RSET
RAJAGIRI SCHOOL OF
ENGINEERING & TECHNOLOGY
(AUTONOMOUS)

Department of Mechanical Engineering

RSET VISION

To evolve into a premier technological and research institution, moulding eminent professionals with creative minds, innovative ideas and sound practical skill, and to shape a future where technology works for the enrichment of mankind.

RSET MISSION

To impart state-of-the-art knowledge to individuals in various technological disciplines and to inculcate in them a high degree of social consciousness and human values, thereby enabling them to face the challenges of life with courage and conviction.

DEPARTMENT VISION

To evolve into a centre of excellence by imparting professional education in mechanical engineering with a unique academic and research ambience that fosters innovation, creativity and excellence.

DEPARTMENT MISSION

- *To have state-of-the-art infrastructure facilities.*
- *To have highly qualified and experienced faculty from academics, research organizations and industry.*
- *To develop students as socially committed professionals with sound engineering knowledge, creative minds, leadership qualities and practical skills.*

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Demonstrate the ability to analyse, formulate and solve/design engineering/real life problems based on his/her solid foundation in mathematics, science and engineering..

PEO 2: Showcase the ability to apply their knowledge and skills for a successful career in diverse domains viz., industry/technical, research and higher education/academia with creativity, commitment and social consciousness.

PEO 3: Exhibit professionalism, ethical attitude, communication skill, team work, multidisciplinary approach, professional development through continued education and an ability to relate engineering issues to broader social context.

PROGRAMME OUTCOMES

1) **Engineering Knowledge:** Apply the knowledge of Mathematics, Science, Engineering fundamentals, and Mechanical Engineering to the solution of complex engineering problems.
2) **Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences.
3) **Design/development of solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4) **Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5) **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
6) **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.
7) **Environment and sustainability:** Understand the impact of the professional Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.
8) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.
9) **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10) **Communication:** Communicate effectively on complex Engineering activities with the Engineering Community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11) **Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
12) **Life -long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

Mechanical Engineering Programme Students will be able to:

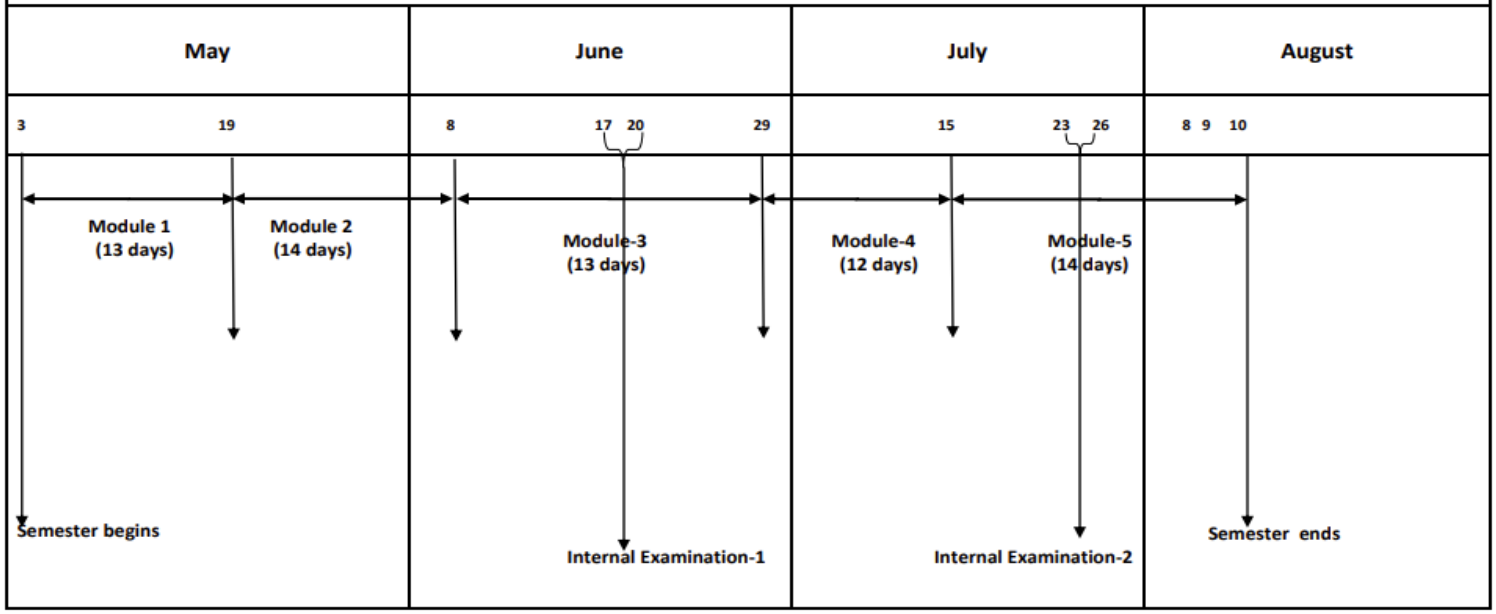
1) Apply their knowledge in the domain of engineering mechanics, thermal and fluid sciences to solve engineering problems utilizing advanced technology.
2) Successfully apply the principles of design, analysis and implementation of mechanical systems/processes which have been learned as a part of the curriculum.
3) Develop and implement new ideas on product design and development with the help of modern CAD/CAM tools, while ensuring best manufacturing practices.

SEMESTER PLAN

RSET
RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)

SEMESTER PLAN (S2/S4)

MAY 2022 – AUGUST 2022



May: 21 **June: 23** **July: 21** **August: 7**

Total no of working days: 72

Total no of instructional days: 66

ASSIGNMENT SCHEDULE	
Week 4	100902/MA400A PROBABILITY, STATISTICS AND NUMERICAL METHODS
Week 5	100006/ME400B ENGINEERING THERMODYNAMICS
Week 7	100006/ME400C MANUFACTURING PROCESS
Week 8	100006/ME400D FLUID MACHINERY
Week 9	100908/EN900E PROFESSIONAL ETHICS
Week 11	100908/ES400F CONSTITUTION OF INDIA
Week 11	100902/MA400A PROBABILITY, STATISTICS AND NUMERICAL METHODS
Week 12	100006/ME400B ENGINEERING THERMODYNAMICS
Week 12	100006/ME400C MANUFACTURING PROCESS
Week 13	100006/ME400D FLUID MACHINERY
Week 13	100908/EN900E PROFESSIONAL ETHICS
Week 14	100908/ES400F CONSTITUTION OF INDIA

SCHEME

Code	Subject	Hours/week			Marks		End-semester duration (hours)	Credits
		L	T	P/D	Internal	End-semester		
100902/MA400A	PROBABILITY, STATISTICS AND NUMERICAL METHODS	3	1	0	50	100	3	4
100006/ME400B	ENGINEERING THERMODYNAMICS	3	1	0	50	100	3	4
100006/ME400C	MANUFACTURING PROCESS	3	1	0	50	100	3	4
100006/ME400D	FLUID MACHINERY	3	1	0	50	100	3	4
100908/EN900E	PROFESSIONAL ETHICS	2	0	0	50	100	3	2
100908/ES400F	CONSTITUTION OF INDIA	2	0	0	50	100	3	Pass/Fail
100006/ME422S	FLUID MECHANICS AND HYDRULIC MACHINES LAB	0	0	3	75	75	2.5	2
100006/ME422T	100006/ME422T MACHINE TOOLS LAB-I	0	0	3	75	75	2.5	2
	Total	26						22

4. 101902/MA400A PROBABILITY, STATISTICS AND NUMERICAL METHODS

4.1 COURSE INFORMATION SHEET

PROGRAMME:**MECHANICAL ENGINEERING**	DEGREE: **BTECH**
COURSE: Probability, Statistics & Numerical Methods	**SEMESTER:** 4 **CREDITS:** 4
COURSE CODE: 101902/MA400A **REGULATION:** UG	**COURSE TYPE:** Core
COURSE AREA/DOMAIN: Mathematics	**CONTACT HOURS:** 3(LECTURE) + 1(TUTORIAL) HOUR/WEEK
CORRESPONDING LAB COURSE CODE (IF ANY):NIL	**LAB COURSE NAME:**NIL

SYLLABUS:

MODULE	CONTENTS	HOURS
I	**Discrete probability distributions** Discrete random variables and their probability distributions, expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation - multiple random variables.	9
II	**Continuous probability distributions** Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation-multiple random variables, i.i.d random variables and Central limit theorem (without proof).	9
III	**Statistical inference** Population and samples, Sampling distribution of the mean and proportion (for large samples only), Confidence interval for single mean and single proportions (for large samples only). Test of	9

	hypotheses: Large sample test for single mean and single proportion, equality of means and equality of proportions of two populations, small sample t-tests for single mean of normal population, equality of means (only pooled t-test, for independent samples from two normal populations with equal variance)	
IV	**Numerical methods -I** Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Newton's forward and backward differencemethod, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (Proof or derivation of the formulae not required for any of the methods in this module)	9
V	**Numerical methods -II** Solution of linear Systems-Gauss-Seidel and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams Moulton predictor-corrector method (Proof or derivation of the formulae not required for any of the methods in this module	9

TEXT/REFERENCE BOOKS:

T/R	*BOOK TITLE/AUTHOR/PUBLICATION*
T1	Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8 th edition, Cengage, 2012
T2	Erwin Kreyszig, Advanced Engineering Mathematics, 10 th Edition, John Wiley& Sons, 2016
R1	V. Sundarapandian, "Probability, Statistics and Queuing theory", PHI Learning, 2009.
R2	C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics"-Sixth Edition.
R3	T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill,2008
R4	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition,2010

COURSE PRE-REQUISITES: NIL

C.CODE	COURSE NAME	DESCRIPTION	SEM
-	-	-	-

COURSE OBJECTIVES:

1	To introduce students to the modern theory of probability and statistics, covering important models of random variables and techniques of parameter estimation and hypothesis testing
2	To familiarize students with basic numerical techniques for finding roots ofequations, evaluating definite integrals solving systems of linear equations
3	To understand numerical techniques for solving ordinary differential equationswhich are especially useful when analytical solutions are hard to find

COURSE OUTCOMES:

Sl. NO	DESCRIPTION	Blooms' Taxomomy Level
CO1	**Understand** the concept, properties and important models of discrete random variables and,using them, analyse suitable random phenomena.	Understand (Level 2)
CO 2	**Understand** the concept, properties and important models of continuous random variables and, using them, analyse suitable random phenomena.	Understand (Level 2)
CO 3	**Perform** statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population	Apply (Level 3)
CO 4	**Compute** roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques	Evaluate (Level 5)
CO 5	**Apply** standard numerical techniques for solvingsystems of equations, fitting curves on given numerical data and solving ordinary differential equations.	Apply (Level 3)

CO-PO AND CO-PSO MAPPING

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

1- Low correlation (Low), 2- Medium correlation(Medium) , 3-High correlation(High)

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM /HIGH	JUSTIFICATION
CO 1-PO 1	3	Apply the knowledge of discrete random variables tothe solution of complex engineering problems.
CO 1-PO 2	2	Identify and analyze complex engineering problems, reaching substantiated conclusions using discrete random variables.
CO 1-PO 3	2	Design solutions for complex engineering problems, using them, analyse suitable random phenomena.
CO 1-PO 4	2	Use research-based knowledge and synthesis of the information to provide valid conclusions.
CO 1-PO 5	2	Create, select, and apply the idea in complex engineering activities with an understanding of the limitations.
CO 1-PO 10	2	Communicate effectively on complex engineering activities with the engineering community and with society .
CO 1-PO 12	1	Recognize the need for, and ability to engage in independent and life-long learning in the broadest context of technological change.
CO 2-PO 1	3	Apply the knowledge of continuous random variables to understand the concept.
CO 2-PO 2	2	Understand the important models of continuous random variables and analyze complex engineering problems .
CO 2-PO 3	2	Using the properties of continuous random variables, design processes that meet the specified needs with appropriate consideration.

CO 2-PO 4	2	Use research-based knowledge and research methodsincluding design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
CO 2-PO 5	2	Create probability tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
CO 2-PO 10	2	Understand the concept to communicate effectively on complex engineering activities with the engineering community
CO 2-PO 12	1	Recognize ability to engage in independent and life-long learning in the broadest context of technological change**.**
CO 3-PO 1	3	Apply the knowledge of engineering fundamentals, and an engineering specialization to the solution of complex engineering problems**.**
CO 3-PO 2	2	Formulate complex engineering problems reaching substantiated conclusions using engineering sciences.
CO 3-PO 3	2	Design solutions for complex engineering problems by performing statistical inferences based on attributes of samples drawn from the population.
CO 3-PO 4	2	Use research methods including analysis and interpretation of data based on attributes of samples.
CO 3-PO 5	2	Select appropriate techniques and modeling to complex engineering activities with an understanding of the limitations.
CO 3-PO 10	2	Communicate effectively on complex engineering activities with the engineering community to make effective presentations, and give and receive clear instructions.
CO 3-PO 12	1	Recognize the need for, and have the preparation in the broadest context of technological change.
CO 4-PO 1	3	Apply the knowledge of numerical techniques in the specialization to the solution of complex engineering problems.
CO 4-PO 2	2	Analyse complex engineering problems reaching substantiated conclusions using standard numericaltechniques.
CO 4-PO 3	2	Design solutions for complex engineering problemsusing definite integral.
CO 4-PO 4	2	Interpretation of data and perform interpolation ongiven numerical data

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
CO 4-PO 5	2	Apply appropriate numerical techniques for complex engineering activities with an understanding of the limitations.
CO 4-PO 10	2	Communicate effectively on complex engineering activities with the engineering community and perform interpolation on given numerical data
CO 4-PO 12	1	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning by evaluating definite integrals
CO 5-PO 1	3	Apply the knowledge of ordinary differential equationsto the solution of complex engineering problems.
CO 5-PO 2	2	Identify and apply standard numerical techniques for solving complex engineering problems reaching substantiated conclusions
CO 5-PO 3	2	Design processes that meet the specified needs with appropriate consideration for the public health and safety.
CO 5-PO 4	2	Interpretation of data, and synthesis of the informationto provide valid conclusions using fitting of data.
CO 5-PO 5	2	Apply appropriate techniques to complex engineeringactivities with an understanding of the limitations.

CO 5-PO 10	2	Write effective reports and design documentation, make effective presentations, and give and receiveclear instructions.
CO 5-PO 12	1	Ability to engage in independent and life-longlearning using standard numerical techniques
CO1-PSO1	3	Apply the knowledge in the domain of engineering mechanics, thermal and fluid sciences using the concept of discrete random variable.
CO2-PSO2	2	Successfully apply the principles of design,analysis and implementation of mechanical processes by using the concept of probability.
CO3-PSO1	3	Based on attributes of samples drawn from the population to solve engineering problems utilizing advanced technology.
CO4-PSO3	2	Develop and implement new ideas on product design and development with the help of modern CAD/CAM tools and perform interpolation on given numerical data using standard numerical techniques
CO5-PSO1	3	Apply standard numerical techniques for thermal and fluid sciences to solve engineering problems utilizing advanced technology.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SI NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	Application of random variables and probability models to solve problems in engineering	Reading	PO5	
2	Applications of numerical methods in solving engineering problems	Reading	PO1 & 2	
	Use of computer programs to	Reading &	PO5	

3	implement statistical models and numerical methods	Assignment		

Proposed actions for Topic beyond syllabus: Assignment

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

N0	Topic	Relevance to PO
1	Advanced numerical methods used in the student's area of specialization	PO 2 & 4
2	Probability models and hypothesis testing methods used for quality control in the student's area of specialization	PO 1,2 & 4

WEB SOURCE REFERENCES:

1	Numerical Methods in Civil Engineering - https://nptel.ac.in/courses/105/105/105105043/
2	Mathematical Methods in Engineering and Sciencehttps://nptel.ac.in/courses/112/104/112104035/
3	Probability Methods in Civil Engineering https://nptel.ac.in/courses/105/105/105105045/#

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ **CHALK & TALK**	☑ **STUD. ASSIGNMENT**	☐WEB RESOURCES
☐ LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES

ASSESSMENT METHODOLOGIES-DIRECT

☑ **ASSIGNMENTS**	☐ STUD. SEMINARS	☑ **TESTS/MODEL EXAMS**	☑ **UNIV. EXAMINATION**
☐STUD. LAB PRACTICES	☐ STUD. VIVA	☐MINI/MAJOR PROJECTS	☑ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ **STUDENT FEEDBACK ON FACULTY (TWICE)**
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

4.2 COURSE PLAN

DAY	MODULE	TOPIC PLANNED
1	1	DISCRETE RANDOM VARIABLES
2	1	PDF
3	1	CUMULATIVE DF
4	1	BINOMIAL DISTRIBUTION
5	1	POISSON APPROXIMATION TO BD
6	1	MEAN AND VARIANCE OF PD
7	2	CONTINUOUS DISTRIBUTIONS
8	2	PROBABILITY DENSITY FUNCTIONS, CUMULATIVE DENSITY FUNCTIONS
9	2	MEAN AND VARIENCE, NORMAL DISTRIBUTION
10	2	PROBLEMS
11	2	UNIFORM DISTRIBUTION
12	2	EXPONENTIAL DISTRIBUTION
13	2	PROBLEMS
14	2	NORMAL DOSRUBUTION
15	2	PROBLEMS
16	2	CONTINUOUS BIVARIATE DISTRIBUTIONS
17	2	MARGINAL DISTRIBUTIONS
18	2	INDEPENDENT RANDOMVARIABLES
19	2	EXPECTATION-MULTIPLE RANDOM VARIABLES
20	2	I.I.D RANDOM VARIABLES
21	2	CENTRAL LIMIT THEOREM (WITHOUT PROOF).

