Seth Jai Parkash Mukand Lal Institute of Engineering & Technology

Department of Mechanical Engineering

Student Handbook

Semester-IVth

January-June-2019

Bachelor of Technology (Mechanical Engineering)
KURUKSHETRA UNIVERSITY KURUKSHETRA
Scheme of Studies/Examination
Semester IV

S. No.	Course No.	Subject	L:T:P	Hours/ Week	Examination Schedule (Marks)				Duration of Exam (Hrs)
					Theory	Sessional	Practical	Total	
1	AS-201N/ HS-201N	Mathematics-III/Fundamentals of Management	3:1:0	4	75	25	0	100	3
2	ME-202N	Production Technology-I	4:0:0	4	75	25	0	100	3
3	ME-204N	Steam Generation & Power	3:1:0	4	75	25	0	100	3
4	ME-206N	Mechanics of Solids-II	3:1:0	4	75	25	0	100	3
5	ME-208N	Fluid Mechanics	4:1:0	5	75	25	0	100	3
6	ME-210N	Dynamics of Machines	3:1:0	4	75	25	0	100	3
7	ME-214N	Fluid Mechanics Lab	0:0:2	2	0	40	60	100	3
8	ME-216N	Dynamics of Machines lab	0:0:2	2	0	40	60	100	3
9	ME-218N	Steam Generation & Power Lab	0:0:2	2	0	40	60	100	3
10	ME-220N	Production Technology Lab	0:0:3	3	0	40	60	100	3
		Total		**34**	**450**	**310**	**240**	**1000**	
11	MPC-202N	Energy Studies*	3:0:0	3	75	25		100	3

*Paper MPC-202 is a mandatory course which will be non-credit subject and student has to get pass marks in order to qualify the semester.
NOTE- 6 weeks hands on training to be done after IVth Semester Exams. Marks will be allotted after training report evaluation in 5th Semester.

Mathematics-III

AS-201 N	Mathematics-III					
Lecture	**Tutorial**	**Practical**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**1**	**-**	**75**	**25**	**100**	**3**
Purpose	To acquaint the students with the basic use of PDE, Linear Programming problems, Fourier series and transforms, Complex variables and Probability.					

Course Outcomes	
CO 1	This section is concerned mainly with Fourier series. However, the underlying ideas can also be extended to non-periodic phenomena. This leads to Fourier integrals and transforms which are very much useful in solving the initial and boundary value problems.
CO 2	Students will learn about the formation and solution the partial differential equations. First order PDE of any degree by using Charpit' s method will be discussed in details. In addition, how to solve homogeneous linear PDE with constant coefficients and variable separable method and LPP will be covered under this section.
CO 3	Complex analysis is concerned with generalization of the familiar real functions of calculus and their detailed knowledge is an absolute necessity in practical work to solve engineering problems.
CO 4	Probability theory provides models of probability distributions(theoretical models of the observable reality involving chance effects) to be tested by statistical methods which has various engineering applications, for instance, in testing materials, control of production processes, robotics, and automatization in general, production planning and so on.

UNIT – I

Fourier Analysis:

Fourier series: Euler's formulae, Orthogonality conditions for the Sine and Cosine function, Dirichlet's conditions, Fourier expansion of functions having points of discontinuity, Change of interval, Odd and even functions, Half-range series.

Fourier Transforms: Fourier integrals, Fourier transforms, Fourier Cosine and Sine transforms, Properties of Fourier transforms, Convolution theorem, Parseval's identity, Fourier transforms of the derivative of a function, Application of transforms to boundary value problems (Heat conduction and vibrating string).

UNIT-II

Partial Differential Equations and LPP:

Formation and Solutions of PDE, Lagrange's Linear PDE, First order non-linear PDE, Charpit's method, Homogeneous linear equations with constant coefficients, Method of

separation of variables.
Solution of linear programming problems: using Graphical and Simplex methods.

UNIT-III

Theory of Complex Variables:
A review of concept of functions of a complex variable, Limit, continuity, differentiability and analyticity of a function. Basic elementary complex functions (exponential functions, trigonometric & Hyperbolic functions, logarithmic functions) Cauchy-Riemann Equations. Line integral in complex plane, definition of the complex line integral, basic properties, Cauchy's integral theorem, and Cauchy's integral formula, brief of Taylor's, Laurent's and Residue theorems (without proofs).

UNIT-IV

Probability theory:
A review of concepts of probability and random variables: definitions of probability, addition rule, conditional probability, multiplication rule, Conditional Probability, Mean, median, mode and standard deviation, Bayes' Theorem, Discrete and continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function.
Standard Distributions: Binomial, Poisson and Normal distribution.

References Books:
1. E. Kreyszig : Advanced Engineering Mathematics, Wiley India.
2. B. V. Ramana: Engineering Mathematics, Tata McGraw Hill.
3. R.K. Jain, S.R.K. Iyengar: Advanced Engineering Mathematics, Taylor & Francis.
4. Murray R Spiegel: Schaum's Outline of Complex Variables, McGraw Hill Professional.
5. Michael D. Greenberg: Advanced Engineering Mathematics, Pearson Education, Prentice Hall.

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

TUTORIAL SHEET-1
UNIT- 1

1. Expand the function $f(x) = x \sin x$ as a Fourier series in the interval $-\pi \le x \le \pi$

Deduce that $\frac{1}{3} + \frac{1}{15} + \frac{1}{35} + \frac{1}{63} + \cdots \dots \dots .. = \frac{\pi-2}{4}$.

2. Obtain the Fourier series to represent $\mathbf{f(x)} = \left(\frac{\boldsymbol{\pi - x}}{\mathbf{2}}\right)^{\mathbf{2}}, 0 \le x \le 2\pi$.

Hence obtain the following relations:

(a) $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \cdots \dots .. = \frac{\pi^2}{6}$

(b) $\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots \dots .. = \frac{\pi^2}{12}$

(c) $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots \dots .. = \frac{\pi^2}{8}$

3. Obtain fourier series of $f(x) = |x|$ in the interval $-\pi \le x \le \pi$. Hence deduce that

$\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots \dots .. = \frac{\pi^2}{8}$

4. Obtain Fourier series of $f(x) = |\cos x|$ in the interval $-\pi \le x \le \pi$.

5. Obtain Fourier series of $f(x) = |\sin x|$ in the interval $-\pi \le x \le \pi$.

6. Obtain Fourier series expansion of the function $\mathbf{f(x) = 2x - x^2}$ in (0, 3) and hence deduce that

$\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots \dots .. = \frac{\pi^2}{12}$.

7. Find half- range sine series of $f(x) = lx - x^2$ in the interval $(0, l)$ .Hence deduce that

$\frac{1}{1^2} - \frac{1}{3^2} + \frac{1}{5^2} - \frac{1}{7^2} + \cdots \dots .. = \frac{\pi^2}{32}$.

8. Find the Fourier Sine transform of $f(x) = \frac{e^{-ax}}{x}$.

9. Find Fourier cosine transform of $f(x) = \frac{1}{1+x^2}$.

10. Obtain Fourier sine transform of

$$f(x) = \begin{cases} x, & 0 < x < 1 \\ 2 - x, & 1 < x < 2 \\ 0, & x > 2 \end{cases}$$

11. State and verify Fourier convolution theorem for: $f(x) = g(x) = e^{-x}$

12. Find the Fourier transform of : $f(x) = g(x) = e^{-x^{2/2}}, -\infty < x < \infty$.

TUTORIAL SHEET-2

UNIT-2

1. Form the partial differential equation the following equation $z = ax^2 + by^2$.

2. Form PDE by eliminating the arbitrary function $f(x^2 + y^2, z - xy) = 0.$

3. Solve the equation $xp + yq = 3z.$

4. Solve the equation $(z - y)p + (x - z)q = y - x.$

5. Solve $p^3 - q^3 = 0.$

6. Solve the equation by Lagrange's multipliers method

$(z - y)p + (x - z)q = y - x$

8. Solve $\frac{\partial^3 z}{\partial x^3} - 4\frac{\partial^3 z}{\partial x^2 \partial y} + 4\frac{\partial^3 z}{\partial x \partial y^2} = 2\sin(3x + 2y).$

9. Solve $\frac{\partial^2 z}{\partial x^2} - 4\frac{\partial^2 z}{\partial x \partial y} + 4\frac{\partial^2 z}{\partial y^2} = 24xy.$

10. Solve the equation $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$, given $u(x, 0) = 6e^{-3x}$.

11. Solve the following LPP by Graphical Method:

Minimize $Z = 20\,x_1 + 30\,x_2$

Subjects to the constraints

$x_1 + 2x_2 \le 40;\ 3x_1 + x_2 \ge 30;\ 4x_1 + 3x_2 \ge 60;\ x_1,\ x_2 \ge 0$

12. Using Simplex Method solve LPP

$Max\ Z = 4\,x_1 + 5x_2$

Subjects to constraints

$x_1 - 2x_2 \le 2;\ 2x_1 + x_2 \le 6;\ x_1 + 2x_2 \le 5;\ -x_1 + x_2 \le 2;\ x_1, x_2 \ge 0$

13. Using graphical method solve LP problem

Maximum $Z = 5x_1 + 3x_2$

Subjects to the constraints

$3x_1 + 5x_2 \leq 15;\ 5x_1 + 2x_2 \leq 10;\ x_1, x_2 \geq 0$

14. Using Simplex method solve the LPP

Maximum $Z = 3x_1 + 5x_2 + 4x_3$

Subjects to the constraints

$2x_1 + 3x_3 \leq 8;\ 2x_1 + 5x_3 \leq 10;\ 3x_1 + 2x_2 + 4x_3 \leq 15;\ x_1, x_2, x_3 \geq 0$

TUTORIAL SHEET -3
UNIT- 3

1. Define the following:

(i) Limit of f(z) (ii) Continuity of f(z) (iii) Derivation of f(z)

(iv) Analyticity of f(z) (v) Singularity of f(z).

2. If $\tan(\theta + i\emptyset) = \cos\alpha + i\sin\alpha = e^{i\alpha}$, prove that

$$\theta = \frac{n\pi}{2} + \frac{\pi}{4} \text{ and } \emptyset = \frac{1}{2}\log\tan\left(\frac{\pi}{4} + \frac{\alpha}{2}\right)$$

3. Separate into real and imaginary parts log sin(x + iy).

4. Show that the function f(z) = $\sqrt{|xy|}$ is not analytic at the origin, even though Cauchy-Riemann equations are satisfied there at.

5. Prove that the function f(z) defined by

$f(x) = \frac{x^3(1+i) - y^3(1-i)}{x^2+y^2}, z \neq 0$ and $f(0) = 0$ is continuous and the C.R. equations are satisfied at the origin, yet f '(0) does not exist.

6. Show that the function $f(z) = \frac{x^2y^3(x+iy)}{x^6+y^{10}}$, $z \neq 0$, f(0)= 0 is not analytic at the origin even though it satisfies C.R. equations at the origin.

7. If f(z) is an analytic function with constant modulus, show that f(z)is constant.

8. If f(z) is a holomorphic function of z, show that

$$\left\{\frac{\partial}{\partial x}|f(z)|\right\}^2 + \left\{\frac{\partial}{\partial y}|f(z)|\right\}^2 = |f'(z)|^2$$

9. Show that the polar form of C. R.equations are

$\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r} = -\frac{1}{r}\frac{\partial u}{\partial \theta}$. Hence deduce that $\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2}$

10. Determine the analytic function whose real part is

(a) $log\sqrt{x^2 + y^2}$ (b) sin2x / (cosh2y- cos2x).

11. An electrostatic field in the xy- plane is given by the potential function $\emptyset = 3x^2y - y^3$. Find the steam function ψ.

12. Evaluate $\int_0^{1+i}(x^2 + iy)dz$ along the paths y = x and $y=x^2$.

13. Find the Taylor's series of $f(z) = \frac{1}{(Z+1)^2}$ about the point z= -i.

14. Find the Taylor's series of f(z)= $(z^2-1)/(z^2+5z+6)$ about z=0 in the region 2< |z| <3.

TUTORIAL SHEET-4
UNIT-4

1. The contents of three urns are: 1 white, 2 red, 3 green balls; 2 white, 1 red, 1 green balls and 4 white, 5 red, 3 green balls. Two balls are drawn from an urn chosen at random. These are found to be one white and one green. Find the probability that the balls so drawn came from the third urn.

