaken during summer after completing six semesters of study. The student will submit detailed report and give presentation on training.

Course Outcomes (CO): Upon successful completion of this seminar, students will be able to:

CO1	Articulate the objectives, activities, and outcomes of their internship experience
CO2	Analyze the relevance of their internship work to their academic curriculum and future career goals
CO3	Develop and deliver a clear, concise, and professional presentation summarizing their internship
CO4	Engage in constructive self-reflection and peer feedback regarding practical industry exposure
CO5	Identify key learning points, challenges, and solutions encountered during the internship period

The seminar will typically involve:

- Pre-Seminar Preparation: Students will prepare a detailed report and a presentation.
- Oral Presentation: Each student will deliver a presentation to their peers and faculty.
- Question & Answer Session: A dedicated time for questions and discussion following each
- presentation.
- Feedback: Constructive feedback will be provided by faculty and peers.

Internship Seminar Topics / Content Guidelines
The seminar presentation should cover the following aspects of the internship:

- Introduction to the Organization:
- Internship Details:
- Project/Work Undertaken:
  - Problem Statement/Objective
  - Methodology/Approach

- Activities Performed
- Challenges Faced & Solutions
- Results/Outcomes

- Learning Outcomes & Impact:
  - Technical Skills Gained/Enhanced
  - Soft Skills Developed
  - Application of Classroom Knowledge
  - Insights into Industry
  - Career Relevance

- Conclusion & Recommendations

Presentation Guidelines

- 8-10 minutes presentation + 2-3 minutes Q&A.

Course Code: SSMS301 **Breakup: 0 – 0 – 4 – 2**
Course Name: SEMINAR

Course Details:
First-year students are required to undertake a four-week summer internship after completion of two Semesters. This internship aims to provide practical experience in the application of engineering principles. Upon completion of the training, students must submit a formal report and their certificate of completion to the department, followed by a professional presentation summarizing their internship experience.
Emphasis on to develop the skill in presentation and group discussion. The subject may be selected from engineering/management.

Course Outcomes (CO): Upon successful completion of this seminar, students will be able to:

CO1	Articulate the objectives, activities, and outcomes of their seminar topic
CO2	Analyze the relevance of their seminar topic work to their academic curriculum and future career goals
CO3	Develop and deliver a clear, concise, and professional presentation summarizing their seminar topic
CO4	Engage in constructive self-reflection and peer feedback regarding practical industry exposure
CO5	Identify key learning points, challenges, and solutions encountered during this study

The seminar will typically involve:

- Pre-Seminar Preparation: Students will prepare a detailed report and a presentation.
- Oral Presentation: Each student will deliver a presentation to their peers and faculty.
- Question & Answer Session: A dedicated time for questions and discussion following each
- presentation.

- Feedback: Constructive feedback will be provided by faculty and peers.

Seminar Topics / Content Guidelines
The seminar presentation should cover the following aspects of the internship:

- Introduction to the Organization:
- Project/Work Undertaken:
  - Problem Statement/Objective
  - Methodology/Approach
  - Activities Performed
  - Challenges Faced & Solutions
  - Results/Outcomes

- Learning Outcomes & Impact:
  - Technical Skills Gained/Enhanced
  - Soft Skills Developed
  - Application of Classroom Knowledge
  - Insights into Industry
  - Career Relevance

- Conclusion & Recommendations

Presentation Guidelines

- 8-10 minutes presentation + 2-3 minutes Q&A.

Course Code: MEES306 **Breakup: 3 – 0 – 2 – 4**
Course Name: COMPUTER AIDED DESIGN

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Understand the applications of computer in the design.
CO-2	Understand and develop the Mathematical representations of curves used in geometric construction.
CO-3	Understand and develop the Mathematical representations of solids used in geometric construction.
CO-4	Able to get the transformed in 2D and 3D using transformation equations
CO-5	evaluate design, analyze and optimize using commercial CAD software.
CO-6	Apply the knowledge of Mathematics and Engineering to solve problems in structural by FEM

Course Details:

Introduction, Computer Graphics, Curve representation, Interpolation vs approximation, Spline curve, Bezier curves and its properties, Brief mention of other curves.3-D Graphics, Solid modelling-sweep representation wire mesh , constructive solid geometry and Boolean operations, boundary representation ,colors.

Computer aided design of machine elements such as shaft, springs, bearings and problem from

other systems such as heat exchanger, inventory control etc. Writing computer program in C, Auto Cad and its uses.

Introduction to numerical method and optimization technique, curve fitting, least square method. Newton – Raphson method for root finding and for optimization.Brief Introduction to numerical differtiation and integration.Linear programing for constrained optimization (only graphical method)

Introduction to finite element method, one and two dimensional beam element (spring system) analysis.

TEXT BOOKS:-

1. Computer graphics ; Hearn & Baker, Second Edition, 1997, Prentice Hall of India
2. CAD/CAM: Computer –Aided Design and Manufacturing,1984,M. P. Groover
3. Computer Aided analysis & design of machine elements, 2010,Rao&Dukhipati
4. C Language and Numerical Methods, reprint 2003;C. Xavier; New Age International Publisher
5. Engineering Optimization, 2013, SS Rao; New Age International Publisher

COMPUTER AIDED DESIGN LAB

Experiments:

1. Line drawing or circle drawing experiment.
2. Geometric transformation algorithm experiment for translation.
3. Design of machine component or other system experiment.
4. Understanding and use of any 3-D Modelling Software commands.
5. Pro/E/Idea etc experiment.
6. Writing a small program for FEM for 2 spring system.
7. Root findings or curve fitting experiment.
8. Numerical differentiation or numerical integration experiment.

Course Code: MEES307 **Breakup: 3 – 0 – 2 – 4**
Course Name: Refrigeration and Air Conditioning

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Understand the principles and applications of refrigeration system
CO-2	Analyze performance of vapour compression refrigeration system
CO-3	Analyse air conditioning process using principles of psychometry
CO-4	Study the working principles of vapour absorption, thermoelectric
CO-5	Evaluate the cooling and heating loads in air-conditioning system

Course Details:

Introduction ,carnot refrigeration cycle, COP, application, Air refrigeration cycle , Bell Coleman air refrigeration cycle , Brayton refrigeration cycle , optimum COP and pressure ratio ,

air craft refrigeration system , Classification of air craft refrigeration system , Actual power for refrigeration system, Dry air rated temperature(DART).

Refrigerants-Classification ,nomanclature, desirable properties of refrigerants, common refigerants, secondery refrigerants & CFC free refrigerants, Vapour compression system- Single stage system , analysis of vapour compression cycle , effect of pressure change on COP , Use of T-S & p-h charts , effect of subcooling of condensate on COP& capacity , effect of superheeting of vapour compression , construction details of refrigerator and air conditioners, Multi stage compression. Vapour absorption system-Working Principles of continuous absorption system, comparision between absorption and compression system. Theory of mixtures, Temp. concentration diagram , Enthalpy concentration diagram. Adiabetic mixing of two systems, Lithium bromide water vapour absorption system. Working principles, Comparison with ammonia water system.

Air conditioning- Introduction to air conditioning , Psychromatrics, terms , definitions, adiabetic saturations& thermodynamics , wet bulb temperature , psychrometers, use of psychrometric charts , air conditioning requirements for comfort and industrial processes, comfort charts , comfort zones , cooling towers ,cooling and heating load calculations.

Refrigeration equipment & application—Expansion devices , duct design , food preservation cold storage , refrigerators , freezers , ice plants , water coolers , thermal analysis for human bodies, automotive air conditioning – brief overview. , Introduction to soler radiation distributions, emperical methods to evolute heat transfer throw walls & roofs, infiltration, passive heating and cooling of building.

Text Books and References:

1. Refrigeration and air conditioning, 2011, Manohar Prasad; New Age International publishers.
2. Principles of refrigeration, 4th edition 1997, Roy J Dosset; Prentice Hall
3. Refrigeration and air conditioning,2009, C. P. Arora McGraw Hill Education(India) Private Limited

Refrigeration and Air Conditioning Lab

Experiments:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration system.
4. To study basic components of air-conditioning system.
5. Experiment on air conditioning test rig and calculation of various performance parameters.
6. To study air washers.
7. Study of window air conditioner.
8. Study & determination of volumetric efficiency of compression.
9. Experiment on ice-plant.
10. Experiment on two stage reciprocating compressors for determination of volumetric efficiency, p-v digram and effect of inter cooling.
11. Study of hermetically sealed compressors.
12. Experiment on desert coolers.

Course Code: MEES308 **Breakup: 3 – 0 – 2 – 4**
Course Name: I C Engines

Course outcome (CO): At the end of the course, the student will be able to:

CO-1	Understand the basic component and working cycle of the IC engine
CO-2	Understand the parameters that affect engine performance, combustion, knock.
CO-3	Apply thermodynamics cycles for steam power plant
CO-4	Evaluate the performance of boiler
CO-5	Know the components which improve the performance of boiler and steam turbines
CO-6	Understand functions of the components of nuclear power plant.

Course Details:

Unit-1 **11**

Introduction to I.C Engines: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto and Diesel cycle , Sterling cycle, Ericsson cycles, Actual cycle analysis, Two and four stroke engines, SI and CI engines, Valve timing diagram

Fuels: Fuels for SI and CI engine, important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Biodiesel, Gaseous fuels, LPG, CNG, Biogas, Alternative fuels for IC engines

Unit–2 10

SI Engines: Combustion in SI engine, Flame speed, Ignition delay, abnormal combustion, combustion chamber design, Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI. Ignition system requirements, Magneto and battery ignition systems, ignition timing and spark plug, Electronic ignition

Unit–3 9

CI Engine: Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines; Fuel injection in CI engines, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings; Scavenging in 2 Stroke engines

Unit-4 10

Engine Cooling: Different cooling systems, Radiators and cooling fans.