22	3	POPULATION AND SAMPLES,
23	3	SAMPLING DISTRIBUTION OF THE MEAN
24	3	SAMPLING DISTRIBUTION OF THE PROPORTION
25	3	PROBLEMS
26	3	CONFIDENCE INTERVAL FOR SINGLE MEAN AND SINGLE PROPORTIONS (FOR LARGE SAMPLES ONLY).
27	3	CONFIDENCE INTERVAL FOR SINGLE MEAN AND SINGLE PROPORTIONS (FOR LARGE SAMPLES ONLY).
28	3	PROBLEMS
29	3	TEST OF HYPOTHESES: LARGE SAMPLE TEST FOR SINGLE MEAN
30	3	TEST OF HYPOTHESES: LARGE SAMPLE TEST FOR SINGLE PROPORTION
31	3	EQUALITY OF MEANS AND EQUALITY OF PROPORTIONS OF TWO POPULATION
32	3	PROBLEMS
33	3	SMALL SAMPLE T-TESTS FOR SINGLE MEAN OF NORMAL POPULATION,
34	3	EQUALITY OF MEANS (ONLY POOLED T-TEST, FOR INDEPENDENT SAMPLES FROM TWO NORMAL POPULATIONS WITH EQUAL VARIANCE)
35	3	PROBLEMS
36	4	ERRORS IN NUMERICAL COMPUTATION-ROUND-OFF, TRUNCATION AND RELATIVE ERROR,
37	4	SOLUTION OF EQUATIONS – NEWTON-RAPHSON METHOD
38	4	SOLUTION OF EQUATIONS – REGULA-FALSI METHOD
39	4	INTERPOLATION-FINITE DIFFERENCES, NEWTON'S FORWARD AND BACKWARD DIFFERENCEMETHOD,

40	4	INTERPOLATION-FINITE DIFFERENCES, NEWTON'S FORWARD AND BACKWARD DIFFERENCEMETHOD,
41	4	NEWTON'S DIVIDED DIFFERENCE METHOD
42	4	LAGRANGE'S METHOD.
43	4	PROBLEMS
44	4	NUMERICAL INTEGRATION-TRAPEZOIDAL RULE
45	4	NUMERICAL INTEGRATION- SIMPSON'S 1/3RD RULE
46	4	PROBLEMS
47	5	SOLUTION OF LINEAR SYSTEMS-GAUSS-SEIDEL METHOD
48	5	SOLUTION OF LINEAR SYSTEMS- JACOBI ITERATION METHODS
49	5	CURVE FITTING-METHOD OF LEAST SQUARES, FITTING STRAIGHT LINES
50	5	CURVE FITTING-METHOD OF LEAST SQUARES, PARABOLAS
51	5	SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS-EULER METHOD
52	5	SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS-R K METHOD
53	5	ADAMS MOULTON PREDICTOR-CORRECTOR METHOD
54	5	PROBLEMS

4.3 MODULE WISE SAMPLE QUESTIONS

Module 1

1. If the random variable X takes the values 1,2,3 and 4 such that 2P (X = 1) = 3P (X = 2) = P (X = 3) = 5P (X = 4), find the probability distribution and cumulative distribution function of X.
2. Suppose that the probabilities are 0.4, 0.3, 0.2, and 0.1 that there will be 0, 1, 2, or 3 power failures in a certain city during the month of July. Find the mean and variance of this probability distribution.
3. During one stage in the manufacture of integrated circuit chips, a coating must be applied.

If 70 %of chips receive a thick enough coating, use Binomial distribution to find the probabilities that, among 15 chips

4. at least 12 will have thick enough coating;
5. at most 6 will have thick enough coating;
6. exactly 10 will have thick enough coating.
7. In an examination, a candidate has to answer 15 multiple choice questions each of which has 4 choices for the answer. He knows the correct answer to 10 questions and for the remaining 5 questions he chooses the answer randomly.
8. What is the probability that he answers 13 or more questions correctly?
9. What is the mean and variance of the number of correct answers he gives?
10. A complex electronic system is built with a certain number of backup components in its subsystems. One subsystem has four identical components, each with a probability of 0.2 of failing in less than 1000 hours. The subsystem will operate if any two of the four components are operating. Assume that the components operate independently. Find the probability that
11. exactly two of the four components last longer than 1000 hours.
12. the subsystem operates longer than 1000 hours.
13. If the sum of the mean and variance of a binomial distribution for 5 trials is 1.8, find the probability distribution function.
14. The probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing (i) at least 2 (ii) exactly 2 (ii) at most 2 defective items in a consignment of 1000 packets using Poisson distribution.
15. Customers arrive at a counter at an average of 1.5 per minute. Find the probability that:
16. at most 4 will arrive in any given minute
17. at least 3 will arrive during an interval of 2 minutes
18. A service station has both self-service and full-service islands. On each island, there is a single regular unleaded pump with two hoses. Let X denote the number of hoses being

used on the self-service island at a particular time, and let Y denote the number of hoses on the full-service island in use at that time. The joint pmf of X and Y appears in the accompanying tabulation.

		y		
p(x,y)		0	1	2
x	0	0.1	0.04	0.02
	1	0.08	0.2	0.06
	2	0.06	0.14	0.30

19. What is P (X = 1andY = 1)?
20. Compute P (X ≤ 1) and P (Y ≤ 1).
21. Compute the marginal pmf of X and of Y.
22. Are X and Y independent random variables? Explain.
23. An instructor has given a short quiz consisting of two parts. For a randomly selected student, let X be the number of points earned on the first part and Y be the number of points earned on the second part. Suppose that the joint pmf of X and Y is given in the accompanying table.

		y			
p(x,y)		0	5	10	15
x	0	0.02	0.06	0.02	0.1
	5	0.04	0.15	0.2	0.1
	10	0.01	0.15	0.14	0.01

24. If the score recorded in the grade book is the total number of points earned on the two parts, what is the expected recorded score E (X + Y)?
25. If the maximum of the two scores is recorded, what is the expected recorded score?
26. Module-2: Continuous Probability Distributions
27. What can you say about P (X = a) for any real number a when X is a (i) discrete random variable? (ii) continuous random variable?
28. A string, 1-meter-long, is cut into two pieces at a random point between its ends. What is the probability that the length of one piece is at least twice the length of the other?

29. A random variable has a normal distribution with standard deviation 10. If the probability that it will take on a value less than 82.5 is 0.82, what is the probability that it will take on a value more than 58.3?
30. X and Y are independent random variables with X following an exponential distribution with parameter μ
31. and Y following and exponential distribution with parameter λ. Find P (X + Y ≤ 1).
32. Suppose the force acting on a column that helps to support a building is normally distributed with mean
33. 15.0 kips and standard deviation 1.25 kips. What is the probability that the force?
34. Is at most 18 kips?
35. Is between 10 and 12 kips?
36. Differs from 15.0 kips by at most 1.5 standard deviations?
37. The article "Reliability of Domestic-Waste Biofilm Reactors" (J. of Envir. Engr., 1995: 785–790) suggests that substrate concentration (mg/cm3) of influent to a reactor is normally distributed with mean = .30 and SD = .06.
38. What is the probability that the concentration exceeds .25?
39. What is the probability that the concentration is at most .10?
40. How would you characterize the largest 5% of all concentration values?
41. The weight distribution of parcels sent in a certain manner is normal with mean value 12 lb and standard deviation 3.5 lb. The parcel service wishes to establish a weight value c beyond which there will be a surcharge. What value of c is such that 99% of all parcels are at least 1 lb under the surcharge weight?
42. Let X denote the distance (m) that an animal moves from its birth site to the first territorial vacancy it encounters. Suppose that for banner-tailed kangaroo rats, X has an exponential distribution with parameter λ = .01386 (as suggested in the article "Competition and Dispersal from Multiple Nests," Ecology, 1997: 873–883).
43. What is the probability that the distance is at most 100 m? At most 200 m? Between 100 and 200 m?

44. What is the probability that distance exceeds the mean distance by more than 2 standard deviations?
45. What is the value of the median distance?
46. A consumer is trying to decide between two long-distance calling plans. The first one charges a flat rate of 10¢ per minute, whereas the second charges a flat rate of 99¢ for calls up to 20 minutes in duration and then 10¢ for each additional minute exceeding 20 (assume that calls lasting a non-integer number of minutes are charged proportionately to a whole-minute's charge). Suppose the consumer's distribution of call duration is exponential with parameter λ.
47. Which plan is better if expected call duration is 10 minutes? 15 minutes?
48. Let X1, X2, ..., X100 denote the actual net weights of 100 randomly selected 50-lb bags of fertilizer.
49. If the expected weight of each bag is 50 and the variance is 1, calculate P (49.9 ≤ X ≤ 50.1)
50. If the expected weight is 49.8 lb rather than 50 lb so that on average bags are underfilled, calculate
51. P (49.9 ≤ X ≤ 50.1).
52. Let X be the total medical expenses (in 1000s of dollars) incurred by a particular individual during a given year. Although X is a discrete random variable, suppose its distribution is quite well approximated by a continuous distribution with pdf f (x) = k (1 + x/2.5) −7, x ≥ 0.
53. What is the value of k?
54. What are the expected value and standard deviation of total medical expenses?
55. This individual is covered by an insurance plan that entails a $ 500 deductible provision (so the first $ 500 worth of expenses are paid by the individual). Then the plan will pay 80% of any additional expenses exceeding $ 500, and the maximum payment by the individual (including the deductible amount) is $ 2500. Let Y denote the amount of this individual's medical expenses paid by the insurance company. What is the expected value of Y?

56. A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find P (X < 0).
57. The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time.
58. The time X (min) for a lab assistant to prepare the equipment for a certain experiment is believed to have a uniform distribution with A = 25 and B = 35.
59. Determine the pdf of X and sketch the corresponding density curve.
60. What is the probability that preparation time exceeds 33 min?
61. What is the probability that preparation time is within 2 min of the mean time? d. For any a such that
62. $25 \leq a \leq a + 2 \leq 35$, what is the probability that preparation time is between a & a + 2 min?
63. Extensive experience with fans of a certain type used in diesel engines has suggested that the exponential distribution provides a good model for time until failure. Suppose the mean time until failure is 25,000 hours. What is the probability?
64. A randomly selected fan will last at least 20,000 hours? At most 30,000 hours? Between 20,000 and 30,000 hours?
65. The lifetime of a fan exceeds the mean value by more than 2 standard deviations? More than 3 standard deviations?
66. The automatic opening device of a military cargo parachute has been designed to open when the parachute is 200 m above the ground. Suppose opening altitude actually has a normal distribution with mean value 200 m and standard deviation 30 m. Equipment damage will occur if the parachute opens at an altitude of less than 100 m. What is the probability that there is equipment damage to the payload of at least one of five independently dropped parachutes?
67. Suppose the diameter at breast height (in.) of trees of a certain type is normally distributed with mean

68. 8.8 and SD 2.8, as suggested in the article "Simulating a Harvester-Forwarder Softwood Thinning" (Forest Products J., May 1997: 36–41).
69. What is the probability that the diameter of a randomly selected tree will be at least 10 in.? Will exceed 10 in.?
70. What is the probability that the diameter of a randomly selected tree will exceed 20 in.?
71. What is the probability that the diameter of a randomly selected tree will be between 5 and 10 in.?
72. What value c is such that the interval (8.8 c, 8.8 c) includes 98% of all diameter values?
73. The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130.
74. The article "Monte Carlo Simulation—Tool for Better Understanding of LRFD" (J. Structural Engr., 1993: 1586–1599) suggests that yield strength (ksi) for A36 grade steel is normally distributed with mean = 43 and SD = 4.5.
75. What is the probability that yield strength is at most 40? Greater than 60?
76. What yield strength value separates the strongest 75% from the others?
77. You have two lightbulbs for a particular lamp. Let X be the lifetime of the first bulb and Y be the lifetime of the second bulb (both in 1000s of hours). Suppose that X and Y are independent and that each has an exponential distribution with parameter $\lambda = 1$.
78. What is the joint pdf of X and Y?
79. What is the probability that each bulb lasts at most 1000 hours?
80. What is the probability that the total lifetime of the two bulbs is at most 2?
81. What is the probability that the total lifetime is between 1 and 2?
82. The inside diameter of a randomly selected piston ring is a random variable with mean value 12 cm and standard deviation .04 cm.
83. If $\bar{X}$ is the sample mean diameter for a random sample of n = 64 rings, where is the sampling distribution of $\bar{X}$ centered, and what is the standard deviation of the $\bar{X}$ distribution?

84. Suppose the sediment density (g/cm) of a randomly selected specimen from a certain region is normally distributed with mean 2.65 and standard deviation .85 (suggested in "Modeling Sediment and Water Column Interactions for Hydrophobic Pollutants," Water Research, 1984: 1169–1174).
85. If a random sample of 25 specimens is selected, what is the probability that the sample average sediment density is at most 3.00? Between 2.65 and 3.00?
86. How large a sample size would be required to ensure that the first probability in part (a) is at least .99?

Module 3

87. The article "Gas Cooking, Kitchen Ventilation, and Exposure to Combustion Products" (Indoor Air, 2006: 65–73) reported that for a sample of 50 kitchens with gas cooking appliances monitored during a one-week period, the sample mean CO2 level (ppm) was 654.16, and the sample standard deviation was 164.43. a. Calculate and interpret a 95% (two-sided) confidence interval for true average CO2 level in the population of all homes from which the sample was selected. b. Suppose the investigators had made a rough guess of 175 for the value of s before collecting data. What sample size would be necessary to obtain an interval width of 50 ppm for aconfidence level of 95%?
88. The article "Limited Yield Estimation for Visual Defect Sources" (IEEE Trans. on Semiconductor Manuf., 1997: 17–23) reported that, in a study of a particular wafer inspection process, 356 dies were examined by an inspection probe and 201 of these passed the probe. Assuming a stable process, calculate a 95% (two-sided) confidence interval for the proportion ofall dies that pass the probe.
89. A state legislator wishes to survey residents of her district to see what proportion of the electorate is aware of her position on using state funds to pay for abortions. a. What sample size is necessary if the 95% CI for p is to have a width of at most .10 irrespective of p? b. If the legislator has strong reason to believe that at least 2/3 of the electorate know of her position, how large a sample size would you recommend?
90. Before agreeing to purchase a large order of polyethylene sheaths for a particular type of high-pressure oil filled submarine power cable, a company wants to see conclusive evidence that the true standard deviation of sheath thickness is less than .05 mm. What

hypotheses should be tested, and why?

91. A mixture of pulverized fuel ash and Portland cement to be used for grouting should have a compressive strength of more than 1300 KN/m2. The mixture will not be used unless experimental evidence indicates conclusively that the strength specification has been met. Suppose compressive strength for specimens of this mixture is normally distributed with $\sigma = 60$. Let μ denote the true average compressive strength. a. What are the appropriate null and alternative hypotheses? b. Let X denote the sample average compressive strength for n = 10 randomly selected specimens. Consider the test procedure with test statistic X itself (not standardized). If x = 1340, should H_0 be rejected using a significance level of .01? [Hint: What isthe probability distribution of the test statistic when H_0 is true?]
92. The calibration of a scale is to be checked by weighing a 10-kg test specimen 25 times. Suppose that the results of different weighing are independent of one another and that the weight on eachtrial is normally distributed with $\sigma = .200$ kg. Let μ denote the true average weight reading on the scale. a. What hypotheses should be tested? b. With the sample mean itself as the test statistic, what is the P-value when x = 9.85, and what would you conclude at significance level .01?
93. Unlike most packaged food products, alcohol beverage container labels are not required to show calorie or nutrient content. The article "What Am I Drinking? The Effects of Serving Facts Information on Alcohol Beverage Containers" (J. of Consumer Affairs, 2008: 81–99) reported on a pilot study in which each of 58 individuals in a sample was asked to estimate the calorie content of a 12-oz can of beer known to contain 153 calories. The resulting sample mean estimated calorie level was 191 and the sample standard deviation was 89. Does this data

    suggest that the true average estimated calorie content in the population sampled exceeds the actual content? Test the appropriate hypotheses at significance level .001.
94. The recommended daily dietary allowance for zinc among males older than age 50 years is 15 mg/day. The article "Nutrient Intakes and Dietary Patterns of Older Americans: A National Study" (J. of Gerontology, 1992: M145–150) reports the following summary data on intake for a sample of males age 65–74 years: n = 115, x = 11.3, and $\sigma = 6.43$. Does this data indicate that average daily zinc intake in the population of all males ages 65–74 falls below the recommendedallowance?

95. The following observations are on stopping distance (ft) of a particular truck at 20 mph under specified experimental conditions ("Experimental Measurement of the Stopping Performance of a Tractor-Semitrailer from Multiple Speeds," NHTSA, DOT HS 811 488, June 2011): 32.1, 30.6,31.4, 30.4, 31.0, 31.9 The cited report states that under these conditions, the maximum allowable stopping distance is 30. A normal probability plot validates the assumption that stopping distance is normally distributed. Does the data suggest that true average stopping distanceexceeds this maximum value? Test the appropriate hypotheses using $\alpha = .01$.
96. Have you ever been frustrated because you could not get a container of some sort to release the last bit of its contents? The article "Shake, Rattle, and Squeeze: How Much Is Left in That Container?" (Consumer Reports, May 2009: 8) reported on an investigation of this issue for various consumer products. Suppose five 6.0 oz tubes of toothpaste of a particular brand are randomly selected and squeezed until no more toothpaste will come out. Then each tube is cut open and the amount remaining is weighed, resulting in the following data (consistent with what the cited article reported): .53, .65, .46, .50, .37. Does it appear that the true average amount left is less than 10% of the advertised net contents? a. Check the validity of any assumptions necessary for testing the appropriate hypotheses. b. Carry out a test of the appropriate hypotheses using a significance level of .05. Would your conclusion change if a significance level of .01 had been used?
97. A plan for an executive travelers' club has been developed by an airline on the premise that 5% of its current customers would qualify for membership. A random sample of 500 customers yielded 40 who would qualify. a. Using this data, test at level .01 the null hypothesis that the company's premise is correct against the alternative that it is not correct. b. What is the probability that when the test of part (a) is used, the company's premise will be judged correct when in fact 10% of all current customers qualify?
98. It is known that roughly 2/3 of all human beings have a dominant right foot or eye. Is there also right-sided dominance in kissing behavior? The article "Human Behavior: Adult Persistence of Head-Turning Asymmetry" (Nature, 2003: 771) reported that in a random sample of 124 kissing couples, both people in 80 of the couples tended to lean more to the right than to the left. a. If2/3 of all kissing couples exhibit this right-leaning behavior, what is the probability that the number in a sample of 124 who do so differ

from the expected value by at least as much as what was actually observed?

99. Is there any systematic tendency for part-time college faculty to hold their students to different standards than do full-time faculty? The article "Are There Instructional Differences Between Full-Time and Part-Time Faculty?" (College Teaching, 2009: 23–26) reported that for a sample of 125 courses taught by full time faculty, the mean course GPA was 2.7186 and the standard deviation was .63342, whereas for a sample of 88 courses taught by part-timers, the mean and standard deviation were 2.8639 and .49241, respectively. Does it appear that true average course GPA for part-time faculty differs from that for faculty teaching full-time? Test the appropriate hypotheses at significance level .01.

1. Calculate the Lagrange Polynomial for the values Γ (1.00) = 1.0000, Γ (1.02) = 0.9888, Γ (1.04) = 0.9784of the Gamma function and from it approximations of Γ (1.01) and Γ (1.03).

2. Apply Newton's method to compute the roots of $2x - \cos x = 0$, $x_0 = 1$

3. Given $\sin 45° = 0.7071$, $\sin 50° = 0.7660$, $\sin 55° = 0.8192$, $\sin 60° = 0.8660$, find $\sin 52°$, using Newton's forward interpolation formula.

4. Given $\text{Sin}45^0 = 0.7071$, $\text{Sin}50^0 = 0.7660$, $\text{Sin}55^0 = 0.8192$, $\text{Sin}\ 60^0 = 0.8660$, find $\text{Sin}52^0$, using Newton's forward formula.