2. In a bolt factory, machines A, B and C manufactures respectively 25%, 35% and 40% of the total. Of their output 5%, 4% and 2% are defective bolts. A bolt is drawn at random from the product and is found to be defective. What is the probability that it was manufactured by machine B?

3. A random variable X has the following probability functions:

X : 0	1	2	3	4	5	6	7
P(X):0	k	2k	2k	3k	k^2	$2k^2$	$7k^2+k$

(a) Find k (b) Evaluate P(X<6), $P(X \geq 6)$, $P(3 < X \leq 6)$.

4. Fit a Binomial distribution to the following frequency distribution:

X :	0	1	2	3	4	5	6
f :	13	25	52	58	32	16	4 .

5. A certain screw making machine produces an average of 2 defective screws out of 100, and packs them in boxes of 500.Find the probability that a box contains 15 defective screws.

6. Fit a Poisson distribution to the following:

x:	0	1	2	3	4	
f:		192	100	24	3	1

7. In a normal distribution, 31% of the items are under 45 and 8% are over 64. Find the mean and standard deviation of the distribution.

8. Show that the standard deviation for a normal distribution is approximately 25% more than the mean deviation.

9. Six dice are thrown together at a same time, the process is repeated 729 times. How many times do you expect at least three dice to have 4 or 6.

10. A certain screw making machine produces an average of 2 defective screws out of 100, and packs them in boxes of 500.Find the probability that a box contains 15 defective screws.

11. If 10% bolts produced by a machine are defective. Find the probability that out of 5 bolts chosen at random (a) one is defective (b) none is defective (c) at least one is defective.

12. In an examination taken by 500 students, the mean and standard deviation of the marks obtained (normally distributed) are 40% and 10% .Find approximately

(a) how many will pass, if 50% is fixed as minimum?

(b) what should be the minimum if 350 candidates are to pass?

(c) how many have scored marks above 60%.

13. The frequency distribution of a measureable characteristic varying between 0 & 2 is as under:

$$f(x) = \begin{cases} x^3, & 0 \leq x \leq 1 \\ (2-x)^3, & 1 \leq x \leq 2 \end{cases}$$

Calculate the standard deviation and also the mean deviation about the mean.

14. Fit a normal curve to the following distribution:

x:	2	4	6	8	10	
f:		1	4	6	4	1

Sample Paper

Mathematics- III (AS-201N)

Time allowed: 3 hours Maximum Marks: 75

Note: Attempt any five questions, selecting at least one question from each unit.

UNIT-1

1. (a) Obtain the Fourier Series for the function

$$f(x) = \begin{cases} \pi x, & 0 \le x \le 1 \\ \pi(2-x), & 1 \le x \le 2 \end{cases}$$

(b) Show that a constant function c can be extended in an infinite series

$$\frac{4c}{\pi}\left\{\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \cdots \ldots \ldots\right\} \text{ in the range } 0 < x < \pi .$$

2. (a) State and prove Parseval's identity, hence evaluate

$$\int_0^\infty \frac{t^2}{(4+t^2)(9+t^2)}\, dt$$

(b) Find the Fourier Cosine Transform of $se^{-ax} (a > 0)$, hence evaluate

$$\int_0^\infty \frac{\cos \lambda x}{(x^2+a^2)}\, dx$$

UNIT-2

3. (a) Form PDE by eliminating the arbitrary function $f(x^2+y^2, z-xy) = 0$.

(b) Solve $\frac{\partial^3 z}{\partial x^3} - 4\frac{\partial^3 z}{\partial x^2 \partial y} + 4\frac{\partial^3 z}{\partial x \partial y^2} = 2\sin(3x+2y)$.

4 (a) Using Graphical Method, solve the LPP,

Minimize $Z = 20\, x_1 + 10\, x_2$

Subjects to the constraints

$x_1 + 2x_2 \leq 40;\ 3x_1 + x_2 \geq 30;\ 4x_1 + 3x_2 \geq 60;\ x_1, x_2 \geq 0$

(b) Using Simplex method solve the LPP

Maximum $Z = 20x_1 + 6x_2 + 8x_3$

Subjects to the constraints

$8x_1 + 2x_2 + 3x_3 \leq 200;\ 4x_1 + 3x_2 \leq 150;\ 2x_1 + x_3 \leq 50;\ x_1, x_2, x_3 \geq 0$

UNIT-3

5. (a) Prove that the real part of the principal value of $i^{\log(1+i)} is\ e^{-n^2/8} cos\left(\frac{n}{4} log 2\right)$

(b) If $\tan(x+iy) = \sin(u+iv)$, *Prove that*

$$\frac{\sin 2x}{\sin h^2 y} = \frac{\tan u}{\tan v}$$

6. (a) Determine the analytic function whose real part is sin2x / (cosh2y- cos2x)..

(b) Evaluate $\int_0^{1+i}(x^2 + iy)dz$ along the paths y = x and $y=x^2$.

UNIT-4

7. (a) An insurance company insured 2000 scooter drivers, 4000 car drivers and 6000 truck drivers. The probability of accident is .01,.03 and 0.15 respectively. One of the insured persons meets an accident. What is the probability that he is a scooter driver?

(b) A random variable X has the following probability distribution:

x	-2	-1	0	1	2	3
P(x)	0.1	K	.2	2k	.3k	k

Find the value of k and calculate mean and variance.

8. (a) The probability that a bomb dropped from a plane will strike the target is 1/5. if six bombs are dropped, find the probability that

(i) Exactly two will strike the target.

(ii) At least two will strike the target.

(b) Fit a Poisson distribution to the following and calculate theoretical frequencies:

x	0	1	2	3	4
f(x)	122	60	15	2	1

Course No.	Course Title	Teaching Schedule				Allotment of Marks		Duration of Exam (Hrs.)
		L	T	P	Theory	Sessional	Total	
ME-202N	Production Technology-I	4	0	0	75	25	100	3

Purpose	To make student aware about various metal cutting tools, mechanism involved and machines used for metal cutting.
Course Outcomes (CO)	
CO-1	Learn about tool geometry and nomenclature, chip classification, metal cutting theories, tool life, geometry, surface finish etc.
CO-2	Learn about cutting fluids and tool life, economics of metal machining.
CO-3	Learn about milling and drilling machines.
CO-4	Learn about specifications of various machine tools, metrology, surface finish and its measurements.

UNIT-I

Geometry of Cutting Tools:

Introduction, Geometry of single point turning tools: Cutting edges, Rake and Clearance angles, Systems of description of tool geometry, Designation of tool geometry in Machine reference system, ORS system and NRS system

Geometry of Multi point cutting tools: Geometry of Milling cutters, Geometry of Drills

Mechanics of Metal cutting:

Cutting Tool Materials, Chip formation, Types of Chips, Chip control and chip breakers, orthogonal and oblique metal cutting, Chip thickness ratio, Velocity relationship in orthogonal cutting, Merchant's Analysis, Stress and Strain on the chip, Forces on single point cutting tool, Torque, heat produced, power and MRR equations, Use of Merchant's circle diagram in force analysis in orthogonal cutting for single point cutting tool.

Popular theories on mechanics of metal cutting: Earnst Merchant Theory, Merchant theory, Stabler Theory, Lee and Shaffer's Theory. Factors affecting temperature in metal cutting.

UNIT-II

Cutting Fluids and Tool life:

Cutting fluids, Purpose, Properties, Types of lubricants, Types of cutting fluids, Tool Failure, Mechanisms of Tool wear, Tool Life, Factors affecting tool life. Taylor's Tool life equation

Economics of metal machining:
Cost Considerations in Manufacturing, Elements of Machining cost, Minimum cost per piece, Maximum Production rate, Optimum cutting speed and optimum tool life for minimum cost of production and maximum production rate, Machinability, Machinability Index, Improving Machinability, Measurement of cutting forces, Tool force Dynamometers, Numerical on Mechanics of Metal cutting and economics.

UNIT-III

Milling Process:
Milling Machine Operations performed on Milling machine, Parts of Milling Machine, Types of Milling machines, fundamentals of Milling process, Milling Cutters, Elements of Plain Milling cutter, Cutter Holing devices, Cutting speed , Feed and depth of cut, Force system in Milling, Dividing head or Indexing Head, Methods of Indexing

Drilling Machine:
Types of Drills, Drilling machine Types, Drilling machine operations,, Size of Drilling machine, Main parts of drilling machine, Force system in Drilling, Cutting speed, Feed and Depth of cut in drilling, MRR in drilling, Numerical Problems on Drilling.

UNIT-IV

Specification of Machine Tools:
Introduction, purpose of machine tool specifications, Methods of specification of conventional machine tools: specification of lathes, specification of drilling and boring machines, specification of shaper, planer and slotter machines, specification of milling machine, specification of gear teeth generating machines, specification of grinding machines.

Metrology
Measurements, Linear Measurement, Callipers, Vernier Calliper, Micrometer, Angular Measurement, Comparators-mechanical, electrical and optical,sine bar, auto-collimator, Surface finish and its measurement, Surface Roughness Measurement methods, Factors affecting surface finish in machining, micro and macro deviation, specifying surface finish.

Suggested reading:

1. Machining and Machine Tools by A.B. Chattopadhyay, Wiley India.
2. Manufacturing Processes by J.P. Kaushish, PHI
3. Metrology & Measurement By Bewoor, McGraw Hill.
4. A Textbook of Production Technology by P.C.Sharma, S.Chand pub.
5. Workshop Technology: B.S.Raghuwanshi, DhanpatRai Publications.
6. Production Technology: R.K.Jain, Khanna Publishers.
7. Machine Tools: R.Kesavan & B.Vijaya Ramnath, Laxmi Publications.
8. Machining and Machine Tools: A.B.Chattopadhyay, WILEY INDIA.

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

LECTURE PLAN

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	4^{th} Semester	Introduction, Geometry of single point turning tools.	Teaching	-
Jan.	4^{th} Semester	Systems of description of tool geometry, Designation of tool geometry in Machine reference system	Teaching	-
Jan.	4^{th} Semester	ORS system and NRS system.	Teaching	-
Jan.	4^{th} Semester	Geometry of Multi point cutting tools: Geometry of Milling cutters.	Teaching	-
Jan.	4^{th} Semester	Geometry of Drills	Teaching	-
Jan.	4^{th} Semester	Cutting Tool Materials, Chip formation, Types of Chips.	Teaching	-
Jan.	4^{th} Semester	Chip control and chip breakers, orthogonal and oblique metal cutting	Teaching	-
Jan.	4^{th} Semester	Chip thickness ratio, Velocity relationship in orthogonal cutting	Teaching	-
Jan.	4^{th} Semester	Merchant's Analysis, Stress and Strain on the chip	Teaching	Assignment
Jan.	4^{th} Semester	Forces on single point cutting tool, Torque, heat produced, power and MRR equations.	Teaching	-
Jan.	4^{th} Semester	Use of Merchant's circle diagram in force analysis in orthogonal cutting for single point cutting tool.	Teaching	-
Feb.	4^{th} Semester	Earnst Merchant Theory, Merchant theory, Stabler Theory, Lee and Shaffer's Theory. Factors affecting temperature in metal cutting	Teaching	-
Feb.	4^{th}	Cutting fluids, Purpose, Properties, Types of lubricants, Types of cutting	Teaching	-

	Semester	fluids.		
Feb.	4th Semester	Tool Failure, Mechanisms of Tool wear , Tool Life, Factors affecting tool life	Teaching	-
Feb.	4th Semester	Taylor's Tool life equation	Teaching	-
Feb.	4th Semester	Cost Considerations in Manufacturing, Elements of Machining cost, Minimum cost per piece	Teaching	-
Feb.	4th Semester	Maximum Production rate	Teaching	-
Feb.	4th Semester	Optimum cutting speed and optimum tool life for minimum cost of production and maximum production rate	Teaching	Assignment
Feb.	4th Semester	Machinability Machinability Index, Improving Machinability, Measurement of cutting forces.	Teaching	-
March	4th Semester	Measurement of cutting forces, Tool force Dynamometers, Numerical on Mechanics of Metal cutting and economics, Numericals.	Teaching	-
March	4th Semester	Milling Machine Operations performed on Milling machine, Parts of Milling Machine, Types of Milling machines, fundamentals of Milling process, Milling Cutters	Teaching	-
March	4th Semester	Elements of Plain Milling cutter, Cutter Holing devices, Cutting speed, Feed and depth of cut.	Teaching	-
March	4th Semester	Force system in Milling, Dividing head or Indexing Head, Methods of Indexing.	Teaching	-

March	4th Semester	Types of Drills, Drilling machine Types, Drilling machine operations,, Size of Drilling machine, Main parts of drilling machine.	Teaching	-
March	4th Semester	Force system in Drilling, Cutting speed, Feed and Depth of cut in drilling, MRR in drilling, Numerical	Teaching	-
March	4th Semester	Introduction, purpose of machine tool specifications, Methods of specification of conventional machine tools: specification of lathes, specification of drilling and boring machines.	Teaching	-
March	4th Semester	Specification of shaper, planer and slotter machines	Teaching	Assignment
March	4th Semester	Specification of milling machine, specification of gear teeth generating machines.	Teaching	-
March	4th Semester	Specification of grinding machines.	Teaching	-
March	4th Semester	Measurements, Linear Measurement, Callipers, Vernier Calliper, Micrometer	Teaching	-
April	4th Semester	Angular Measurement, Comparators - mechanical, electrical and optical.	Teaching	-
April	4th Semester	Sine bar, auto-collimator.	Teaching	-
April	4th Semester	Surface finish and its measurement.	Teaching	-
April	4th Semester	Surface Roughness Measurement methods	Teaching	Assignment
April	4th Semester	Factors affecting surface finish in machining, micro and macro deviation, specifying surface finish.	Teaching	-

April	4^{th} Semester	Introduction, Geometry of single point turning tools.	Teaching	-
April	4^{th} Semester	Systems of description of tool geometry, Designation of tool geometry in Machine reference system	Teaching	-
May	4^{th} Semester	ORS system and NRS system.	Teaching	-

TUTORIAL SHEET-1

Q.1 Briefly explain the nomenclature of single point cutting tool with a neat sketch.

