Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – WINTER • 2014

Subject Code: 151902 **Date: 28-11-2014**

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)** What is the main function of a governor? How does it differ from flywheel? Differentiate between inertia and centrifugal governor. **07**

(b) In a spring controlled governor, the controlling force curve is a straight line. The balls are 400 mm apart when the controlling force is 1500 N and 240 mm when it is 800 N. The mass of each ball is 10 kg. Determine the speed at which the governor runs when the balls are 300 mm apart. By how much should the initial tension be increased to make the governor isochronous? Also find the isochronous speed. **07**

Q.2 **(a)** "Rope brake type dynamometer is an absorption type dynamometer." Justify this statement. Also explain principle and working of belt transmission dynamometer with neat sketch. **07**

(b) A band and block brake having 12 blocks, each of which subtends an angle of 16^0 at the center, is applied to a rotating drum of diameter 600 mm. The blocks are 75 mm thick. The drum and the flywheel mounted on the same shaft have a mass of 1800 kg and have a combined radius of gyration of 600 mm. The two ends of the band are attached to pins on the opposite sides of the brake fulcrum at distances of 40 mm and 150 mm from the fulcrum. If a force of 250 N is applied at a distance of 900 mm from the fulcrum, find: **07**

1. The maximum braking torque
2. The angular retardation of the drum
3. The time taken by the system to be stationary from the rated speed of 300 rpm.

Take coefficient of friction between the blocks and the drum as 0.3.

OR

(b) Design a slider-crank mechanism so that displacement of the slider is proportional to the crank rotation in the interval $30^0 \leq \theta \leq 100^0$. Assume initial distance of the slider equal to 15 cm and final distance to be 10 cm. **07**

Q.3 **(a)** In an I.C. engine mechanism, the crank radius is 400 mm and connecting rod is 950 mm long. The diameter of piston is 100 mm and net gas pressure acting on the piston is 15 MPa. Mass of connecting Rod is 100 Kg and engine speed is 1000 RPM. Find : **07**

1) Thrust in connecting rod, 2) Piston side thrust,

3) Torque acting on crank shaft and 4) Radial force or load on main bearings when crank has made 45^o from TDC.

(b) Draw and explain Klein's construction for determining the velocity and acceleration of the piston in slider crank mechanism. **07**

OR

Q.3 **(a)** Explain dynamically equivalent two mass system with neat sketch using analytical method and prove the same using graphical method. **07**

(b) A vertical double acting steam engine runs at 220 rpm and having cylinder diameter of 320 mm and the stroke of 460 mm. The mass of the reciprocating parts is 230 kg and the diameter of piston rod is 50 mm. The connecting rod length is 1.22 m. When the crank has turned through 130^{o} from the TDC, the steam pressure above the piston is 32000 N/mm^2 and below the piston is 16000 N/mm^2. Determine the effective turning moment on the crank shaft. **07**

Q.4 **(a)** A machine has to carry out punching operations at the rate of 10 holes per minute. It does 6 kN-m of work per mm^2 of the sheared area in cutting 25 mm diameter holes in 20 mm thick plates. A flywheel is fitted to the machine shaft, which is driven by constant torque. The fluctuation of speed us between 180 and 200 rpm. The actual punching operation takes 2 second. The frictional losses are equivalent to $1/6^{th}$ of the work done during punching. Find: 1) power required to drive the punching machine, and 2) mass of flywheel, if the radius of gyration of the wheel is 0.5 m. **07**

(b) Draw and explain turning moment diagram for: 1) 4-Stroke single cylinder engine and, 2) Punching press. **07**

OR

Q.4 **(a)** Explain Bloch's Synthesis Method for synthesizing a 4- bar mechanism. **07**

(b) The length of the arms of a Porter governor is 300 mm long. The upper and lower arms are pivoted to links at 50 mm and 60 mm, respectively, from the axis of rotation. The mass of each ball is 5 kg and the sleeve is of mass 60 kg. The frictional force on sleeve is 35 N. Determine the range of speed for extreme radii of rotation of 120 mm and 150 mm. **07**

Q.5 **(a)** The mass of a turbine rotor of a ship is 8000 kg and has a radius of gyration of 0.75 m. It rotates at 1800 rpm clockwise when viewed from the stern. Determine the gyroscopic effects in the following cases: **07**

1. If the ship travelling at 100 km/h steers to the left along a curve of 80 m radius.
2. If the ship is pitching and the bow is descending with maximum velocity. The pitching is with simple harmonic motion with periodic time of 20 s and the total angular movement between extreme positions is 10^{o}.
3. If the ship is rolling with an angular velocity of 0.03 rad/s clockwise when looking from stern.

In each case, determine the direction in which the ship tends to move.

(b) Explain concept of synthesis of mechanism with example. **07**
Also explain the following terms : 1) Function generation 2) Path generation 3) Type synthesis 4) Number synthesis

OR

Q.5 **(a)** A racing car of mass 3000 kg has a wheel base of 2.5 m and track of 1.5 m. The C.G is located 0.6 m above the ground level and 1.5 m from the rear axle. Each wheel is of 1 m diameter and 0.8 $kg.m^2$ moment of inertia. The back axle ratio is 4.5. The drive shaft engine flywheel and transmission are rotating clockwise when viewed from the front with equivalent mass of 150 kg with radius of gyration 0.2 m. Determine the load distribution on the wheels if the car is rounding a curve of 80 m radius at 120 km/h when: 1) taking a right turn, and 2) taking a left turn. **07**

(b) Define: 'Co-efficient of fluctuation of Energy' and 'Co-efficient of fluctuation of Speed'. Also prove that the maximum fluctuation of energy, $\Delta E = 2.E.C_s$ **07**
Where, E = Mean kinetic energy of flywheel, and
C_s = Coefficient of fluctuation of speed.

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