5. From the following table, estimate the number of students who obtained marks Between 40 and 45.

Marks	30-40	40-50	50-60	60-70	70-80
No. of students	31	42	51	35	31

14. For the following data calculate the value of y when $x = 9$.

x	8	10	12	14	16
$f(x)$	10	19	32.5	54	89.5

Module 4

1. Solve the IVP by Adam-Moulton method $y' = y$, $y(0) = 1$, $h = 0.1$, $y(0.1) = 1.105171$, $y(0.2) = 1.221403$, $y(0.3) = 1.349858$.
2. Solve by Jacobi's method

$$10x + 3y - 4z = 8$$
$$x - 10y + 2z = 6$$
$$x + y - 10z = 7$$

3. Solve the system of equations by (i) Gauss-Jacobi method (ii)Gauss- Seidel method.

$10x + 2y + z = 9$

$2x + 20y - 2z = -44$

$-2x + 3y + 10z = 22$.

4. Using the method of least squares, fit a straight line to (0,2), (2,0), (3, -2), (5, -3).

Module 5

1. Use Newton Raphson method, with 0 as a starting point to find the root of the following function

   $f(x) = e^{-x} - x$ correct to 5 decimal places.
2. Find the root of the function $y = x^3 + 4x^2 + 7$ in the vicinity of $x = -4$ correct to 5 decimal places.
3. Find the root of the function $cosx = 2x$ correct to 5 decimal places ($x_0 = 0.5$).

5. 100006/ME400B ENGINEERING THERMODYNAMICS

5.1 COURSE INFORMATION SHEET

*PROGRAMME:**MECHANICAL ENGINEERING***	*DEGREE: **BTECH***
COURSE: ENGINEERING THERMODYNAMICS	**SEMESTER:** 4, **CREDITS:** 4
COURSE CODE: 100006/ME400B **REGULATION:** 2020	**COURSE TYPE:** CORE
COURSE AREA/DOMAIN:THERMAL SCIENCE	**CONTACT HOURS:**3(LECTURE) + 1(TUTORIAL) HOUR/WEEK
CORRESPONDING LAB COURSE CODE (IF ANY):NIL	**LAB COURSE NAME:**NIL

SYLLABUS:

MODULE	CONTENTS	HOURS
1	Role of Thermodynamics and its applications in Engineering and Science –Basic Concepts- Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.	5L+1T
2	Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity. Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, first law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process, Limitations of the First Law.	7L+4T
3	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump – Kelvin- Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation, Entropy and Disorder, Reversible adiabatic process- isentropic process, Third law of thermodynamics, Available Energy, Availability and Irreversibility- Second law efficiency.	8L+3T

4	Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables. The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State, Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts.	6L+2T
5	Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve.	8L+2L

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHOR/PUBLICATION
T1	P. K. Nag, Engineering Thermodynamics, McGraw Hill, 2013
T2	E. Rathakrishnan; *Fundamentals of Engineering Thermodynamics*, PHI,2005
T3	Y. Cengel, Boles; *Thermodynamics: An Engineering Approach*, Tata McGraw Hill, 7th edition, 2010
R1	Moran J., Shapiro N. M., Fundamentals of Engineering Thermodynamics, Wiley, 2006
R2	Holman J. P. Thermodynamics, McGraw Hill, 2004
R3	M. Achuthan, Engineering Thermodynamics, PHI,2004
R4	R. E. Sonntag and C. Borgnakke, Fundamentals of Thermodynamics, Wiley, 2009

COURSE PRE-REQUISITES: NIL

COURSE OBJECTIVES:

1	To understand basic thermodynamic principles and laws.
2	To develop the skills to analyze and design thermodynamic systems.

COURSE OUTCOMES:

Sl. NO	DESCRIPTION	Blooms' Taxomomy Level
100006/ME 400B.1	Understand basic concepts and laws of thermodynamics	Level 1 & 2 Knowledge, understand
100006/ME 400B.2	Conduct first law analysis of open and closed systems	Level 3 Apply
100006/ME 400B.3	Determine entropy and availability changes associated with different processes	Level 3 Apply
100006/ME 400B.4	Understand the application and limitations of different equations of state	Level 2 understand
100006/ME 400B.5	Determine change in properties of pure substances during phase change processes	Level 3 Apply
100006/ME 400B.6	Evaluate properties of ideal gas mixtures	Level 3 Apply

CO-PO AND CO-PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	**PSO 1**	**PSO 2**	**PSO 3**
100006/ME400 B.1	2	2										2	3		
100006/ME400 B.2	2	2	1	1								1	3		
100006/ME400 B.3	3	3	2	2								1	2		
100006/ME400 B.4	2	2	2	2								1	2		
100006/ME400 B.5	3	3	2	1								1	3		
100006/ME400 B.6	3	3	2	2								1	2		

1- Low correlation (Low), 2- Medium correlation(Medium), 3-High correlation(High)

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
100006/ME400 B.1 - PO1	2	Students will be able to use the acquired knowledge of fundamental concepts to solve complex problems related to Open, Closed and Isolated systems to a considerable extent.
100006/ME400 B.1 - PO2	2	Problem analysis based on zeroth law of thermodynamics and research based relevant data is essential to solve complex problems related to temperature scales.
100006/ME400 B.1- PO12	2	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.
100006/ME400 B.2- PO1	2	The acquired knowledge of the first law of thermodynamics for open and closed systems can be used in the solution of complex problems that involve Steady State Steady Flow process (SSSF) processes in various components such as turbines, compressors, nozzles, throttle valves etc.
100006/ME400 B.2- PO2	2	Problem analysis based on first law for uniform state uniform flow process (USUF) is essential to solve complex problems that involve USUF processes such as filling of tanks and evacuation of tanks etc.
100006/ME400 B.2- PO3	1	Development of solution for complex engineering problems and processes requires analysis based on laws of thermodynamics as preliminary criteria.
100006/ME400 B.2– PO4	1	The knowledge of first law and ability to conduct analysis will be useful for conducting experimental investigation.
100006/ME400 B.2- PO12	1	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.
100006/ME400 B.3- PO1	3	Quantify the second law of thermodynamics for a cycle by establishing the inequality of Clausius; Calculation of entropy changes that take place during processes for pure substances and ideal gases;
100006/ME400 B.3- PO2	3	Problem analysis based on second law of thermodynamics is essential to establish the increase of entropy principle and thereby apply the same to evaluate the feasibility of a thermodynamic process based on the acquired knowledge.
100006/ME400 B.3– PO3	2	The determination of entropy and availability associated with processes can be used for design of systems, processes, understand its feasibility and draw necessary conclusions
100006/ME400	2	Understanding entropy and availability will help with

B.3– PO4		understanding the results obtained from experiments and in conducting experiments
100006/ME400 B.3– PO12	1	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.
100006/ME400 B.4- PO1	2	Students will be able to use the acquired knowledge of fundamental concepts to identify the properties of a system at given state from the property table in order to solve complex problems to a considerable extent.
100006/ME400 B.4- PO2	2	Problem analysis based on laws of thermodynamics involves determining the property values of the system considered from the property table and is essential to develop solutions for complex engineering problems and processes also check its feasibility.
100006/ME400 B.4- PO3	2	Understanding equations of state and its limitations will be useful in simplifying design solutions
100006/ME400 B.4- PO4	2	Interpretation of property values and its analysis obtained from the property table is required to arrive at valid conclusions.
100006/ME400 B.4– PO12	1	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.
100006/ME400 B.5– PO1	3	Students will be able to use the acquired knowledge pure substances and phase changes to solve complex problems on steam
100006/ME400 B.5– PO2	3	Problem analysis based on phase changes will help in understanding steam powered devices and study them closely
100006/ME400 B.5– PO3	2	Development of solution for complex engineering problems and processes requiring analysis based on phase change and mixtures .
100006/ME400 B.5– PO4	1	Helps with conducting experimental investigation and correct interpretation of data related to study of steam
100006/ME400 B.5– PO12	1	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.
100006/ME400 B.6– PO1	3	Students will be able to use the acquired knowledge mixtures to solve complex problems related to mixtures like air
100006/ME400 B.6– PO2	3	Problem analysis based on mixtures will help in understanding study of multiple fluids behaviour

100006/ME400 B.6– PO3	2	Development of solution for complex engineering problems and processes requiring analysis based on mixtures .
100006/ME400 B.6– PO4	2	Helps with conducting experimental investigation and correct interpretation of data related to study of mixtures
100006/ME400 B.6– PO12	1	Students will be encouraged to learn continuously by solving more complex problems which are of social relevance.

JUSTIFATIONS FOR CO-PSO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
100006/ME400 B.1-PSO1	H	Students will be able to apply the acquired knowledge of fundamental concepts to solve engineering problems.
100006/ME400 B.2-PSO1	H	Students will be able to apply the acquired knowledge of first law of thermodynamics to solve engineering problems and processes.
100006/ME400 B.3-PSO1	H	Students will be able to apply the acquired knowledge of second law of thermodynamics to determine the feasibility of a complex thermodynamic process.
100006/ME400 B.4-PSO1	M	Students will be able to apply the acquired knowledge to identify the thermodynamic properties and obtain the data from property tables for solution of complex engineering problems.
100006/ME400 B.5-PSO1	H	Students will be able to use the acquired knowledge of fundamental concepts of chemical thermodynamics, with mphasis on the first and second laws to solve complex engineering problems.
100006/ME400 B.6-PSO1	M	Students will be able to apply the acquired knowledge of ideal and real gas mixtures to solve complex engineering problems.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSION REQUIREMENTS:

SI NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH POs	RELEVANCE WITH PSOs
1	Gibb's Phase rule, State postulate	Lecture Class	1	1

WEB SOURCE REFERENCES:

1	https://nptel.ac.in/courses/112/105/112105123/
2	https://onlinecourses.nptel.ac.in/noc20_ce27/preview

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ **CHALK & TALK**	☑ **STUD. ASSIGNMENT**	☑WEB RESOURCES
☑ LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES

ASSESSMENT METHODOLOGIES-DIRECT

☑ **ASSIGNMENTS**	☐ STUD. SEMINARS	☑ **TESTS/MODEL EXAMS**	☑ **UNIV. EXAMINATION**
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ **STUDENT FEEDBACK ON FACULTY (TWICE)**
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

5.2 COURSE PLAN

Module	*Topics*	*Hours Allotted*
1	Role of Thermodynamics and it's applications in Engineering and Science – Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe	1L
1	Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function.	1L
1	Zeroth Law of Thermodynamics, Measurement of Temperature, reference Points, Temperature Scales.	2L + 1T
1	Role of Thermodynamics and it's applications in Engineering and Science – Basic Concepts Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe	1L
2	Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	2L + 1T
2	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1	2L + 1T
2	First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE	2L + 1T
2	Transient flow –Filling and Emptying Process, Limitations of the First Law.	1L + 1T
3	Second Law of Thermodynamics, Thermal Reservoir, Heat	2L

	Engine, Heat pump – Kelvin-Planck and Clausius Statements, Equivalence of two statements	
3	Reversibility, Irreversible Process, Causes of Irreversibility, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale.	2L + 1T
3	Clausius Inequality, Entropy- Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation, Entropy and Disorder, Reversible adiabatic process- isentropic process, Third law of thermodynamics	2L + 1T
3	Available Energy, Availability and Irreversibility- Second law efficiency.	2L + 1T
4	Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface,	2L
4	Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables	2L + 1T
4	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances, Vander Waals Equation of State, Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts.	2L +1T
5	Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law.	2L
5	Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy	1L +1T
5	Introduction to real gas mixtures- Kay's rule	1L
5	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations	2L
5	Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve.	2L + 1T

5.3 MODULE WISE SAMPLE QUESTIONS

Module 1

1. Explain thermodynamic equilibrium.
2. What is the concept of continuum? How will you define density and pressure using this concept?
3. Write short notes on:
    a) System, boundary and surroundings,
    b) Point and path functions

4. Discuss the quantity defined using Zeroth of thermodynamics.
5. Explain working of constant pressure gas thermometer
6. Explain working of constant volume gas thermometer
7. Explain intensive and extensive properties
8. Explain the importance of quasi static process
9. What is concept of continuum? Explain using pressure as an example
10. Deduce a relationship for converting Fahrenheit scale to Kelvin scale

Module 2

1. State first law for closed system undergoing a change of state and show that energy a property of system.
2. Write steady flow energy equation for a single stream entering and single stream leaving a control volume and explain the various terms in it.
3. A gas of 4 kg is contained within the piston cylinder machine. The gas undergoes a process for which $pv^{1.5}$ = Constant. The initial pressure is 3 bar and the initial volume is $0.1m^3$, and the final volume is $0.2m^3$. The specific internal energy of the gas decreases by 4.6kJ/kg. There is no significant change in KE and PE. Determine net heat transfer for the process.
4. Calculate the internal energy and enthalpy of 1kg of air occupying $0.03m^3$ at 3MPa.
5. A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas – tight, frictionless piston – cylinder device. The air is now compressed to a final pressure of 600 kPa. During this process, heat is transferred from the air such that the temperature inside the cylinder remains constant. Calculate the work input during this process.
6. Carbon dioxide enters an adiabatic nozzle steadily at 1 MPa and 500°C with a mass flow rate of 600 kg/hr and leaves at 100 kPa and 450 m/s. The inlet area of the nozzle is 40 cm^2. Determine (a) the inlet velocity and (b) the exit temperature
7. A vertical piston – cylinder device initially contains 0.25 m^3 of air at 600 kPa and 300°C. A valve connected to the cylinder is now opened and air is allowed to escape until three-quarters of the mass leave the cylinder at which point the volume is 0.05 m^3. Determine the final temperature in the cylinder and the boundary work during this process.
8. Discuss the limitation of first law of thermodynamics
9. Show that isothermal process as lower slope than adiabatic process
10. Deduce the governing equations for transient flow process

Module 3

1. Establish the equivalence of Kelvin-Plank and Clausius statements.
2. Establish the Inequality of Clausius?
3. Establish the equivalence of Kelvin-Plank and Clausius statements.

4. A fluid undergoes a reversible adiabatic compression from 0.5MPa, 0.2m^3 to 0.05m^3 according to the law, $pv^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy, and the heat transfer and work transfer during the process
5. Second law of thermodynamics is often called a directional law. Why?
6. An adiabatic vessel contains 2 kg of water at 25˚C. B paddle – wheel work transfer, the temperature of water is increased to 30˚C. If the specific heat of water is assumed to be constant at 4.186 kJ/kg.K, find the entropy change of the universe.
7. Two kilograms of water at 80°C is mixed adiabatically with 3 kg of water at 30°C in a constant pressure process at 1 atm. Find the increase in entropy of the total mass of water due to the mixing process.
8. Argon enters an insulated turbine operating under steady state at 1000˚C and 2 MPa and exhausts at 350 kPa. The mass flow rate is 0.5 kg/s and the turbine develops power at the rate of 120 kW. Determine (a)the temperature of the argon at the turbine exit, (b) the irreversibility of the turbine and (c) the second law efficiency. Neglect KE and PE effects. Take To = 20˚C and Po = 1 bar
9. Explain the term entropy and its significance in study of thermodynamics
10. What is absolute zero temperature? Can we achieve it?

Module 4

1. Write down the van der Waals equation of state. How does it differ from the ideal gas equation of state?
2. What is energy, dead state and triple point?
3. Steam initially at 0.3 MPa, 250°C is cooled at constant volume. (a) At what temperature will the steam become saturated vapour? (b) What is quality at 80°C? (c) What is the heat transferred per kg of steam in cooling from 250°C to 80°C?
4. Explain mollier chart, P-V, P-T, P-V-T diagrams for pure substances.
5. What are the limitations of ideal gas equation and how does Van der Waals equation overcome these limitations?
6. Discuss law of corresponding states and its role in the construction of compressibility chart
7. A rigid tank contains 2 kmol of N_2 and 6 kmol of CH_4 gases at 200 K and 12 MPa. Estimate the volume of the tank, using (a) ideal gas equation of state (b) the compressibility chart and Amagat's law
8. Steam is throttled from 3 MPa and 600˚C to 2.5 MPa. Determine the temperature of the steam at the end of the throttling process.
9. Determine the change in specific volume, specific enthalpy and quality of steam as saturated steam at 15 bar expands isentropically to 1 bar. Use steam tables
10. Estimate the enthalpy of vapourization of steam at 500 kPa, using the Clapeyron equation and compare it with the tabulated value

Module 5

1. Explain different properties of real gas mixtures and the laws associated.

2. A certain gas has $P_c = 0.913$ and $V_c = 0.653$ kJ/kg K. Find the molecular weight and the gas constant R of the gas.
3. Derive Maxwell relations from basic thermodynamic relations?
4. Explain Joule-Kelvin effect. What is the significance of the inversion curve?
5. A gaseous mixture contains, by volume, 21%nitrogen, 50% hydrogen and 29% carbon dioxide. Calculate the molecular weight of the mixture, the characteristic gas constant of the mixture and the value of the reversible adiabatic expansion index - γ. At 10˚C, the C_p values of nitrogen, hydrogen and carbon dioxide are 1.039, 14.235 and 0.828 kJ/kg.K respectively.
6. A mixture of 2 kmol of CO_2 and 3 kmol of air is contained in a tank at 199 kPa and 20˚C. Treating air to be a mixture of 79% N_2 and 21% O_2 by volume, calculate (a) the individual mass of CO_2, N_2 and O_2, (b) the percentage content of carbon by mass in the mixture and (c) the molar mass, characteristic gas constant and the specific volume of the mixture
7. A gas mixture in an engine cylinder has 12% CO_2, 11.5 % O_2 and 76.5% N_2 by volume. The mixture at 1000˚C expands reversibly, according to the law $PV^{1.25}$ = constant, to 7 times its initial volume. Determine the work transfer and heat transfer per unit mass of the mixture

6. 100006/ME400C MANUFACTURING PROCESS

6.1 COURSE INFORMATION SHEET

PROGRAMME: ME	***DEGREE:*** BTECH
PROGRAMME: **MECHANICAL ENGINEERING**	DEGREE: **B. TECH** UNIVERSITY**: A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
COURSE: **MANUFACTURING PROCESS**	SEMESTER**: IV** CREDITS: **4**
COURSE CODE: **100006/ME400C** ***REGULATION:*** **UG**	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: **PRODUCTION ENGINEERING**	CONTACT HOURS: **3+1 (Tutorial) hours/Week.**

SYLLABUS:

UNIT	***DETAILS***	***HOURS***
I	Casting:-Introduction & classification of casting, characteristics of sand - patterns- cores - chaplets- simple problems- solidification of metals and Chvorinov's rule - Elements of gating system- risering -chills –simple problems- Special casting process- Defects in castings- Super alloy Production Methods.	7L + 2T
II	Welding:-welding metallurgy-heat affected zone- grain size and hardness-stress relieving- joint quality -heat treatment of welded joints - weldability - destructive and non-destructive tests of welded joints- classification of welding - Resistance welding: HAZ, process and correlation of process parameters with welded joints - applications of each welding process- Arc welding:-HAZ, process and correlation of process parameters with welded joints- simple problems - applications of each welding process – Oxyacetylene welding:-chemistry, types of flame and its applications-Thermit welding, friction welding, electroslag, electrogas welding, Plasma arc, electron beam and laser beam welding- brazing- soldering - adhesive bonding.	7L + 2T
III	Rolling: - principles - types of rolls and rolling mills - mechanics of flat rolling-Defects-vibration and chatter - flat rolling -miscellaneous rolling process- simple problems - Bulk deformation of metals:- State of stress; yield criteria of Tresca, von Mises, comparisons; Flow rules; power and energy deformations; Heat generation and heat transfer in metal forming process.	6L + 2T
IV	Forging: methods analysis, applications, die forging, defects in forging - simple problems - Metal extrusion:- metal flow, mechanics of extrusion, miscellaneous process, defects, simple problems, applications - Wire, Rod, and Tube drawing:- mechanics of rod and wire drawing, simple problems, drawing defects - swaging, applications – deep drawing.	7L + 2T

V	Locating and clamping methods- locating methods- locating from plane, circular, irregular surface. Locating methods and devices- simple problems - Basic principles of clamping –Sheet metal operations- Press tool Operations- Tension, Compression, tension and compression operations - applications - Fundamentals of die cutting operations - simple problems - types of die construction.	7L + 3T
TOTAL HOURS		**45**

TEXT/REFERENCE BOOKS:

T/R	*BOOK TITLE/AUTHORS/PUBLICATION*
T1	Cyril Donaldson, George H. LeCain, V. C. Goold, Joyjeet Ghose, "Tool Design", Tata McGraw-Hill,4th Edition, 2012.
T2	Serope Kalpakjian, Steven R. Schmid - Manufacturing Engineering and Technology, Pearson Publishers, 4th Edition 2014.
R1	Richard W Heine, Carl R Loper, Philip C Rosenthal," Metal Casting", Tata McGraw Hill, 2015.
R2	Rao P.N., "Manufacturing Technology Foundry, Forming and Welding", Volume -1, Tata McGraw Hill, 4th Edition,2013.
R3	Joseph R. Davis, S. L. Semiatin, American Society for Metals - ASM Metals Handbook, Vol. 14 Forming and Forging ASM International, Asm Intl, 9th Edition, 1989.
R4	Taylan Altan, Gracious Ngaile, Gangshu, Shen," Cold and Hot Forging Fundamentals and Applications", ASM International, 2004
R5	Matthew J. Donachie, Stephen J. Donachie, "Super alloys A Technical Guide", ASM International, 2nd Edition, 2002.