Q.2 Difference between ORS System and NRS system.

Q.3 Briefly explain the geometry of multipoint cutting tool.

Q.4 Describe the mechanism of chip formation. Explain different types of chips.

Q.5 What is Merchant's circle diagram .Explain various types of forces acting on tool and work piece, with neat sketch.

Q.6 Explain different theories on mechanism of metal cutting.

TUTORIAL SHEET-2

Q.1 What is purpose of cutting fluid. Explain different types of cutting fluid and their characteristics.

Q.2 What is tool failure. What are causes for crater & flank wear.

Q.3 What is tool life. What are the factors which affect the tool life. Also give Taylor's equation for the tool life.

Q.4 Write notes on Machine economics and optimization.

Q.5 What is machinability and machinability index. Also explain tool force dynamoemters.

TUTORIAL SHEET-3

Q.1 What are the operations performed on milling machine, explain its parts and types of milling machine.

Q.2 What are the forces system in milling machine an d explain method of indexing in milling machine.

Q.3 Explain the operation of drilling machine. Explain main parts of it.

Q.4 What are the force system in drilling machine .Explain MRR in drilling machine.

TUTORIAL SHEET-4

Q.1 Explain the specification of lathe, shaper and palner machines.
Q.2 Give specifications of gear teeth generating machines and grinder machine.
Q.3 Write short note on:
a. Angular measurement
b. Micro and macro deviation
c. Sine bar
Q.4 What is a comparator. Explain its different types.
Q5. Explain Surface finish and its evaluation. What are the factors affecting surface finish in machining.

STEAM GENERATION & POWER

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
		L	T	P	Theory	Sessional	Total	
ME-204N	**STEAM GENERATION & POWER**	3	1	0	75	25	100	3
Purpose	To make student learn about basics of Thermal engineering, steam generation and applications.							
Course Outcomes (CO)								
CO-1	Learn about boilers, types of boilers and accessories and mounting used on boilers.							
CO-2	Learn about simple and modified Rankine cycle and working of steam engine.							
CO-3	Learn about design and analysis of steam flow through steam nozzles. To learn about the working of different types of condensers.							
CO-4	Learn about working of Steam turbines and about design and analysis of the steam turbine.							

UNIT I

Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc.; boiler mountings; stop valve; safety valve; blow off valve; feed check etc.; water level indicator; fusible plug; pressure gauge; boiler accessories; feed pump; feed water heater; preheater; superheater; economizer; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation(no numerical problem)

UNIT II

Carnot cycle; simple and modified Rankine cycle; effect of operating parameters on rankine cycle performance; effect of superheating; effect of maximum pressure; effect of exhaust pressure; reheating and regenerative Rankine cycle; types of feed water heater; reheat factor; binary vapour cycle. Simple steam engine, compound engine; function of various components.

UNIT III

Function of steam nozzle; shape of nozzle for subsonics and supersonics flow of stream; variation of velocity; area of specific volume; steady state energy equation;

continuity equation; nozzle efficiency; critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. Advantage of steam condensation; component of steam condensing plant; types of condensers; air leakage in condensers; Dalton’s law of partial pressure; vacuum efficiency; calculation of cooling water requirement; air expansion pump.

UNIT IV

Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine.

Text Books :

1. Thermal Engineering – P L Ballaney, Khanna Publishers
2. Thermodynamics and Heat Engines vol II – R Yadav, Central Publishing House

Reference Books :

1. Applied Thermodynamics for Engineering Technologists – T D Eastop and A. McConkey, Pearson Education
2. Heat Engineering – V P Vasandani and D S Kumar, Metropolitan Book Co Pvt Ltd.

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

Lecture Plan

Month	Class	Topic/ Chapter covered	Academic activity	Test/ assignment
Jan.	4th Sem	Introduction to the boilers, its classification, comparison of fire & water tube boilers	Teaching Teaching	
Jan.	4th Sem	Description of boilers & their mountings and accessories	Teaching	
Jan.	4th Sem	Draught: natural, artificial and mechanical	Teaching Teaching	
Jan.	4th Sem	Maximum discharge through chimney, boiler efficiency, equivalent evaporation	Teaching Teaching	
Jan.	4th Sem	Steam generation, steam table reading	Teaching Teaching	
Jan.	4th Sem	Elements of steam power plant, carnot cycle	Teaching	
Jan.	4th Sem	Simple and modified Rankine cycle	Teaching	
Jan.	4th Sem	Effects of operating parameters on Rankine cycle	Teaching	
Jan.	4th Sem	Reheat cycle	Teaching	
Feb.	4th Sem	Regenerative cycle	Teaching	
Feb.	4th Sem	Binary-vapour cycle	Teaching	
Feb.	4th Sem	Types of feed water heater	Teaching	
Feb.	4th Sem	Simple steam engine	Teaching	

Feb.	4th Sem	Compound engine	Teaching	
Feb.	4th Sem	Functions of components	Teaching	
Feb.	4th Sem	Steam nozzle	Teaching	
Feb.	4th Sem	Subsonic and supersonic flow	Teaching	Assignment
March	4th Sem	Nozzle efficiency, critical pressure ratio	Teaching	
March	4th Sem	Super saturated flow	Teaching	
March	4th Sem	Design of nozzle	Teaching	
March	4th Sem	Maximum discharge	Teaching	
March	4th Sem	Steam condenser; types, advantages	Teaching	
March	4th Sem	Dalten's law	Teaching	
March	4th Sem	Vaccume efficiency	Teaching	
March	4th Sem	Cooling water requirement	Teaching	
March	4th Sem	Air pump	Teaching	
March	4th Sem	Air leakage	Teaching	Assignment

April	4^{th} Sem	Introduction to steam turbines	Teaching	
April	4^{th} Sem	Pressure-velocity diagram	Teaching	
April	4^{th} Sem	Velocity triangle	Teaching	
April	4^{th} Sem	Efficiency of turbine	Teaching	
April	4^{th} Sem	Impulse turbine	Teaching	
April	4^{th} Sem	Reaction turbine, Losses in turbine	Teaching	
April	4^{th} Sem	Governing of turbine, Revision	Teaching	Assignment

TUTORIAL SHEET-1

Q.1:- Explain the terms boiler and steam generating unit. Give the uses of steam produced by the boilers.

Q.2:- How are the boilers classified? Compare ‗Fire-tube and water-tube' boilers.

Q.3:-Write the factors which should be considered while selecting a boiler.

Q.4:- Explain the construction and working of different types of boilers with the help of neat diagram:

Water tube boilers

(i) Simple vertical boiler (ii) Cochran boiler

(iii) Cornish boiler (iv) Locomotive boiler

Fire-tube boilers

(i) Babcock and Wilcox boiler (ii) Stirling boiler

High pressure boilers

(i) LaMont boiler

Q.5:- Write short notes on the following:

(i) Supercharged boilers

(ii) Pulverised fuel firing

Q.6:- Explain with the neat sketch various accessories normally used in a steam generating plant. Q.7:- What is the function of a steam separator? Discuss with a neat sketch any one.

TUTORIAL SHEET -2

Q.1:- What is the function of a boiler chimney? Define the term _boiler draught.

Q.2:- Define the chimney efficiency and find out expression for the same.

Q.3:- What are the various types of draughts used? What are the advantages of artificial draught over natural draught?

Q.4:- Derive an expression for maximum discharge rate of gases through the chimney for a given height of the chimney.

Q.5:-Determine the height and diameter of the chimney used to produce a draught for a boiler which has an average cool coal consumption of 1950 kg/h and flue gases formed per kg of coal fired are 15 kg. The pressure losses through the system are given below : Pressure loss in fuel bed= 7 mm of water, pressure loss in boiler flues= 7 mm of water, pressure loss in bends= 3 mm of water, pressure loss in chimney= 3 mm of water.

Pressure head equivalent to velocity of flue gases passing through the chimney= 1.3 mm of water. The temperatures of ambient air and flue gases are 35°C and 310°C respectively. Assume actual draught is 80% of theoretical.

Q.6:- A 30 meters high chimney discharge flue gases at 357°C, when the outside temperature is 27°C. air fuel ratio of 16 is required to burn the coal on the grate. Determine:

(i) The draught in mm of water column.

(ii) The draught produced in terms of height of column of flue gases in meters.

(iii) Volume of flue gases passing through chimney per second if 360 kg of coal is burnt per hour over the grate.

(iv) The base diameter of chimney if the velocity of flue gases at the base of the chimney is given by

$H_1 = KC^2/2$,where the value of K= 1.627

TUTORIAL SHEET -3

Q.1:- Explain various operation of a carnot cycle. Also represent it on a *T-s* and *p-V* diagrams.

Q.2:- Explain with the help of diagram a ‗Rankine cycle'. Derive also an expression for its thermal efficiency.

Q.3:- What are the effects of operating parameters on rankine cycle performance; effect of superheating maximum pressure, exhaust pressure, reheating and regenerative rankine cycle.

Q.4:- Explain the working of a Binary vapour cycle with neat sketch.

Q.5:- A simple Rankine cycle works b/w pressure of 30bar and 0.04bar, the initial condition of steam being dry saturated, calculate the cycle efficiency, work ratio and specific steam consumption.

Q.6:- Compare the Renkine efficiency of a high pressure plant operating from 80bar and 400°C and a low pressure plant operating from 40bar 400°C, if the condenser pressure in both cases is 0.07bar.

TUTORIAL SHEET -4

Q.1:- In a steam turbine steam at 20 bar, 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes, find per kg of steam the net work and the cycle efficiency.

Q.2:- In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine:

(i)The pump work,

ii) The turbine work

(iii)The Rankine efficiency,

(iv) The condenser heat flow

(v) The dryness at the end of expansion Assume flow rate of 9.5 kg/s.

Q.3:- Steam at a pressure of 15 bar and 300°C is delivered to the throttle of an engine. The steam expands to 2 bar when release occurs. The steam exhaust takes place at 1.1bar. a performance test gave the result of the specific steam consumption of 13.8 kg/kWh and a mechanical efficiency of 80%.

Determine:

i) Ideal work or modified Rankine engine work per kg.

ii) Efficiency of the modified rankine engine or ideal thermal efficiency.

iii) The indicated and brake work per kg.

iv) The brake thermal efficiency.

v) The relative efficiency on the basis of indicated work and brake work.

Q.4:- In a regenerative cycle the inlet conditions are 40 bar and 400°C. Steam is bled at 10bar in regenerative heating. The exit pressure is 0.8bar. Neglecting pump work determines the efficiency of the cycle.Q.5:-Explain the various parts of a reciprocating steam engine with neat sketch. Also discuss terms applied to the steam engine.Q.6:- In a single-heater regenerative cycle the steam enters the turbine at 30bar, 400°C and the exhaust pressure is 0.10bar. The feed water heater is a direct contact type which operates at 5bar. Find:(i) the efficiency and the steam rate of cycle.(ii) the increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without regeneration)

TUTORIAL SHEET - 5

Q.1:- In a steam nozzle, the steam expands from 4bar to 1 bar. The initial velocity is 60 m/s and the initial temperature is 200°C. Determine the exit velocity if the nozzle efficiency is 92%.