Lubrication: Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation.

Supercharging: Effect of altitude on power output, Types of supercharging

Testing and Performance: Basic measurements, Optical measurement techniques, Laser Doppler anemometry, testing of SI and CI engines.

Text Books and References:

1. IC Engine, 4th edition 2017, V. Ganesan; TMH
2. IC Engine, 2nd edition 2000, C. R. Ferguson; J Willey and sons
3. ICEngine, 2018, M. L. Mathur and R. P. Sharma; DhanpatRai Publications
4. Gill, Smith, Ziurs - Fundamentals of Internal Combustion Engine , 4th edition 2007; Oxford & IBH Publishing Co.
5. Internal Combustion Engine Fundamental, 1988, J. B. Heywood; McGraw hill

I C Engine lab

Experiments: Any 8 experiments out of following:

1. Performance analysis of Four stroke S.I. Engine
2. Determination of Indicated H.P. of I.C. Engine by Morse Test
3. Performance analysis of Four stroke C.I. Engines
4. Study & experiment on valve mechanism
5. Experiment on Exhaust gas analysis of an I.C. Engine
6. Study & experiment on differential gear mechanism of rear axle
7. Study & experiment on Steering mechanism
8. Study & experiment on Automobile Braking System
9. Study & experiment on Chassis and suspension system
10. Study & experiment on Ignition system of I.C. Engine
11. Study & experiment on Fuel supply system of S.I. Engine
12. Study & experiment on Fuel supply system of C.I. Engine

Course Code: HSSS301 **Breakup: 3 – 0 – 0 – 3**
Course Name: Engineering Economics

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	To help students gain an understanding in certain core concepts of Industrial Economics.
CO-2	To familiarize students with theories in Industrial Economics.
CO-3	To help students understand cost structures and their role and importance in firm decisions.
CO-4	To analyze the performance of the Indian Industrial Economy against the backdrop of contemporary development.

Course Details:

Unit -I

Definition and scope of engineering economics, Concept of supply and demand, Price elasticity and cross elasticity of demand Production, Engineering costs and cost estimation Concept of time value of money Cash flow analysis

Unit-II

Perfect competition, Monopoly, Monopolistic competition

Unit-III

National Income, GDP, Inflation, Deflation and treatment

Unit-IV

Functions of RBI Indian Tax System

Text Books and References:

1. Henderson, M. James and Quandt, E. Richards, "Microeconomic Theory: A Mathematical

Approach", 1980; McGraw Hill.
2. Koutsoyiannis, A., "Modern micro economics".ardwick, Philip., Khan Bahadure., Langmeed, John, "An Introduction to modern economics".
3. Samuelson, A. Paul, "Economics".
4. Shapiro, Edward. "Macro economics".
5. Newnan, G. Donald, Eschenbach, G.Ted, Lavelle, P. Jerome, "Engineering Economic Analysis".

(Detailed Syllabus 4th Year)

Course Code: MEES401 **Breakup: 3 – 0 – 2 – 4**
Course Name: Computer aided manufacturing

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	To Study the Automation and need and future of NC Systems, To educate students by covering different aspects of computer Aided Manufacturing.
CO-2	Basic knowledge of NC and CNC machines and its components
CO-3	Improves the quality of manufacturing and To educate students by covering robotics and different material handling system required in manufacturing shop floor.
CO-4	To create strong skills of writing NC/CNC programs, Basic knowledge of Manual part programming and Basic knowledge of APT programming
CO-5	To educate students to understand different advances in manufacturing system like: GT, CAPP and FMS.

Course Details:

Differentiate between NC, CNC and DNC. Identify parameters governing for selection of CNC machines. CAM - concept and definition. NC (Numerical Control), CNC (Computerized Numerical Control) and DNC (Direct Numerical Control) - concept, features and differences. Advantages and limitations of CNC. Selection criteria for CNC machines.

Classify CNC machines. Identify role of main elements of CNC machines. Identify CNC axes. Preset tool on CNC machines. Use qualified tools and tool holders on CNC machines. CNC machines: Types, classification, working and constructional features. Spindle drives and axes drives on CNC machines. Machine structure- Requirements and reasons. Elements of CNC machines - Types, sketch, working and importance of: i. Slide ways. ii. Re-circulating ball screw. iii. Feedback devices (transducers, encoders). iv. Automatic tool changer (ATC). v. Automatic pallet changer (APC). CNC axes and motion nomenclature. CNC tooling: i. Tool presetting-concept and importance. ii. Qualified tools-definition need and advantages. iii. Tool holders- types and applications.

List features of specified CNC turning and machining centre. Identify various work

holding and tool holding devices.

Interpret ISO format of CNC part programming with used codes. Prepare part programme by using applicable codes like G& M etc. Apply advanced CNC part programming features like canned cycle, do loop, subroutine etc., Describe procedure for Setting various compensations on CNC. Prepare part programme considering various compensations.

Select suitable standard for CAD/CAM interfacing. List source of variability for adaptive control. Interpret different FMS layouts. Correlate areas of CIM. Identify types and elements of robots. Describe concept of Rapid prototyping and robotics.

Text Books and References:

1. CAD/CAM/CIM , 2007, Radha Krishnan and Subramanyam S.; Wiley eastern ltd., india
2. Koren Y. ,Benuri J., Numarical control of machinestools , 1984; Khanna publishers , ND
3. Roger S. Pressman , Numarical control and computer aided manufacturing; John WilleyAND SONS

Computer aided manufacturing Lab

Experiments:

1. To study the characteristic features of CNC machine
2. Part programming(in word address format) experiment for turning operation(including operations such as grooving and threading) and running on CNC machine
3. Part programming(in word address format or ATP) experiment for drilling operation (point to point) and running on CNC
4. Part programming(in word address format or ATP) experiment for milling operation (contouring) and running on CNC
5. Experiments on Robot & programs
6. Experiment on transfer line/material handling
7. Experiment on difference between ordinary and NC machine, study or retrofitting
8. Experiment on study of system devices such as motors and feed back devices
9. Experiment on Mecatronics and controls

Course Code: MEES402 **Breakup: 3 – 0 – 0 – 3**

Course Name: Material additive manufacturing Process

Course outcomes (CO): At the end of the course, the student will be able to:

CO-1	Demonstrate appropriate level of understanding on principles of additive manufacturing processes
CO-2	Choose appropriate materials for additive manufacturing processes
CO-3	Apply suitable CAD tools and CAD interface for additive manufacturing process
CO-4	Develop physical prototypes by identifying suitable process with optimum process parameters

Course Details:

UNIT I

Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes.

UNIT II

Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT III

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

UNIT IV

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT V

RP Applications: Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd edition 2015, Ian Gibson ,DSavid W. Rosen , Brent Stucker, Springer.
2. Understanding Additive Manufacturing, 2012, Andreas Gebhardt, Hanser.

Science Direct.
3. Additive Manufacturing, 2016, AmitBandyopadhyay, Susmita Bose, CRC Press.
4. Rapid Prototyping: Principles and Applications, 3rd edition 2010, Chee Kai Chua, Kah Fai Leong, Chu Sing Lim; World Scientific Publishing Co. Pvt. Ltd.

Course Code: **SSTS401** **Breakup: 0 –0 – 4 – 2**
Course Name: **Summer Training**

Course Details:
Third year students are required to undertake an eight-week summer internship after completion of six semesters in a chemical or allied industry or national level laboratory/institute. This internship aims to provide practical experience in the application of engineering principles. Upon completion of the training, students must submit a formal report and their certificate of completion to the department, followed by a professional presentation summarizing their internship experience.

Course Outcomes (CO): Upon successful completion of this seminar, students will be able to:

CO1	Articulate the objectives, activities, and outcomes of their internship experience
CO2	Analyze the relevance of their internship work to their academic curriculum and future career goals
CO3	Develop and deliver a clear, concise, and professional presentation summarizing their internship
CO4	Engage in constructive self-reflection and peer feedback regarding practical industry exposure
CO5	Identify key learning points, challenges, and solutions encountered during the internship period

The seminar will typically involve:
- Pre-Seminar Preparation: Students will prepare a detailed report and a presentation.
- Oral Presentation: Each student will deliver a presentation to their peers and faculty.
- Question & Answer Session: A dedicated time for questions and discussion following each presentation.
- Feedback: Constructive feedback will be provided by faculty and peers.

Internship Seminar Topics / Content Guidelines
The seminar presentation should cover the following aspects of the internship:
- Introduction to the Organization:
- Internship Details:
- Project/Work Undertaken:
- Problem Statement/Objective
- Methodology/Approach
- Activities Performed
- Challenges Faced & Solutions
- Results/Outcomes
- Learning Outcomes & Impact:

- Technical Skills Gained/Enhanced
- Soft Skills Developed
- Application of Classroom Knowledge
- Insights into Industry
- Career Relevance
- Conclusion & Recommendations

Presentation Guidelines

- 8-10 minutes presentation + 2-3 minutes Q&A.

Course Code: **PRTS401** **Breakup: 0 –0 – 8 –4**
Course Name: **Project-I**

Course Details:
Equipment/Plant design problem related to Mechanical engineering at Global, local and regional level to be done by groups of students.

Course Code: **PRTS402** **Breakup: 0 –0 – 8 – 4**
Course Name: **Project-II**
Course Details:

Simulation/Experimental/Research/Design Projects based on Global, local and regional level to be done by groups of students.

(Detailed Syllabus of Program Elective (PE) Courses or MOOCs)

Course Code: **MEES501** **Breakup: 3 –0 – 0 – 3**
Course Name: **Mechanical Vibrations**

Course Outcomes (CO): At the end of the course, the student will be able to:
CO1: Determine natural frequency of undamped and damped single degree freedom systems
CO2: Calculate natural frequencies of two degree freedom system
CO3: Determine natural frequencies of multi degree freedom system
CO4: Apply numerical methods to determine natural frequencies of multi degree freedom system
CO5: Calculate critical speed of shaft and describe vibration measuring instruments.