COURSE PRE-REQUISITES:

C.CODE	*COURSE NAME*	*DESCRIPTION*	*SEM*
100006/ME300D	Metallurgy and material science	Knowledge about material behaviour under processing.	III

COURSE OBJECTIVES:

1	To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in production processes.
2	Provide a detailed discussion on the welding process and the physics of welding. Introduce students to different welding processes, weld testing and advanced processes to be able to appreciate the practical applications of welding.
3	The course will also provide methods of analysis allowing a mathematical/physical description of forming processes.
4	Correlate the material type with the possible fabrication processes
5	Generate solutions to problems that may arise in manufacturing engineering

COURSE OUTCOMES:

Sl.NO	*DESCRIPTION*	*Bloom's Taxonomy Level*
CME100006/ ME400C.1	Illustrate the basic principles of foundry practices and special casting processes, their advantages, limitations and applications.	Understand (level 2)
CME100006/ ME400C.2	Categorize welding processes according to welding principle and material.	Analyze (level 4)
CME100006/ ME400C.3	Understand requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.	Understand (level 2)
CME100006/ ME400C.4	Student will estimate the working loads for the processes like pressing, forging, wire drawing etc.	Evaluate (level 5)
CME100006/ ME400C.5	Recommend appropriate part manufacturing processes when provided a set of functional requirements and product development constraints.	Apply (level 3)

CO-PO AND CO-PSO MAPPING

	PO 1	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PS O1*	*PS O2*	*PS O3*
CME100006/ ME400C.1	3														
CME100006/ ME400C.2												2			
CME100006/ ME400C.3			3												
CME100006/ ME400C.4				3										2	
CME100006/ ME400C.5		3												2	

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	*LOW/MEDIUM/ HIGH*	*JUSTIFICATION*
CME100006/ ME400C.1-PO1	H	Knowledge on various casting methods and foundry practices will be acquired.

CME100006/ ME400C.2-PO12	M	Analyse the welding principles, environmental considerations and its longevity will let students to have a lifelong learning in the field.
CME100006/ ME400C.3-PO3	H	Knowledge in welding of dissimilar metals will be gained after learning its complexity
CME100006/ ME400C.4-PO4	H	Estimation of working loads will benefit the process of design of manufacturing systems
CME100006/ ME400C.5-PO2	H	Students will be able to recommend the rightmost manufacturing process after analyzing the problem correctly.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	*LOW/MEDIUM/ HIGH*	*JUSTIFICATION*
CME100006/ ME400C.4-PSO2	M	Understanding of working parameters of various manufacturing processes will enable the students to apply it in the field of production of quality components
CME100006/ ME400C.5-PSO2	M	Knowledge in various processes will encourage students to opt for the manufacturing method intended for the desired product

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS:

SNO	*DESCRIPTION*	*RELEVENCE TO PO\PSO*	*PROPOSED ACTIONS*
1	Testing methods and inspection of manufactured products	PO2, PO12, PSO2	NPTEL and Learning materials

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SINO:	TOPIC	RELEVENCE TO PO\PSO
1	Nano manufacturing	PO1, PO3, PO5

WEB SOURCE REFERENCES:

1	https://www.digimat.in/nptel/courses/video/112104195/L01.html
2	https://www.digimat.in/nptel/courses/video/112107219/L01.html
3	https://youtu.be/vXNTLlOVQyQ
4	http://nptel.ac.in/downloads/112105127/
5	https://youtu.be/koULXptaBTs

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK& TALK	☑ STUD. ASSIGNMENT	☑ WEB RESOURCES	☑LCD/SMART BOARDS
☐ STUD. SEMINARS	☐ ADD-ON COURSES		

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (ONCE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

6.2 COURSE PLAN

No. of Lectures	*MODULE*	*TOPIC PLANNED*
2	1	Casting:-Introduction and Classification of casting, Characteristics of sand - pattern and allowances - type of patterns cores - core prints – chaplets - simple problems.
2	1	Solidification of metals and Chvorinov's rule - Elements of gating system - gating system, pouring time, choke area - risering Caine's method - chills – simple problems.
2	1	Special casting process:-shell molding, precision investment, die casting, centrifugal casting, continues casting, squeeze casting, surface

		roughness obtainable and application of each casting process.
2	1	Defects in castings: - Shaping faults arising in pouring, Inclusions and sand defects, Gas defects, Shrinkage defects, Contraction defects, Dimensional errors, Compositional errors and segregation; significance of defects on Mechanical properties. (Kalpakjian, Beeley, Rao).
1	1	Superalloy Production Methods: Vacuum Induction Melting; Electroslag Remelting; Vacuum Arc Remelting (ASM).
2	2	Welding:- welding metallurgy, diffusion, heat affected zone, driving force for grain growth, grain size and hardness - joint quality: porosity, slag inclusions, cracks, surface damage, residual stress lamellar tears, stress relieving, heat treatment of welded joints - weldability (Kalpakjian, Lindberg) - destructive and non-destructive tests of welded joints (may be provided as class assignment - Lindberg).
3	2	Classification of welding - Resistance welding: HAZ, process and correlation of process parameters with welded joints of spot, seam, projection, stud arc, percussion welding applications of each welding process – simple problems. (Kalpakjian).
3	2	Arc welding: - HAZ, process and correlation of process parameters with welded joints of shielded metal arc, submerged, gas metal, flux cored, electrogas, electroslag, gas tungsten, plasma arc, electron beam, laser beam – simple problems - Thermit welding, friction welding-applications of each welding process. (Kalpakjian, Lindberg).
1	2	Oxyacetylene welding:- chemistry, types of flame and its applications – brazing - soldering - adhesive bonding.
3	3	Rolling:- principles - types of rolls and rolling mills - mechanics of flat rolling, roll pressure distribution, neutral point, front and back tension, torque and power, roll forces in hot rolling, friction, deflection and flattening, spreading - simple problems.
2	3	rolling defects -vibration and chatter - flat rolling - miscellaneous rolling process: shape, roll forging, ring, thread and gear, rotary tube piercing, tube rolling - applications – simple problems. (Kalpakjian).
2	3	Plastic deformation of metals - stress-strain relationships - State of stress - yield criteria of Tresca, von Mises, and comparisons - applications
1	3	Flow rules - power and energy deformations - Heat generation and heat transfer in metal forming process - temperature in forging. (ASM-Taylan Altan).
3	4	Forging:- material characterization; grain flow and strength - Forging:- classification - open die forging, forces and work of deformation - Forging methods analysis:- slab method only, solid cylindrical, rectangular work piece in plane strain, forging under sticking condition - simple problems - applications.
1	4	Deformation zone geometry – die forging: - impression, close, coining, skew rolling etc. – simple problems – defects in forging. (Kalpakjian).

2	4	Metal extrusion: - metal flow - mechanics of extrusion: - deformation and friction, actual forces, die angle, forces in hot extrusion – miscellaneous process - defects – simple problems - applications. (Kalpakjian, Lindberg).
2	4	Wire, Rod, and tube drawing: - mechanics of rod and wire drawing: deformation, friction, die pressure and angle, temperature, reduction per pass, drawing flat strip and tubes – simple problems - drawing defects swaging - applications. (Kalpakjian, Lindberg, Rao).
1	4	Deep drawing- deep drawability, simple problems - different drawing practices
2	5	Locating and clamping methods: - basic principle of location; locating methods; degrees of freedom; locating from plane, circular, irregular surface – simple problems.
1	5	Locating methods and devices: - pin and button locators, rest pads and plates, nest or cavity location.
2	5	Basic principles of clamping: - strap, cam, screw, latch, wedge, hydraulic and pneumatic clamping –simple problems. (Donaldson, Wilson F.W.).
2	5	Sheet metal operations: Press tool operations: shearing action, shearing operations: blanking, piercing, simple problems, trimming, shaving, nibbling, notching – simple problems - applications.
2	5	Tension operations: stretch forming - Compression operations: - coining, sizing, ironing, hobbing - tension and compression operations: drawing, spinning, bending, forming, embossing – simple problems- applications. (Donaldson, Wilson F.W., Rao P.N).
1	5	Fundamentals of die cutting operations - inverted, progressive and compound die - simple problems. (Donaldson)

6.3 MODULE WISE SAMPLE QUESTIONS

MODULE 1

1) Why draft allowances are important for patterns.

2) What are the importance's of permeability of molding sand?

3) How runner extension is helpful for good casting quality.

4) Internal corners are more prone to solidification shrinkages than external corners. Explain?

5) Which of the casting processes would be suitable for making small toys in large numbers? Why?

6) What is a pattern? How does it differ from actual product to be made from it?

7) What are common materials for making pattern?

8) What are the functions of risers?

9) What are the properties of moulding sand?

10) What are the various pattern allowances?

11) Explain the importance of gating in casting.

12) What are the advantages and disadvantages of shell moulding?

13) Illustrate and explain investment casting

14) Write notes on casting defects

MODULE II

1) Why is the quality of welds produced by submerged arc welding very good?

2) What does the strength of a weld nugget in resistance spot welding depends on?

3) What is the strength of a welded joint being inferior or superior to the parent metal? Why?

4) Why some joints may have to be preheated prior to welding.

5) Assume that you are asked to inspect a weld for a critical application. Describe the procedure you would follow. If you find a flaw during your inspection, how would you go about determining whether or not this flaw is important for the particular application?

6) In the building of large ships, there is a need to weld large sections of steel together to form a

7) hull, for this application, which welding process would you select? Why?

8) Define the term weldability

9) Write short notes on welding defects

10) What do you mean by HAZ? Write short notes on gas welding?

11) Write notes on Plasma arc welding

12) Explain about Gas tungsten arc welding

13) Explain about Submerged arc welding

14) Compare TIG and MIG.

15) Explain resistance welding.

MODULE III

1) Explain the operation of a three high rolling mill.

2) What is ring rolling?

3) What is the importance of roll velocity and strip velocity?

4) How material behavior affects rolling process?

5) Explain the theory and mechanics of rolling.

6) Explain about rolling defects

7) What are the methods used to reduce the roll force requirement in rolling process?

8) Write short notes on hot and cold rolling process

MODULE 1V

1) Two solid cylindrical specimens A and B, made of a perfectly plastic material, are being

2) forged with friction and isothermally at room temperature to a reduction in height of 50%.

3) specimen A has a height of 2 inch and cross sectional area of 1 square inch, and specimen

4) B has a height of is 1 inch and a cross sectional area of 2 square inch will the work done

5) be the same for the two specimens? Explain.

6) Differentiate between blanking and punching.

7) Explain how forging die are classified

8) Sketch drop hammer and pneumatic hammer

9) Explain deep drawing, coining

10) What are the advantages for forging over casting?

11) What do you mean by precision forging?

12) Explain various presses used for forging

13) Explain the different forging defects

MODULE V

1) What is a clamp?
2) Write short notes on locating from circular surfaces
3) Explain about vacuum clamping
4) Write notes on Hinge clamping
5) Explain about 3-2-1 principle
6) Define degrees of freedom
7) Explain about clamping principles
8) What are the locating principles?

7. 100006/ME400D FLUID MACHINERY

7.1 COURSE INFORMATION SHEET

PROGRAMME: ME	***DEGREE:*** BTECH
COURSE: FLUID MACHINERY	**SEMESTER: 4** **CREDITS:** 4
COURSE CODE: 100006/ME400D ***REGULATION:*** 2020	**COURSE TYPE:** CORE
COURSE AREA/DOMAIN: FLUID SCIENCE	**CONTACT HOURS:** 3+1 (Tutorial) Hours/Week.
CORRESPONDING LAB COURSE CODE (IF ANY): 100006/ME422S	**LAB COURSE NAME:** FLUID MECHANICS AND HYDRAULIC MACHINES LAB

SYLLABUS:

UNIT	*DETAILS*	*HOURS*
I	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve) - Series of vanes - work done and efficiency. Hydraulic Turbines: Impulse and Reaction Turbines – Degree of reaction – Pelton Wheel – Constructional features - Velocity triangles – Euler's equation – Speed ratio, Jet ratio and Work done, Losses and Efficiencies, Design of Pelton wheel. Inward and outward flow Reaction turbines - Francis Turbine – Constructional features – Velocity triangles, Work done and Efficiencies. Axial flow turbine (Kaplan) - Constructional features – Velocity triangles, Work done and Efficiencies	7L + 3T
II	Theory of draft tubes – Surge tanks – Cavitation in turbines – Governing of turbines – Specific speed of turbine, Type Number - Scale Laws – Unit speed, Unit discharge and Unit power - Characteristic curves of turbines. Rotary motion of liquids – free, forced and spiral vortex flows. Rotodynamic pumps: Centrifugal pump - Impeller types, Velocity triangles, Manometric head, Work, Efficiency and Losses - H-Q characteristic, typical flow system characteristics, Operating point of a pump. Cavitation in centrifugal pumps - NPSH required and available - Pumps in series and parallel operations. Performance characteristics - Specific speed, Type number – Shape numbers – Impeller shapes based on shape numbers.	7L + 3T
III	Positive displacement pumps: Reciprocating pump – Single acting and double acting – Slip and negative slip - Work required and Efficiency - Indicator diagram - Acceleration head - Effect of acceleration and friction on indicator diagram – Speed calculation.	7L + 3T

	Air vessels and their purposes - Saving in work required using air vessels - Multi cylinder pumps - Multistage pumps - Selection of pumps. Pumping devices: Hydraulic ram, Accumulator, Intensifier, Jet pumps, Gear pumps, Vane pump and Lobe pump.	
IV	Compressors: Classification of compressors - Reciprocating compressors - Single stage compressor - Equation for work with and without clearance volume, Efficiencies - Multistage compressor, Intercooler, Free air delivered (FAD). Centrifugal compressor: Working, Velocity diagram, Work done, Power required - Width of blades of impeller and diffuser - Isentropic efficiency - Slip factor and Pressure coefficient - Surging and Chocking. Axial flow compressors: - Working, Velocity diagram, Degree of reaction, performance. Roots blower, Vane compressor, Screw compressor.	7L + 3T
V	Gas turbines: Classification, Thermodynamic analysis of gas turbine cycles - Open, closed and semi closed cycle - Ideal working cycle - Brayton Cycle - P-v and T-s diagrams - Thermal efficiency - Effect of compressor and turbine efficiencies - Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies. Analysis of open cycle gas turbine - Improvements of the basic gas turbine cycles - Regeneration, Intercooling and Reheating - Cycle efficiency and Work output - Condition for minimum compressor work and maximum turbine work - Comparison of gas turbine and IC engines - Combustion chambers for gas turbines - Pressure loss in combustion process and Stability loop.	7L + 3T
TOTAL HOURS		**50**

TEXT/REFERENCE BOOKS:

T/R	*BOOK TITLE/AUTHORS/PUBLICATION*
T1	Subramanya, K., Hydraulic Machines, Tata McGraw Hill, 1st edition, 2017
T2	Rathore, M., Thermal Engineering, Tata McGraw Hill, 1st edition, 2010
R1	Ganesan, V., Gas Turbines, Tata McGraw Hill, 3rd edition, 2017.
R2	Sawhney G.S., Thermal and Hydraulic Machines, Prentice Hall India Learning Private Limited; 2nd edition , 2011
R3	D.S Kumar, Fluid Mechanics and Fluid Power Engineering, S.K Katria & Sons
R4	R.K. Rajput, Fluid Mechanics & Hydraulic Machines, S. Chand & Company.
R5	Yunus A. Cengel & John M. Cimbala, Fluid Mechanics, Tata McGraw Hill

COURSE PRE-REQUISITES: Nil

COURSE OBJECTIVES:

1	To acquire knowledge on hydraulic machines such as pumps and turbines.
2	To prepare the students to solve complex problems related to fluid forces on a vane.
3	To Introduce the concepts of design aspects of hydraulic machines like turbines and pumps and their applications.
4	To understand the working of air compressors and gas turbines and do the analysis.
5	Describe the operating characteristics of Fluid machinery (pumps, turbines and compressors) and the factors affecting their operation and specifications.