Q.2:- An impulse turbine having a set of 16 nozzles receives steam at 20 bar, 400°C. The pressure of steam at exit is 12 bar. If the total discharge is 260 kg/min and nozzle efficiency is 90%, find cross-sectional area of the exit of each nozzle. If the steam has a velocity of 80 m/s at entry to the nozzles, find the percentage increase in discharge.

Q.3:- A steam nozzle supplied steam at 15bar 350°C and discharge steam at 1bar. If the diverging portion of the nozzle is 80 mm long and the throat diameter is 6mm, determine cone angle of the divergent portion. Assume 12% of total available enthalpy drop is lost in friction in the divergent portion. Also determinethe velocity and temperature of the steam at throat.

Q.4:- Steam initially dry and saturated is expanded in a nozzle from 12bar to 0.95bar. If the frictional loss in the nozzle is 10% of the total heat drop, calculate the mass of steam discharge when exit diameter of the nozzle is 12mm.

Q.5:- Steam at 35bar and 300°C is supplied to a group of six nozzles. The exit pressure of steam is 8bar. The rate of flow of steam being 5.2 kg/s. Determine:

i) The dimensions of the nozzle of rectangular cross-section with aspect ratio of 3:1. The expansion may be considered as metastable and friction negelected.
ii) The degree of undercooling and supersaturation.
iii) Loss in available heat drop due to irreversibility.
iv) Increase in entropy.
v) Ratio of mass flow rate with metastable expansion to thermal expansion.

Q.6:- Determine the throat area, exit area and exit velocity for a steam nozzle to pass 0.2 kg/s when the inlet conditions are 12bar and 250°C and the final pressure is 2bar. Assume that the expansion is isentropic and that the inlet velocity is negligible. Taken n= 1.3 for superheated steam.

Q.7:- A delaval type impulse turbine is to develop 150 kW with a probable consumption of 7.5 kg of steam per kWh with initial pressure being 12bar and the exhaust 0.15bar. Taking the diameter at the throat of each nozzle as 6mm, find the numbers of nozzle required. Assume that 10% of the total drop is lost in diverging part of nozzle, find the diameter at exit of the nozzle and the quality of steam which is to be fully expanded as it leaves the nozzle.

TUTORIAL SHEET -6

Q.1:- Define steam turbine. How are the steam turbines classified?

Q.2:- What do you mean by compounding of steam turbines? Explain the difference b/w an impulse turbine and reaction turbine.

Q.3:- Explain with the help of neat sketch a single stage impulse turbine. Also explain the pressure and velocity variations along the axial direction.

Q.4:- Derive the expression for maximum blade efficiency in a single-stage impulse turbine.

Q.5:- Define the term ―degree of reaction‖ used in reaction turbines and prove that it is given by

$R_d = C_f (\cot\phi - \cot\theta)/2C_{bl}$ when $C_{f1}=C_{f0}=C_f$

Q.6:- Explain ‗reheat factor'. Why is its magnitude always greater then unity?

Q.7:- Define the following as related to steam turbines:

(i) Speed ratio (ii) Blade velocity co-efficient.

(iii) Diagram efficiency (iv) Stage efficiency

TUTORIAL SHEET -7

Q.1:- Steam with absolute velocity of 300 m/s is supplied through a nozzle to single stage impulse turbine. The nozzle angle is 25°. The mean diameter of blade rotor is 1 meter and it has a speed of 2000 r.p.m. Find suitable blade angle for zero axial thrust. If the blade velocity co-efficient is 0.9 and the steam flow rate is 10 kg/s, calculate the power developed.

Q.2:- In a single-stage impulse turbine the mean diameter of the blade ring is 1 meter and the rotational speed is 3000 r.p.m. The steam is issued from the nozzle at 300 m/s and nozzle angle is 20°C. the blades are equiangular. If the friction loss in the blade channel is 19% of the kinetic energy corresponding to the relative velocity at the inlet to the blades, what is the power developed in the blading when the axial thrust on the blades is 98 N?

Q.3:- The following data refer to a single-stage impulse turbine :

Isentropic nozzle heat drop = 251 kJ/kg; nozzle efficiency= 90%; nozzle angle = 20°; ratio of blade speed to whirl component of steam speed= 0.5; blade velocity co-efficient= 0.9; the velocity of steam entering the nozzle= 20 m/s. Determine:

i) The blade angle at inlet and outlet if the steam enters into the blades without shock and leaves the blades in an axial direction.
ii) Blade efficiency.
iii) Power developed and axial thrust if the steam flow is 8 kg/s.

Q.4:- The first stage of an impulse turbine is compounded for velocity and has two rings of moving blades and one ring of fixed blades. The nozzle angle is 20° and leaving angle of the blades are respectively as follows:

First moving 20°, fixed 25° and second moving 30°. Velocity of steam leaving the nozzles is 600 m/s and steam velocity relative to the blade is reduced by 10% during the passage through each ring. Find the diagram efficiency and power developed for a steam flow of 4 kg per second. Blade speed may be taken as 125 m/s.

Q.5:- In a reaction turbine, the fixed blades and moving blades are of the same shape but reversed in direction. The angles of receiving tips are 35° and of the discharge tips 20°. Find the power developed per pair of blades for a steam consumption of 2.5 kg/s, when the blade speed is 50 m/s. If the heat drop per pair is 10.04 kJ/kg, find the efficiency of the pair.

Q.6:- The following data relate to a stage of reaction turbine:

Mean rotor diameter= 1.5 m; speed ratio= 0.72; blade outlet angle=20°; rotor speed=3000 r.p.m. Determine:

i) the diagram efficiency.

ii) The percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at the best theoretical speed, the exit angle being 20°.

MECHANICS OF SOLIDS-II

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
		L	T	P	Theory	Sessional	Total	
ME-206N	**MECHANICS OF SOLIDS-II**	3	1	0	75	25	100	3
Purpose	The objective of this course is to show the development of strain energy and stresses in springs, pressure vessel, rings, links, curved bars under different loads. The course will help the students to build the fundamental concepts in order to solve engineering problems							
Course Outcomes (CO)								
CO-1	Identify the basics concepts of strain energy and various theories of failures and solve the problems							
CO-2	Differentiate different types of stresses induced in thin pressure vessel and solve the problems. Use of Lame's equation to calculate the stresses induced in thick pressure vessel.							
CO-3	Able to compute stresses in ring, disk and cylinder due to rotation. Classify the different types of spring and analyze the stresses produced due to loading							
CO-4	Determine the stresses in crane hook, rings, chain link for different cross section and also the deflection of curved bars and rings. Analyze the stresses due to unsymmetrical bending and determine the position of shear centre of different section.							

Unit-I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a bodywhen load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beamsin bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's theorem, Numerical.
Theories of Elastic Failure: Various theories of elastic failures with derivations and graphicalrepresentations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numericals.

Unit-II

Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical &spherical vessels & their derivations under internal pressure, wire would cylinders, Numericals.

Thick Cylinders & Spheres: Derivation of Lame's equations, radial & hoop stresses andstrains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, hub shrunk on solid shaft, Numericals.

Unit-III

Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders. Numericals.

Springs: Stresses in closed coiled helical springs, Stresses in open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numericals.

Unit-IV

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initialsmall radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections,deflection of curved bars & rings, deflection of rings by Castigliano's theorem, stresses in simple chain link, deflection of simple chain links, Problems.

Unsymmetrical Bending: Introduction to unsymmetrical bending, stresses due to unsymmetrical bending, deflection of beam due to unsymmetrical bending, shear center for angle, channel, and I-sections, Numericals.

Text Books:

1. Strength of Materials – R.K. Rajput, Dhanpat Rai & Sons.
2. Strength of Materials – Sadhu Singh, Khanna Publications.
3. Strength of Materials – R.K. Bansal, Laxmi Publications.

Reference Books:

1. Strength of Materials – Popov, PHI, New Delhi.

2.Strength of Materials – Robert l. Mott, Pearson, New Delhi

3. Strength of Material – Shaums Outline Series – McGraw Hill
4. Strength of Material – Rider – ELBS

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

Lecture Plan

Month	Class	Topic/ Chapter covered	Academic activity	Test/ assignment
January	4th Sem.	Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a bodywhen load is applied (i) gradually, (ii) suddenly and (iii) with impact	Teaching	
January	4th Sem.	Strain energy of beamsin bending, beam deflections	Teaching	
January	4th Sem.	Strain energy of shafts in twisting, energy methods in determining spring deflection	Teaching	
January	4th Sem.	Castigliano's theorem	Teaching	
January	4th Sem.	Numerical Problems	Teaching	
January	4th Sem.	Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations	Teaching	
January	4th Sem.	Numerical Problems	Teaching	
January	4th Sem.	Applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading	Teaching	
January	4th Sem.	Numerical Problems	Teaching	Assignment
February	4thSem.	Thin Walled Vessels: Hoop & Longitudinal stresses & strains in cylindrical &spherical vessels & their derivations under internal pressure	Teaching	
February	4th Sem.	Wire would cylinders	Teaching	
February	4th Sem.	Numerical Problems	Teaching	

February	4^{th} Sem.	Thick Cylinders & Spheres: Derivation of Lame’s equations	Teaching	
February	4^{th} Sem.	Radial & hoop stresses andstrains in thick, and compound cylinders subjected to internal fluid pressure only	Teaching	
February	4^{th} Sem.	Radial & hoop stresses andstrains in spherical shells subjected to internal fluid pressure only	Teaching	
February	4^{th} Sem.	Hub shrunk on solid shaft	Teaching	
February	4^{th} Sem.	Numerical Problems	Teaching	Test
March	4^{th} Sem.	Rotating Rims & Discs: Stresses in uniform rotating rings & discs	Teaching	
March	4^{th} Sem.	Rotating discs of uniform strength,	Teaching	
March	4^{th} Sem.	Stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders	Teaching	
March	4^{th} Sem.	Hollow cylinders & solids cylinders. Numericals	Teaching	
March	4^{th} Sem.	Numerical Problems	Teaching	
March	4^{th} Sem.	Springs: Stresses in closed coiled helical springs	Teaching	
March	4^{th} Sem.	Stresses in open coiled helical spring subjected to axial loads and twisting couples	Teaching	
March	4^{th} Sem.	Leaf springs	Teaching	
March	4^{th} Sem.	Flat spiral springs	Teaching	Assignment

April	4^{th} Sem.	Concentric springs, Numericals	Teaching	
April	4^{th} Sem.	Numerical Problems	Teaching	
April	4^{th} Sem.	Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature	Teaching	
April	4^{th} Sem.	Stresses in crane hooks, rings of circular & trapezoidal sections,deflection of curved bars & rings	Teaching	
April	4^{th} Sem.	Deflection of rings by Castigliano’s theorem	Teaching	
April	4^{th} Sem.	Stresses in simple chain link, deflection of simple chain links, Problems	Teaching	
April	4^{th} Sem.	Unsymmetrical Bending: Introduction to unsymmetrical bending, stresses due to unsymmetrical bending	Teaching	
April	4^{th} Sem.	Deflection of beam due to unsymmetrical bending	Teaching	
April	4^{th} Sem.	Shear center for angle, channel, and I-sections, Numericals.	Teaching	Assignment
April	4^{th} Sem.	Numerical Problems	Teaching	
April	4^{th} Sem.	Numerical Problems	Teaching	
April	4^{th} Sem.	Numerical Problems	Teaching	
April	4^{th} Sem.	Numerical Problems	Teaching	

Tutorial Sheet: 1

1. A simply supported beam of span L has an overhang of length 'a' on the left. The vertical load W is applied at the end of the overhang. Calculate the deflection of the point of application of the load by castigliano's first theorem.

2. (a) Derive an expression for the strain energy stored in a material when subjected to three principal stresses.

