

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2024****Subject Code:2151902****Date:09-12-2024****Subject Name:Theory of Machines****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

	Marks
Q.1 (a) Explain the gyroscopic effect in an aero plane with neat sketch.	03
(b) Explain the concept of gyroscopic couple. Derive a formula for its magnitude.	04
(c) What is a clutch? Classify clutch. Describe with a neat sketch a centrifugal clutch and deduce an equation for the total torque transmitted.	07
Q.2 (a) Explain various applications of flywheel.	03
(b) Define: (1) fluctuation of energy (2) maximum fluctuation of energy (3) co-efficient of fluctuation of energy (4) co-efficient of fluctuation of speed.	04
(c) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 r.p.m. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: 1) The ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius. 2) The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. 3) The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.	07
OR	
(c) Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve.	07
Q.3 (a) Enlist the factors affecting capacity of brakes.	03
(b) Define and explain the following terms relating to governors: 1) Stability, 2) Sensitiveness, 3) Isochronism, and 4) Hunting.	04
(c) A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and $\mu = 0.3$; find the total spring load pressing the plates together to transmit 25 kW at 1575 r.p.m. If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces has worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear.	07
OR	
Q.3 (a) What information can be availed from turning moment diagrams.	03
(b) Enlist dead weight governor. Explain any one.	04

- (c) The equation of the turning moment curve of a three crank engine is $(5000 + 1500 \sin 3\theta)$ N-m, where θ is the crank angle in radians. The moment of inertia of the flywheel is 1000 kg-m^2 and the mean speed is 300 r.p.m. Calculate: 1) power of the engine, and 2) the maximum fluctuation of the speed of the flywheel in percentage when (i) the resisting torque is constant, and (ii) the resisting torque is $(5000 + 600 \sin \theta)$ N-m. 07

- Q.4** (a) Explain Rope brake dynamometer in detail. 03
 (b) What are the materials for friction clutches? State the characteristics of good friction material. 04
 (c) A band and block brake, having 14 blocks each of which subtends an angle of 15° at the centre, is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find: 1) maximum braking torque, 2) angular retardation of the drum, and 3) time taken by the system to come to rest from the rated speed of 360 r.p.m. The coefficient of friction between blocks and drum may be taken as 0.25. 07

OR

- Q.4** (a) Explain D'Alembert's Principle. 03
 (b) Explain impulse and momentum. 04
 (c) A machine punching 38 mm holes in 32 mm thick plate requires 7 N-m of energy per sq. mm of sheared area, and punches one hole in every 10 seconds. Calculate the power of the motor required. The mean speed of the flywheel is 25 meters per second. The punch has a stroke of 100 mm. Find the mass of the flywheel required, if the total fluctuation of speed is not to exceed 3% of the mean speed. Assume that the motor supplies energy to the machine at uniform rate. 07

- Q.5** (a) State Lami's theorem and give suitable example. 03
 (b) Explain the principle of virtual work. 04
 (c) The Four bar chain mechanism shown in figure 1 in which crank 2 is driven by an input torque T_2 and link 4 is subjected to external force $F = 500 \text{ N}$ at point O on link 4. Find all the constraint forces and torque T_2 for static equilibrium of the mechanism. 07

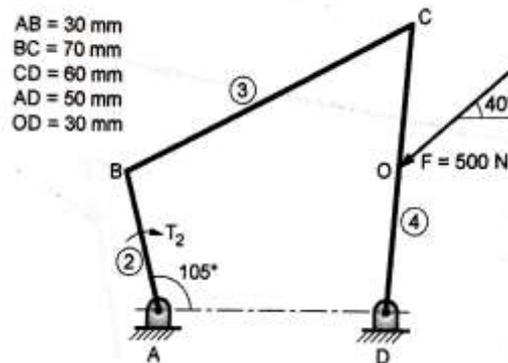


Figure 1.

OR

- Q.5** (a) Describe shaking force and shaking moment. 03
 (b) Differentiate between brakes and dynamometer. 04
 (c) 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° from top dead centre, the gas pressure is 700 kN/m^2 . Determine: 1) Net force on the piston, 2) Resultant load on the gudgeon pin, 3) Thrust on the cylinder walls, and 4) Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction. 07