COURSE OUTCOMES:

Sl. No.	*DESCRIPTION*	*Bloom's Taxonomy Level*
CME400D.1	Students will be able to **calculate** forces and work done by a jet on a plate (flat and curved) in fixed or moving conditions.	Apply (level 3)
CME400D.2	Students will be able to **understand** the working of turbines and **select** suitable turbine for specific application.	Understand (level 2) Analyse (level 4)
CME400D.3	Students will be able to **understand** the working of various pumps and **select** suitable pump for specific application.	Understand (level 2) Analyse (level 4)
CME400D.4	Students will be able to **understand** the working of air compressors and **select** suitable compressor for specific application.	Understand (level 2) Analyse (level 4)
CME400D.5	Students will be able to **understand** the working of gas turbines and **identify** the improvements in basic gas turbine cycles.	Understand (level 2) Analyse (level 4)

CO-PO AND CO-PSO MAPPING

	PO 1	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PSO 1*	*PSO 2*	*PSO 3*
CME400D.1	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CME400D.2	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CME400D.3	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CME400D.4	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CME400D.5	3	3	2	-	-	-	-	-	-	-	-	-	3	-	-

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	*LOW/MEDIUM/HIGH*	*JUSTIFICATION*
CME400D.1-PO1	H	As they could use their acquired knowledge to solve engineering problems
CME400D.1-PO2	H	Knowledge in principles of Hydraulic Machines helps the students to identify many problems related to power plants and power generation.
CME400D.1-PO3	M	Knowledge in principles of Hydraulic Machines is the basis for a new design.
CME400D.2-PO1	H	Analytical knowledge on the turbine performance helps the students to solve of the engineering problems related to fluid power plants.
CME400D.2-PO2	H	Analytical knowledge on the turbo machinery performance help the students to analyse engineering problems related to power producing and power consuming machineries (Turbine/Pump).
CME400D.2-PO3	M	Ability to apply various energy equations to find the performance of turbo machinery is useful for designing efficient system components.
CME400D.3-PO1	H	Ability design, carry out complex calculation helps solve complex problems.
CME400D.3-PO2	H	Ability design, carry out complex calculation helps analyse complex problems.
CME400D.3-PO3	M	Ability design, carry out complex calculation helps in designing various system components.
CME400D.4-PO1	H	Knowledge about various performance parameters help to solve problems.
CME400D.4-PO2	H	An ability to interpret characteristic curve of various turbo machinery equip the students to review research literatures, and analyse complex engineering problems related to hydraulic machines reaching substantiated conclusions.
CME400D.4-PO3	M	Knowledge on process parameter helps in better designs.
CME400D.5-PO1	H	As they could use their acquired knowledge to solve engineering problems

CME400D.5-PO2	H	Knowledge in principles of compressors helps the students to identify many problems related to gas turbine power plants and power generation.
CME400D.5-PO3	M	Knowledge in principles of fluid Machines is the basis for a new design.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	*LOW/MEDIUM/HIGH*	*JUSTIFICATION*
CME400D.1-PSO1	H	Ability to apply the knowledge regarding the domain of engineering mechanics to calculate forces and work done by a jet on fixed or moving plate and curved plates.
CME400D.2-PSO1	H	Students can apply their knowledge in fluid science to solve engineering problems related to various hydraulic turbines.
CME400D.3-PSO1	H	Students can apply their knowledge in fluid science to solve engineering problems related to various Rotodynamic and positive displacement pumps.
CME400D.4-PSO1	H	Students can apply their knowledge in fluid and thermal science to solve engineering problems related to various air compressors.
CME400D.5-PSO1	H	Students can apply their knowledge in fluid and thermal science to solve engineering problems related to various gas turbines and identify the improvements in basic gas turbine cycles.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS: NIL

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

WEB SOURCE REFERENCES:

1	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-7.htm
2	https://www.youtube.com/watch?v=oLUjy8Iyfbk
3	http://nptel.ac.in/courses/112105182/9
4	http://www.slideshare.net/ArchieSecorata/fluid-mechanicsfundamentals-and-applications-by-cengel-cimbala-3rd-c2014-txtbk
5	https://www.youtube.com/watch?v=RBVgwpYUp18

6	https://www.youtube.com/watch?v=KqfYobOYRTc

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☑ LCD/SMART BOARDS	☑ WEB RESOURCES
☐ STUD. SEMINARS	☐ ADD-ON COURSES		

ASSESSMENT METHODOLOGIES-DIRECT

☑ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (TWICE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

7.2 COURSE PLAN

DAY	*MODULE*	*NO: OF LECTURES*	*TOPIC PLANNED*
1	1	2	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve)
2	1	1	Series of vanes - work done and efficiency
3	1	1	Hydraulic Turbines : Impulse and Reaction Turbines, Degree of reaction
4	1	1	Pelton Wheel – Constructional features - Velocity triangles
5	1	1	Euler's equation – Speed ratio, Jet ratio and Work done , Losses and efficiencies - Design of Pelton wheel
6	1	1	Inward and outward flow reaction turbines - Francis Turbine – Constructional features
7	1	1	Velocity triangles, work done and efficiencies.
8	1	2	Axial flow turbine (Kaplan) Constructional features – Velocity triangles, work done, efficiencies

9	**2**	**1**	Theory of draft tubes – Surge tanks – Cavitation in turbines – Governing of turbines
10	**2**	**2**	Specific speed of turbine, Type Number - Scale Laws – Unit speed, Unit discharge and Unit power - Characteristic curves of turbines
11	**2**	**1**	Rotary motion of liquids – free, forced and spiral vortex flows.
12	**2**	**1**	Rotodynamic pumps: Centrifugal pump - Impeller types, Velocity triangles
13	**2**	**1**	Manometric head, Work, Efficiency and Losses
14	**2**	**1**	H-Q characteristic, typical flow system characteristics, Operating point of a pump
15	**2**	**1**	Cavitation in centrifugal pumps - NPSH required and available - Pumps in series and parallel operations
16	**2**	**2**	Performance characteristics - Specific speed, Type number – Shape numbers – Impeller shapes based on shape numbers
17	**3**	**1**	Positive displacement pumps: Reciprocating pump – Single acting and double acting
18	**3**	**1**	Slip and negative slip - Work required and Efficiency - Indicator diagram
19	**3**	**3**	Acceleration head - Effect of acceleration and friction on indicator diagram – Speed calculation.
20	**3**	**2**	Air vessels and their purposes - Saving in work required using air vessels
21	**3**	**1**	Multi cylinder pumps - Multistage pumps - Selection of pumps.
22	**3**	**1**	Pumping devices: Hydraulic ram, Accumulator, Intensifier
23	**3**	**1**	Jet pumps, Gear pumps, Vane pump and Lobe pump
24	**4**	**1**	Compressors: Classification of compressors - Reciprocating compressors - Single stage compressor
25	**4**	**2**	Equation for work with and without clearance volume, Efficiencies
26	**4**	**2**	Multistage compressor, Intercooler, Free air delivered (FAD).
27	**4**	**2**	Centrifugal compressor: Working, Velocity diagram, Work done, Power required
28	**4**	**1**	Width of blades of impeller and diffuser - Isentropic efficiency

29	**4**	**1**	Slip factor and Pressure coefficient - Surging and Chocking.
30	**4**	**1**	Axial flow compressors: - Working, Velocity diagram, Degree of reaction, performance.
31	**4**	**1**	Roots blower, Vane compressor, Screw compressor
32	**5**	**1**	Gas turbines: Classification, Thermodynamic analysis of gas turbine cycles - Open, closed and semi closed cycle
33	**5**	**1**	Ideal working cycle - Brayton Cycle - P-v and T-s diagrams
34	**5**	**1**	Thermal efficiency - Effect of compressor and turbine efficiencies
35	**5**	**2**	Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies.
36	**5**	**1**	Analysis of open cycle gas turbine
37	**5**	**1**	Improvements of the basic gas turbine cycles - Regeneration, Intercooling and Reheating
38	**5**	**1**	Cycle efficiency and Work output - Condition for minimum compressor work and maximum turbine work
39	**5**	**1**	Comparison of gas turbine and IC engines - Combustion chambers for gas turbines
40	**5**	**1**	Pressure loss in combustion process and Stability loop.

7.3 MODULE WISE SAMPLE QUESTIONS

MODULE 1

1) Explain in detail about hydraulic turbines
2) Explain the constructional features of Pelton turbine
3) Explain the constructional features of Francis turbine
4) Give detailed notes on Degree of reaction
5) A Francis turbine develops 160kW at 150 rpm under a head of 10 m. The peripheral velocity at inlet and flow velocity at inlet of the turbine are $0.3x(2gh)^{0.5}$ and $0.9x(2gh)^{0.5}$ respectively. The overall efficiency of the turbine is 78% and hydraulic

efficiency is 82%. Draw velocity triangle and find 1). Guide blade angle and vane angle at inlet 2). Diameter and width of runner at inlet.

6) Prove that that the maximum efficiency of a jet striking normally on a moving vane in the direction of jet is 8/27.
7) A Pelton wheel having mean bucket diameter of 1.2 m is running at 1000 rpm. The net head on the Pelton wheel is 840 m. If the side clearance angle is 15^{o} and discharge through the nozzle is 0.12 m^3/s. Determine 1). Power available at nozzle 2). Hydraulic efficiency of the turbine.

MODULE 2

1) Explain in detail about Specific speed of turbine & Type Number
2) Explain the constructional features of Kaplan turbine
3) Give detailed notes on Characteristic curves of turbines
4) Give notes on Velocity triangles, Euler's equation.
5) What is a draft tube and show mathematically that the pressure head at exit of the reaction turbine runner is less than atmospheric pressure head?
6) A Kaplan turbine runner is to be designed to develop 9100kW. The net available head is 5.6 m. If the speed ratio = 2.09, flow ratio = 0.68, overall efficiency 86% and the diameter of the boss is $1/3^{rd}$ of diameter of the runner. Find the diameter of the runner and its speed.
7) Derive expression for the force exerted by the jet of water on a series of moving radial curved vanes mounted on a wheel. Also find the maximum efficiency.

MODULE 3

1. Two geometrically similar pumps are running at the same speed of 1000 rpm. One pump has an impeller diameter of 0.3 m and lifts water at the rate of 20 lit/s against a head of 15 m. Determine the head and impeller diameter of the other pump to deliver half the discharge.
2. A centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 30° and velocity of flow at outlet is 3 m/s. The pump is working against a total head of 30 m and discharge through the pump is 0.3 m^3/s. If the manometric efficiency of the pump is 75%. Determine the diameter of the impeller and width of the impeller.

3. Define cavitation. What are the effects of cavitation? Give the necessary precautions against cavitation.
4. Give notes on Impeller shapes based on shape numbers
5. Distinguish between free, forced and spiral vortex flows
6. Briefly explain about Cavitation in centrifugal pumps
7. Explain what is meant by NPSH required and available and also explain type number.

MODULE 4

1. The diameter and stroke length of a single acting reciprocating pump are 75 mm and 150 mm respectively. It takes its supply of water from a sump 3m below the pump through a pipe 5m long and 40mm in diameter. It delivers water to a tank 12 m above the pump through a pipe 30mm in diameter and 15m long. If separation occurs at 75kN/m2 below atmospheric pressure. Find the maximum speed at which pump may be operated without separation
2. With the help of a neat sketch explain the working of a hydraulic accumulator.
3. The diameter and stroke of a single acting reciprocating pump are 20cm and 30cm respectively. The pump is 5m above the water surface. The diameter and length of suction pipe are 10cm and 6m respectively. The diameter and length of delivery pipe are 10cm and 25m respectively. The water is delivered in the tank which is 20m above the centre of the pump. Find the following if the pump is running at 4 rps.

a). Pressure head in the cylinder at the beginning and end of suction stroke, both in absolute and gauge pressure.

b). Pressure head in the cylinder at middle of suction stroke, both in absolute and gauge pressure.

4. With the help of neat sketch explain the functions of air vessels

5. With the help of a neat sketch explain the working of a Jet pumps, gear pumps, vane pump and lobe pump
6. Show the percentage of work saved by connecting air vessels to a reciprocating pump.
7. Give notes on slip, % Slip and negative slip

MODULE 5

1. Explain the factors affecting volumetric efficiency of a reciprocating air compressor.
2. A single acting, single cylinder reciprocating air compressor has a cylinder diameter of 200mm and a stroke of 300mm. Air enters the cylinder at 1 bar, 27^0 C. It is then compressed polytropically to 8 bar according to the law $pv^{1.3}$ = Constant. If the speed of the compressor is 250rpm, calculate (i) the mass of air compressed per minute and (ii) the power required in KW for driving the compressor, if mechanical efficiency is 80%. Neglect clearance.
3. Give detailed notes on free air delivered (FAD)
4. Classify compressors
5. Derive the equation for work with and without clearance volume in a reciprocating compressor
6. Derive the condition for minimum work in a 2 stage compressor
7. Explain the uses of intercooler and after cooler
8. Give detailed notes on Roots blower and vane compressor with sketches
9. Explain surging and chocking
10. Give notes on slip factor and pressure coefficient
11. Explain the working of an Axial flow compressor
12. With neat sketch explain the working of a screw compressor
13. Draw the velocity diagram of a centrifugal compressor.

8. 100908/EN900E PROFESSIONAL ETHICS

7.1 COURSE INFORMATION SHEET

PROGRAMME: ALL PROGRAMMES	***DEGREE:*** BTECH
PROGRAMME: ALL PROGRAMMES	**DEGREE: B.TECH** **UNIVERSITY: A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
COURSE: PROFESSIONAL ETHICS	**SEMESTER: IV CREDITS: 2**
COURSE CODE: 100908/EN900E ***REGULATION: 2019***	**COURSE TYPE: MANDATORY CREDIT COURSE**
COURSE AREA/DOMAIN: HUMANITIES	**CONTACT HOURS: 2 hours/Week.**

SYLLABUS:

UNIT	***DETAILS***	***HOURS***
I	Understanding Ethics and Values: Morals, Values, and Ethics-Integrity-Academic Integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others-Living Peacefully-Caring and Sharing- Honesty- Courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations	**4L**
II	Scope and Aim of Engineering Ethics: Senses of Engineering Ethics - Variety of moral issues- Types of inquiry; Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy; Profession and Professionalism- Models of professional roles; Theories about right action –Self-Interest-Customs and Religion- Uses of Ethical Theories	**5L**
III	Engineering as Social Experimentation: Engineers as responsible Experimenters-Codes of Ethics- Plagiarism- A balanced outlook on law - Challenger case study- Bhopal gas tragedy	**5L**
IV	Professional Responsibilities: Collegiality and loyalty–Managing Conflict-Respect for Authority-Collective bargaining- Confidentiality- Role of confidentiality in moral Integrity-Conflicts of interest- Occupational crime Professional Rights: Employee rights- IPR-Discrimination	**5L**
V	Global Issues: Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development	**5L**
TOTAL HOURS		**24**

TEXT/REFERENCE BOOKS:

T/R	***BOOK TITLE/AUTHORS/PUBLICATION***
T	M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning

	Private Ltd, New Delhi,2012.
T	R S Naagarazan, A textbook on professional ethics and human values, New age international (P) limited, New Delhi,2006
R	http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.
R	Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and Cases, Wadsworth Thompson Learning, United States,2005.
R	Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
R	Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
R	P Arne Vesilind, Alastair S. Gunn, Engineering Ethics and the Environment, Cambridge University Press, 1998

COURSE PRE-REQUISITES:

C.CODE	*COURSE NAME*	*DESCRIPTION*	*SEM*
NIL	**NIL**	**NIL**	**NIL**

COURSE OBJECTIVES:

1	Brief students on the core values that are required by any professional.
2	Help students identify the ethical thought process in a professional environment.
3	Explain the implementation of values and morals in a workspace at a personal level.
4	Enable students to effectively solve problems within a given moral and ethical framework through examples, case studies and thought experiments.
5	Encourage students to implement the same pattern of thought process for real world issues.

COURSE OUTCOMES:

SNO	*DESCRIPTION*	*Bloom's Taxonomy Level*
CO1	Understand the core values that shape the ethical behaviour of a professional.	**Remember, Understand, Apply (Levels 1,2 and 3)**
CO2	Adopt a good character and follow an ethical life.`	**Remember, Understand, Apply (Levels 1,2 and 3)**
CO3	Explain the role and responsibility in technical development by keeping personal ethics and legal ethics.	**Remember, Understand, Apply (Levels**

		1,2 and 3)
CO4	Solve moral and ethical problems through exploration and assessment by established experiments.	**Remember, Understand, Apply (Levels 1,2 and 3)**
CO5	Apply the knowledge of human values and social values to contemporary ethical dilemmas and global issues.	**Remember, Understand, Apply (Levels 1,2 and 3)**

CO-PO AND CO-PSO MAPPING

	PO 1	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PSO 1*	*PSO 2*	*PSO 3*
CO1						**2**		**2**	**2**		**2**	**3**			**1**
CO2								**2**			**2**	**2**			**1**
CO3				**3**		**3**		**3**	**3**	**2**	**2**	**3**			**1**
CO4			**2**	**3**		**3**	**2**	**3**	**2**		**2**	**3**			**1**
CO5						**3**	**3**	**3**	**3**	**2**	**2**	**3**			**1**

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM /HIGH	JUSTIFICATION
CO1-PO6	**M**	The ethical behaviour of an engineer is a prerequisite to address the issues in society.
CO1-PO8	**M**	Knowledge about the essential values needed to lay the foundation of ethics in the work-life and otherwise.
CO1-PO9	**M**	A thorough understanding of professional ethics helps a

		person to be productive as an individual and as a team member.
CO1-PO11	**M**	Awareness about the ethics that govern a profession will help a person to apply these in managing a team.
CO1-PO12	**H**	A strong ethical foundation is very much essential for an engineer in a rapidly evolving technocratic society.
CO2-PO8	**M**	Good personal ethics helps an engineer be responsible and morally autonomous while making his decisions.
CO2-PO11	**M**	Successful team members and team leaders should have a strong ethical character.
CO2-PO12	**M**	A working professional operating on good morals always prepares themselves for newer challenges that will aid their development.
CO3-PO4	**H**	An engineer must solve complex problems in society with his technical expertise.
CO3-PO6	**H**	Engineers as responsible leaders must always take into consideration the cultural and legal ramifications of his work in a society.
CO3-PO9	**H**	A clear and precise road map on ethics is a must for everyone in a multidisciplinary setting.
CO3-PO10	**M**	An engineer must be able to effectively communicate the technological developments , and their role in solving issues faced by the general public.