(b) A bending moment of 4 KN is found to cause elastic failure of a solid circular shaft. An exactly similar shaft is now subjected to a torque T. Determine the value of T which causes failure of the shaft according to the following theories: (i) Maximum principal stress (ii) Maximum principal strain (iii) Maximum shear strain energy ($\nu = 0.3$)

3. a) Derive the relation for the strain energy resulting from the bending of a beam (neglecting shear).

b) A beam, simply supported at its ends, is of 4 m span and carries, at 3 m from the left hand support, a load of 20 KN. If I is 120 x 10^{-6} m4 and E = 200 GN/m^2 , find the deflection under the load using the relation in part (a).

4. A solid circular shaft is subjected to a B.M. of 100 k N.m and a torque of 120 k N.m. In a uniaxial test the shaft material gave following results: E = 2 x 10^5 MPa; stress at yield point σp = 300 MPa, Poisson's ratio = 0.3 = 1/m; F.O.S = 3 Estimate the least diameter of the shaft using (a) Maximum shear stress theory and (b) Maximum strain energy theory.

5. The load on a bolt consists of an axial pull of 10 KN together with a transverse shear force of 5KN. Estimate the diameter of bolt requires according to different theories of failure. Elastic limit in tension is 270 N/mm^2 and a factor of safety of 3 is to be applied. Poisson's ratio= 0.3.

6. If the principal stresses at a point in an elastic material are 2f tensile, f tensile and 1/2f compressive, calculate the value of f at failure according to five different theories. The elastic limit in simple tension is 200 N/mm^2 and Poisson's ratio= 0.3.

Tutorial Sheet: 2

1. A cooper cylinder, 90cm long, 40cm external diameter and wall thickness 6mm has its both ends closed by rigid blank flanges. It is initially full of oil at atmospheric pressure. Calculate the additional volume of oil which must be pumped into in order to raise the oil pressure of 5 N/mm^2 above atmospheric pressure. Assume E= 100,00 N/mm^2 and possion's ratio= 0.33. Take bulk modulus for oil as 2600 N/mm^2.

2. A compound thick cylinder is formed by shrinking a tube of external diameter 300 mm over another tube of internal diameter 150 mm. After shrinking, the diameter at the junction of the tube is found to be 250 mm and radial compression as 28 MPa. Find the original difference in radii at the junction. Take E = 2 x 10^5 MPa

3. A gun metal tube of 100mm bore, wall thickness 2.5mm is closely wound externally by a 1mm diameter wire. Determine the tension under which the wire must be wound on the tube, if an internal radial pressure of 3 MN/m^2 is required before the tube is subjected to the tensile stress in circumferential direction. Take for gun metal, E= 102 GN/m^2 and possion's ratio= 0.35. Take for Steel, E= 210 GN/m^2.

4. Find the thickness of a spherical shell of 75mm internal diameter, to withstand an internal pressure of 28 N/mm^2, if the permissible tensile stress is 63 N/mm^2, and shear stress 47 N/mm^2. What is the change of thickness under pressure of such a shell? Take E = 210,000 N/mm^2, poission's ratio= 0.3.

5. Two thick steel cylinders A and B, closed at the ends, have the same dimensions, the outside diameter being 1.6 times the inside. A is subjected to internal pressure only and B to external pressure only. Find the ratio of these pressures (1) when the greatest circumferential stress has the same numerical value, and (2) when the greatest circumferential strain has the same numerical value. Poisson’s ratio= 0.304.

6. A boiler drum consists of a cylindrical portion 2 m long, 1 m diameter and 25 mm thick, closed by hemispherical ends. In a hydraulic test to 10N/mm^2 how much additional water will be pumped in, after initially filling with atmospheric pressure? Assume the circumferential strain at the junction of the cylinder and hemisphere is same for both. For the drum material, E= 207000N/mm^2, poisson’s ratio=0.3. For water K= 2100 N/mm^2.

Tutorial Sheet: 3

1. A ring made of 25 mm diameter steel bar carries a pull of 10 k N. Calculate the maximum tensile and compressive stresses in the material of the ring. The mean radius of the ring is 15 cm.

2. Design a laminated steel spring, simply supported at the ends, and centrally loaded with a span of 800 mm, given the following: (a) Proof load = 8.5 KN, (b) Max. central deflection = 50 mm, (c) Ratio of width to thickness = 10, (d) E = 2 x 10^5 MPa, (e) Permissible bending stress = 370 MPa. The plates are available in the multiples of 1 mm for thickness and in the multiples of 3 mm for width.

3. A steel disc 25cm external diameter and 5cm internal diameter is shrunk on a steel shaft so that the pressure between the shaft and the disc at stand still is 45 MPa. Assuming the change in dimensions on the shaft is negligible, find at which speed the disc will loosen from the shaft. Density= 7800kg/m^3 and possion's ratio= 0.3.

4. An open coiled helical spring of 20 coils extends by 18mm under an axial load and develops a bending stress of 100 MN/m^2 and twisting stress of 105 MN/m^2. If the mean coil diameter is 8 times the diameter of wire, find the load, diameter of spring, coil diameter, helix angle, maximum normal stress, maximum shear stress and rotation of ends of spring. take E= 200GN/m^2 and G= 80GN/m^2.

5. A thin uniform steel disc of 25 cm diameter, with a central hole of 5 cm diameter, runs at 10000 rpm. Calculate the maximum principal stress and maximum shearing stress in the disc. Poisson's ratio= 0.3 and density=7700 kg/m^3.

6. A laminated spring of quarter elliptic type, 0.6 m long, is to provide a static deflection of 75 mm under an end load of 200 kg. If the leaf spring material is 60 mm wide and 6 mm thick, find the number of leaves required and the maximum stress. From which height can the load be dropped onto the undeflected spring to cause a maximum stress of 750 MPa. E= 208000N/mm^2.

Tutorial Sheet: 4

1. A thin channel section has outside flange and web dimensions of 10.2cm and 20.4cm respectively. The thickness of flanges and web is uniform and equal to 4mm. Draw the shear stress and shear flow distribution for section and find the position of shear centre. Take S.F. = 50 kN.

2. A steel hook has a rectangular section 5cm x 2.5cm. The inner and outer radii are 5cm and 20cm. It supports a load of 2000 kg. Find the maximum tensile and compressive stress set up in the hook.

3. A cantilever of T- Section (Flange- 120mm x 20mm, Web- 130mm x 20mm) is 2.8m long and carries a concentrated load W at its free end but inclined at an angle of $45^0$to the vertical. If E= 200 GN/m^2 and the deflection at the free end is not to exceed 2mm. Determine

i) The maximum value of W

ii) Direction of the neutral axis with respect to vertical axis.

4. Derive an expression for deflection of the simple chain link due to bending.

5. A crane hook whose horizontal cross section is trapezoidal, 50 mm wide at the inside and 25 mm wide at the outside, thickness 50 mm, carries a vertical load of 1000kg whose line of action is 38 mm from the inside edge of the section. The centre of curvature is 50 mm from the inside edge. Calculate the maximum tensile and compressive stresses set up.

6. A 5 cm by 3 cm by 0.5 cm angle is used as a cantilever of length 50 cm with the 3 cm leg horizontal. A load of 1000 N is applied at the free end. Determine the position of the neutral axis and maximum stress set up.

FLUID MECHANICS

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam
		L	T	P	Theory	Sessional	Total	(Hrs.)
ME-208N	**FLUID MECHANICS**	4	1	0	75	25	100	3
Purpose	To familiarize the students with the basic concepts of Fluid Mechanics.							
Course Outcomes (CO)								
CO-1	Understand the basic concepts of fluid and learn about fluid statics.							
CO-2	Understand the basic concepts of fluid kinematics and analyse the laws of fluid dynamics and its applications.							
CO-3	Determine the major and minor losses through pipes and learn to draw the hydraulic gradient and total energy lines.							
CO-4	Understand the concept of boundary layer and flow over bodies.							

Unit I

Fluid Properties: Concept of fluid and flow, ideal and real fluids, continuum concept, Properties of fluid: mass density, weight density, specific volume, specific gravity, viscosity, causes of viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus, Newtonian and non-Newtonian fluids.

Fluid Statics: Pressure, Pascal’s law, hydrostatic law, pressure measurement, manometers, hydrostatic forces on submerged plane and curved surfaces, buoyancy, stability of floating and submerged bodies, liquids in relative equilibrium. Problems.

Unit II

Fluid Kinematics: Eulerian and Lagrangian description of fluid flow; types of fluid flows, stream, streak and path lines; acceleration of a fluid particle, flow rate and continuity equation, differential equation of continuity in cartesian and polar coordinates, rotation and vorticity, circulation, stream and potential functions, flow net. Problems.

Fluid Dynamics: Concept of system and control volume, Euler’s equation, Bernoulli’s equation and its practical applications, venturimeter, orificemeter, orifices, mouthpieces, Impulse momentum equation, kinetic energy and momentum correction factors. Problems.

Unit III

Viscous Flow: Flow regimes and Reynold’s number, Navier-Stokes equation, relationship between shear stress and pressure gradient, flow of viscous fluids in circular pipe and between stationary and moving parallel plates, hydrodynamic lubrication, movement of piston in a dashpot, power absorbed in bearings. Problems.

Turbulent Flow Through Pipes: Transition from laminar to turbulent flow, Reynold's equation of turbulence, Shear stress in turbulent flow, Prandtl mixing length hypothesis, Major and minor losses in pipes, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes. Problems.

Unit IV

Boundary Layer Flow: Boundary layer concept, displacement, momentum and energy thickness, Blasius solution, von-Karman momentum integral equation, laminar and turbulent boundary layer flows, separation of boundary layer and its control.

Flow over Bodies: Drag and lift, friction and pressure drag, lift and drag coefficients, stream lined and bluff bodies, drag on a flat plate, drag on a cylinder and an airfoil, circulation and lift on a circular cylinder and an airfoil. Problems.

Reference and Text Books:

1. Introduction to Fluid Mechanics – R.W. Fox, Alan T. McDonald, P.J. Pritchard, Wiley Publications.
2. Fluid Mechanics – Frank M. White, McGraw Hill
3. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
4. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
5. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, Tata McGraw Hill.
6. Mechanics of Fluids – I H Shames, Mc Graw Hill
7. Fluid Mechanics: Fundamnetals and Applications -YunusCengel and John Cimbala, McGraw Hill.
8. Fluid Mechanics: Pijush K. Kundu, Ira M. Cohen and David R. Rowling, Academic Press.

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

Lecture Plan

Month	Class	Topic/Chapter Covered	Academic Activity	Test/Assignment
Jan.	4th Sem	Concept of fluid and flow, ideal and real fluids, Newtonian and non-Newtonian fluids and continuum concept.	Teaching	
Jan.	4th Sem	Properties of fluid: mass density, weight density, specific volume, specific gravity.	Teaching	
Jan.	4th Sem	Kinematic & dynamic viscosity and causes of viscosity.	Teaching	
Jan.	4th Sem	Surface tension, capillarity, vapours pressure, Compressibility and bulk modulus.	Teaching	
Jan.	4th Sem	Pressure, Pascal's law and Hydrostatic law.	Teaching	
Jan.	4th Sem	Pressure measurement and manometers.	Teaching	
Jan.	4th Sem	Hydrostatic forces on plane and inclined surfaces.	Teaching	
Jan.	4th Sem	Hydrostatic forces on Curved surfaces. Buoyancy, stability of floating and submerged bodies.	Teaching	
Jan.	4th Sem	Liquids in relative equilibrium, Metacentric height & Calculations of Metacentric height.	Teaching	
Jan.	4th Sem	Eulerian and Lagrangian description of fluid flow; types of fluid flows.	Teaching	
Jan.	4th Sem	Stream, streak path lines and acceleration of a fluid particle.	Teaching	Assignment

Feb.	4^{th} Sem	Flow rate and continuity equation in Cartesian coordinates.	Teaching	
Feb.	4^{th} Sem	Continuity equation in polar coordinates, rotation, vorticity and circulation.	Teaching	
Feb.	4^{th} Sem	Stream and potential functions, flow net.	Teaching	
Feb.	4^{th} Sem	Concept of system and control volume, Euler's equation, Bernoulli's equation and its practical applications.	Teaching	
Feb.	4^{th} Sem	Calculation of discharge through Venturimeter and Orificemeter.	Teaching	
Feb.	4^{th} Sem	Mouthpieces, Impulse momentum equation, Energy and momentum correction factors.	Teaching	
Feb.	4^{th} Sem	Flow regimes and Reynold's number, Navier-Stokes equation flow.	Teaching	
Feb.	4^{th} Sem	Relationship between shear stress and pressure gradient.	Teaching	
March	4^{th} Sem	Flow of viscous fluids in circular pipe.	Teaching	
March	4^{th} Sem	Flow of viscous fluids between stationary and moving parallel plates.	Teaching	
March	4^{th} Sem	Hydrodynamic lubrication, movement of piston in a dashpot and power absorbed in bearings.	Teaching	Assignment
March	4^{th} Sem	Transition from laminar to turbulent flow, Reynold's equation of turbulence.	Teaching	

