Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V • EXAMINATION – SUMMER • 2015

Subject Code: 151902 **Date: 05/05/2015**

Subject Name: Theory of Machines

Time: 02.30pm-05.00pm **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)**	For a vehicle with brakes applied on front wheels, derive the equation of retardation for following conditions: (a) Vehicle moves up on an inclined road (b) Vehicle moves on a level ground (c) Vehicle moves down the road	**07**
	(b)	With the help of a neat sketch, explain functioning of a hydraulic dynamometer.	**07**
Q.2	**(a)**	Derive the equation of natural frequency of a compound pendulum.	**07**
	(b)	A rear engine automobile travelling along a track of 100 m mean radius has 4 wheels each of 2 kg.m^2 and 0.6 m radius. Rotating parts of engine have moment of inertia of 1 kg.m^2. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The gear ratio, engine to back axle, is 3:1. The vehicle weighs 14.17 kN and has its CG 0.5 m above the ground level. Determine speed of the vehicle around the curve for all four wheels to maintain contact with the road surface if wheel track is 1.5 m.	**07**
		OR	
	(b)	Derive the expression of stability of a two wheeled vehicle.	**07**
Q.3	**(a)**	Synthesize a four-bar linkage to give the following values for the angular velocities and accelerations: ω_2 = 200 rad / sec, ω_3 = 85 rad / sec, ω_4 = 130 rad / sec, α_2 = 0 rad / sec^2, α_3 = -1000 rad / sec^2, α_4 = -1600 rad / sec^2.	**07**
	(b)	The controlling force in a spring controlled governor is 1500 N when the radius of rotation of the balls is 200 mm and 887.5 N when it is 130 mm. The mass of each ball is 8 kg. If the controlling force curve is a straight line, determine the controlling force and the speed of rotation when the radius of rotation is 150 mm. Also find the increase in the initial tension so that the governor is isochronous. What will be the isochronous speed?	**07**
		OR	
Q.3	**(a)**	Differentiate between flywheel and governor and explain following terms related to governor: (a) Sensitivity (b) Power of the governor	**07**
	(b)	Derive the expression of effort of a Porter governor.	**07**
Q.4	**(a)**	Define: 'Co-efficient of fluctuation of Energy' and 'Co-efficient of fluctuation of Speed'. Also prove that the maximum fluctuation of energy, $\Delta E = 2.E.Cs$ Where, E = Mean kinetic energy of flywheel, and Cs = Coefficient of fluctuation of speed.	**07**

(b) The effective steam pressure on the piston of a vertical steam engine is 200 kN/m^2 when the crank is at 40° from the IDC on the down stroke. The crank length is 300 mm and the connecting rod length is 1200 mm. The diameter of the cylinder is 800 mm. What will be the torque on the crankshaft if the engine speed is 300 rpm and the mass of the reciprocating parts 250 kg? **07**

OR

Q.4 **(a)** A turbine rotor weighing 9.8 kN rotates at 2000 rpm clockwise when viewed from stern. The vessel pitches with an angular velocity of 0.5 rad/s. Calculate the gyroscopic couple during the rise of the bow if rotor has radius of gyration as 0.254 m. **07**

(b) A vertical cylinder petrol engine has a bore of 100 mm and stroke of 120 mm. The length of the connecting rod between centres is 250 mm. The mass of the piston is 1.1 kg. Speed of the engine is 1500 rpm. In the expansion stroke with a crank at 30° from TDC, the gas pressure is 700 kN/m^2. Determine **07**

a. Net force on the piston
b. Force on the connecting rod
c. Thrust on the cylinder wall
d. Crank effort
e. Speed above which the gudgen pin force would reverse in direction.

Q.5 **(a)** Synthesise a 4-bar linkage using Freudenstein's equation to generate the function $y = x^{1.5}$ for the interval $1 \leq x \leq 4$. The input crank is to start from 30° and have a range of 90°. The output follower is to start from 0° and have range of 90°. Take three accuracy points. Assume length of the fixed link to be 50 mm. **07**

(b) Turning moment diagram for an engine consists of a curve defined by equation: **07**

$T = (19614 + 9316.7 \sin(2\theta) - 5590 \cos(2\theta))$ N.m, θ: crank angle from IDC.

If resisting torque is constant, determine (a) Power developed by the engine (b)Moment of inertia of flywheel in $kg.m^2$, to limit the fluctuation of speed to 1% of mean speed which is 180 rpm (c) Angular acceleration of flywheel when the crank has turned through 45° from IDC.

OR

Q.5 **(a)** With the help of a neat sketch explain relative pole method for motion generation using 4-bar mechanism. **07**

(b) Derive the expression of displacement, velocity and acceleration of piston with respect to the crank rotation. **07**

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