



R20 Regulation  
TKR COLLEGE OF ENGINEERING AND TECHNOLOGY  
(Autonomous, Accredited by NAAC with 'A' Grade)  
B.Tech V Semester Supplementary Examinations, June/July 2023

Subject code:3P5CA

**DYNAMICS OF MACHINERY**  
(Mechanical Engineering)

Maximum Marks: 70

Date:23.06.2023 Duration: 3 hours

Part-A

- All the following questions carry equal marks (10x2M=20 Marks)
- 1 Give the expression for gyroscopic couple and specify the terms.
  - 2 Where do we use D'Alembert's principle?
  - 3 Define the term 'coefficient of fluctuation of energy' as applied to flywheels.
  - 4 The flywheel of a steam engine has a radius of gyration of 0.8 m and mass 2000 kg. The starting torque of the steam engine is 1000 Nm and may be assumed constant. Find angular acceleration of flywheel.
  - 5 What is a self-locking brake?
  - 6 Determine the maximum pressure in a plate clutch when the axial force is 5 kN. The inside radius of contact surface is 50 mm and the outside radius is 100 mm. Assume uniform wear.
  - 7 Calculate the vertical height of a Watt governor when it rotates at 60 rpm. Also find the change in vertical height, when its speed increases to 61 rpm.
  - 8 Why is balancing of rotating parts necessary for high speed engines?
  - 9 What is transverse vibration?
  - 10 Define critical speed of a shaft.

Part-B

Answer All the following questions.

(10MX 5=50Marks)

- 11 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 (a) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. (b) 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. [10m]
- OR
- 12 In a slider crank mechanism, the length of the crank and connecting rod are 100 mm and 400 mm respectively. The crank rotates uniformly at 600 rpm clockwise. When the crank has turned through 45° from the inner dead centre, find (a) Velocity and acceleration of the slider (b) Angular velocity and angular acceleration of the connecting rod. [10m]
  - 13 The turning moment diagram for a multi-cylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows: +52, -124, +92, -140, +85, -72 and +107 mm<sup>2</sup>, when the engine is running at a speed of 600rpm. If the total fluctuation of speed is not to exceed ±1.5 % of the mean, find the necessary mass of the flywheel of radius 0.5 m [10m]
- OR

14 A vertical double acting steam engine develops 95 kW at 280 rpm. The maximum fluctuation of energy is 25% of the work done per stroke. The maximum and minimum speeds are not to vary more than 2% on either side of the mean speed. Find the mass of the flywheel required, if the radius of gyration is 0.8 m. [10m]

15 A conical friction clutch is used to transmit 90 kW at 1500 rpm. The semi-cone angle is  $20^\circ$  and the coefficient of friction is 0.2. If the mean diameter of the bearing surface is 375 mm and the intensity of normal pressure is not to exceed  $0.25 \text{ N/mm}^2$ , find the dimensions of the conical bearing surface and the axial load required. [10m]

OR

16 In a band and block brake, the band is lined with 14 blocks, each of which subtends an angle of  $20^\circ$  at the drum centre. One end of the band is attached to the fulcrum of the brake lever and the other to a pin 150 mm from the fulcrum. Find the force required at the end of the lever 1 metre long from the fulcrum to give a torque of 4 kNm. The diameter of the brake drum is 1 metre and the coefficient of friction between the blocks and the drum is 0.25. [10m]

17 A shaft carries five masses A,B,C,D and E which revolve at the same radius in planes which are equidistant from one another. The mass of A,C,D are 50 kg, 40 kg and 80 kg respectively. The angle between A and C is  $90^\circ$  and that between C and D is  $135^\circ$ . Determine the magnitude of masses in planes B and E and their positions to put the shaft in complete rotating balance. [10m]

OR

18 A Proell governor has arms of 300 mm length. The upper arms are hinged on the axis of rotation, whereas the lower arms are pivoted at a distance of 35 mm from the axis of rotation. The extension of lower arms to which the balls are attached is 100 mm long. The mass of each ball is 8 kg and the mass on the sleeve is 60 kg. At the minimum radius of rotation of 200 mm, the extensions are parallel to the governor axis. Determine the equilibrium speed of the governor for the given configuration. What will be the equilibrium speed for the maximum radius of 250 mm? [10m]

19 A shaft of length 0.75 m, diameter 50 mm, supported freely at the ends, is carrying a body of mass 90 kg at 0.25 m from one end. Find the natural frequency of transverse vibration. Assume  $E=200 \text{ GN/m}^2$ . [10m]

OR

20 A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is  $7700 \text{ kg/m}^3$  and its modulus of elasticity is  $200 \text{ GN/m}^2$ . Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. [10m]