March	4^{th} Sem	Shear stress in turbulent flow, Prandtl mixing length hypothesis.	Teaching	
March	4^{th} Sem	Major and minor losses in pipes.	Teaching	
March	4^{th} Sem	Hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes.	Teaching	
March	4^{th} Sem	Equivalent pipe, power transmission through pipes, hydraulically smooth and rough pipes.	Teaching	
March	4^{th} Sem	Velocity distribution in pipes and friction coefficients for smooth and rough pipes.	Teaching	
March	4^{th} Sem	Boundary layer concept, displacement, momentum and energy thickness.	Teaching	
March	4^{th} Sem	Blasius solution, von-Karman momentum integral equation.	Teaching	Assignment
April	4^{th} Sem	laminar and turbulent boundary layer flows.	Teaching	
April	4^{th} Sem	Separation of boundary layer and its control.	Teaching	
April	4^{th} Sem	Drag and lift, friction and pressure drag.	Teaching	
April	4^{th} Sem	Lift and drag coefficients, stream lined and bluff bodies.	Teaching	
April	4^{th} Sem	Drag on a flat plate; drag on a cylinder and an air foil.	Teaching	
April	4^{th} Sem	Circulation and lift on a circular cylinder and an air foil.	Teaching	Assignment

TUTORIAL SHEET-1

1. Explain: thermodynamic properties of fluid (ii) compressibility (iii) Surface tension and capillarity

2. Draw an expression for centre of pressure in case of inclined plane surface submerged in liquid.

3. Draw an expression for total pressure and centre of pressure in case of vertical plane surface submerged in liquid. Determine the total pressure and centre of pressure on an isosceles triangular plate of base 4 m and altitude 4 m when it is immersed vertically in an oil of sp. Gr. 0.9. The base of the plate coincides with the free surface of oil.

4. An inverted differential manometer containing an oil of specific gravity 0.9 is connected to find the difference of pressures at two point of a pipe containing water. If the manometer reading is 40 cm, find the difference of pressures

5. Determine the total pressure on an isosceles triangular plate of base 4m & altitude 4m when it is immersed vertically in an oil of sp. gr 0.9. The base of the plate coincides with the free surface of the oil.

6. A wooden block of 0.8m diameter & 6m length is floating in river water. Find the depth of wooden log in water when the sp. gr. of the wooden block is 0.7

7. A 40 cm diameter pipe, conveying water, branches into two pipes of diameter 30 cm & 20cm respectively. If the average velocity in the 40cm diameter pipe is 30m/s. find the discharge in the pipe. Also determine the velocity in 20cm pipe if the average velocity in 30cm diameter pipe is 2m/s.

8. The velocity potential function, Φ= x2 – y2. Find the velocity component in x & y direction. Also show that Φ represents a possible case of fluid flow.

9. Explain what is viscosity of fluid? Can it also be defined as shear stress required to produce unit rate of shear strain? If yes, how?

10. Explain Velocity Potential function and stream net function.

11. Describe continuity equation for cylindrical polar co-ordinates.

12. The velocity distribution in a viscous flow over a plate is given by $U = 4y-y^2$ for $y \leq 2$m.

    Where u = velocity in m/s at a point distance y from the plate if where the coefficient of

    dynamic viscosity is 1.5 Pa. Determine the shear stress at y = 0 and y = 2.0 m

13. How types of fluid can be defined? What are the Newtonian and Non-Newtonian fluids?

TUTORIAL SHEET 2

1. State and explain two practical applications of Bernoulli's Equation.

2. A horizontal venturimeter with 30 cm diameter inlet and 10 cm throat is used for measuring the flow of water through a pipe line. If the pressure in the pipe is 1.5 KPa and the vacuum pressure at the throat is 40 cm of Hg. Calculate the rate of flow. It may be presumed that 5% of differential head is lost between the pipe main and throat section. Also make calculation for the discharge coefficient. Take x water =10KN/m^2.

3. State and explain two practical applications of Bernoulli's Equation.

4. A horizontal venturimeter with 30 cm diameter inlet and 10 cm throat is used for measuring the flow of water through a pipe line. If the pressure in the pipe is 1.5 KPa and the vacuum pressure at the throat is 40 cm of Hg. Calculate the rate of flow. It may be presumed that 5% of differential head is lost between the pipe main and throat section. Also make calculation for the discharge coefficient. Take x water =10 KN/m^2.

5. Water is flowing through a pipe having diameter 30 cm & 15 cm at the bottom and upper end respectively. The intensity of pressure at the bottom end is 29.43 N/cm2 and the pressure at the upper end is 14.715 N/cm^2. Determine the difference in the datum head if the rate of flow through pipe is 50 lit/s.

6. A horizontal venturimeter with inlet and throat diameter 30 cm & 15cm respectively is used to measure the flow of water. The reading of differential manometer connected to inlet and throat is 10 cm of mercury. Determine the rate of flow. Take $C_d = 0.98$

7. A nozzle diameter 20 mm is fitted to a pipe of diameter 40 mm. Find the force exerted by the nozzle on the water which is flowing through the pipe at the rate of 1.2m^3/min.

8. An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50 cm of mercury. Find the rate of flow of oil of specific gravity 0.9 when the coefficients of the discharge of the meter=0.64.

9. A 45° reducing bend is connected in a pipe line, the diameter at the inlet & outlet of the bend being 600 mm & 300 mm respectively. Find the force exerted by water on the bend if the intensity of pressure at inlet to bend is 8.829 N/cm^2 & the rate of flow of water is 600 litres/sec.

TUTORIAL SHEET 3

1. In case of viscous fluid between two parallel moving plates, find out (i) Velocity distribution, (ii) Ratio of maximum velocity to average velocity, (iii) Drop pressure head for a given length.

2. Derive Hagen-Poiseuille equation and state the assumptions made.

3. In case of viscous fluid between two parallel stationary plates, find out (i) Velocity distribution, (ii) Ratio of maximum velocity to average velocity, (iii) Drop pressure head for a given length, (iv) Shear stress distribution.

4. Find out power absorbed in viscous flow in case of Journal bearing and foot step bearings.

5. Describe power transmission through pipes, condition of maximum transmission of power, maximum efficiency transmission of power.

6. A viscous flow is taking place in a pipe of diameter 100mm. The maximum velocity is 2m/s. Find the mean velocity and the radius at which it occurs. Also calculate the velocity at 30mm from the wall of the pipe.

7. Water is flowing through a 150 mm diameter pipe with a coefficient of friction, f = 0.05.The shear stress at a point 40 mm from the pipe wall is 0.01962 N/cm^2. Calculate the shear stress at the pipe wall.

8. An oil of viscosity10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2m be $0.3N/cm^3$. The width of the plates is 200 mm.

9. The discharge through a pipe is 200litres/sec. Find the loss of the head when the pipe is suddenly enlarged from 150mm to 300mm diameter.

10. A nozzle is fitted at the end of the pipe of length 400m & of diameter 150 mm. Find the maximum transmission of the power through the nozzle, find the diameter of nozzle. Take f = .008.

TUTORIAL SHEET 4

1. Give the velocity distribution in a laminar boundary layer on a flat plate as $u/U = 2(y/\delta) + (y/\delta)^4$.

2. Explain velocity distribution in turbulent flow in Hydro dynamically smooth and rough boundaries pipes

3. Explain shear stress in turbulent flow and also explain Prandtl mixing length theory.

4. What is boundary layer separation? Discuss the various methods to prevent the separation of a boundary layer.

5. Derive Von Karman momentum equation. How it is useful in calculating drag on flat plate?

6. Discuss, the variation of drag on a cylinder over a wide range of Reynolds number.

For the velocity profile in laminar boundary layer given as $u/U= 3/2(y/\delta)- ½ (y/\delta)^3$, find the thickness of the boundary layer & shear stress 1.8m from the leading edge of a plate. The plate is 2.5m long & 1.5m wide & is placed in water which is moving with a velocity of 15cm/sec. Find the drag on one side of the plate if the viscosity of water = 0.01poise.

7. A thin plate is moving in still atmospheric air at a velocity of 5m/s. The length of the plate is 0.6m & width 0.5m. Calculate (i) the thickness of the boundary layer at the end of the plate, and (ii) drag force on one side of the plate. Take density of air as 1.24kg/m^3 and the kinematic viscosity 0.15 stokes.

8. a) For the velocity profile $u/U= 3/2(y/\delta) - ½ (y/\delta)2$, calculate the coefficient of drag in terms of Reynold number.

b) A thin smooth plate of 0.3mm width & 1 m length moves at 4m/s velocity in still air of density 1.2 kg/m3 and kinematics viscosity 1.49 X 10-5 m2/s. Calculate the drag on the plate.

9. Determine the wall shearing stress in a pipe of diameter 100mm which carries water. The velocities at the pipe centre & 30mm, from the pipe centre are 2m/s & 1.5m/s respectively. The flow in pipe is given as turbulent.

10. A rough pipe of diameter 400mm & length 1000m carries water at a rate of 0.4m^3/s. The wall roughness is 0.012mm. Determine the coefficient of friction, wall shear stress, centre line velocity & velocity at a distance of 150mm from the pipe wall.

11. A smooth pipe of diameter 300mm & length 600m carries water at a rate of 0.04m^2/s. Determine the head lost due to friction, wall shear stress, centre-line velocity & thickness of laminar sub-layer. Take the kinematic viscosity of water as 0.018 stokes.

BT-4 / M-18

MECHANICS OF SOLIDS- II

(ME-206N)

Unit-I

1. A vertical tie fixed rigidly at the top consists of a steel rod 3 .5 m long and 25 mm diameter encased throughout in a brass tube 25 mm internal diameter and 35 mm external diameter. The casing and the rod are fixed together at both ends. The compound rod is suddenly loaded in tension by weight of 15 KN falling through 5 mm before being arrested by the tie. Determine the maximum stresses in steel and brass. Given: E_s= 200 GPa and E_b = 100 GPa

2. An axial pull of 20 KN along with a shear force of 15 KN is applied to a circular bar of 20 mm diameter. The elastic limit of the bar material is 230 MPa and the Poisson's ratio is 0.3. Determine the factor of safety against failure based on

(i) Maximum strain energy stress theory

(ii) Maximum shear stress theory

(iii) Maximum shear strain energy theory

(v) Maximum principal strain energy theory.

Unit-II

3. Define hoop and circumferential stress.

A copper tube of 30 mm bore and 3 mm thick is plugged at its ends. It is just filled with water at atmospheric pressure. If an axial compressive load of 8kN is applied to the plugs, find by how much the water pressure will increase? Modulus of elasticity for copper = 100 GN/m^2. Poisson's ratio= 0.33. Bulk modulus for water= 2.2 GN/m^2.

4. A steel ring of 180 mm outside diameter and 50 mm width is mounted on a steel plug of 120 mm diameter. An electric resistance strain gauge fitted on the external surface of the ring in the circumferential direction measures the stain to be $180x\ 10^{-6}$ mm per mm. Determine the force required to push the plug out of the ring. What is the maximum hoop stress in the ring? E = 204 GPa and coefficient of friction is 0.22.

Unit-III

5. A close coiled helical spring whose free length when not compressed is 15 cm, is required to absorb strain energy equal to 50 Nm when fully compressed with the coils in contact. The maximum shearing stress is limited to l40Mpa. Assuming a mean coil diameter of 10 cm, find the diameter of the steel wire required and number of coils. C= 80 GPa.

6. What do you mean by uniform strength of a disk?

A thin uniform steel disc with a 260 mm diameter has a central hole of 100mm diameter. Determine the maximum principal stress and the maximum shear stress in the disc when disc rotates at 9000 rpm. Density of steel= 7700 Kg/m^3 and Poisson's ratio= 0.3.

Unit-IV

7. A central horizontal section of a hook is a trapezium with inner width 80 mm, outer width 50 mm and depth 150 mm. The centre of the curvature of the section is at a distance of 120 mm from the inner fibre and the load line is 100 mm from the inner fibre. What maximum load, the hook will carry if maximum stress is not to exceed l20 MN/m^2.