Course Details:
UNIT- I
Single Degree of Freedom Systems: Undamped free vibration: Classical method, Energy method, equivalent systems, Damped free vibration- Viscous damping-underdamping, critical damping, overdamping; Coulomb damping, equivalent damping coefficient.

UNIT- II

Forced vibrations of Single Degree Freedom Systems: Steady state forced vibration, sources of excitation, impressed harmonic force, resonance, impressed force due to rotating unbalance, base excitation, transmissibility and isolation, performance of different type of isolators, power absorbed by viscous damping.

UNIT- III

Two degree Freedom Systems: Principal modes of vibration, two masses fixed on tightly stretched string, double pendulum, torsional system with damping, forced vibration with harmonic excitation, undamped dynamic vibration absorber, untuned viscous damper.

UNIT- IV

Multi Degree Freedom Systems: Lagrangian method for formulation of equation of motion Rayleigh's method, Dunkerley's method, Stodola method, Rayleigh-Ritz method, Method of matrix iteration.

UNIT- V

Whirling of shafts: Critical speeds of shafts – Critical speed of a light shaft having a single disc – without damping and with damping. Critical speed of a shaft having multiple discs – secondary critical speed. Vibration measurement and Applications: Piezoelectric transducers and linear variable differential transformer transducer; Vibration pickups: Vibrometer, Accelerometer, Vibration exciters- Mechanical exciters, impact hammer and electrodynamic shaker.

Textbook: G. K. Groover, Mechanical Vibrations, 8th Edition, Nem Chand & Bros, 2009.

Reference Books:

1. L. Meirovich, Elements of Vibrations Analysis, 1st Edition, Tata McGraw Hill, 1986
2. S. Graham Kelly, Mechanical Vibrations, 1st Edition, Tata McGraw Hill, 1996
3. Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson Education, 2018.

Course Code: **MEES502** **Breakup: 3 –0 – 0 – 3**
Course Name: **Production & operation management**

Course Outcomes (CO): At the end of the course, the student will be able to:

Course Details:

UNIT I - Functions of Production Planning Controls operations and productivity, productivity measurement, Design of goods and services: selection, generating new products, product development, issues in product design. Strategies for aggregates planning, aggregate planning using O.R. Models, Chase planning, Expediting, controlling aspects.

UNIT II - Forecasting - Importance of forecasting - Types of forecasting, their uses - General Principles of forecasting - Forecasting techniques - qualitative methods and quantitive methods - accuracy of forecasting methods.

UNIT III - Factors affecting facilities location, mathematical models for facilities, location, Types of facilities- layout: product layout, process layout, group technology layout, Assembly line balancing, computerized layout: ALDEP, CRAFT, CORELAP.

UNIT IV - Lean Management, philosophy and creation of lean enterprise, JIT concepts-Kanban SystemElements of total quality management, Six Sigma Quality Control. MRP, -lot sizing techniques in MRP, introduction to ERP, LOB (Line of Balance).

UNIT V - Scheduling Policies - Techniques, flow shop and job shop Scheduling techniques. Inventory management - Functions of inventories - relevant inventory costs - ABC analysis - VED analysis - EOQ model - Inventory control systems - P-Systems and Q-Systems-(S, s) Policy.

TEXT BOOKS:

1. Modern Production, Operations Management, Baffa&RakeshSarin
2. Operation Management by B. Mahadevan, Pearson Edu.
3. Operation and O.M by Adam & Ebert- PHI Pub.,

REFERENCE BOOKS:

1. Operations Management - S.N. Chary.
2. Inventory Control Theory and Practice, Martin K. Starr and David W. Miller
3. Production Control A Quantitative Approach, John E. Biegel.
4. Production Control, Moore.
5. Operations Management, Joseph Monks.
6. Operation Management by Jay Heizar& Read new Pearson
7. Elements of Production Planning and Control, Samuel Eilon.

Course Code: **MEES503** **Breakup: 3 –0 – 0 – 3**
Course Name: **Power Plant Engg.**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1-Understand the concept of Rankine cycle.
CO2-Understand working of boilers including water tube, fire tube and high pressure boilers and determine efficiencies.
CO3-Analyze the flow of steam through nozzles
CO4-Evaluate the performance of condensers and steam turbines
CO5-Evaluate the performance of gas turbines

Course Details:

UNIT I-

Introduction To The Sources Of Energy - Resources and Development of Power in India. Layouts of Steam, Hydel, Diesel, MHD, Nuclear and Gas Turbine Power Plants - Combined Power Cycles - Comparison and Selection. Power Plant Economics and Environmental Considerations: Capital Cost, Investment of Fixed Chorao Onorotina Cogto Gonorol Arrongomont of Rouer Dictribution Load Curves Ioad Duration Curve. Definitions of Connected Load, Maximum Demand, Demand Factor, Average Load, Load Factor, Diversity Factor - Tariff - Related Exercises. Effluents from Power Plants and Impact on Environment - Pollutants and Pollution Standards - Methods of Pollution Control. Inspection And Safety Regulations.

UNIT II-

Steam Power Plant: Modern High Pressure and Supercritical Boilers - Analysis of Power Plant Cycles - Modern Trends in Cycle Improvement - Waste Heat Recovery, Fluidized Bed Boilers., Fuel and Handling Equipments, Types of Coals, Coal Handling, Choice of Handling Equipment, Coal

Storage, Ash Handling Systems. Steam Power Plant : Combustion Process: Properties of Coal - Overfeed and Under Feed Fuel Beds, Traveling Grate Stokers, Spreader Stokers, Retort Stokers, Pulverized Fuel Burning System And Its Components, Combustion Needs and Draught System, Cyclone Furnace, Design and Construction, Dust Collectors, Cooling Towers And Heat Rejection. Analysis of Pollution from Thermal Power Plants - Pollution Controls.CO2 Recorders.

UNIT III-

Diesel Power Plant:Diesel Power Plant: Introduction - IC Engines, Types, Construction- Plant Layout with Auxiliaries - Fuel Storage GAS TURBINE PLANT:Introduction - Classification - Construction - Layout With Auxiliaries - Principles of Working Closed and Open Cycle Gas Turbines. Advantages And Disadvantages Combined Cycle Power Plants.

UNIT IV-

Hydro Electric Power Plant: Water Power - Hydrological Cycle / Flow Measurement Drainage Area Characteristics - Hydrographs - Storage and Pondage - Classification of Dams and Spill Ways. Hydro Projects And Plant: Classification - Typical Layouts - Plant Auxiliaries - Plant Operation Pumped Storage Plants.

UNIT V-

Power From Non-Conventional Sources: Utilization of Solar Collectors- Principle of its Working, Wind Energy - Types of Turbines - HAWT & VAWT-Tidal Energy. MHD power Generation. Nuclear Power Station: Nuclear Fuel - Nuclear Fission, Chain Reaction, Breeding and Fertile Materials - Nuclear Reactor -Reactor Operation. Types Of Reactors: Pressurized Water Reactor, Boiling Water Reactor, Sodium-Graphite Reactor, Fast breeder Reactor, Homogeneous Reactor, Gas Cooled Reactor, Radiation Hazards and Shielding - Radioactive Waste Disposal.

TEXT BOOKS:

1. Power plant Engineering, P.K. Nag, TMH, 3rd Edition, 2013.
2. A course in power plant Engineering, Arora and S. Domkundwar.

REFERENCE BOOKS:

1. A Text Book of Power Plant Engineering, Rajput, Laxmi Publications, 4th edition, 2012.
2. Power plant Engineering, Ramalingam, Scietech Publishers
3. Power plant engineering P.C. Sharma, S.K. Kataria Publications,2012.

Course Code: **MEES504** **Breakup: 3 –0 – 0 – 3**
Course Name: **Thermal Turbo Machines**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1-Ability to design and calculate different parameters for turbo machines
CO2-Prerequisite to CFD and Industrial fluid power courses
CO3-Ability to formulate design criteria
CO4-Ability to understand thermodynamics and kinematics behind turbo machines

Course Details:

UNIT - I Introduction to Turbomachinery: Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler‘s, Bernoulli‘s, equation and its applications, expansion and compression process, reheat factor, preheat factor

UNIT - II Fundamental Concepts of Axial and Radial Machines: Euler‘s equation of energy transfer,

vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

UNIT - III Gas Dynamics: Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory. Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT - IV Axial Flow Compressors: Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT - V Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

TEXT BOOKS:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

REFERENCE BOOKS:

1. A Treatise on Turbo machines / G. Gopal Krishnan and D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

Course Code: **MEES511** **Breakup: 3 –0 – 0 – 3**
Course Name: **Gas Dynamics & Jet Propulsions**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1: Apply the thermodynamics concepts in relation to compressible flows and derive relationships between various compressible flow parameters

CO2: Understanding of isentropic compressible flows in variable area ducts and apply in design of static components like nozzles and diffusers

CO3: Solve for compressible flow characteristics with friction and heat transfer

CO4: Develop relationship for shocks and determine their characteristics under various conditions

CO5: Analyse the performance of aircraft and rocket propulsion engines

Course Details:

Unit I-

Basic concepts: Energy and momentum equations of compressible fluid flows – Stagnation states – Mach waves and Mach cone – Effect of Mach number on compressibility. Isentropic flows: Isentropic flow through variable area ducts.

Isentropic Flow: Nozzle and Diffusers, compressors and turbines – Use of Gas tables. Flow through ducts: Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – Variation of flow properties – Use of tables and charts – Generalized gas dynamics.

Unit II-

Normal and oblique shocks: Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl Meyer relations – Expansion of supersonic flow, Use of table and charts – Applications.

