Printed page: 04 Subject Code: AME0502

Roll No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech.

SEM: V - THEORY EXAMINATION (2024-2025)

Subject Theory of Machines

Time: 3 Hours Max. Marks:100

General Instructions:

IMP: Verify that you have received question paper with correct course, code, branch etc.

1. *This Question paper comprises of three Sections -A, B, & C. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*
2. *Maximum marks for each question are indicated on right hand side of each question.*
3. *Illustrate your answers with neat sketches wherever necessary.*
4. *Assume suitable data if necessary.*
5. *Preferably, write the answers in sequential order.*
6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION – A 20

1. Attempt all parts:-

1-a. The mechanism forms a kinematic chain, when the number of degrees of freedom (n) is equal to (CO1, K1) 1

(a) 0
(b) 1
(c) 2
(d) 3

1-b. Which method is used for velocity analysis in a four-bar mechanism? (CO1, K2) 1

(a) Instantaneous center method
(b) Kinematic equation
(c) Inverse kinematic relation
(d) None of the above

1-c. Which of the following is a type of profile of cam? (CO2, K1) 1

(a) Cycloidal profile
(b) Simple Harmonic profile
(c) Parabolic profile
(d) All of the above

1-d. The circle from which an involute curve is generated is known as (CO2, K2) 1

(a) Pitch
(b) Addendum
(c) Base circle
(d) None of the mentioned

1-e. Which of the following is used in static balancing of rotating masses? (CO3, K1) 1

(a) Analytical method
(b) Graphical method
(c) Both a and b
(d) None of the above

1-f. What is the function of a flywheel in an engine? (CO3, K1) 1

(a) Smooth out fluctuations in power
(b) Store energy
(c) Maintain constant torque
(d) All of the above

1-g. Which of the following is a type of governor used in mechanical systems? (CO4, K2) 1

(a) Centrifugal governor
(b) Hydraulic governor
(c) Electrical governor
(d) All of the above

1-h. In an inside cylinder locomotive, the position of the driving wheels is ____ (CO4, K1) 1

(a) Outside cylinder
(b) Inside cylinder
(c) Down to cylinder
(d) Above the cylinder

1-i. Gyroscopic forces affect the stability of: (CO5, K1) 1

(a) Aeroplanes
(b) Ships
(c) Cars moving on curved paths
(d) All of the above

1-j. Which of the following dynamometer belongs to a different type? (CO5, K1) 1

(a) Prony brake dynamometer
(b) Torsional dynamometer
(c) Epicyclic train dynamometer
(d) Belt transmission dynamometer

2. Attempt all parts:-

2.a. Differentiate between a lower and higher. (CO1, K2) 2

2.b. Differentiate between radial follower and off-set follower. (CO2, K2) 2

2.c. Define the term ‘coefficient of fluctuation of speed’. (CO3, K2) 2

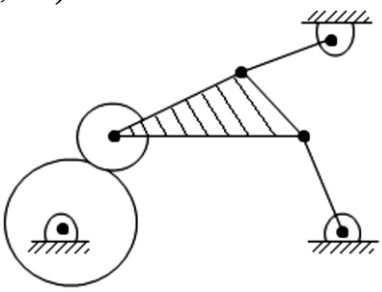
2.d. What is hunting of governor? (CO4, K2) 2

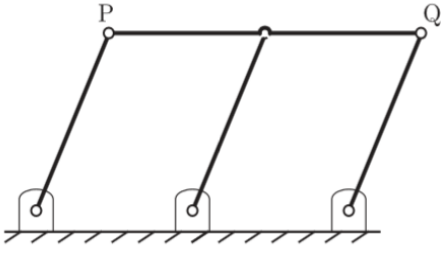
2.e. How the Dynamometers are classified? (CO5, K2) 2

SECTION – B 30

3. Answer any <u>five</u> of the following-

3-a. Calculate the degree of freedom of the following mechanism as shown in figure. (CO1, K2) 6