CO3-PO11	**M**	Engineering and management principles must always be built on ethical and legal frameworks that govern the profession.
CO3-PO12	**H**	The application of technical innovations must always be under the guidance of personal and legal ethics.
CO4-PO3	**M**	Explorations and assessments help in finding solutions for complex ethical problems.
CO4-PO4	**H**	Truthful analysis and interpretation of data should assist in engineering investigation. This requires a sound critical assessment by an engineer.
CO4-PO6	**H**	Through exploration and assessment of ethical and moral case-studies, the engineer will have an unbiased approach to solving issues of public concern.
CO4-PO7	**M**	Sustainable development can be achieved only by the assessment of prior engineering projects involving the environment.
CO4-PO8	**H**	The application of ethical principles helps engineers find better solutions for problems.
CO4-PO9	**M**	Problem-solving activities will unite the participants in setting up a workable strategy.
CO4-PO11	**M**	Critical evaluation is a necessary ingredient in the successful management of a project.
CO4-PO12	**H**	Engineers should always adopt objective assessment and thorough explorations of ethical concerns to engage in

		independent and life-long deliberation of professional and personal issues.
CO5-PO6	**H**	Human and social values must be taken into consideration while developing engineering solutions as it will directly affect society at large.
CO5-PO7	**H**	Application of human and social values on global issues can help in achieving sustainable development.
CO5-PO8	**H**	Human and social values are very essential in helping a professional to adhere to the norms of engineering practice.
CO5-PO9	**H**	Knowledge about the well-being and sustainability of everything is essential, and can only be achieved through a combined effort.
CO5-PO10	**M**	Effective communication of ethical and moral values is a requisite for solving contemporary ethical and global dilemmas.
CO5-PO11	**M**	Application of knowledge and management principles to one's own workspace, which is a multicultural environment, demands a leader to be ethically and morally strong and also knowledgeable about global issues.
CO5-PO12	**H**	An engineer would be able to update his technical expertise only if he is ready to address global issues.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	LOW/MEDIUM/ HIGH	JUSTIFICATION
CO1-PSO3	**L**	Understanding the core ethical values helps to modify the design and manufacturing process to meet the needs of society rather than satisfying selfish desires.
CO2-PSO3	**L**	Moral and ethical autonomy is required to develop and implement decisions regarding design and development while ensuring the best manufacturing practices.
CO3-PSO3	**L**	Engineers must uphold the ethical and moral responsibility in ensuring the best manufacturing practices.
CO4-PSO3	**L**	Critical evaluation of the design and development process will help to ensure the best manufacturing practices.
CO5-PSO3	**L**	Ensuring ethical manufacturing practices and thorough knowledge of the global requirements is necessary to develop and implement sustainable solutions.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS:

SNO	*DESCRIPTION*	*RELEVANCE TO PO\PSO*	*PROPOSED ACTIONS*
1	**Nil**		

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SI NO:	TOPIC	RELEVANCE TO PO\PSO
1	Three types of ethics or morality – common, personal and professional	PO2, PO4, PO8, PSO3
2	Preventive and Aspirational Ethics	PO2, PO4, PO8, PSO3
3	Social and value dimensions of technology	PO2, PO4, PO6, PO8, PSO3
4	Environmental Ethics in Engineering	PO2, PO4, PO6, PO7, PO8,

		PSO3
5	Organizational culture and types	PO2, PO4, PO6, PO8, PO9, PSO3
6	Functions of engineers and managers	PO2, PO4, PO8, PO9, PSO3
7	Corporate Social Responsibility (CSR)	PO2, PO4, PO8, PO9, PSO3
8	Social Sensitivity and Gender Sensitivity	PO2, PO4, PO6, PO8, PO9, PSO3

WEB SOURCE REFERENCES:

1	**www.nptel.ac.in**

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ **STUD. ASSIGNMENT**	☐ **WEB RESOURCES**	☐ **LCD/SMART BOARDS**
☐ STUD. SEMINARS	☐ **ADD-ON COURSES**		

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☐ **STUD. SEMINARS**	☑ **TESTS/MODEL EXAMS**	☑ **UNIV. EXAMINATION**
☐ STUD. LAB PRACTICES	☐ **STUD. VIVA**	☐ **MINI/MAJOR PROJECTS**	☐ **CERTIFICATIONS**
☐ ADD-ON COURSES	☐ **OTHERS**		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ **STUDENT FEEDBACK ON FACULTY (TWICE)**
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ **OTHERS**

7.2 COURSE PLAN

DAY	*MODULE*	*TOPIC PLANNED*
1	**-**	Introduction to Professional Ethics
2	**I**	Morals, Values and Ethics; Project
3	**I**	Integrity- Academic Integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others; Case Study
4	**I**	Living Peacefully-Caring and Sharing- Honesty- Courage; Case Study
5	**I**	Cooperation- Commitment- Empathy-Self Confidence -Social Expectations; Project
6	**II**	Senses of Engineering Ethics - Variety of moral issues- Types of inquiry
7	**II**	Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory; Case Study
8	**II**	Consensus and Controversy; Profession and Professionalism- Models of professional roles
9	**II**	Theories about right action –Self-Interest-Customs and Religion- Uses of Ethical Theories; Case Study
10	**-**	Project
11	**III**	Engineering as Social Experimentation: Engineers as responsible Experimenters
12	**III**	Codes of Ethics- Plagiarism- A balanced outlook on law
13	**III**	Challenger case study
14	**III**	Bhopal gas tragedy
15	**IV**	Collegiality and loyalty–Managing Conflict-Respect for authority-Collective bargaining; Case Study
16	**IV**	Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest; Case Study
17	**IV**	Occupational crime, Professional Rights, Employee rights; Project
18	**IV**	IPR-Discrimination; Project
19	**V**	Multinational Corporations- Business Ethics; Case Study
20	**V**	Environmental Ethics; Case Study
21	**V**	Computer Ethics; Case Study
22	**V**	Role in Technological Development, Moral leadership
23	**V**	Engineers as Managers- Consulting Engineers-Engineers as Expert witnesses and advisors
24	**-**	Project/ Revision
25	**-**	Project/ Revision

7.3 MODULE WISE SAMPLE QUESTIONS

MODULE I

1. Compare and contrast morals and values.
2. Define academic integrity.
3. What is volunteering?
4. What is empathy?
5. Define morals, values and ethics
6. How does volunteering help with professional ethics?
7. Define self-confidence.
8. What does the term social expectations mean?
9. Define morals and ethics. Give an example to show the difference between them.
10. What values lead to academic integrity?
11. Differentiate between civic virtues and civic rights.
12. How is empathy important for human beings to live together peacefully? Give two examples of empathy in action.
13. What are the five pillars of Academic Integrity as per ICAI?
14. What is the relationship between morals, values and ethics? Give two examples.
15. What are some habits of empathetic people?
16. What are social expectations? Explain some social expectations expected from you.

MODULE II

1. What are the probable moral issues that an engineer can face?
2. What is the role of professional engineering organizations in guiding engineers to solve moral dilemmas?
3. What are moral dilemmas? What are the different ways in which an engineer can resolve these dilemmas?
4. How does normative inquiry differ from conceptual inquiry?
5. How does moral dilemma and moral autonomy come into play in an engineering professional's life?
6. Why did Gilligan name her book 'In a different voice'? What was her main argument?
7. How did 'Heinz dilemma' help Kohlberg in propounding his theory of moral development?
8. Why did Gilligan criticize Kohlberg's theory as biased?
9. How does tolerance help an engineer in turning controversy into consensus?
10. According to you, what should be the traits of an ideal engineer?
11. What is the importance of professionalism in the engineering field?

12. What are the different ethical theories? How does it help an engineer in his profession?
13. What are the different models of professional roles an engineer has to perform?
14. Is it ethical for an engineer to have self-interest while performing his duty? Is selfishness different from self-interest?
15. How does custom and religion influence a person in terms of ethics?

MODULE III

1. Which are the steps involved in the designing process in an engineering experiment?
2. Differentiate between engineering and standard experiments.
3. What is informed consent? Why is it important while conducting experiments?
4. Which are the unique responsibilities that engineers are required to undertake as responsible professionals?
5. Why are industry standards and certifications important?
6. Explain the factual and ethical issues involved in the Challenger Space Shuttle incident.
7. Why is it important to follow the academic codes of ethics?
8. What are the limitations of codes of ethics?
9. Differentiate between codes of conduct and codes of ethics.
10. What is a control group?
11. Explain the factual and ethical issues involved in the Bhopal Gas Tragedy of 1984.

MODULE IV

1. What is the importance of loyalty and collegiality in teamwork?
2. What are the central elements of collegiality needed for an engineer?
3. Why is conflict a key part of the engineering profession?
4. What are the ways in which an engineer can manage conflicts? How do you deal with a co-engineer who is loud, angry and frustrated?
5. Do engineers have an obligation to respect their employees' legitimate authority? Give your reasons.
6. Collective bargaining helps to make the relationship between employees and employers smooth. Do you agree?
7. Is confidentiality a vital aspect in the engineering profession?
8. When and how can an engineer expose unethical practices and intentions of his employers?
9. What are some examples of conflicts of interest in the engineering profession?
10. What happens if there is a serious mismanagement of conflict of interests?
11. Give three examples for occupational crime? What should be done to reduce it?

12. What are the basic rights of engineers? What all are included in his/her professional rights?
13. List out two legal and moral rights of an engineering employee?
14. Are intellectual property rights critical in the engineering field? Explain

MODULE V

1. Explain the duties of engineers towards environmental ethics.
2. Describe different types of issues found in computer ethics.
3. What are the ethical features involved in computer crime?
4. What are the issues related to privacy in the cyber world?
5. How can managers resolve conflicts in a firm?
6. Define the term consulting engineers.
7. How do engineers who act as expert witnesses abuse their power?
8. What are the duties of engineers who act as expert witnesses?
9. Why is moral leadership important for engineers?
10. Explain the causes and effects of global warming?

8. 100908/ES400F CONSTITUTION OF INDIA

8.1 COURSE INFORMATION SHEET

PROGRAMME: B. TECH ALL BRANCHES	DEGREE: BTECH
PROGRAMME: B. TECH ALL BRANCHES	DEGREE: **B. TECH** UNIVERSITY**: KTU**
COURSE: CONSTITUION OF INDIA	SEMESTER**: IV** CREDITS: **NIL**
COURSE CODE:100908/ES400f **REGULATION: UG**	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: SOCIAL SCIENCE	CONTACT HOURS: **2 hours/Week.**

SYLLABUS:

UNIT	*DETAILS*	*HOURS*
I	Definition of constitution, historical back ground, salient features of the constitution. Preamble of the constitution, union and its territory Meaning of citizenship, types, termination of citizenship.	4L
II	Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.	6L
III	The Union executive, the President, the vice President, the council of ministers, the Prime minister, Attorney-General, functions. The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament. Union judiciary, the supreme court, jurisdiction, appeal by special leave.	5L
IV	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories. The State Legislature, composition, qualification and disqualification of membership, functions. The state judiciary, the high court, jurisdiction, writs jurisdiction.	5L
V	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals. Official language, elections, special provisions relating to certain classes, amendment of the Constitution.	5L
TOTAL HOURS		25L.

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	Das Basu Durga, *Introduction to The Constitution of India*, Lexix Nexis Publication, RELX India Pvt. Ltd. 24th Edition, 2020
T2	PM Bhakshi, The constitution of India, Universal Law, 14e, 2017
R1	Ministry of law and justice, The constitution of India, Govt of India, New Delhi, 2019
R2	JN Pandey, The constitutional law of India, Central Law agency, Allahabad, 51e,2019
R3	MV Pylee, India's Constitution, S Chand and company, New Delhi, 16e, 2016

COURSE PRE-REQUISITES: NIL

COURSE OBJECTIVES:

1	To enable the students to understand the importance of the Indian Constitution
2	To create awareness among the students about the Indian Judiciary and its functions.
3	To make the students aware about their fundamental rights and duties

COURSE OUTCOMES:

SNO	DESCRIPTION	Bloom's Taxonomy Level
C100908/ES400F.1	Explain the background of the present constitution of India and features	Remember (level1)
C100908/ES400F.2	Utilize the fundamental rights and duties	Understand (level2) Apply (level3)
C100908/ES400F.3	Understand the working of the union executive, parliament and judiciary	Understand (level2)
C100908/ES400F.4	Understand the working of the state executive, legislature and judiciary	Understand (level2)
C100908/ES400F.5	Utilize the special provisions and statutory institutions	Understand (level2) Apply (level3)
C100908/ES400F.6	Show national and patriotic spirit as responsible citizens of the country	Understand (level2)

CO-PO AND CO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C100908/ES4OOF.1						2	2	2		2					
C100908/ES400F.2						3	3	3		3					
C100908/ES400F.3						3	2	3		3			1		
C100908/ES400F.4						3	2	3		3			1		
C100908/ES400F.5						3	2	3		3					
C100908/ES400F.6						3	3	3		2					

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	*LOW/MEDIUM/HIGH*	*JUSTIFICATION*
C100908/ES400F.1 ***PO 6***	M	To conceptualize the cause effect relationship between professional practices upon society within the constitutional framework.
C100908/ES400F.1 ***PO 7***	M	Engineering practices are subject to the environmental protection laws and regulations of the respective nations. The Constitution lays down Articles which specify the rules and regulations to preserve national resources.
C100908/ES400F.1 ***PO 8***	M	Engineering projects have a direct impact on the society and hence engineers should follow honesty, impartiality, fairness, and equity in engineering practices twined with the protection of the public health, safety, and welfare. The Constitution lays down the fundamental duties of a citizen along with ethical code of conduct to be followed.
C100908/ES400F.1 ***PO 10***	M	The constitutional framework helps a citizen undertaking any profession, to consider the interest of stake holders while engaging in any activity.
C100908/ES400F.2 ***PO6***	H	To design and plan any activity that so that it does not result in breaching the rights and privileges enjoyed by the society and it abide by the constitutional provisions.
C100908/ES400F.2 ***PO7***	H	Constitution lays down the provisions for environmental protection while undertaking engineering projects in future.

		E.g. Article 48 (A) and Article 51 (A)
C100908/ES400F.2 ***PO8***	H	To regulate any arbitrary action by the individual against any entity and helps to work in an ethical manner.
C100908/ES400F.2 ***PO10***	H	Fundamental rights and duties create a sense of responsibility and accountability among the students towards the society
C100908/ES400F.3 PO6	H	An awareness of the judiciary, parliament makes the students realize the pros and cons of negligence of respective laws related to their business as well as social environment.
C100908/ES400F.3 PO7	M	The Articles laid down by the Constitution create awareness among citizens, to give priority to the natural resources while undertaking any activity in the country.
C100908/ES400F.3 PO8	H	The Indian constitution lays down certain ethical codes of conduct and moral principles for its citizens. Every individual must follow integrity, honesty, transparency, impartiality etc. in his profession.
C100908/ES400F.3 PO10	H	Understands the procedure and law abiding by the Centre, State and the Judiciary conduct the engineering practices in accordance with the same.
C100908/ES400F.4 PO6	H	An awareness of the State Executive, Legislature and Judicial system makes a student realize the consequences of negligence of the laws applicable to their profession. This helps them to think about the legal consequences while undertaking projects
C100908/ES400F.4 PO7	M	Art.47 and Art.48(A) emphasize the duty of citizens to protect the country's environment. Awareness of the environmental laws under the constitutional framework regulates actions of the citizen by prioritizing environmental sustainability.
C100908/ES400F.4 PO8	H	The engineers are to use their expertise for the benefit of society. Ethics laid down by the Constitution regulates the performance of their own selves and their fellow engineers. The constitutional ethical values discussed under Liberty (eg. Art. 19 to 21), Justice (Art. 20,21, 39A, 39) Equity (Art. 15, 16 17), Impartiality (art. 17, 21, 21A,25, 26), Transparency and accountability, Public Welfare and Fraternity gives an idea of ethical values to be

		followed within a country
C100908/ES400F.4 PO10	H	Understands the procedure and law abiding by the Centre, State and the Judiciary conduct the engineering practices in accordance with the same
C100908/ES400F.5 PO6	H	Special Provisions are framed in order to protect the interest of Women, Children and Backward classes. This helps a student to develop an empathy towards these groups as and when required. The statutory institutions are formed to protect the rights of people, environment etc. An idea of the same creates an alertness among the students while engaging in engineering activities.
C100908/ES400F.5 PO7	M	To be aware that not all places in a country are treated alike and some places have its own uniqueness w.r.t language, tribes, environmentally fragility, historical importance etc. and to plan actions by considering the special provisions granted to these places by the constitution.
C100908/ES400F.5 PO8	H	Certain States are having special provisions to safeguard the minorities, backward areas and their development. An awareness of the special provisions helps a student to realize that certain moral principles have to be followed while undertaking engineering practices with respect to different States.
C100908/ES400F.5 PO10	H	Special Provisions are framed in order to protect the interest of Women, Children and Backward classes. This helps the engineer to plan and execute projects in such a way that the interest of these groups are also incorporated. The statutory institutions are formed to protect the rights of people, environment etc. An idea of the same reminds the engineer to communicate effectively the purpose and motive of every engineering practice undertaken within the State
C100908/ES400F.6 PO6	H	Reminds every student about his/her duties as citizen of India as an ordinary citizen as well as a professional engineer.
C100908/ES400F.6 PO7	H	Understanding the constitution creates a sense of conscious effort from the part of the students to utilize the natural resources efficiently.
C100908/ES400F.6 PO8	H	Understanding the ethical code of conduct laid down by the constitution creates a sense of responsibility within the

		students towards the society while engaging in engineering practices
C100908/ES400F.6 PO10	M	The Indian constitution enables the citizen to understand the toil and struggle undertaken by the freedom fighters and the emotion behind framing such a constitution. This will enlighten them to the fact that they have a great deal of responsibility for the welfare of the nation and will also create a sense of accountability in their actions.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	*LOW/MEDIUM/ HIGH*	*JUSTIFICATION*
C100908/ES4F.3-PS01	L	While trying to find solutions to industrial problems and meeting the demands of the industry the awareness about the judiciary acts as a deterrent to unlawful practices.
C100908/ES400F.4-PS01	L	While trying to find solutions to industrial problems and meeting the demands of the industry the awareness about the judiciary acts as a deterrent to unlawful practices

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS:

SNO	*DESCRIPTION*	*RELEVENCE TO PO\PSO*	*PROPOSED ACTIONS*
1	Environmental Protection Act	**PO7**	NPTEL
2	Pollution Control Laws: Administrative process	PO7	NPTEL
3	Cyber Laws: Administrative Process	P08	Assignment
4	Intellectual Property Law & Rights	PO8	NPTEL
5	Human Rights	PO8	Webinar
6	Contract Laws and Tort Laws	PO8	Webinar

PROPOSED ACTIONS: TOPICS BEYOND SYLLABUS/ASSIGNMENT/INDUSTRY VISIT/GUEST LECTURER/NPTEL ETC

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SI NO:	TOPIC	RELEVENCE TO PO\PSO
	Challenges to Indian Political System	PO6
2	India's External Relations	PO6
3	Working of Election Commission	PO6
4	Environmental Impact Assessment and Administrative Process	PO6

WEB SOURCE REFERENCES:

1	E – PG pathshaala – Law
2	https://indiankanoon.org/
3	https://www.sci.gov.in/
4	https://cag.gov.in/en
5	www.india.gov.in
6	https://www.epw.in/
7	https://www.barandbench.com/
8	https://www.lawweb.in/

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☑ STUD. ASSIGNMENT	☑ WEB RESOURCES	☐ LCD/SMART BOARDS
☑ STUD. SEMINARS	☐ ADD-ON COURSES	☑ ICT ENABLED CLASSESS	

ASSESSMENT METHODOLOGIES-DIRECT

☑ ASSIGNMENTS	☑ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
☐ STUD. LAB PRACTICES	☐ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☑ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (ONCE)
☐ ASSESSMENT OF MINI/MAJOR	☑ OTHERS

8.2 COURSE PLAN

DAY	MODULE	TOPIC PLANNED
1	1	Definition of constitution, historical back ground, salient features of the constitution.
2	1	Preamble of the constitution, union and its territory.
3	1	Meaning of citizenship, types.
4	1	Termination of citizenship
5	2	Definition of state, fundamental rights, general nature, classification.
6	2	Right to equality, right to freedom, right against exploitation
7	2	Right to freedom of religion, cultural and educational rights, right to constitutional remedies
8	2	Protection in respect of conviction for offenses.
9	2	Directive principles of state policy, classification of directives.
10	2	Fundamental duties
11	3	The Union executive, the President, the Vice President, the council of ministers
12	3	The Prime minister, Attorney-General, functions.
13	3	The parliament, composition, Rajya sabha, Lok sabha
14	3	Qualification and disqualification of membership, functions of parliament.
15	3	Union judiciary, the supreme court, jurisdiction, appeal by special leave
16	4	The State executive, the Governor, the council of ministers
17	4	The Chief minister, advocate general, union Territories
18	4	The State Legislature, composition.
19	4	Qualification and disqualification of membership, functions.
20	4	The state judiciary, the high court, jurisdiction, writs jurisdiction.
21	5	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission
22	5	Emergency provision, freedom of trade commerce and inter course,
23	5	Comptroller and auditor general of India, public Services, public service commission, administrative Tribunals.
24	3	Official language, elections,
25	3	Special provisions relating to certain classes, amendment of the Constitution.