Unit III-

Jet propulsion: Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operation principle – cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo-prop engines – Aircraft combustors. (7 hours)

Space propulsion: Types of rocket engines – Propellants – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – Space flights.

Textbook(s)

- Yahya S. M. "Fundamentals of Compressible Flow with aircraft and rocket propulsion", 5/e,New Age International publishers, 2016.

Reference(s)

- Balachandran P. "Fundamentals of Compressible Fluid Dynamics", PHI Learning India Private Ltd., 2009.
- John D. Anderson Jr. "Modern Compressible Flow with historical perspective", 2/e, McGraw Hill Publishing company, International Edition, 1990.
- Shapiro A. H. "Dynamics and Thermodynamics of Compressible Fluid Flow – Volume I", John Wiley, New York, 1953.

Course Code: **MEES512** **Breakup: 3 –0 – 0 – 3**

Course Name: **Design Thinking and Product Innovation**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Apply fundamental principles of physics and engineering to analyze basic mechanical and electrical systems, including forces, motion, energy, and electrical circuits.

CO2 Explain the historical development and impact of key inventions and innovations in mechanical, electrical, electronics, and computing fields on engineering products and societal progress.

CO3 Utilize systematic approaches to product development, such as Design Thinking, brainstorming, and various solution-finding methods, to foster innovation and creativity in design challenges.

CO4 Analyze existing products using reverse engineering techniques to identify areas for improvement, incorporate new materials and technologies (like 3D printing and electronic controls), and consider ergonomic, environmental, and safety factors in product redesign.

CO5 Design and conceptualize engineering solutions for real-world applications across various domains, including agriculture (e.g., specialized machinery), electrical systems (e.g., alarms, smart devices), and advanced vehicles (e.g., electric and unmanned vehicles, drones).

Course details:

UNIT I: Science to Engineering: Job of engineers, engineering units and measurement, elements of engineering analysis, forces and motion, energy, kinematics and motion, conversion of linear motion to rotary and vice versa, motion transmission. Physics to Engineering: Application of Newton laws, Pascal's law, Bouncy, Bernoulli's theorem, Ohm's law, and electrical induction in engineering products.

UNIT II: Historical Development: Invention wheel, early mechanics in design, mechanical advantages, industrial revolution, steam and petrol for mobility. Innovations in Electrical and Electronics: Electrical energy generation, electrical bulb, electrical equipment, electronics and automation, computing for early days to present, innovations in communications.

UNIT III: Systematic approach to product development: Design Thinking, Innovation, Empathize Design Thinking as a systematic approach to Innovation, brainstorming, visual thinking, design challenges, innovation, aft of Innovation, strategies for idea generation, creativity, teams for innovation. Solution finding methods: Conventional, intuitive, discursive, methods for combining solution, decision making for new design.

UNIT IV: Reverse engineering in product development: Reversing engineering methods, identifying the bad) features in a product, reduction in size and weight, usage of new materials, 3D printing, and study of introducing electrical and electronic controls to the old products, impoftance of ergonomics in product development, environmental considerations in design, and safety considerations in design.

UNIT V: Study of Product Development- Agriculture, development of machines for separation of corn seeds, peeling of groundnut shells, husk removing from paddy. Electrical: Design of burglar alarm, speedometer, water level indicator, smaft gates, and smart lights. Design of electrical vehicles, unmanned vehicles, ! design principles in drones.

Reference Books:

1. L Philip Kosky, Robert T. Balmer, William D. Keat, George Wise, "Exploring Engineering: An Introduction to Engineering and Design", 4/e, Elsevier,2016.

2. David Ralzman, "History of Modem Design", 2le,Laurence King Publishing I*ir,d.,2010.

3. An AVA Book, "Design Thinking",

4. G. Pahl, W.Beitz, J. Feldhusen, KH R- 19 AVA Publishing 2010. Grote, "Engineering Design: A Systematic Approach,', 3le, Springe42007.

5. Tom Kelley, Jonathan Littman, "Ten Faces in Innovation',, currency Books, 2006.

Course Code: **MEES513** **Breakup: 3 –0 – 0 – 3**

Course Name: **Advance Manufacturing Process**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Analyze and differentiate various non-traditional machining processes, including their physical setups, process parameters, material removal rates, capabilities, and appropriate industrial applications.

CO2 Evaluate the principles and applications of high-speed machining (HSM), assessing its impact on material removal rates, surface integrity, accuracy, and economic considerations in manufacturing.

CO3 Explain the advancements in modern grinding technologies and laser applications in manufacturing, identifying their roles in cutting, welding, surface treatment, and automation processes.

CO4 Describe and compare a range of advanced casting and welding processes, understanding their underlying principles, advantages, and suitable applications for complex material fabrication.

CO5 Investigate and apply advanced metal forming techniques, such as High Energy Rate Forming (HERF), electromagnetic, explosive, and electro-hydraulic forming, to produce components with specific geometries and properties.

Course Details:

UNIT I:

Non-traditional manufacturing processes – chemical machining – electro chemical machining – ultrasonic machining – physical setup, metal removal rate, process parameters, process capabilities, and applications.

Non-traditional manufacturing processes – electrical discharge machining – wire EDM – abrasive flow machining – physical setup, metal removal rate, process parameters, process capabilities, and applications. Advanced Machining Processes/ Non- Conventional Machining Processes: EDM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM process principle, process parameters and their applications. Process capabilities and their applications.

UNIT II:

High-speed machining: high performance machining of components. Application of HSM, improved material removal rate, surface finish and integrity, accuracy, economic considerations.

UNIT III:

Modern grinding technologies, high speed and high performance grinding. Hard machining using single point tools.

Laser applications in manufacture: Cutting, welding, surface treatment, automation and in-process sensing.

UNIT IV:

Advanced Casting Processes: Metal mould casting, continuous casting, squeeze casting, vaccum mould casting, evaporative pattern casting and ceramic shell casting. Advanced Welding Processes: Atomic hydrogen, ultrasonic welding (USW), Plasma arc welding (PAW), laser beam welding (LBW), and Electron beam welding (EBW). Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electromagnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming and Contour roll forming.

Text Books:

- Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' – Prentice Hall – 2013 – 7th Edition
- Kalpakjian S., Schmid S. R., Manufacturing Engineering and Technology, Pearson publication.
- Gibson D. W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer Publications.

References:

- Benedict G. F. – 'Non-Traditional Manufacturing Processes' – Marcell Dekker Inc., NY – 1987
- Krar S. F. and Gill A. – 'Exploring Advanced Manufacturing Technologies' -Industrial Press – 2003

Course Code: **MEES514** **Breakup: 3 –0 – 0 – 3**
Course Name: **Automation and Robotics**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Understand the concept of automation, its classification and terminology

CO2 Understand the concept of basic principles of Robots.

CO3 Understand and interpret the components of Industrial Automation

CO4 Understand the basic elements of Automation in manufacturing.

CO5 Apply the concept of Automation & Robotics in different industrial applications

UNIT I: Introduction to Automation Brief history of automation, Requirement of automation systems, classification & level of automation, Industrial Automation, benefits of Industrial Automation, closed loop & open loop system, role of automation in Industry 4.0.

Unit II: Introduction to Robotics Overview: History, Definition and scope of robotics, laws of robotics, classification, advantages and disadvantages of Robot, applications of robots. Robot components: Joints, links, end-effectors, degrees of freedom, brief introduction to forward and inverse kinematics. Robot Ethics: Social impact of robots in society, ethical implications of robotics and automation.

Unit III: Industrial Automation Architecture Input Devices: Transducers &sensors, Classification of sensors and applications. Controllers: Classification of controllers in Industrial Automation, principles of hard wire system and PLC, Types of PLC, I/O: Analog and Digital, Ladder programming for logic functions. Actuators: Basics of Hydraulic, Pneumatic and Electric actuators, merits and demerits.

Unit IV: Automation in Manufacturing Fundamentals of Computer Integrated Manufacturing, elements of a CIM system, benefits of CIM, types of automation in production system, fundamentals of Group Technology and Flexible Manufacturing System. Types and components of FMS.

Unit V: Industrial Applications Industrial Applications of Automation and Robotics for material handling, welding, Spray painting, medical, mining, space, defence, security, domestic, entertainment.

Text Books

1. Gary Dunning, “Introduction to Programmable Logic Controllers” Thomson Learning, 2001.

2. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.

3. .Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015

4. Introduction to Robotics (Mechanics and control), Niku, Wiley 2013.

5. Introduction to Robotics by S K Saha, McGraw Hill Education

6. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.

Reference book

1. Introduction to Robotics (Mechanics and control), J.J.Craig Pearson Education Asia 2002.

2. Program logic controllers, W.Bolton ,Elsevier 2009.

Course Code: **MEES521** **Breakup: 3 –0 – 0 – 3**
Course Name: **Operation Research**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	Define and formulate linear programming problems and appreciate their limitations.
CO-2	Solve linear programming problems using appropriate techniques and optimization
CO-3	Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.
CO-4	Solve Transportation Problems
CO-5	Develop mathematical skills to analyse and solve Queing models arising from a wide range of applications.