3-b. What do you mean by inversion of mechanism? Show that the locus of mid-point of the link connecting the two sliders in an elliptical trammel is a circle. (CO1, K3) 6

3-c. Deduce the expression for displacement, velocity and acceleration when the follower moves with simple harmonic motion. (CO2, K3) 6

3-d. Define Gear and Gear train. What are the different types of gear train? (CO2, K2) 6

3-e. What is the function of a flywheel? Prove that the maximum fluctuation of energy. (CO3, K3) 6

$$\Delta E = mk^2\omega^2 C_s.$$

3-f. Explain the term of height of governor. Derive an expression for the height in the case of a Watt governor. What are the limitations of a Watt governor? (CO4, K2) 6

3-g. Derive an expression for the gyroscopic couple acting on a rotating body. Explain the effect of the gyroscopic couple on aeroplane with neat sketch, if the propeller of an aeroplane rotates counter clockwise when viewed from the front and the aeroplane takes a left turn. (CO5, K3) 6

SECTION – C 50

4. Answer any <u>one</u> of the following-

4-a. Define the term 'mechanism.' Explain the inversion of a four-bar chain mechanism with relevant diagrams. (CO1, K2) 10

4-b. In a slider-crank mechanism, the length of the crank is 150 mm, and the length of the connecting rod is 750 mm. The crank rotates uniformly at 300 rpm in a clockwise direction. Determine: 10

1. The velocity of the slider at the instant when the crank makes an angle of 30° with the line of stroke.
2. The angular velocity of the connecting rod at the same instant.

Use the relative velocity method for the solution and provide a neat diagram to support your calculations. (CO1, K3)

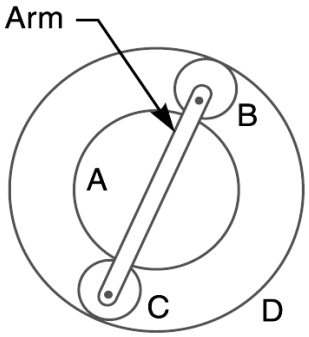
5. Answer any <u>one</u> of the following-

5-a. A cam is to be designed for a knife edge follower with the following data: 10

1. Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.
2. Dwell for the next 30°.
3. During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.
4. Dwell during the remaining 180°.

Draw the profile of the cam when the line of stroke of the follower passes through the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the maximum velocity of the follower during its ascent and descent, if the cam rotates at 240 rpm. (CO2, K3)

5-b. An epicyclic train of gears is arranged as shown in figure. How many revolutions does the arm, to which the pinions B and C are attached, make: 1. when A makes one revolution clockwise and D makes half a revolution anticlockwise, and 2. when A makes one revolution clockwise and D is stationary? The number of teeth on the gears A and D are 40 and 90 respectively. (CO2, K3) 10



6. Answer any <u>one</u> of the following-

6-a. The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm^2. The connecting rod length between centers is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 rpm and if the effect of piston rod diameter is neglected, calculate: 1. pressure on slide bars, 2. thrust in the connecting rod, 3. tangential force on the crank-pin, and 4. turning moment on the crank shaft. (CO3, K3) 10

6-b. 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°. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960 and 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 rpm. (CO3, K3) 10

7. Answer any <u>one</u> of the following-

7-a. Derive the following expressions, for an uncoupled two-cylinder locomotive engine: (a) Variation in tractive force; (b) Swaying couple (CO4, K3) 10

7-b. In a spring loaded Hartnell type governor, the extreme radii of rotation of the balls are 80 mm and 120 mm. The ball arm and the sleeve arm of the bell crank lever are equal in length. The mass of each ball is 2 kg. If the speeds at the two extreme positions are 400 and 420 rpm, find: 1. the initial compression of the central spring, and 2. the spring constant. (CO4, K3) 10

8. Answer any <u>one</u> of the following-

8-a. What is Dynamometer? Describe the construction and operation of a prony brake absorption dynamometer. (CO5, K3) 10

8-b. The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 rpm clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 10

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

2. 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. (CO5, K3)