8.3 MODULE WISE SAMPLE QUESTIONS

MODULE 1

1. What were the salient features of Government of India Act 1935?
2. Which were the changes introduced by Indian Independence Act 1947?
3. Charter of 1833 was a turning point in the history of British rule in India. Discuss
4. Discuss the historical background of the Indian constitution.
5. Explain the salient features of the Indian constitution.
6. Discuss the importance of Article 32 of the Indian Constitution.
7. Which are the modes of losing Indian Citizenship? Explain.
8. Which are the modes of acquiring Indian Citizenship? Explain.
9. Explain the federal features of constitution.
10. Define and explain the term Constitution
11. What the major commitments of the Constitution of India are as incorporated in its preamble?
12. What is the significance of a Preamble to a Constitution? Bring out the philosophy of the Indian polity as enshrined in the Preamble of Indian Constitution.
13. Describe the emergence of Basic Structure concept in the Indian Constitution.
14. Explain the procedure to amend the constitution. Also explain importance basic structure doctrine in the amending the constitution.
15. Discuss the development of constitutional model in India.
16. Explain the need and importance of the Preamble
17. Discuss the Rights of citizenship of certain migrants to Pakistan (Article 7)
18. Can Parliament to regulate the right of citizenship by law? Discuss
19. Discuss in detail the four different ways of acquiring Citizenship at the commencement of the Constitution under the Constitution of India.
20. Article 1, Article 2, Article 3 and Article 4 – how article 2 is different from Article 3?

Module 11

1. State and Explain the Constitutional Remedies.
2. Define a Writ. How can a citizen file a writ petition?
3. State the following: (i) Writ of Habeas Corpus, (ii) Writ of Mandamus, (iii) Writ of Certiorari,
   (iv) Writ of Prohibition, (v) Writ of Quo-Warranto
4. Write short note on "Right against exploitation".
5. "No person shall be deprived of his property save by authority of law". Comment.
6. What were the recommendations of the 'Swarna Singh Committee'?
7. State the difference between the fundamental rights and DPSP.
8. What is meant by DPSP? What are the features of DPSP? List the directives.
9. What are the new DPSPs added by the 42nd Amendment Act, 1976?
10. What are the socialist principles stated in the DPSP?
11. Discuss: Right to Equality under the Constitution.
12. What is "discrimination"? State the provisions in the Constitution with regard to "prohibition of discrimination on certain grounds."
13. How is the "Right to Freedom" guaranteed under the Indian Constitution?
14. Discuss right to education guaranteed under the Constitution.
15. Discuss right to freedom of religion guaranteed under the Constitution.
16. Explain fundamental duties establishing their relationship between the fundamental rights.
17. Explain the background under which the fundamental duties were inserted to the constitution of India.
18. Are all fundamental duties enforceable? Substantiate your answer.
19. What do you mean by cultural and educational rights? Explain with example.
20. Critically discuss the Gandhian Principles laid down via DPSP in the constitution.
21. Discuss in what manner "Right to Equality" is guaranteed under Indian Constitution.
22. "No person shall be divided of his life or personal liberty except according to procedure established by law." Comment.

23. "Article 22 of the Constitution makes provision for protection against arrest and dentition in certain cases." Explain fully (a) the scope of and (b) the limitation of this protection.
24. Discuss right to property guaranteed under the Constitution.
25. Write arguments for and against whether the fundamental duties should be made enforceable.
26. People displaced by a big dam project take out a rally demanding rehabilitation. Which fundamental right is being used or violated? Justify your answer.
27. Is Banning a book a violation of fundamental right? Justify your answer.
28. Over five crore tonnes of food grains was stored in the warehouse of Food Corporation of India. Many ration card holders do not know about the quantity of food grains they can purchase from fair price shops. A petition by Human Rights Group drew attention of the court to this condition and it requested the court to order government to improve its Public Distribution System. Which different Rights does this case involve? How are they linked?
29. Critically analyze whether the non-enforceability of DPSPs make them subservient to Fundamental Rights?
30. On what basis is of Directive Principles of State Policy criticized?
31. "No person shall be prosecuted and punished for the same offence more than once".Discuss this clause.
32. A high court passes a judgement against X. X desires to file a writ petition in the supreme court under Art32, on the ground that the judgement violates his fundamental rights. Advise him whether he can do so.

Module 3

1. What is meant by impeachment?
2. Who are deputy ministers?
3. How is the vice president elected?

4. What is the tenure of Prime minister?
5. How can the President be removed from the office?
6. Write a short note on the judicial powers of the President.
7. Write a short note on financial powers of the President.
8. What are the special powers of rajyasabha?
9. What are the powers and functions of the Prime Minister?
10. Write a short note on Council of Ministers.
11. What is the maximum strength of Rajya Sabha as well as Lok Sabha?
12. What do you mean by judiciary?
13. Write down the composition of the Supreme Court of India.
14. What is a Money Bill?
15. What is ordinary bill?
16. How can we categorize the council of ministers?
17. Apart from being as an Indian citizen what are the qualification needed for being as a Prime Minister.
18. What are the qualification required to be the Vice President of India?
19. How many members does each state have in Rajya Sabha?
20. How many members are elected from union territories?
21. How is the vice president of India elected?
22. What are the responsibilities of deputy chairman?
23. How are members of Rajya Sabha elected?
24. What are the requirements to become a member of Rajya Sabha?
25. How many members are nominated from rajyasabha and from which all field?
26. Can a member of rajyasabha be disqualified if yes, state the reasons?
27. What are the special powers of rajyasabha?
28. What is the legislative relation between Rajya Sabha and Lok Sabha?
29. Is any deadlock between the two houses possible? If yes, how it is solved.
30. What is a bill, an act and a law?
31. Explain the qualification and disqualification for membership of the state legislature.
32. Explain the qualification and disqualification for membership in the house of people.
33. Explain the concept of Appeal by Special Leave.

34. Explain the composition, original and appellate jurisdiction of Supreme Court of India.
35. How can a judge of Supreme Court be removed from his office?
36. Explain the role of Attorney General of India.
37. How is the Lok Sabha more powerful than the Rajya Sabha?
38. Mention power of Parliament to amend the Constitution.
39. Describe the law-making procedure in the Parliament of India.
40. Explain the various kinds of jurisdiction of Supreme court.

Supreme Court may in its discretion grant special leave to appeal. Examine the situation..

41.Read the following statements. Match them with the different jurisdictions the Supreme Court can exercise – Original, Appellate, and Advisory.

- The government wanted to know if it can pass a law about the citizenship status of residents of Pakistan-occupied areas of Jammu and Kashmir.
- In order to resolve the dispute about river Cauvery the government of Tamil Nadu wants to approach the court.

.Court rejected the appeal by people against the eviction from the dam site.

41. Do you think that judicial activism can lead to a conflict between the judiciary and the executive? Why?
42. How is judicial activism related to the protection of fundamental rights? Has it helped in expanding the scope of fundamental rights?
43. Looking at the constitutional provisions, it seems that the President is only a rubber stamp. Do you agree with statement? Substantiate your answer with reason.
44. In what circumstances, the President's rule is imposed in a state? What role does the Governor

play during this?

45. Do you think that the Presidential form of Government is the most suitable for India? Justify.
46. Arif wanted to know that if ministers propose most of the important bills and if the majority party often gets the government bills passed, what is the role of the Parliament in the law making process? What answer would you give him?

MODULE IV

1. What are the minimum qualifications to be a Governor of a State?
2. Explain the Ordinance making power of the Governor.
3. Which Articles of the Constitution deals with State Executive?
4. Explain the procedure in which Governor is removed from office?
5. What is the procedure for imposition of President's Rule in a State?
6. Which are the States that have a bicameral legislature? And why?
7. What are the two main ways in which the Legislative Assembly keeps its control over the Council of Ministers? 8. What are the two electoral functions of the State Legislative Assembly?
9. What is the procedure followed during the dismissal of a Minister?
10. Explain the composition and duration of state legislative council.
11. How is the Governor appointed? What are the powers and functions of the Governor?
12. How is the Council of Ministers constituted? Explain the powers and the position of the Chief Minister.
13. Examine the organization, powers, and functions of the State Legislature
14. State the duties of the Chief Minister.
15. How is a Chief Minister appointed?
16. What is the term of the Chief Minister's office?
17. What is the term of the Governor's office?
18. How is the Council of Ministers appointed?
19. What are the functions of the Chief Minister in relation to the Governor?
20. What are the functions of the Chief Minister in relation to the Council of Ministers?
21. Elaborate on the composition of the State Legislative Assembly.
22. State the difference between Vidhan Sabha and Vidhan Parishad.
23. Explain the collective responsibility of the Council of Ministers towards the Vidhan Sabha.
24. Explain the role of the Governor as the agent of the Central Government.
25. Explain the conditions of eligibility and appointment of the Advocate General of the State.
26. Explain the duties and responsibilities of the Advocate General of the State.
27. Explain the Constitutional provisions ensuring separation of powers with respect to State Executive.

28. What are the provisions under the State List?
29. Explain the duties of advocate general of India?
30. Explain the procedure for the appointment of the chief minister.
31. What is the position of the Legislative Assembly in the administration of the state
32. Can Governor reserve a Bill? Substantiate your answer.
33. State the role of the Speaker of the State Legislative Assembly.
34. Explain the various writs issued by High court of Kerala.
35. Explain the constitution of Highcourt. What are the essential qualifications required for the appointment of high court judge?
36. What are the powers of the high court?

How can a judge of the high court be removed from the office?

37. The Governor has no power to dissolve the legislative assembly. Why?
38. Why Governor is called the nominal executive and Chief Minister the real executive?
39. Can the Governor appoint a non - member of the house as Chief Minister? Explain your answer with justification.
40. Explain the relationship between Governor and Chief Minister.
41. What are the minimum qualifications required to be a member of the State Legislative Council?
42 .Explain how the sessions of the State Legislature are held
43. What is a bicameral State?
44. Who are the officers of the State Legislature?
45. How is a Bill passed in the State Legislative Assembly?
46. State the composition of the State Legislative Council.
47. State the executive powers of the Governor.
48. State the financial powers of the Governor.
49. State the pardoning powers of the Governor.
50. State the judicial powers of the Governor
51 .State the powers of the Chief Minister.
52 .Describe the composition of the State Legislative Assembly.
53. Explain the manner of election to the State Legislative Council.

54. Explain the procedure for the abolition of the State Legislative Council.

55. What are the conditions under which a member of the State Legislature is removed or disqualified?

56 .Explain the privileges of the State Legislature

57. What is the procedure for the formation of the State Legislative Council? Also, examine its relevance vis-a-vis legislative assembly.

58. Can the Governor be dismissed arbitrarily? Justify your answer.

59. What are the provisions under the Constitution in which state Assembly can be dissolved?

60. Explain the powers and functions of the State Legislature.

61. Explain the limitations to the powers of the State Legislature.

62 .Compare the functions of the State Legislative Assembly and State Legislative Council.

63. State the electoral functions of the State Legislative Assembly.

64. Can the Governor sanction prosecution of Ministers under the corruption Act? Justify your answer.

65. Explain the Centre's control over the State Legislation.

66. Explain the Constitutional Powers of the State Legislature. 67. What is the jurisdiction of the high courts?

68. Explain the various writs issued by High court of Kerala.

69. What is judicial review exercised by the high court?

70. X filed a writ petition under Art 226 which was dismissed. Subsequently, he filed a writ petition under Art 32 of the constitution, seeking the same remedy. The Government argued that the writ petition should be dismissed, on the ground of res judicata. Decide.

71 .Does independence of the judiciary mean that the judiciary is not accountable to any one? Jusify your answer

72. Examine the situation –No single party got majority in the state election in Kerala- how is the Chief Minister appointed?

73. Mention the situations to when a Governor can use his discretionary powers.

74. In what circumstances, the President's rule is imposed in a state? What role does the Governor play during this?

Module v

1. List three types of emergency under Indian constitution.
2. What is federalism?
3. How have the powers been distributed in the federation of India?
4. What is the electoral process in India?
5. What is the administrative relationship between the central and state government in India? Explain.
6. Mention some features of federal government.
7. What do you know the article 351 of our Constitution?
8. What do you understand by Article 343 of our constitution?
9. Explain the provisions in Constitution related to official language.
10. Explain the functions of finance commission
11. Explain the procedure for the amendment of the Constitution
12. What is the need of the administrative tribunals? Explain the functions of State administrative tribunals.
13. Discuss the functions of Comptroller and Auditor General of India.
14. Explain the distribution of tax revenue with respect to center-state financial relation.
15. Explain the powers of public service commission.
16. How have the powers been distributed in the federation of India?
17. What is the composition of Election Commission of India?
18. Mention the different methods to amend the constitution.
19. Legislative powers have been distributed between the central and state government. Justify.
20. Explain the financial relations between the union and the states.
21. Write a Short note on Parliamentary Committee on Official Language.
22. .Give complete list of Languages included in the Eighth Schedule of the Constitution? Also point out significance of this Schedule?

23 .Discuss the functions of Inter State council.

24. Explain the clause of freedom of trade commerce and intercourse in the Constitution

25. Discuss the effects of national and financial emergencies.

26. Discuss the effects of proclamation of emergency.

27. List four features of the Indian Constitution that give greater power to the central government than the State government.

28. Should some States be governed by special provisions? Does this create resentment among? other States? Does this help in forging greater unity among the regions of the country?

29. The Constitution of India is a living document". Explain.

30. Universal Adult Franchise is important in a democracy". Justify the statement.

31. Can Union Parliament frame laws on the subjects mentioned in the state list? Explain

10. 100006/ME422S FLUID MECHANICS AND HYDRAULIC MACHINES LAB

10.1. COURSE INFORMATION SHEET

PROGRAMME: ME	**DEGREE:** BTECH
COURSE: FLUID MECHANICS AND HYDRULIC MACHINES LAB	**SEMESTER:** 4 **CREDITS:** 2
COURSE CODE: 100006/ME422S **REGULATION:** 2020 (Autonomous)	**COURSE TYPE:** CORE
COURSE AREA/DOMAIN: FLUID SCIENCE	**CONTACT HOURS:** 3 (Practical) hours/Week

SYLLABUS:

UNIT	DETAILS	Lab cycle
EXPERIMENTS	1. Determination of coefficient of discharge and calibration of Notches.	Cycle 1
	2. Determination of coefficient of discharge and calibration of Orifice meter.	
	3. Determination of coefficient of discharge and calibration of Venturimeter.	
	4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus.	
	5. Determination of metacentric height and radius of gyration of floating bodies.	
	6. Performance test on positive displacement pumps.	Cycle 2
	7. Performance test on centrifugal pumps, determination of operating point and efficiency.	
	8. Performance test on Impulse turbines.	
	9. Performance test on reaction turbines (Francis and Kaplan Turbines).	
	10. Impact of jet.	

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
R1	Yunus A. Cenegel, John M. Cimbala; "Fluid Mechanics- Fundamentals and Applications (in SI Units)"; McGraw Hill, 2010.
R2	Bansal R.K, "Fluid Mechanics and Hydraulic Machines (SI Units)"; Laxmi Publications, 2011.
R3	Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic

	Machines" Standard Book House, New Delhi, 20th Edition, 2015
R4	Graebel. W. P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
R5	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Fluid Mechanics and Machinery", John Wiley and sons, 2015.
R6	J. Frabzini, "Fluid Mechanics with Engineering Applications", McGraw Hill, 1997.

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
100006/ME300C	MECHANICS OF FLUIDS	This course gives an introduction to the fundamentals of fluid flow and its behaviour.	3

COURSE OUTCOMES:

SNO	DESCRIPTION	Bloom's Taxonomy Level
C100006/ME422S .1	Determine the coefficient of discharge of flow measuring devices (notches, orifice meter and Venturi meter)	Analyse (level 4)
C100006/ME422S .2	Calibrate flow measuring devices (notches, orifice meter and Venturi meter)	Understand (level 2)
C100006/ME422S .3	Evaluate the losses in pipes	Apply (level 3)
C100006/ME422S .4	Determine the metacentric height and stability of floating bodies	Analyse (level 4)
C100006/ME422S .5	Determine the efficiency and plot the characteristic curves of different types of pumps and turbines	Evaluate (level 5)

CO-PO AND CO-PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C100006/ME422S .1	2	1						2	3	2		2	2		
C100006/ME422S .2	2	1						2	3	2		2	2		
C100006/ME422S .3	2	1						2	3	2		2	2		
C100006/ME422S .4	2	1						2	3	2		2	2		
100006/ME422S .5	2	1						2	3	2		2	2		

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	LOW/MEDIUM/HIGH	JUSTIFICATION
100006/ME422S .1-PO 1	M	Students can apply the mathematical skills and engineering knowledge in calculation of coefficient of discharge of the flow measuring devices.
100006/ME422S .1-PO 2	L	Students can analyse and infer the results obtained for discharge coefficients by comparing with the theoretical values.
100006/ME422S .1-PO 8	M	Students will stick on to the professional ethical values while reporting the results.
100006/ME422S .1-PO 9	H	Students will learn how to work in a team and as an individual to take out the readings and do the calculations.
100006/ME422S .1-PO 10	M	Students will learn to effectively furnish the observations, results and inferences in the form of lab record.
100006/ME422S .1-PO 12	M	Since students acquire knowledge about different basic flow measuring devices, he/she can explore different devices used in the industry.
100006/ME422S .2-PO 1	M	Students can apply their mathematical knowledge for the calibration of the flow measuring devices
100006/ME422S .2-PO 2	L	Students will be able to interpret the calibration curves and understand how to predict the discharge at different heads.
100006/ME422S .2-PO 8	M	Students will stick on to the professional ethical values while reporting the results.
100006/ME422S .2-PO 9	H	Students will learn how to work in a team and as an individual to take out the readings and do the calculations.
100006/ME422S .2-PO 10	M	Students will learn to effectively furnish the observations, results and inferences in the form of lab record.
100006/ME422S .2-PO 12	M	Ability to interpret calibration curves act as a foundation for higher studies.
100006/ME422S .3 - PO 1	M	Students can apply the theoretical knowledge gained from the Fluid mechanics class, to calculate various losses than can incur in pipe flow.
100006/ME422S .3 - PO 2	L	Students will be able to analyse the losses at different sections in a pipe, so that they can calculate the required input for the desired flow.