Course Details:

UNIT I:
Introduction To Or And Linear Programming - 1: OR definition- Classification of Models Types of Operations Research models; Linear Programming- Problem Formulation, Graphical Method, Simplex Method, Two-Phase Simplex Method, Big-M Method, Special Cases of LP Degeneracy, Infeasibility and Multiple Optimal Solutions;
UNIT II Linear Programming-2: Duality- Principle, Economic Interpretation of Duality, Dual Simplex Method, Transportation Problem - Formulation; Different Methods of Obtaining Initial Basic Feasible Solution- North-West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Methods-Stepping Stone Method and Modified Distribution (MODI) Method; Special Cases -Unbalanced Transportation Problem, Degenerate Problem;Assignment Problem Formulation; Optimal Solution -Traveling Salesman problem.
UNIT III Game Theory: .Introduction - Minimax (Maximin) Criterion and Optimal Strategy, Saddle Point, Solution of Games with Pure Strategy -Games with Mixed Strategies - 2 X 2 Games Dominance, Principle- Solution by Graphical Method of m X 2 & 2 X n games Queuing Theory: Introduction -Terminology, Service Channel, Arrival Pattern, Population, Departure Pattern(Service Pattern), Queue Discipline, Birth & Death Process, Balking, Reneging, Jockeying; Single Channel Models with Poisson Arrivals, Exponential Service Times with finite queue length and non-finite queue length; Multichannel Models with Poisson Arrivals. Exponential Service Times with finite queue length and non finite queue length.
UNIT IV Sequencing:Assumptions-n-jobs-2 Machines model, n-jobs-3-machines models. PERT & CPM: Introduction to Project Management, Activities, Events, Predecessor Relationships, AOA Diagram, Early Start, Early Finish, Late Start & Late Finish Times, Earliest Occurrence and Latest Occurrence of the Event, Total Float, Free Float, Independent Float- CPMDeterministic Model-Critical Path, Crashing, Optimal Project Duration, Least Possible Project Duration- PERT-Probabilistic Model- Various types of Activity Time Estimates, Standard Deviation and Varianceof the Activities and Projects, and Probability of Completing the Project within scheduled time.
UNIT V Dynamic Programming :Introduction - Bellman's Principle of Optimality - Applications of Dynamic Programming- Capital Budgeting Problem - Shortest Path Problem - Solution of Linear Programming Problem by DP Replacement And Maintenance Analysis: Introduction - Types of Maintenance, Types of Replacement Problem, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group Replacement Model.

Text Books and References:

1. Taha,H A, "Operations Research - An Introduction", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
2. Hillier, F S, "Operations Research", First Indian Edition, CBS Publishers & Distributors, Delhi, 1994.
3. Wagner H M, "Principles of Operations Research", Second Edition, Prentice Hall of India Private Limited, New Delhi, 2003.
4. Gupta P K, &Hira D.S., "Operations Research", Third Edition, S Chand & Company Ltd., New Delhi, 2005.
5. Introduction to OperationsResearchFrederick K. Hiller,Bodhibrata Nag, PreetamBasu, Geralld J. Lieberman, TMH, 9th edition, 2011.

Course Code: **MEES522** **Breakup: 3 –0 – 0 – 3**
Course Name: **Automobile Engineering**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	Explain the construction, working, and application of different types of chassis, bodies, of automobile and use suitable diagram to support their description.
CO-2	Explain construction, working and features of different elements of power transmission in automobile namely gear boxes, differential, power transmission through rear and front axle and automatic transmission system.
CO-3	Explain the concept of steering geometry including camber/ wheels, steering mechanism and suspension systems with neat sketches as required.
CO-4	Explain the construction, features and namely battery, alternator, starter, ignition systems, electric wiring, head lamps and electric horn.
CO-5	Explain the importance and working of automobile Air Bags and Belts with reference to automotive safety requirements.

Course Details:

UNIT I:

Introduction: Automobile and Automobile Engineering, history and development, classification of autovehicles, status of modern autovehicles, automobile chassis, frames, types of frames, design of frame, components, function and layout of automobiles, related terminologies like wheel base, track, turning radius and ground clearance.

Unit 2 Brakes: Principle of braking, weight transfer, types of brakes, factors influencing the braking effect, disc and drum brake, hydraulic brakes. Suspension System: Introduction, types of suspension system, leaf springs, helically coiled spring, torsion bar, shock absorbers, independent front suspension system, independent rear suspension system.

Unit 3 Steering Mechanism: Wheel alignment, principal of correct steering, layout of steering system, arrangement of steering linkage, steering gears. Gear Box: Need of gear box, principle of gearing, types of gear boxes, constant mesh gear box, sliding mesh gear box, synchromesh gear box.

Unit 4 Driveline System: Propeller shaft, universal coupling, analysis and design of hooke's joint, differential assembly. Rear And Front Axle: Front Axle, rigid axle beam, stub axle, loads on rear axle and their mounting style, types of rear axle, types of drives, rear axle casing.

UNIT V:

Vehicle Dynamics: Power and torque characteristics,, Air gradient and rolling resistance, variation of tractive effort, automatic transmission system, torque converter, Overdrive. Pollution: Pollution caused by the vehicles, types of pollutants, controlling pollution and vehicular emission control norms

Text Books and References:

1. Heldt.P.M.- "Automotive Chassis"- Chilton Co., New York- 1990
2. K.K.Ramalingam - "Automobile Engineering" – Scitech Publication, Chennai - 2001.
3. Steed W - "Mechanics of Road Vehicles"- Illiffe Books Ltd., London- 1960
4. Newton Steeds and Garrot- "Motor Vehicles"- Butterworths, London- 2000.
5. Judge A.W- "Mechanism of the Car"- Chapman and Halls Ltd., London- 1986
6. Automobile Engineering by K.M. Gupta
7. Automobile engineering by R.K. Rajput

Course Code: **MEES523** **Breakup: 3 –0 – 0 – 3**

Course Name: **Machine Tool Design**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	Apply cutting mechanics to metal machining based on cutting force and power consumption.
CO2	Operate lathe, milling machines, drill press, grinding machines, etc.
CO3	Select cutting tool materials and tool geometriesfor different metals.
CO4	Select appropriate machining processes and Learn machine tool structures and machining economics.
CO5	Write simple CNC programs and conduct CNC machining.

Course Details:

UNIT I

Elementary treatment of metal cutting theory - Elements of cutting process - Geometry of single point tool and angles, chip formation and types of chips - built up edge and its effects, . Mechanics of orthogonal cutting -Merchant's Force diagram, cutting forces cutting speeds, teed, depth of cut, heat generation, tool life, machinability. cutting Iool materials and cutting fluids -types and characteristics.

UNIT II

Engine lathe - Principle of working - specification of lathe - types of lathes - work holders and tool holders -Taper turning, thread turning and attachments for Lathes. Turret and capstan lathes

collet chucks - other work holders - tool holding devices - box. Principal features of automatic lathes - classification - Single spindle and multi-spindle automatic lathes.

UNIT III

Drilling and Boring Machines - Principles of working, specifications, types, operations performed - tool holding devices - twist drill - Boring tools - machining time calculation. Shaping, Slotting and Planning machines -Principles of working - Principal parts - specification, classification, Operations performed. Machining time calculations

UNIT IV

Milling Machine - Principles of working - specifications - classifications of milling machines - Principal features - machining operations, Types and geometry of milling cutters- methods of indexing - Accessories to milling machines.

Grinding Machine -Theory of grinding - classification- cylindrical and surface grinding machine Tool and cutter grinding machine - special types of grinding machines - Grinding wheel: Different types of abrasives - bonds, specification and selection of a grinding wheel. Static and dynamic balancing of a wheel Truing and Dressing of wheels.Lapping, Honing and Broaching machines.

UNIT V

Principles of design of Jigs and fixtures and uses, 3-2-1 Classification of Jigs & Fixtures Principles of location and clamping - Types of clamping & work holding devices, Typicał examples of jigs and Fixtures.

Text books & References:

1. Lindberg Roy A, "Processes and materials of manufacture", Fourth edition PHI, 1990.
2. Ostwald Phillip F, "Manufacturing processes and systems", John Wiley and Sons, ninth edition (1998).
3. Rao P N, "Manufacturing technology", Tata McGraw-Hill, 2002.
4. Gerling, "All About Machine Tools", New Age International (P) Limited, sixteenth edition, 2000.
5. Chapman W A J, "Workshop Technology", Part1, 2,3, CBS Publishers and distributors.,2000

Course Code: **MEES524** **Breakup: 3 –0 – 0 – 3**

Course Name: **Advance Solid Mechanics**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	Understand the concept of state of stress, strain, and significance of compatibility conditions.
CO-2	Understand The concept of energy methods for solving problems.
CO-3	Understand the theory of bending of curved bars for solving problems.
CO-4	Learn the underlying theory of unsymmetrical bending and concept of shear centre

Course Details:
Theory of 3D Stresses: Introduction to stress tensor components, Equilibrium equations, Stress transformation, Principal stresses, Boundary conditions. Theory of 3D Strains: Introduction to strain tensor components, Strain transformation, Principal Strains, Compatibility. Stress-strain relationship, Generalized Hooke‟s law, Strain-energy, St. Venant's principle. Plane problems in Cartesian and polar coordinates, Stress functions, axisymmetric problems, Stress concentration. Unsymmetrical bending and Torsion. Theory of Failure. Introduction to plasticity for metals..

Text Book and References:

1. Boresi A P and Sidebottom O M –Advanced mechanics of materials , John willey and sons 1985
2. Srinath L S –Advanced mechanics of materials , 1952
3. Seeley F B and Smith J O –Advanced mechanicsof materials , 1952
4. Richard G Budynas – Advanced strength and applied stress analysis , McGraw Hill, ND
5. M. Filonenko-Borodich, 'Theory of Elasticity‟, University Press of the Pacific, 2003
6. S.P. Timoshenko and J. N. Goodier, 'Theory of Elasticity', 3rd ed., McGraw-Hill Education, 2010.