8. The load at the end of a 1.6 m long cantilever of T section is increased so that the top of the flange just yields. Find the position of the neutral axis and the load if the yield stress is 240 MPa. The web is 55mm x 10mm and the flange is 80 mm x 10 mm.

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
ME-210N	**DYNAMICS OF MACHINES**	**L 3**	**T 1**	**P 0**	**THEORY 75**	**SESSIONAL 25**	**TOTAL 100**	**3**
Purpose	To familiarize the students with the effect of dynamic forces in various machines and vehicles							
Course Outcomes (CO)								
CO-1	To study the effect of static and dynamic forces on the components of mechanisms							
CO-2	To study the design and working of various gears and gear trains							
CO-3	To study the various types of brakes and dynamometers							
CO-4	To study the unbalanced forces and vibrations in various components of rotating and reciprocating machines.							
CO-5	To study the gyroscopic effect in aeroplanes, ships, two and four wheelers.							

UNIT I

Static force analysis: Static equilibrium, Equilibrium of two and three force members, Members with two forces and a torque, Equilibrium of four force members, free body diagram, Principle of Superposition, static forces Analysis of four bar mechanisms and slider crank mechanism,

Dynamic Force Analysis: D'Alembert's principle, Equivalent offset inertia force, Dynamic force analysis of four bar mechanism and slider crank mechanism Engine force analysis, Turning moment on crank shaft, Dynamic Equivalent systems, Inertia of connecting rods, Inertia force in reciprocating engines(Graphical and Analytical methods), Turning moment diagrams, fluctuation of energy, Flywheels, Flywheel dimensions, Punching Press.

UNIT II

Gears: Classification of gears, Gear terminology, Fundamental law of gearing, Forms of Teeth, Cycloidal and involutes profiles of gear teeth, Interchangeable Gears, path of contact, arc of contact, number of pairs of teeth in contact (Contact Ratio), Interference in involute gears, minimum number of teeth, undercutting,

Helical, Spiral, Bevel and worm & worm gears, Terminology, Efficiency

Gear trains: Simple, compound, reverted, Planetary or epicyclic gear trains, Analysis of Epicyclic Gear trains, Torques in epicyclic gear trains, Sun and Planet gear, Automotive transmissions gear train. Differential.

UNIT III

Brakes: Types of brakes, Block and shoe brake, band brake, band and block brakes, internal expanding shoe brake, Effect of Braking.

Dynamometers: Types of Dynamometers, Pony and Rope Brake Dynamometer, Hydraulic Dynamometer, Belt Transmission Dynamometer, Epicyclic train Dynamometer, Bevis Gibson torsion dynamometer.

Governors: Types of Governors, Watt, Porter, Proell, Hartnell, Hartung, Wilson-Hartnell, Inertia Governors, Sensitiveness, Hunting, Isochronism, Stability of Governors, Effort and Power of a Governor, Controlling Force.

UNIT IV

Balancing of rotating masses: Static and Dynamic Balancing, Single Rotating mass, Many Masses rotating in same plane and in different planes. Analytical method for balancing of rotating masses.

Balancing of reciprocating masses: Reciprocating Engine, Partial Primary balance, Balancing of Multi-cylinder in line engines, Balancing of Radial Engines, Balancing of V-Engines, Balancing of Rotors

Gyroscope: Angular Velocity, Angular Acceleration, pitching and rolling, Gyroscopic couple and its effect on Aeroplanes, Naval ships, Stability of an automobile (2 & 4-wheeers), taking a turn, Gyroscopic effect in stone crusher.

Suggested reading:

1. Theory of machines: S. S. Rattan, Tata McGraw Hill Publications.
2. Theory of Machines: V. P. Singh, Dhanpat Rai & Co. Pvt. Ltd.
3. Theory of machines: Kinematics and Dynamics by Sadhu Singh, Pearson Publications
4. Theory of Machines and Mechanisms.:Uicker, J.J., Pennock G.R and Shigley, J.E.,3rd Edition, Oxford University Press, 2009.
5. Mechanism synthesis and analysis: A.H. Soni, McGraw Hill Publications.
6. Mechanism: J.S. Beggs.
7. Mechanics of Machines: P.Black, Pergamon Press.
8. Theory of Machines: P.L.Ballaney, Khanna Publisher.

Note: *Examiner will set eight questions by selecting two from each unit. Students will be required to attempt five questions selecting at least one question from each unit.*

LECTURE PLAN

DYNAMICS OF MACHINES
ME-210N

Month	**Class**	**Topic/Chapter Covered**	**Academic Activity**	**Test/Assignment**
Jan.	4^{th} Semester	**Static force analysis:** Static equilibrium, Equilibrium of two and three force members.	Teaching	
Jan.	4^{th} Semester	Members with two forces and a torque, Equilibrium of four force members.	Teaching	
Jan.	4^{th} Semester	Free body diagram, Principle of Superposition.	Teaching	
Jan.	4^{th} Semester	Static forces Analysis of four bar mechanism.	Teaching	
Jan.	4^{th} Semester	Static forces Analysis of Slider crank mechanism.	Teaching	
Jan.	4^{th} Semester	**Dynamic Force Analysis:** D'Alembert's principle, Equivalent offset inertia force.	Teaching	
Jan.	4^{th} Semester	Dynamic force analysis of four bar mechanism.	Teaching	
Jan.	4^{th} Semester	Dynamic force analysis of slider crank mechanism	Teaching	
Jan.	4^{th} Semester	Engine force analysis.	Teaching	
Jan.	4^{th} Semester	Turning moment on crank shaft, Dynamic Equivalent systems.	Teaching	
Jan.	4^{th} Semester	Inertia of connecting rods, Inertia force in reciprocating engines (Graphical and Analytical methods).	Teaching	Assignment
Jan.	4^{th} Semester	Turning moment diagrams.	Teaching	
Jan.	4^{th} Semester	Fluctuation of energy, Flywheels.	Teaching	

Jan.	4^{th} Semester	Flywheel dimensions, Punching Press.	Teaching	
Jan.	4^{th} Semester	Gears: Classification of gears, Gear terminology.	Teaching	
Jan.	4^{th} Semester	Fundamental law of gearing, Forms of Teeth.	Teaching	
Feb.	4^{th} Semester	Cycloidal and involutes profiles of gear teeth.	Teaching	
Feb.	4^{th} Semester	Interchangeable Gears, path of contact.	Teaching	
Feb.	4^{th} Semester	Arc of contact, number of pairs of teeth in contact (Contact Ratio).	Teaching	Assignment
Feb.	4^{th} Semester	Interference in involute gears, minimum number of teeth, undercutting.	Teaching	
Feb.	4^{th} Semester	Helical, Spiral, Bevel and worm & worm gears Terminology, Efficiency.	Teaching	
Feb.	4^{th} Semester	Gear trains: Simple, compound.	Teaching	
Feb.	4^{th} Semester	Reverted, Planetary or epicyclic gear trains.	Teaching	
Feb.	4^{th} Semester	Analysis of Epicyclic Gear trains.	Teaching	
Feb.	4^{th} Semester	Torques in epicyclic gear trains.	Teaching	
Feb.	4^{th} Semester	Sun and Planet gear.	Teaching	
Feb.	4^{th} Semester	Automotive transmissions gear train, Differential.	Teaching	
Feb.	4^{th} Semester	Brakes: Types of brakes, Block and shoe brake.	Teaching	
Feb.	4^{th} Semester	Band brake, band and block brakes.	Teaching	

March	4th Semester	Internal expanding shoe brake, Effect of Braking.	Teaching	Assignment
March	4th Semester	Dynamometers: Types of Dynamometers, Pony and Rope Brake Dynamometer.	Teaching	
March	4th Semester	Hydraulic Dynamometer, Belt Transmission Dynamometer.	Teaching	
March	4th Semester	Epicyclic train Dynamometer, Bevis Gibson torsion dynamometer.	Teaching	
March	4th Semester	Governors: Types of Governors, Watt, Porter.	Teaching	
March	4th Semester	Proell, Hartnell.	Teaching	
March	4th Semester	Hartung, Wilson-Hartnell.	Teaching	
March	4th Semester	Inertia Governors, Sensitiveness.	Teaching	
March	4th Semester	Hunting, Isochronism, Stability of Governors.	Teaching	
March	4th Semester	Effort and Power of a Governor, Controlling Force.	Teaching	Assignment
April	4th Semester	Balancing of rotating masses: Static and Dynamic Balancing.	Teaching	
April	4th Semester	Single Rotating mass.	Teaching	
April	4th Semester	Many Masses rotating in same plane and in different planes.	Teaching	
April	4th Semester	Analytical method for balancing of rotating masses.	Teaching	
April	4th Semester	Balancing of reciprocating masses: Reciprocating Engine.	Teaching	
April	4th Semester	Partial Primary balance.	Teaching	

April	4^{th} Semester	Balancing of Multi-cylinder in line engines.	Teaching	
April	4^{th} Semester	Balancing of Radial Engines.	Teaching	
April	4^{th} Semester	Balancing of V-Engines.	Teaching	
April	4^{th} Semester	Balancing of Rotors.	Teaching	
April	4^{th} Semester	Gyroscope: Angular Velocity, Angular Acceleration.	Teaching	
April	4^{th} Semester	Gyroscopic couple and its effect on Aeroplanes.	Teaching	Assignment
April	4^{th} Semester	Pitching and rolling effect on Naval ships.	Teaching	
April	4^{th} Semester	Stability of an automobile (2 & 4-wheeers), taking a turn.	Teaching	
April	4^{th} Semester	Gyroscopic effect in stone crusher.	Teaching	

TUTORIAL SHEET 1

1. Describe equilibrium of two and three members with neat diagram.

2. Explain Dynamic force analysis of four bar mechanism and slider crank mechanism.

3. Explain Engine force analysis and Turning moment on crank shaft.

4. Explain static forces Analysis of four bar mechanisms and slider crank mechanism.

5. Calculate the static forces Analysis of four bar mechanisms and slider crank mechanism.

6. State D'Alembert's principle.

7. A Vertical petrol engine 100 mm diameter and 120 mm stroke has a connecting rod 250 mm long. The mass of the piston is 1.1 kg. The speed is 2000 r.p.m. on the expansion stroke with a crank 20^0 from top dead Centre; the gas pressure is 700 N/m^2. Determine:

(i) Net force on Piston

(ii) Resultant load on the gudgeon pin

(iii) Thrust on the cylinder walls

(iv) Speed above which other things remaining same, the gudgeon pin load would be reversed in direction.

8. The turning moment diagram for a petrol engine is drawn to the following Scales: Turning moment, 1 mm = 5 N-m; crank angle, 1 mm = 1^0. The turning moment diagram repeats itself at every half revolution of the engine and the areas above & below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 mm^2. The rotating parts are equivalent to a mass of 36 kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800 r.p.m.

9. The turning moment diagram for a multi-cylinder engine has been drawn to a scale of 1 mm to 500 N-m torque and 1 mm to 60 of crank displacement. The intercepted areas between output torque curve and mean resistance line taken in order from one end, in sq. mm are -30, +410, -280, +320, -330, +250, -360, +280, -260 sq. mm, when the engine is running at 800 r.p.m. The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed ±2% of the mean speed. Determine a suitable diameter and cross-section of the flywheel rim for a

limiting value of the safe centrifugal stress of 7MPa. The material density may be assumed as 7200 kg/m3. The width of the rim is to be 5 times the thickness.

10. A punching press is driven by a constant torque electric motor. The press is provided with a flywheel that rotates at maximum speed of 225 r.p.m. The radiusof gyration of the flywheel is 0.5 m. The press punches 720 holes per hour; each punching operation takes 2 second and requires 15 kN-m of energy. Find the power of the motor and the minimum mass of the flywheel if speed of the same is not to fall below 200 r.p.m.

TUTORIAL SHEET 2

1. Define interference and pressure angle in involute profile gears. Show how interference is affected by pressure angle.

2. Draw and explain differential of automobile.

3. State planetary or Epicyclic Gear trains.

4. Drive an expression for Length of Path of Contact.

5. A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20^0 pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio.

6. In a reverted epicyclic gear train, the arm A carries two gear B and C and compound gear D-E. The gear B meshes with gear E and gear C meshes with gear D. The number of teeth on gear B, C and D are 75, 30 and 90 respectively. Find the speed and direction of gear C when gear B is fixed and arm A makes 100 r.p.m. clockwise.

