Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – SUMMER • 2014

Subject Code: 151902 Date: 13-06-2014

Subject Name: Theory of Machines

Time: 10:30 am - 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.**

Q.1 **(a)** Describe the working of a band and block brake with the help of a neat sketch. Deduce the relation for ratio of tight and slack side tensions. **07**

(b) A Porter governor has all the arms of 300 mm long. The upper and lower arms are pivoted to the links of 50 mm and 60 mm respectively from the axis of rotation. Each ball has a mass of 6 kg and the sleeve mass is 55 kg. The force of friction on the sleeve of the mechanism is 40 N. Determine the range of speed of the governor if the extreme radii of rotation of the balls are 150 mm and 200 mm. **07**

Q.2 **(a)** How do the effects of gyroscopic couple and of centrifugal force make the rider of a two-wheeler tilt on one side? Derive a relation for the angle of heel. **07**

(b) In a single acting four stroke engine, the work done by the gases during the expansion stroke is three times the work done during the compression stroke. The work done during the suction and exhaust strokes is negligible. The engine develops 15 kW at 300 rpm. The fluctuation of speed is limited to ±2% of the mean speed. The turning-moment diagram during the compression and the expansion strokes may be assumed to be triangular in shape. Determine the inertia of the flywheel. **07**

OR

(b) The crank and the connecting rod of a vertical single cylinder gas engine running at 1500 rpm are 50 mm and 225 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1.25 kg. At a point during the expansion stroke when the piston has moved 20 mm from the TDC, the pressure on the piston is 750 kN/m^2. Determine the (i) net force on the piston, (ii) thrust in the connecting rod, (iii) thrust on the sides of the cylinder walls and (iv) engine speed at which the above values are zero. **07**

Q.3 **(a)** Describe the procedure to design a four-bar mechanism by relative pole method when three positions of the input link (θ_1, θ_2, θ_3) and the out put link (ϕ_1, ϕ_2, ϕ_3) are known. **07**

(b) A double block brake shown in Figure 1, is applied on a drum of diameter 500 mm. The angle of contact is 90^o and the coefficient of friction is 0.35. The force applied on end of each lever arm is 4000 N. Determine the brake torque on the drum. **07**

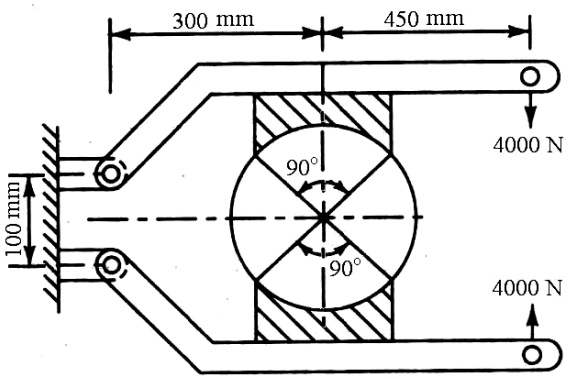

Figure 1

OR

Q.3 **(a)** Define the following terms in context of governor: **07**
(i) Sensitiveness, (ii) Hunting, (iii) Isochronism, (iv) Stability (v) Effort,
(vi) Power and (vii) Coefficient of insensitiveness.

(b) The rotor of a marine turbine has a moment of inertia of 750 kg.m^2 and rotates at 3000 rpm clockwise when observed from aft. If the ship pitches with angular SHM having a periodic time of 16 s and amplitude of 0.1 rad, find (i) maximum angular velocity of the rotor axis, (ii) maximum value of the gyroscopic couple and (iii) the gyroscopic effect as the bow dips. **07**

Q.4 **(a)** 1) What are the turning moment diagrams? Why are they drawn? **07**
2) Find a relation for the coefficient of fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the fly wheel at mean speed.

(b) When, why and how is the correction couple applied by considering the inertia of the connecting rod of a reciprocating engine? **07**

OR

Q.4 **(a)** What is Freudenstein's equation? How is it helpful in designing the four-bar mechanism when three positions of the input (θ_1, θ_2, θ_3) and the out put link (ϕ_1, ϕ_2, ϕ_3) are known? **07**

(b) 1) What is a function of dynamometer? List out the different types of dynamometers. **07**
2) The rope brake dynamometer consisting of a pulley of 1 m diameter. The rope of diameter of 10 mm is wrapped over the rim of the pulley. The dead weight on the brake is of 50 kg while the spring balance shows a reading of 120 N when the speed of the engine is 180 rpm. Find the power of the engine.

Q.5 **(a)** Each arm of a Proell governor is 250 mm long and each ball has a mass of 4.5 kg. The central load acting on the sleeve is 30 kg. The pivots of all the arms are 40 mm from the axis of rotation. The vertical height of the governor is 190 mm. the extension links of the lower arms are vertical and the governor speed is 200 rpm when the sleeve is in the mid position. Determine the length of the extension links and the tension in the upper arms. **07**

(b) A rear engine automobile is traveling along curved track of 120 m radius. Each of the four wheels has a moment of inertia of 2.2 kg.m^2 and an effective diameter of 600 mm. The rotating parts of the engine have a moment of inertia of 1.25 kg.m^2. The gear ratio of the engine to the rear wheel is 3.2. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The mass of the vehicle is 2050 kg and the centre of mass is 520 mm above the road level. The width of the track is 1.6 m. What will be the limiting speed of the vehicle to maintain the stability during turning? **07**

OR

Q.5 **(a)** A riveting machine is driven by an electric motor of 2.5 kW. The actual time to complete one riveting operation is 1.2 s and it absorbs 10 kN.m of energy. The moving parts including the flywheel are equivalent to 200 kg and 0.5 m radius of gyration. Determine the speed of the flywheel immediately after riveting if it is 360 rpm before riveting. Also, find the number of rivets closed per minute. **07**

(b) The piston diameter of an IC engine is 120 mm and the stroke is 200 mm. The connecting road is 4.2 times the crank length and has a mass of 50 kg. The mass of the reciprocating parts is 25 kg. The centre of gravity of the connecting rod is at a distance of 170 mm from the crank pin centre and the radius of gyration about an axis through the centre of mass is 140 mm. The engine runs at 300 rpm. Find the magnitude and the direction of the inertia force and the corresponding torque on the crank shaft when the angle turned by the crank is 60^o from the IDC. **07**

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