Course Code: **MEES525** **Breakup: 3 –0 – 0 – 3**
Course Name: **Advance Fluid Mechanics**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO-1	Apply the fundamentals of kinematics and conservation laws of fluid flow systems.
CO-2	Apply the principles of high and low Reynolds number flows to fluid flow systems.
CO-3	Review the concepts of boundary layer and flow in transition.
CO-4	Review the concepts of boundary layer and flow in turbulent
CO-5	Apply Momentum integral technique to turbulent flow conditions

Course Details:
Reynolds transports theorem, Integral and differential forms of mass balance equation, limit of incompressibility.Stress tensor, stress at a point, momentum equation in terms of stress tensor, and LaGrange and Euler description of flow.Construction of rate of strain tensor, Linearity between stress and rate of strain, stokes hypotheses, thermodynamics and hydrostatic pressure.Navier stokes equation in Cartesian , cylindrical and spherical coordinates ,special form of navier stocks equations , Initial and boundary conditions.
Exact solution Definition and examples Boundary- Layer theory Prandtl’s boundary – layer theory, order of magnitude analysis, derivation of boundary layer equations, origin of separation and turbulence.
Flat plate problem Momentum integral techniqueTurbulance, equilibrium turbulence boundary layers, Prandtl’s mixing length , Moody’s diagram ,pipe network calculations

Text Book and References:

1. Agarwal , " Fluid Mechanics & Machinery" , TMH, 2010.
2. Som , S.K. &Biswas,G. " Introduction to Fluid Mechanics &Machins "TMH, 2012.
3. Bansal R.K. "A Text Book Of Fluid Mechanics & Hydraulic Machines" Laxmi Publications (p) Ltd. 2019.
4. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.

Course Code: **MEES526** **Breakup: 3 –0 – 0 – 3**

Course Name: **Product Design and Manufacturing**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Ability to apply knowledge of basic science and engineering fundamentals
CO2 Ability to undertake problem identification, formulation and solution
CO3 Understanding of the principles of sustainable design and development
CO4 Understanding of professional and ethical responsibilities and commitment to them

Course Details:

Unit I

Introduction: Characteristics of successful product development, Design and development of products, duration andcost of product development, the challenges of product development.
Development Processes and Organizations: A generic development process, conceptdevelopment: the front-endprocess, adopting the generic product development process, the AMF development process, product developmentorganizations, the AMF organization.
Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocateresources and plan timing, complete pre project planning, reflect all the results and the process.

Unit II

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs,organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and theprocess. Product Specifications: What are specifications, when are specifications established, establishing targetspecifications, setting the final specifications.
Concept Generation: The activity of concept generation clarify the problem, search externally, search internally,explore systematically, reflect on the results and the process.

Unit III

Concept Selection: Overview of methodology, concept screening, and concept scoring, Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format,communicate the concept, measure customer response, interpret the result, reflect on the results and the process. Product Architecture: What is product architecture, implications of the architecture, establishing the architecture,variety and supply chain considerations, platform planning, related system level design issues.

Unit IV

INDUSTRIAL DESIGN: Assessing the need for industrial design, the impact of industrial design, industrial designprocess, managing the industrial design process, assessing the quality of industrial design. Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly,supporting production, impact of DFM on other factors. Prototyping:

Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Unit V

Product Development Economics: Elements of economic analysis, base case financial mode,. Sensitive analysis,project trade-offs, influence of qualitative factors on project success, qualitative analysis. Managing Projects: Understanding and representing task, baseline project planning, accelerating projects, projectexecution, postmortem project evaluation.

Text Book and References:

1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000.
2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
3. New Product Development - Timjones. Butterworth Heinmann -Oxford. UCI -1997
4. Product Design for Manufacture and Assembly - GeofferyBoothroyd, Peter Dewhurst and Winston Knight – 2002

Course Code: **MEES527** **Breakup: 3 –0 – 0 – 3**

Course Name: **Advance Engineering Materials**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Describe metallic and non-metallic materials.
CO2 Explain preparation of high strength materials.
CO3 Suggest materials for low and high temperature applications.
CO4 Integrate knowledge of different types of advanced engineering materials
CO5 Analyse problem and find appropriate solution for use of materials

Course Details:

Unit – I Classification and Selection of Materials , Classify materials. ,. Select engineering materials for various applications. ,Classification of materials. Properties required in Engineering materials. ,Criteria of selection of materials. Requirements / needs of advance materials

Unit – II Non Metallic Materials Describe different non-metallic engineering materials with respect to properties and applications – Plastics, Ceramics, Optical fibres, Composites.Explain processes for Rubber Classification of non metallic materials. Rubber : Properties, processing and applications. Plastics : Thermosetting and Thermoplastics, Applications and properties. Ceramics : Properties and applications. Adhesives: Properties and applications. Optical fibers : Properties and applications. Composites : Properties and applications.

Unit – III High Strength Materials Describe methods of strengthening of alloys. Describe materials available for high strength applications.. Explain the properties and applications of high strength materials. Methods of strengthening of alloys. Materials available for high strength applications. Properties required for high strength materials. Applications of high strength materials.

Unit – IV Low & High Temperature Materials Describe different materials for low and high temperature applications. Properties required for low temperature applications. Materials available for low temperature applications. Requirements of materials for high temperature

applicationsMaterials available for high temperature applications. Applications of low and high temperature materials.
Unit – V Nanomaterials Define nanomaterials. Describe types of nano materials. Explain physical and mechanical properties and applications of nanomaterials. Definition Types of nanomaterials including carbon nanotubes and nanocomposites Physical and mechanical properties Applications of nanomaterials.

Text Book and References:

1. R. E. Reed Hill & Reza Abbaschian, Physical Metallurgy Principles, 3rd Edition, 1994, PWS Publishers USA
2. W. E. Smith, Structure & Properties of Engineering Alloys, McGraw Hill, 1993
3. F.L. Matthews & R. D. Rawlings, Composite Materials Engg. & Science, 1994
4. K. K. Chawla, Composite Materials, 2nd Edition, Springer Verlag 2001

Course Code: MEES528 Breakup: 3 –0 – 0 – 3
Course Name: UNCONVENTIONAL MACHINING PROCESSES

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1. Explain need for unconventional machining processes, elements and working of ultrasonic machining process.
CO2. Demonstrate mechanical material removal processes.
CO3. Explain thermal metal removal processes.
CO4. Discuss electron beam machining and laser beam machining processes.
CO5.Explain chemical material removal processes

Course Details:
UNIT-I
INTRODUCTION: Need for non-conventional machining processes, Comparision between conventional and unconventional machining processes, Classification of non – conventional machining processes, considerations in process selection-shape, materials, process parameters,effects on equipment and tooling, economic considerations. Ultrasonic machining: Elements of ultrasonic machining, Mechanics of material removal-Grain throwing and Grain hammering models, Process parameters, Applications, Recent developments, simple problems.
UNIT-II
Mechanical Material Removal Process
Abrasive Jet Machining: Elements of abrasive jet machining, working principle,advantages, limitations, applications. Water Jet Machining: Working principle, elements & their functions, disadvantages, applications and mechanics of water jet machining, advantages. Abrasive Water Jet Machining – basic principles, components, process parameters advantages and disadvantages, applications.
UNIT-III
Thermal Material Removal Processes: Electro Discharge Machining(EDM)-principle of operation, elements of EDM ,Power delivered, MRR, surface finish, process parameters problems on R-C

generator, Layers formed on machined components during EDM, Flushing methods in EDM, Different circuits used in EDM, Factors to be considered for tool selection in EDM, Dielectric fluids used in EDM, Advantages of EDM, Limitations of EDM, Applications of EDM. Wire EDM: working, advantages, limitations and applications, Electric Discharge Grinding: Working, process parameters.

UNIT-IV Electron Beam Machining & Laser Beam Machining Electron Beam Machining: Elements, Generation of electron beam and working, process parameters, advantages, disadvantages, applications, MRR, specific power consumption. Laser Beam Machining: Elements, working, laser materials, cutting speed, accuracy, thermal features, advantages, disadvantages, applications.

UNIT-V

Chemical Material Removal Processes: Chemical Machining, Electro chemical machining-elements, working, accuracy, surface finish, economics, advantages, disadvantages, applications, MRR, problems, Electro chemical grinding, Electro chemical honing and Electro chemical deburring.

Text Book and References:

1. Advanced machining processes by VK Jain, Allied publishers.
2. Non Traditional Manufacturing Processes by Gary F Benedict, CRC Press.
3.MEMS & Microsystems – Design and Manufacture by Tai-Ran Hsu, Tata McGraw Hill
4. Modern Machining Process by Pandey P.C. and Shah H.S., TMH
5. New Technology by Bhattacharya A,the Institution of Engineers, India 1984.
6. Non-Traditional Machining by P.K.Mishra, New Age.
7. Micro Machining of Engineering Materials Edited by J.Mc Geough, CRC Press.

(Detailed Syllabus of Open Electives (OE) Courses from MEE Department/ or MOOCs)

Course Code: **MEES531** **Breakup: 3 –0 – 0 – 3**

Course Name: **Robotics**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	Demonstrate knowledge of industrial robots, characteristics, end effectors and actuator
CO2	Apply spatial transformation to obtain forward and inverse kinematics
CO3	Solve robot dynamics problems, generate joint trajectory for path planning
CO4	Describe working principle of various sensors and program different operations
CO5	Appreciate applications of robots in industry

Course Details:

INTRODUCTION TO INDUSTRIAL ROBOTICS: Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers.

ROBOT ACTUATORS AND FEEDBACK COMPONENTS: Actuators, Pneumatic, Hydraulic

actuators, Electric &Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors. MANIPULATOR KINEMATICS: Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics.
MANIPULATOR DYNAMICS: Differential transformations, Jacobians, Lagrange - Euler and Newton - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.
ROBOT PROGRAMMING: Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages.
ROBOT APPLICATION IN MANUFACTURING: Material Transfer - Material handling, loading and unloading - Process spot and continuous arc welding & spray painting – Assembly and Inspection.