100006/ME422S .3 - PO 8	M	Students will stick on to the professional ethical values while reporting the results.
100006/ME422S .3 - PO 9	H	Students will learn how to work in a team and as an individual to take out the readings and do the calculations.
100006/ME422S .3 -PO 10	M	Students will learn to effectively furnish the observations, results and inferences in the form of lab record.
100006/ME422S .3-PO 12	M	Since students acquire knowledge about calibration of devices, they gain confidence to apply this knowledge in the future.
100006/ME422S .4 - PO 1	M	Students will be able to apply the engineering knowledge for determining the metacentric height of floating bodies.
100006/ME422S .4 - PO 2	L	With the knowledge gained they can analyse and interpret data regarding the stability and arrive at valid conclusions.
100006/ME422S .4 - PO 8	M	Students will stick on to the professional ethical values while reporting the results.
100006/ME422S .4 - PO 9	H	Students will learn how to work in a team and as an individual to take out the readings and do the calculations.
100006/ME422S .4 -PO 10	M	Students will learn to effectively furnish the observations, results and inferences in the form of lab record.
100006/ME422S .4-PO 12	M	Understanding the stability of the floating bodies enables the students to apply this knowledge in future.
100006/ME422S .5 - PO 1	M	Analytical knowledge on the pump/turbine performance helps the students to solve some of the engineering problems.
100006/ME422S .5 - PO 2	L	With the knowledge gained they can interpret the data and can provide valid conclusions
100006/ME422S .5 - PO 8	M	Students will stick on to the professional ethical values while reporting the results.
100006/ME422S .5 - PO 9	H	Students will learn how to work in a team and as an individual to take out the readings and do the calculations.
100006/ME422S .5 -PO 10	M	Students will learn to effectively furnish the observations, results and inferences in the form of lab record.
100006/ME422S .5-PO 12	M	An ability to interpret characteristic curve of various turbo machinery equip the students to review research literatures, and analyse complex engineering problems related to hydraulic machines.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	LOW/ MEDIUM /HIGH	JUSTIFICATION
100006/ME422S .1-PSO1	M	Students can apply their knowledge in fluid science to solve engineering problems in the domain of flow measuring devices.
100006/ME422S .2- PSO1	M	Students can apply their knowledge in mathematics & fluid science for the interpretation of calibration curves.
100006/ME422S .3-PSO1	M	Students can apply their knowledge in fluid science to calculate the pipe losses.
100006/ME422S .4-PSO1	M	Students can apply their knowledge in fluid sciences to understand the stability of the floating devices
100006/ME422S .5-PSO1	M	Design knowledge in turbine/ pumps helps to implement various mechanical systems.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS: Nil

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: Nil

WEB SOURCE REFERENCES:

1	https://nptel.ac.in/courses/112/105/112105206/
2	https://fm-nitk.vlabs.ac.in/
3	https://eerc03-iiith.vlabs.ac.in/List%20of%20experiments.html?domain=Civil%20Engineering

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK & TALK	☐ STUD. ASSIGNMENT	☑ WEB RESOURCES	☑ VIDEO RECORDINGS
☑LCD/SMART BOARDS	☐ STUD. SEMINARS	☐ ADD-ON COURSES	

ASSESSMENT METHODOLOGIES-DIRECT

☐ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑UNIV. EXAMINATION
☑ STUD. LAB	☑ STUD. VIVA	☐ MINI/MAJOR	☐

PRACTICES		PROJECTS	CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (ONCE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

10.2. COURSE PLAN

DAY	CYCLE	NAME OF EXPERIMENT
1	I	Determination of coefficient of discharge and calibration of Notches.
2		Determination of coefficient of discharge and calibration of Orifice meter.
3		Determination of coefficient of discharge and calibration of Venturimeter.
4		Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus.
5		Determination of metacentric height and radius of gyration of floating bodies.
6	II	Performance test on positive displacement pumps.
7		Performance test on centrifugal pumps, determination of operating point and efficiency.
8		Performance test on Impulse turbines.
9		Performance test on reaction turbines (Francis and Kaplan Turbines).
10		Impact of jet.

10.3. SAMPLE QUESTIONS

1. What are obstruction flow meters? Give 3 examples.
2. What is the purpose of closing delivery valve before starting a centrifugal pump?
3. Define orifice. What is the difference between a small orifice and a large orifice?
4. Define specific speed of a Pump? Write the formula and label each term.
5. How is a Kaplan turbine different from a Francis turbine?
6. What do you mean by vena contracta? Why the area at the vena contracta is the smallest?
7. Why diverging part is made longer than converging part in a venturimeter?
8. Why the '*casing'* is important in reaction turbines? What purpose does it serve in an impulse turbine?
9. Explain pumps in series and parallel.
10. What is slip in a Reciprocating pump? How negative slip occurs in a Reciprocating pump?
11. Classify Pelton, Francis & Kaplan turbines according to discharge, head and specific speed.

    (Mention the range of specific speed)
12. Name any four flow measuring devices that can be used in a pipe flow.
13. What is an air vessel? What is its purpose? In which type of pump it is used?
14. Define metacentre and metacentric height.
15. What is priming? What do you mean by a self-priming pump?
16. Define the terms Crest (or Sill) and Nappe (or Vein) of a notch.
17. Explain Hydraulic Energy Line and Total Energy Line.
18. What is cavitation? In which part of the reaction turbine it's likely to take place?
19. What is the difference between an Orifice and a Mouthpiece?
20. Draw the indicator diagram of Reciprocating pump with and without friction.
21. State Bernoulli's theorem. What are its assumptions?
22. What do you mean by '*load*' on a turbine?
23. What is the purpose of a surge tank?
24. Why Venturimeter is more efficient among all other flow measuring devices?
25. Differentiate single acting and double acting reciprocating pump.
26. What is the difference between a U-Tube manometer and a differential manometer?
27. For a freely floating body discuss the conditions of equilibrium.

28. What is the difference between Darcy's friction factor and coefficient of friction in a pipe flow?
29. Why draft tubes are necessary in reaction turbines? What will happen if a uniform cross section tube is used instead of draft tube?
30. What are the types of impellers used in Centrifugal Pumps?
31. What do you understand by the term Calibration?
32. What is NPSH?
33. Why foot valve is not necessary in reciprocating pumps? Explain.
34. Explain the function of a deflector in Pelton turbines.
35. Define an Orifice. What are the ranges of the values of hydraulic coefficients of an orifice for general purpose?
36. What is the difference between propeller and Kaplan turbine?
37. Write the energy equation in terms of head for flow through pipe. Express the equation in energy per unit volume
38. State "Law of conservation of mass" of a flowing fluid? Write the equation.
39. What is the difference between a notch and a weir? Write down the equation for discharge through a rectangular notch.
40. What do you mean by separation in reciprocating pump? What is the condition to avoid separation?
41. Define specific speed of a Pump? Write the formula and label each term.
42. How is a Kaplan turbine different from a Francis turbine?
43. Define coefficient of velocity and coefficient of friction and write the formulas.
44. Why the '*casing'* is important in reaction turbines? What purpose does it serve in an impulse turbine?
45. Why diverging part is made longer than converging part in a venturimeter?
46. State Bernoulli's theorem. What are its assumptions?
47. What do you mean by '*load*' on a turbine?
48. For a fully submerged body discuss the conditions of equilibrium.
49. What is the difference between Darcy's friction factor and coefficient of friction in a pipe flow?
50. What do you mean by separation in reciprocating pump? What is the condition to avoid separation?

11. 100006/ME422T MACHINE TOOLS LAB- I

11.1 COURSE INFORMATION SHEET

PROGRAMME: ME	***DEGREE:*** BTECH
PROGRAMME: **MECHANICAL ENGINEERING**	DEGREE: **B. TECH** UNIVERSITY**: A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY**
COURSE: **MACHINE TOOLS LAB- I**	SEMESTER**: IV** CREDITS: **2**
COURSE CODE: **100006/ME422T** ***REGULATION:*** **UG**	COURSE TYPE: **CORE**
COURSE AREA/DOMAIN: **PRODUCTION ENGINEERING**	CONTACT HOURS: **3 practical hours/Week.**

SYLLABUS:

Experiments	*DETAILS*	*HOURS*
PART - A	Safety precautions in machine shop - Exercises on machine tools: turning, knurling, drilling, boring, reaming, trepanning, milling, hobbing, planning, shaping, slotting, broaching, grinding, lapping, honing etc. - Welding practice.	30
PART - B	Metallurgy, heat treatment and testing.	12
	PART A ***(minimum eight experiments)***	
1	**Centre Lathe** Study of lathe tools: - tool materials - selection of tool for different operations - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness obtainable – tool grinding. · Study the different methods used to observe the workpiece is precisely fixed on lathe. · Study the optimum aspect ratio of work-piece to avoid vibration and wobbling during turning. · Machine tool alignment test on lathe. · Re-sharpening of turning tool to specific geometry	3
2,3,4,5,6	**Exercises on centre lathe**:- Facing, plain turning, step turning and parting – groove cutting, knurling and chamfering - form turning and	3

	taper turning – eccentric turning, multi-start thread, square thread and internal thread etc.	
	Exercises on lathe: - Measurement of cutting forces in turning process and correlate the surface roughness obtainable by varying feed, speed, feed, nose radius, side and end cutting edge angles.	6
7	Measurement of cutting temperature and tool life in turning and machine tool alignment test on lathe machine.	3
8	**Exercises on Drilling machine** Drilling, boring, reaming, taping and counter sinking etc.	3
	Exercises on drilling machine: - Measurement of cutting forces in drilling process and correlate with process parameters.	
9	**Exercises on Shaping machine** · Exercises on shaping machine: - flat surfaces, grooves and key ways.	3
	Exercises on Slotting machine · Exercises on slotting machine: - flat surfaces, grooves and key ways.	
10	**Planing and Broaching machine** Study and demonstration of broaching and hobbing machine. · Exercises on planing machine	3
11	**Exercises on Grinding machine** · Exercise on surface grinding, cylindrical grinding and tool grinding etc. · Measurement of cutting forces and roughness in grinding process and correlate with process parameters. · Study and demonstration of lapping and honing machines.	3
12	**Exercises on Welding machine** · Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets.	3
	PART B - Metallurgy ***(minimum two experiments)***	
13	**Specimen preparation**, etching & microscopic study of Steel, Cast iron and Brass and grain size measurement.	6
14	**Heat treatment study**:–Effect on mechanical properties and microstructure of ferrous and non ferrous metals.	6
	Studies of various quenching mediums, Carryout heat treatments on steel based on ASM handbook vol.4 and observe the hardness obtained.	
TOTAL HOURS		**42**

TEXT/REFERENCE BOOKS:

T/R	BOOK TITLE/AUTHORS/PUBLICATION
T1	Acherkan N. S., *Machine Tool*, Vol. I, II, III and IV, MIR Publications, 2010.
T2	HMT, *Production Technology*, First edition, Tata McGraw Hill, 2010.
T3	W. A. J. Chapman, *Workshop Technology Part I*, Fifth edition, ELBS & Edward Arnold Publishers, 2001.
R1	A. B. Chattopadhyay, *Machining and machine tools*, Second edition, Wiley, 2017
R2	Hajra Choudary, *Elements of workshop technology, Vol I & II*, Media Publishers, 2009
R3	Winston A. Knight, Geoffrey Boothroyd, *Fundamentals of Metal Machining and Machine Tools*, Third edition, Taylor and Francis, 2005
R4	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, *Fundamentals of Digital Manufacturing Science*, First edition, Springer-Verlag London Limited, 2012
R5	Ghosh A. And Malic A. K., *Manufacturing Science*, Second edition, East West Press, 2010

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
100006/ME400C	Manufacturing Process	Knowledge about manufacturing technologies is required for analyzing the job/experiment	IV

COURSE OBJECTIVES:

1	To understand the parts of various machine tools and impart hands on experience on lathe, drilling, shaping, milling, slotting, grinding, tool and cutter grinding machines.
2	To develop knowledge and importance of metal cutting parameters such as feed, velocity and depth of cut etc on cutting force and surface roughness obtainable.
3	To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
4	To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.
5	To study process parameters and practice on arc and gas welding technologies.
6	To gain knowledge on the structure, properties, heat treatment, testing and applications of ferrous and non ferrous metals.

COURSE OUTCOMES:

Sl.NO	*DESCRIPTION*	*Bloom's Taxonomy Level*
CME100006/ ME422T.1	The students can operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality.	Create (level 6)
CME100006/ ME422T.2	Apply cutting mechanics to metal machining based on cutting force and power consumption.	Apply (level 3)
CME100006/ ME422T.3	Select appropriate machining processes and process parameters for different metals.	Analyze (level 4)
CME100006/ ME422T.4	Fabricate and assemble various metal components by welding and students will be able to visually examine their work and that of others for discontinuities and defects.	Create (level 6)
CME100006/ ME422T.5	Infer the changes in properties of steel on annealing, normalizing, hardening and tempering.	Analyze (level 4)

CO-PO AND CO-PSO MAPPING

	PO 1	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PS O1*	*PS O2*	*PS O3*
CME100006/ ME422T.1			3											3	
CME100006/ ME422T.2		3												2	
CME100006/ ME422T.3				2											
CME100006/ ME422T.4	2													3	
CME100006/ ME422T.5					2									2	

JUSTIFICATIONS FOR CO-PO MAPPING

MAPPING	*LOW/MEDIUM/ HIGH*	*JUSTIFICATION*
CME100006/ ME422T.1-PO1	H	Knowledge on various manufacturing methods will enable the students to operate on machine tools to create products useful for the society.
CME100006/ ME422T.2-PO2	H	Analyze the metal cutting principles and its mechanics to carry out practical sessions effectively.
CME100006/ ME422T.3-PO3	M	Understanding on process parameters of various machining processes will let the students to select appropriate manufacturing method.
CME100006/ ME422T.4-PO4	M	Enable students to carryout welding process and also to examine the quality and defects of the weld they made.
CME100006/ ME422T.5-PO5	M	Usage of metallurgical microscopes will create knowledge on the metallurgical aspects of the material.

JUSTIFICATIONS FOR CO-PSO MAPPING

MAPPING	*LOW/MEDIUM/ HIGH*	*JUSTIFICATION*
CME100006/ ME422T.1-PSO2	H	Understanding of manufacturing processes and its principles will enable students to come up with quality products.
CME100006/ ME422T.2-PSO2	M	Knowledge in cutting mechanics will empower students to use the right machining parameter to create components.
CME100006/ ME422T.4-PSO2	H	Quality of the weld could be examined by the students with the help of the knowledge that they gained as a part of their curriculum.
CME100006/ ME422T.5-PSO2	M	Metallurgical aspects of the material and the ways of enhancing properties of metals will be learned through the experiments.

GAPS IN THE SYLLABUS - TO MEET INDUSTRY/PROFESSIONAL REQUIREMENTS:

SNO	*DESCRIPTION*	*RELEVENCE TO PO\PSO*	*PROPOSED ACTIONS*
1	Exercises on milling machines	PSO2	Extra practical sessions, Industry visits

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

SINO:	TOPIC	RELEVENCE TO PO\PSO
1	Machining of irregular profiles	PO1, PSO2

WEB SOURCE REFERENCES:

1	http:// nptel.ac.in/courses/112106179/19
2	https://www.festo.com/cms/en-in_in/59398.htm
3	www.maschinen-kistner.de/home_en.html
4	https://www.rofin.com/en/markets/machine_tool_industry/
5	https://www.tu-chemnitz.de/mb/WerkzMasch/lufa/.../index.php.en
6	http:// nptel.ac.in/noc/individual_course.php?id=noc16-me15

DELIVERY/INSTRUCTIONAL METHODOLOGIES:

☑ CHALK& TALK	☑ STUD. PRACTICALS	☑ WEB RESOURCES	☑LCD/SMART BOARDS
☐ STUD. SEMINARS	☐ ADD-ON COURSES		

ASSESSMENT METHODOLOGIES-DIRECT

☐ ASSIGNMENTS	☐ STUD. SEMINARS	☑ TESTS/MODEL EXAMS	☑ UNIV. EXAMINATION
☑ STUD. LAB PRACTICES	☑ STUD. VIVA	☐ MINI/MAJOR PROJECTS	☐ CERTIFICATIONS
☐ ADD-ON COURSES	☐ OTHERS		

ASSESSMENT METHODOLOGIES-INDIRECT

☑ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	☑ STUDENT FEEDBACK ON FACULTY (ONCE)
☐ ASSESSMENT OF MINI/MAJOR PROJECTS BY EXT. EXPERTS	☐ OTHERS

1.2 COURSE PLAN

No	List of experiments	No. of hours
1	**Cycle 1 (15 hours)**	
1.1	**Exercises on centre lathe:** Facing, plain turning, step turning and parting – groove cutting.	3
1.2	**Exercises on centre lathe:** Taper turning, form turning. Knurling and chamfering, Measurement of cutting forces in turning process and correlate the surface roughness obtainable by varying feed, speed and feed.	3
1.3	**Exercises on Shaping machine:** Exercises on shaping machine: - flat surfaces, grooves and key ways	3
1.4	**Exercises on Slotting machine:** Exercises on slotting machine: - flat surfaces, grooves and key ways.	3
1.5	**Exercises on Drilling machine:** Exercises on drilling machine: - drilling, boring, reaming, taping and counter sinking etc.	3
2	**Cycle 2 (15 hours)**	
2.1	**Exercises on Grinding machine:** Exercise on surface grinding, cylindrical grinding and tool grinding etc. Measurement of cutting forces and roughness in grinding process and correlate with varying input parameters	3
2.2	**Exercises on Milling machine:** Exercises on milling machine: - face milling, end milling – spur and helical gear cutting – milling of keyways etc., Measurement of cutting forces in milling process and correlate the surface roughness obtainable by varying input	3

	parameters.	
2.3	**Exercises on Welding:** Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets	3
2.4	**Metallurgy: Specimen preparation**, etching & microscopic study of Steel, Cast iron and Brass and Grain size measurement	3
2.5	**Heat treatment study**:–Effect on mechanical properties and microstructure of Steel, Cast Iron and Brass.	3

11.3 SAMPLE QUESTIONS

1. Name a device used for measuring cutting force.

2. Give any work holding device that is used in slotter.

3. Which type of quick return mechanism is used in Shaper?

4. Give one difference between TIG and MIG.

5. What do you mean by tapping?

6. List the different types of grinding machines.

7. Give the steps need to be carried out for specimen surface preparation.

8. Give the temperature and weight % value of eutectoid point in Iron Carbon phase diagram.

9. What are the different types of mounting process in specimen surface preparation?

10. Give any two examples for etchants used for different metals and alloys.

11. Give the equation to find out grain size.

12. Give any examples for multipoint cutting tool.

13. Which are the different types of chips formed during machining process?

14. What is the purpose of Merchant circle?

15. Name any 2 materials used in tool manufacturing.

16. Give the function of clapper box used in shaper.

17. Give the equation for cutting speed in machining.

18. Give any 2 uses of tail stock in lathe?

19. Which are the different indexing methods used in milling?

20. Give any 2 features of radial drilling machine.