

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BACHELOR OF ENGINEERING – SEMESTER 5 – EXAMINATION – SUMMER 2026**

**Subject Code: 2151902**

**Date: 02/06/2026**

**Subject Name: Theory of Machines**

**Time: 02:30 PM TO 05:00 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.**

- Q.1**
- (a) State and explain parallel axis theorem. **03**
  - (b) Explain concept of Free Body Diagram with suitable example. **04**
  - (c) Explain the dynamics force analysis of slider crank mechanism in detail. **07**
- Q.2**
- (a) Explain impulse and momentum. **03**
  - (b) Explain D'Alembert's Principle. **04**
  - (c) Demonstrate working principle of centrifugal clutch with neat sketch. **07**
- OR
- (c) Explain construction and operation of rope brake absorption dynamometer. **07**
- Q.3**
- (a) What is the function of a clutch? Classify clutches. **03**
  - (b) Enlist the factors on which capacity of a brake depends. **04**
  - (c) A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed  $0.1 \text{ N/mm}^2$ . If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 r.p.m. **07**
- OR
- Q.3**
- (a) What are the materials for friction clutches? State characteristics of good friction material. **03**
  - (b) Distinguish simple band brake and differential band brake. **04**
  - (c) Describe with the help of a neat sketch the principles of operation of an internal expanding shoe. Derive the expression for the braking torque **07**
- Q.4**
- (a) Explain turning moment diagram for reciprocating engines. **03**
  - (b) Explain necessity of governor and classification of centrifugal governors. **04**
  - (c) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm =  $3^\circ$  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  $+ 107 \text{ mm}^2$ , when the engine is running at a speed of 600 r. p . m. If the total fluctuation of speed is not to exceed  $\pm 1.5\%$  of the mean, find the necessary mass of the flywheel of radius 0.5 m. **07**

OR

- Q.4** (a) Explain turning moment diagram for punching press. **03**  
(b) State the function of governor. Distinguish between flywheel and governor. **04**  
(c) A punching press is required to punch 40 mm diameter holes in a plate of 15 mm thickness at the rate of 30 holes per minute. It requires 6 N-m of energy per mm of sheared area. If the punching takes 1/10 of a second and the r.p.m. of the flywheel varies from 160 to 140, determine the mass of the flywheel having radius of gyration of 1 metre. **07**

- Q.5** (a) Explain the gyroscopic effect with suitable example. **03**  
(b) Explain roll, pitch and yaw motions. **04**  
(c) An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it. **07**

OR

- Q.5** (a) Discuss in brief the effect of gyroscopic couple on two-wheeled vehicle taking a turn. **03**  
(b) What do you understand by gyroscopic couple? Derive formula for its magnitude. **04**  
(c) Describe the gyroscopic effect on sea going vessels. **07**

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