TEXT BOOKS:-

- K. M. Lynch and F. C. Park, Modern Robotics: Mechanics, Planning, and Control. Cambridge University Press. 2017.
- Industrial Robotics - Mikell P. Groover and Mitchell Weiss, Roger N. Nagel, Nicholas, G.Odrey - McGraw Hill, 1986.
- Robotics and control - RK Mittal and I J nagrath, TataMcGraw Hill 2004.
- An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
- Robotic Engineering - integrated approach by Richard d Klafter-London: Prentice-Hall1989.
- Robotics, Fundamental Concepts and analysis -AshitaveGhosal, Oxford Press
- Introduction to Robotics - John J. Craig, PearsonEdu.

Course Code: MEES532 **Breakup: 3 –0 – 0 – 3**

Course Name: Design & Manufacturing of Composites

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	Explain the advantages and applications of composite materials.
CO2	Describe the properties of various reinforcements of composite materials.
CO3	Summarize the manufacture of metal matrix, ceramic matrix and C-C composites.
CO4	Describe the manufacture of polymer matrix composites.
CO5	Formulate the failure theories of composite materials.

Course Details:

Unit I-Types of reinforcements, their mechanical properties and functions -ceramics, glass, carbon, boron. silicon carbide, metal, aramid. Forms of reinforcements- particulate, fibre, filaments, whiskers, flakes. Pre-fabricated forms- preforms, prepegs, fabrics, honeycomb. Type of matrix, its mechanical properties and functions- polymers (thermosets and thermoplastics), metals, ceramics, glass and carbon. Basic principles in the design of composites and selection of matrix and reinforcement. Bonding mechanisms.

Unit II- Anisotropic behaviourand relationship between structure-mechanical properties.Mechanical testing- tensile, compressive, Intra-laminar shear, Inter-laminar shear and fracture. Polymer Matrix Composites: Types of thermoset and thermoplastic resins. Principles in the selection of matrix and

the reinforcements. Process selection criteria. Mould and tool making. Basic manufacturing steps- impregnation, lay-up, consolidation and solidification.

Unit III- Manufacturing processes for polymer composites- lay-up, compression moulding, extrusion, injection moulding, sheet forming, pultrusion, hot press & autoclave techniques and filament winding. Metal and ceramic matrix composites- wettability of reinforcement to matrix and bonding, methods of manufacturing reinforcements with intermediate wetting layer. Manufacturing processes for metal matrix composites: casting methods- gravity & low pressure die, investment, squeeze, spray forming, compression moulding and thixo-moulding. Manufacturing processes for ceramic matrix composites: reaction sintering, electro-deposition, spray forming, infiltration. Applications of composites: daily usages- industrial, automotive and aerospace, advanced composites, design- selection and process of composite for new application, case studies.

Text Books and References:

1. R.W.Cahn, Material Science and Technology – Vol 13 – Composites, West Germany, 1994.
2. WD Callister, Jr., Adapted by R. Balasubramaniam, Materials Science and Engineering, John Wiley & Sons, NY, Indian edition, 2007
3. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993) Chapman & Hall, London.
4. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.
5. Suresh, S., Martensen, A., and Needleman, A., 'Fundamentals of Metal Matrix Composites', Butterworth, Heinemann, 1993.
6. Mallick, P. K., 'Fiber-reinforced Composites: Materials, Manufacturing and Design', Marcel Dekker, 1993.
7. Mazumdar, S.K., 'Composites Manufacturing-Materials, Product, & Process Engineering', CRC Press, 2002.

Course Code: **MEES533** **Breakup: 3 –0 – 0 – 3**

Course Name: **Renewable Energy Technology**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	Able to understand the renewable energy sources available at present.
CO2	Able to understand the solar energy operation and its characteristics.
CO3	To educate the wind energy operation and its types.
CO4	To educate the tidal and geothermal energy principles and its operation.
CO5	Able to understand the biomass energy generation and its technologies.

Course Details:

Indian and global energy sources, energy exploited, energy demand, energy planning, introduction to varios sources of energy.

Solar Radiation:

Extra-terrestrial and terrestrial, radiation measuring instrument, radiation measurement and predictions. Solar thermal conversion: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of

concentrators, solar water heater, solar dryers, solar stills, solar cooling and refrigeration. Solar photovoltaic: Principle of photovoltaic conversion of solar energy; Technology for fabrication of photovoltaic devices; Applications of solar cells in PV generation systems; Organic PV cells.

Wind Energy:

Characteristics and measurement: Metrology of wind speed distribution, wind speed statistics, Weibull, Rayleigh and Normal distribution, Measurement of wind data, Energy estimation of wind regimes; Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics; power curve of wind turbine, capacity factor, matching wind turbine with wind regimes; Application of wind energy.

Production of biomass:

Photosynthesis-C3 & C4 plants on biomass production; Biomass resources assessment; Co2 fixation potential of biomass; Classification of biomass; Physicochemical characteristics of biomass as fuel Biomass conversion routes: biochemical, chemical and thermo chemical Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plant manure-utilization and manure values. Biomass Gasification: Different types, power generation from gasification, cost benefit analysis of power generation by gasification.

Small Hydropower Systems:

Overview of micro, mini and small hydro system; hydrology; Elements of turbine; Assessment of hydro power; selection and design criteria of turbines; site selection and civil works; speed and voltage regulation; Investment issue load management and tariff collection; Distribution and marketing issues. Ocean Energy: Ocean energy resources, ocean energy routs; Principle of ocean thermal energy conversion system, ocean thermal power plants. Principles of ocean wave energy and Tidal energy conversion.

Geothermal Energy:

Origin of geothermal resources, type of geothermal energy deposits, site selection geothermal power plants; Hydrogen Energy: Hydrogen as a source of energy, Hydrogen production and storage. Fuel Cells: Types of fuel cell, fuel cell system and sub-system, Principle of working, basic thermodynamics.

Text Books and References:

1. P.D.Dunn, Renewable Energies: Sources, Conversion and Application, P.Peregrinius Ltd, London, 1986.
2. J.W.Twidell and A.D.Weer, Renewable Energy Sources, ELBS, 2nd Edition, Taylor & Francis, 2006.
3. S. Rao and B. B.Parulekar, Energy Technology- Non conventional,
4. Renewable and Conventional 3rd Edition, Khanna Pub, 1999.
5. B.T. Nijaguna, Biogas Technology, New Age International Pub, 2002

Course Code: **MEES541** **Breakup: 3 –0 – 0 – 3**

Course Name: **Total Quality Management**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1-Demonstrate basic concepts of total quality management.

CO2- Explain principles of total quality management.

CO3- Explain seven tools of quality, management tools and bench marking.

CO4- Enumerate and describe various control charts, quality costs and quality management.

CO5- Explain quality systems for TQM.

Course Details:

Unit I-Introduction – Need for quality – Evolution of quality – Definitions of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework – Contributions of Deming, Juran and Crosby – Barriers to TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

Unit II- Leadership – Strategic quality planning, Quality Councils – Employee involvement – Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal – Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.

Unit III- The seven traditional tools of quality – New management tools – Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

Unit IV- Control Charts – Process Capability – Concepts of Six Sigma – Quality Function Development (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures.

The Cost of Quality: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost information, Accounting Systems and Quality Management.

Unit V- Need for ISO 9000 – ISO 9001-2008 Quality System – Elements, Documentation, Quality Auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – TQM Implementation in manufacturing and service sectors.

Text Books & Reference Books:

1. Total Quality Management / Joel E. Ross/Taylor and Franscis Limited
2. Total Quality Management/P. N. Mukherjee/PHI
3. Beyond TQM / Robert L.Flood 2. Statistical Quality Control / E.L. Grant.
4. Total Quality Management:A Practical Approach/H. Lal
5. Quality Management/Kanishka Bedi/Oxford University Press/2011
6. Total Engineering Quality Management/Sunil Sharma/Macmillan

Course Code: MEES542 **Breakup: 3 –0 – 0 – 3**

Course Name: Optimization Methods in Engineering

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	Identify different types of optimization problems
CO2	Explain different optimization techniques
CO3	Solve various multivariable optimization problems
CO4	Solve problems by using Linear Programming
CO5	Solve optimization problems of staged and discrete processes, understand the concept of specialized & Non-traditional Algorithms

Course Details:

Unit I-Introduction to optimization

Introduction to Classical Methods & Linear Programming Problems Terminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn Tucker conditions, Method of Multipliers.

Unit II-Linear Programming Problem

Linear Programming Problem, Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis.

Unit III-Single Variable Optimization Problems

Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method.

Unit IV-Multivariable and Constrained Optimization Techniques

Multi Variable and Constrained Optimization Technique, Optimality criteria , Direct search Method, Simplex search methods, Hooke-Jeeve‘s pattern search method, Powell‘s conjugate direction method, Gradient based method, Cauchy‘s Steepest descent method, Newton‘s method, Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method

Unit V-Intelligent Optimization Techniques

Introduction to Intelligent Optimization, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO), Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Text books& References:

1. Engineering Optimization (4th Edition) by S.S.Rao, New Age International, 2014
2. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers 2014
3. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers, 2015
4. Operations Research by Hillar and Liberman, TMH Publishers, 2018
5. Optimal design – JasbirArora, McGraw Hill (International) Publishers, 2020

Course Code: **MEES543** **Breakup: 3 –0 – 0 – 3**

Course Name: **Oil Hydraulic and Pneumatics**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1. Identify and analyse the functional requirements of a power transmission system for a given application. (Application involving fluid power transmission)

CO2. Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application. Develop a circuit diagram.

CO3. Visualize how the hydraulic/pneumatic circuit will work to accomplish the function.

CO4. Selection and sizing of components of the circuit.

Course Details:

Unit I

Introduction: Introduction, Global fluid power Scenario, Basic system of Hydraulics-Major advantages and disadvantages, Principles of Hydraulic Fluid power, Hydraulic Symbols, Electrical Elements used in hydraulic circuits.