7. Define interference and pressure angle in involute profile gears. Show how interference is affected by pressure angle.

8. A 200 involute pinion with 20 teeth drives a gear having 60 teeth. Module is 10 mm state whether interference occurs or not give reasons?

9. Two shafts A and B are co-axial. A gear C (50 teeth) is rigidly mounted on shaft A. A compound gear D-E gears with C and an internal gear G. D has 20 teeth and gears with C and E has 35 teeth and gears with an internal gear G. The gear G is fixed and is concentric with the shaft axis. The compound gear D-E is mounted on a pin which projects from an arm

keyed to the shaft B. Sketch the arrangement and find the number of teeth on internal gear G assuming that all gears have the same module. If the shaft A rotates at 110 r.p.m., find the speed of shaft B.

10. An epicyclic gear consists of three gears A, B and C as shown in the figure 1. The Gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m. If the gear A is fixed. Determine the speed of gears B and C.

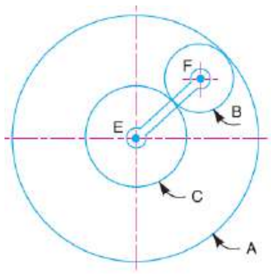

Figure: 1

TUTORIAL SHEET 3

1. Drive an expression for internal expending shoe brake.

2. Drive an expression for band and block brakes.

3. What are dynamometers? Explain any one type absorption dynamometer.

4. Discuss the following terms used in governors:

   (i) Sensitiveness of Governors
   (ii) Stability of Governors
   (iii)Isochronous Governors
   (iv)Hunting
   (v) Effort & Power of a Governor
   (vi)Controlling Force

5. Write a short note on Inertia Governor with sketch.

6. Describe with sketch of Epicyclic-train dynamometer and explain with detail the calculations involved in finding the power transmitted.

7. In a Spring-controlled governor of the Hartung type, the length of the ball and sleeve arms are 80 mm and 120 mm respectively. The total travel of the sleeve is 25 mm. In the mid position, each spring is compressed by 50 mm and the radius of rotation of the mass centres is 140 mm. Each ball has a mass of 4 Kg and the spring has a stiffness of 10 KN/m of compression. The equivalent mass of the governor gear at the sleeve is 16 Kg. Neglecting the moment due to the revolving masses when the arms are inclined; determine the ratio of the range of speed to the mean speed of the governor. Find also the speed in the mid- position.

8. A governor of the Hartnell type has equal balls of mass 3 kg, set initially at a radius of 200 mm. the arms of the bell crank lever are 110 mm vertically and 150 mm horizontally. Find

(i) The initial compressive force on the spring, if the speed for an initial ball radius of 200 mm is 240 r.p.m. and
(ii) The stiffness of the spring required to permit a sleeve movement of 4 mm on a fluctuation of 7.5% in the engine speed.

9. Drive an expression for Porter Governor with its neat and clean sketch.

10. A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 r.p.m. and 310 r.p.m. for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine: a) Loads on the spring at the lowest and the highest equilibrium speeds and b) stiffness of the spring.

TUTORIAL SHEET 4

1. Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg and their distance from axis of rotation are 0.2m, 0.15m, 0.25m and 0.3m respectively and the angles between successive masses are 45^0, 75^0, and 135^0. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2m?

2. Discuss the effect of the gyroscopic couple on a two wheeled vehicle when taking a turn.

3. Explain the application of gyroscopic principles to naval ships while steering, pitching and rolling.

4. Discuss the effect of the gyroscopic couple on a four wheeled vehicle when taking a turn.

5. Gyroscopic couple and its effect on aeroplanes when taking a left turn.

6. The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45m and a speed of 3000 r.p.m clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:

(i) When the ship is steering to the left on a curve of 100m radius at a speed of 36km/h.

(ii) When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.

(iii) Maximum angular acceleration of the ship during pitching.

(iv) The Ship rolls and at a certain instant it has an angular velocity of 0.03 rad/sec, clockwise when viewed from the stern.

7. The mass of the turbine rotor of a ship is 20 tonnes and has a radius of gyration of 0.60m. Its speed is 2000 r.p.m. The ship pitches 6^0 above & 6^0 below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine:

1) Maximum gyroscopic couple.
2) Maximum angular acceleration of the ship during pitching.

The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left (rear end or stern).

BT-4 / M-18

DYNAMICS OF MACHINES

Paper-ME-2l0N

Time allowed: 3 hours Maximum marks: 75

Note:- Attempt five questions in all, selecting at least one question from each unit. All questions carry equal marks.

Unit - I

1. How the dynamic force analysis of a Slider-crank mechanism is done? Explain. (15)

2. An engine runs at a constant load at a speed of 480 rpm. The crank effort diagram to a scale of I cm=2 kN-m torque and 1 cm=36 deg. crank angle. The areas of the diagram above and below the mean torque line are measured in sq. cm and are in the following order: + 1.1, -1.32, + 1.53, -1.66,+ 1.97,-1.62 Design the flywheel if the total fluctuation of speed is not to exceed 10 rpm and the centrifugal stress in the rim is not to exceed 5 MPa. It may be assumed that the rim breadth is approximately 3.5 times the rim thickness and 90% of the moment of inertia is due to the rim. The density of the material of the fly wheel is 7250kg/m^3. (15)

Unit-II

3. Two 20 deg. involute gears in mesh have a gear ratio of 2 and 20 teeth on the pinion. The module is 5 mm and the pitch line speed 1.5 m/s. assuming addendum to be equal to one module. Find (a) Angle turned through by pinion when one pair of teeth is in mesh and (b) Maximum velocity of sliding. (15)

4. In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 rpm in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, make 300 rpm in the clockwise direction, what will be the speed of the gear B? (15)

Unit-III

5. A band brake acts on the3/4^{th} of circumference of a drum of 450 mm diameter which is keyed to the shaft. The band brake provides a braking torque of 225N-m. One end of the band is attached to a fulcrum pin of the lever and the other end to a pin 100 mm from the fulcrum.

If the operating force is applied at 500 mm from the fulcrum and the coefficient of friction is 0.25, find the operating force when the drum rotates in the (a) anticlockwise direction (b) clockwise direction. (15)

6. (a) Prove that the sensitiveness of a Proell governor is greater than that of a Porter governor.

(b) What is stability of a governor? Derive the condition for stability. (15)

Unit-IV

7. A five cylinder in-line engine running at 750 has successive cranks 144 deg. apart, the distance between the cylinder centre lines being 375 mm. The piston stroke is 225 mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values of these and the position of the central crank at which these maximum values occurs. The reciprocating masses for each cylinder is 15 kg. (15)

8. A flywheel of mass 10kg and radius of gyration 200mm is spinning about its axis, which is horizontal and is suspended at a point distance 150 mm from the plane of rotation of the flywheel. Determine the angular velocity of precession of the flywheel. The spin speed of flywheel is 900 rpm. (15)

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
		L	T	P	Sessional	Practical	Total	
ME-214N	**FLUID MECHANICS LAB**	0	0	2	40	60	100	3
Purpose	To familiarize the students with the equipment and instrumentation of Fluid Mechanics.							
Course Outcomes (CO)								
CO-1	Operate fluid flow equipment and instrumentation.							
CO-2	Collect and analyse data using fluid mechanics principles and experimentation methods.							
CO-3	Determine the coefficient of discharge for various flow measurement devices.							
CO-4	Calculate flow characteristics such as Reynolds number, friction factor from laboratory measurements.							
CO-5	Identify and discuss foundation-level fluid phenomena including laminar to turbulent transition, turbulence etc.							
CO-6	Measure pressure loss due to friction for pipe flow.							

List of Experiments:

1. To determine the meta-centric height of a floating body.
2. To determine the hydrostatic force and center of pressure on both a submerged or partially submerged plane surface and compare with the theoretical result.
3. To demonstrate the working of different pressure measuring devices.
4. To measure the pressure and pressure difference by pressure gauge, single column manometer, U-Tube manometer & Inclined tube manometer.
5. To verify the Bernoulli's Theorem.
6. To determine coefficient of discharge of an orifice meter.
7. To determine the coefficient of discharge of venturimeter.
8. To determine the coefficient of discharge of Notch (V and Rectangular types).
9. To determine the coefficient of discharge, contraction & velocity of an orifice.
10. To find critical Reynolds number for a pipe flow.
11. To determine the friction factor for the pipes.
12. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
13. To show the velocity and pressure variation with radius in a forced vertex flow.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
		L	**T**	P	**Sessional**	**Practical**	**Total**	
ME-216N	**DYNAMICS OF MACHINES LAB**	0	0	2	40	60	100	3
Purpose	To familiarize the students with the equipment and instrumentation of Fluid Mechanics.							
Course Outcomes (CO)								
CO-1	To learn about the working of Flywheel.							
CO-2	To experimentally calculate Gyroscopic couple of a motorised gyroscope							
CO-3	To learn about balancing of rotating mass.							
CO-4	To learn about the working of various types of governors.							
CO-5	To study various types of brakes used in automobiles.							

LIST OF EXPERIMENT

1. To determine experimentally, the moment of inertia of a flywheel and axle compare with theoretical values.
2. To find out critical speed experimentally and to compare the whirling speed of a shaft with theoretical values.
3. To find experimentally the Gyroscopic couple on motorized gyroscope and compare with applied couple.
4. To perform the experiment of balancing of rotating parts and finds the unbalanced couple and forces.
5. To determine experimentally the unbalance forces and couples of reciprocating parts.
6. To calculate the torque on a planet carrier and torque on internal gear using epicyclic gear train and holding torque apparatus.
7. To study the different types of centrifugal and inertia governors and demonstrate any one.
8. To study the automatic transmission unit.
9. To study the differential types of brakes.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.

Course No.	**Course Title**	**Teaching Schedule**			**Allotment of Marks**			**Duration of Exam (Hrs.)**
		L	T	**P**	**Sessional**	**Practical**	**Total**	
ME-218N	**STEAM GENERATION AND POWER LAB**	0	0	2	40	60	100	3

Purpose	To make the students aware of different boilers and steam turbines using different experiments.
Course Outcomes (CO)	
CO-1	Students will be able to collect broad knowledge of about the different boilers.
CO-2	Students will be able to understand the working of the steam engine.
CO-3	Ability to determine the power and efficiency of the steam turbine and cooling tower
CO-4	Able to describe quantitatively the heat balance sheet of the boiler.

List of Experiments:

1. To study the Babcock-Wilcox boiler (Model).
2. To study thelocomotive boiler (Model).
3. To study the Lancashire boiler (Model).
4. To study the Nestler'sboiler.(Model)
5. To study various parts of the vertical steam engine.
6. To prepare heat balance sheet for given boiler.
7. To find dryness fraction of steam by separating and throttling calorimeter.
8. To find power output & efficiency of a steam turbine.
9. To study cooling tower and find its efficiency.
10. To study the various mountings and accessories of a boiler
11. To study and find volumetric efficiency of a reciprocating air compressor.
12. To find the efficiency of condenser.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.

Course No.	Course Title	Teaching Schedule			Allotment of Marks			Duration of Exam (Hrs.)
		L	**T**	**P**	**Sessional**	**Practical**	**Total**	
ME-220N	**PRODUCTION TECHNIOLOGY LAB**	0	0	3	40	60	100	3
Purpose	To make the students understand the different types of machines in production industries and welding machines.							
Course Outcomes (CO)								
CO-1	To practice on Milling machine							
CO-2	To make gears and study grinders.							
CO-3	To study the working CNC machines.							
CO-4	To carry welding out using TIG/MIG Welding machine.							

List of Experiments:

1. Practice of slab milling on milling machine.
2. Practice of slotting on milling machine.
3. To cut gear teeth on milling machine using dividing head.
4. Introduction to gear hobber, demonstration of gear hobbing and practice.
5. Introduction to various grinding wheels and demonstration on the surface grinder.
6. Introduction to tool and cutter grinder and dynamometer.
7. Study the constructional detail and working of CNC lathes Trainer.
8. To carry out welding using TIG/MIG welding set.
9. Introduction, demonstration & practice on profile projector & gauges.
10. To make a component on lathe machine using copy turning attachment.
11. To cut external threads on a lathe.
12. To cut multi slots on a shaper machine.
13. To perform drilling and boring operation on a Component.

Note: Any 8 experiments from the above list and other 2 from others (developed by institute) are required to be performed by students in the laboratory.