Unit II

System Components, Hydraulic Oils, Fluid Properties and Filter: Hydraulic & Pneumatic Symbols as per ISO/ANSI, Types, Properties, physical characteristics & functions of hydraulic Oils, Classification- Mineral based, Fire resistant& Biodegradable Oils, Filters, Contaminations, location of filter. Hydraulic Pumps, Motors and Actuators: Construction, working principle and operation of rotary & reciprocating pumps like Gear, Vane, Generated-Rotor, Screw, Axial Piston, Radial Piston, Pump characteristics, Linear and Rotary Actuators, Hydrostatic Transmission Systems. Selection of components for applications.

Unit III

Hydraulic Valves and Hydraulic System Accessories: Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses. Selection of valves for circuits. Design of hydraulic circuits: Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits.

Unit IV

Introduction to Pneumatic Systems: Basic Requirements for Pneumatic System, Applications, Pneumatic fundamentals, Construction, working principle and operation of pneumatic power transmission system components like Power source, FRL unit, Actuators and control valves like DCV, FCV, PCV, time delay, quick exhaust, twin pressure, shuttle.

Unit V

Pneumatic circuits: Basic pneumatic circuits, Development of single Actuator Circuits, Development of multiple Actuator Circuits, Cascade method for sequencing. Introduction to Automation in hydraulic and Pneumatic Systems.

Text books& References:

1. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw Hill.
2. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
3. Fluid Power with Applications by Anthony Esposito, Pearson.
4. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
5. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.
6. Control of Fluid Power Analysis and Design by Mc Clay Donaldson, Ellis Horwood Ltd

Course Code: **MEES551** **Breakup: 3 –0 – 0 – 3**

Course Name: **Finite Element Methods**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	To develop some experience with a commercial FEM code and some practical modeling exercises.
CO2	To analyze the displacement-based finite element method for displacement and stress a0lysis and to introduce related analytical and computer tools.

CO3	To use 1-D and 2D element stiffness matrices and load vectors from various methods to solve for displacements and stresses calculations.
CO4	To understand Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal's triangle , primary and secondary variables, properties of shape functions
CO5	To interpret approximate future of the finite element method and convergence of results are examined

Course Details:

Unit I

Introduction to FEM, engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packagespreprocessor, solver and post processor. Principles of Elasticity: Strain displacement relations, Stressstrain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions, Introduction to Numerical Methods, Potential energy method, RayleighRitz method and Galerkin methodapplied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.

Unit II

One Dimensional Element: Formulation of a linear bar element, Shape Functions Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary

Unit III

Trusses and Beams: Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, stiffness matrix and load vector (No derivations), Numerical Problems on beams carrying concentrated, UDL and couples. (Problems with 2 elements only)

Unit IV

Two dimensional Element: Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Lagrangian and serendipity elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymmetric– triangular elements. Convergence criteria, pascal triangle. (No numerical problems)

Unit V

Dynamic considerations and Heat Transfer: Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars. Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governi

Text Books and References:

Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
4. J.N.Reddy, "Finite Element Method" McGraw Hill International Edition.

Course Code: MEES552 **Breakup: 3 –0 – 0 – 3**

Course Name: Computational Fluid Dynamics

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1	To help the students understand the fundamentals and relevance of fluid mechanics in the broader context of engineering sciences in general.
CO2	To enable students to understand fluid properties and apply laws of fluid mechanics and analyze fluid flows .
CO3	To empower students with the expertise of experimentation, simulation and the fundamental concepts .
CO4	To expose students to a wide variety of research areas and concerns in and around fluid mechanics such as energy, health etc. across multidisciplinary domains.
CO5	To equip students with necessary engineering skills such as solving engineering problems in a professional way.

Course Details:

Unit I

Introduction: Introduction to C.F.D., comparison of the three basic approaches in engineering problem solving analytical, experimental and computational; models of the flow, substantial derivative, governing equations continuity equation, momentum equation, energy equation, Navier-Stokes equation; physical boundary conditions.

Mathematical behavior of governing equations: classification of quasi linear partial differential equations, general method of determining the classification of partial differential equations, general behavior of hyperbolic, parabolic, elliptic equations.

Unit II

Discretization: Introduction, finite difference method, difference equations, explicit and implicit approaches, error and stability analysis, Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

Unit III

Heat Conduction: control volume formulation of one-dimensional steady state diffusion, unsteady one dimensional diffusion, two and three dimensional diffusion problems, over and under relaxation.

Convection & Diffusion: Steady one-dimensional convection and diffusion, central differencing scheme, upwind differencing scheme, exact solution, exponential, hybrid, and power law schemes, discretization equations for two dimensions & three dimensions.

Unit IV

Simple CFD Techniques: Lax-Wendroff technique, MacCormacks technique, space marching, relaxation technique, pressure correction technique, SIMPLE algorithm.

Fluid Flow: CFD solution of subsonic-supersonic isentropic nozzle flow, solution of incompressible Couette flow problem by F.D.M., solution of Navier-Stokes equations for incompressible flows using MAC and SIMPLE methods.

Text books & References:

1. John D Anderson, Jr., Computational Fluid Dynamics -The Basics with Applications, McGraw Hill, 1995.

2. H. K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Longman Scientific and Technical, 1995.
3. Joel H. Ferziger and MilovanPeric, Computational Method for Fluid Dynamics, 3rd Edition, Springer, 2002.
4. Dale A. Anderson, John C. Tannehill and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, 2nd Edition, Taylor and Francis, 1984.

Course Code: MEES553 **Breakup: 3 –0 – 0 – 3**
Course Name: Non Destructive Testing

Course Outcomes (CO): At the end of the course, the student will be able to:
CO1: Apply the various NDT techniques to identify the defects
CO2: Select the suitable NDT techniques for various defects
CO3: Identifying the nature and quantifying the defects
CO4: Understand the instruments and interpretation on techniques

Course Details:

Unit I

Introduction: Non-Destructive testing – Relative Merits and Limitations – NDT vs Mechanical testing. Dry technique and Wet technique – Principle – Applications – Advantages and Limitations.Dyes – Developers – Cleaners. Fluorescent penetrant test.Liquid penetrant inspection.

Radiography: X-rays and Gamma rays, Properties of X-rays relevant to NDT – Absorption of rays – scattering. Types and use of Filters – screens – Geometric factors, Film type and Processing. Characteristics of films graininess, Density, Speed, Contrast. Characteristic curves. Characteristics of Gamma rays – fluoroscopy – X-ray – Radiography.Safety with X-rays and Gamma rays.

Unit II

Ultrasonic Testing: Types of Ultrasonic Waves – Principles of wave propagation – Characteristics of ultrasonic waves – Attenuation. Production of ultrasonic waves – Couplants. Inspection methods – pulse echo, Transmission and Resonance techniques. Thickness measurement.Types of scanning. Test block – Reference blocks.

Unit III

Techniques for Specific Purposes: Magnetic particle inspection – Principles – Applications – Magnetization methods – Magnetic particles, demagnetization. Eddy current testing – Thermal inspection Principle, Application – Instrumentation of Thermal Inspection. Holography.Acoustic Emission.Pressure and Leak Testing.Chemical Spot Testing. Spark Testing.

Course Code: **MEES554** **Breakup: 3 –0 – 0 – 3**
Course Name: **Control System**

Course Outcomes (CO): At the end of the course, the student will be able to:

CO1 Evaluate the effective transfer function of a system from input to output using (i) block diagram reduction techniques (ii) Mason's gain formula

CO2 Compute the steady state errors and transient response characteristics for a given system and excitation

CO3 Determine the absolute stability and relative stability of a system

CO4 Draw root loci

CO5 Design a compensator to accomplish desired performance

CO6 Derive state space model of a given physical system and solve the state equation

Course Details

Unit -I

Introduction Open Loop and closed loop control systems and their differences- Examples of control systemsClassification of control systems, Feedback Characteristics, Effects of positive and negative feedback. Mathematical models - Differential equations of Translational and Rotational mechanical systems, and Electrical Systems, Block diagram reduction methods - Signal flow graph - Reduction using Mason's gain formula. Transfer Function of DC Servo motor - AC Servo motor - Synchro transmitter and Receiver

Unit –II

Time Response Analysis Step Response - Impulse Response - Time response of first order systems - Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications - Steady state response - Steady state errors and error constants

Unit – III

Stability The concept of stability - Routh's stability criterion - Stability and conditional stability - limitations of Routh's stability. The root locus concept - construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci.

Unit – IV

Frequency Response Analysis Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Stability Analysis from Bode Plots. Polar Plots-Nyquist Plots- Phase margin and Gain margin-Stability Analysis. Compensation techniques - Lag, Lead, Lag-Lead Compensator design in frequency Domain.

Unit - V

State Space Analysis Concepts of state, state variables and state model, derivation of state models from differential equations. Transfer function models. Block diagrams. Diagonalization. Solving the Time invariant state Equations- State Transition Matrix and it's Properties. System response through State Space models. The concepts of controllability and observability.

Text Books:

1. Modern Control Engineering - by Katsuhiko Ogata - Prentice Hall of India Pvt. Ltd., edition, 2010.

2. 5th Control Systems Engineering - by I. J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers, 5th edition, 2007.

Reference Books:

1. Control Systems Principles & Design 4th Edition, M.Gopal, Mc Graw Hill Education, 2012.

2. Automatic Control Systems- by B. C. Kuo and Farid Golnaraghi - John wiley and son's, 8th edition, 2003.

3. Control Systems 3rd Edition, Joseph J Distefano III, Allen R Stubberud & Ivan J Williams, Schaum's Mc Graw Hill Education.

4. John J D'Azzo and C. H. Houpis, "Linear Control System Analysis and Design Conventional and Modern", Mc Graw Hill Book Company1998