Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V(New) • EXAMINATION – WINTER 2016

Subject Code:2152509 **Date:22/11/2016**

Subject Name:Machine Dynamics

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. **Use drawing sheet/s for graphical solutions & answer-book/s for analytical solutions.**

Q.1 Short Questions: [each carries equal marks] 14

1 Define static balance & dynamic balance.

2 State D'alembert's principle.

3 What is the function of a governor?

4 Longitudinal vibrations are said to occur when the particles of a body moves _____.
(a) perpendicular to its axis (b) parallel to its axis
(c) in a circle about its axis (d) randomly

5 The factor that affects the critical speed of a shaft is _____.
(a) diameter of the disc (b) span of the shaft (c) eccentricity
(d) all of the above (e) none of the above

6 The essential condition of placing the two masses, so that the system becomes dynamically equivalent is _____.
(a) $I_1I_2 = k_G^2$ (b) $I_1I_2 = k_G$ (c) $I_1 = k_G$ (d) $I_2 = k_G$;
where, I_1 & I_2 = Distance of two masses from the center of gravity of the body and k_G = Radius of gyration of the body.

7 In order to facilitate easy starting of locomotives in any position, their two cranks are placed at _____ to each other.
(a) 45^0 (b) 180^0 (c) 90^0 (d) 360^0 (e) 270^0

8 In vibration isolation system, if $\omega/\omega_n > 1$, then the phase difference between the transmitted force and the disturbing force is _____.
(a) 0^0 (b) 90^0 (c) 180^0 (d) 270^0 (e) 45^0

9 A shaft carrying two rotors at its ends will have _____
(a) no node (b) one node (c) two nodes (d) three nodes

10 Secondary forces in reciprocating mass on engine frame are ____.
(a) of same frequency as of primary forces
(b) twice the frequency as of primary forces
(c) four times the frequency of primary forces
(d) none of the above

11 What is meant by transmissibility as regards to vibrations?

12 Which of the following governor is used to drive a gramophone?
(a) Pickering governor (b) Hartnell governor (c) Hartung governor
(d) Watt governor (e) Inertia governor

13 In locomotives, the ratio of the connecting rod length to crank radius is kept very large in order to _____.
(a) minimize the effect of primary forces
(b) minimize the effect of secondary forces
(c) have perfect balance
(d) start the locomotive quickly

14 For two governors A & B, the lift of the sleeve of governor A is more than that of governor B, for a given fractional change in speed. It indicates that _____.
(a) Governor B is more sensitive than governor A.
(b) Governor A is more sensitive than governor B.
(c) both governors A and B are equally sensitive.
(d) none of the above.

Q.2 (a) State the difference among piston effort, crank effort & crank pin effort. **03**

(b) Explain the effects of partial balancing on reciprocating parts of two cylinder locomotives. **04**

(c) The firing order in a five cylinder vertical two stroke in-line engine is 3-5-2-4-1.The piston stroke is 130 mm and the length of each connecting rod is 260 mm. The pitch distance between cylinder-center lines is 250 mm. The reciprocating mass for each cylinder is 5 kg. Engine runs at 750 rpm. Determine the out-of-balance primary & secondary forces & couples on this engine taking cylinder '3' as a reference plane. Use graphical method. **07**

OR

(c) A small connecting rod 220 mm long between centers has a mass of 2 kg and a moment of inertia of 0.02 kg-m^2 about its center of gravity (C.G.). The center of gravity is located at a distance of 150 mm from the small end center of connecting rod. Determine the dynamically equivalent two-mass-system when one mass is located at the small end center. **07**
If the connecting rod is replaced by two masses located at the two centers of it, find the correction couple that must be applied for complete dynamical equivalence of the system when the angular acceleration of the connecting rod is 20,000 rad/sec^2 anticlockwise.

Q.3 (a) Draw the neat sketch of Pickering governor & label the same completely. **03**

(b) What is the difference between 'Direct Crank & Reverse Crank' method? What is the use of this method? **04**

(c) In a vertical internal combustion engine, the crank radius is 300 mm and the length of connecting rod is 750 mm. the mass of the piston & other reciprocating parts is 1.25 kg. The diameter of piston is 100 mm. the speed of the engine is 900 rpm and the net gas pressure is 750 kN/m^2. Find: (i) Piston effort (ii) Thrust in connecting rod (iii) Piston side thrust (iv) Crank pin effort (v) Torque acting on crank shaft (vi) Radial force or load on main bearings when the crank has made 45^0 from top dead center. **07**

OR

Q.3 (a) Define the following terms for a governor: **03**
(i) Sensitivity (ii) Hunting (iii) Stability

(b) The connecting rod of an engine is 450 mm long between its centers. It has a mass of 7 kg and mass moment of inertia of 5000 kg-mm^2. The distance of the center of gravity from the small end is 180 mm. Find the radius of gyration and the equivalent dynamical system if one of the masses coincides with the small end center. **04**

(c) Following data refer to uncoupled outside cylinder locomotive: **07**
Mass of reciprocating parts per cylinder = 300 kg; Mass of revolving parts per cylinder = 250 kg; Pitch of cylinder = 1.8 m; Distance between the planes of driving wheels = 1.50 m; Length of each crank = 0.325 m; Angle between cranks = 90^0; Wheel tread diameter = 1.825 m; Radius of balance mass = 0.76 m.
If whole of the revolving & 2/3rd of reciprocating masses are to be balanced, determine magnitude & position of balance mass in the plane of wheel.

Q.4 **(a)** What is the effect of friction of moving parts of governor on the functioning of a governor? **03**

(b) Explain the analytical method of balancing of five masses lying in the same plane at five different angles. Mention the notations used. **04**

(c) The arms of a Porter governor are 200 mm long. All the upper and sleeve arms are pivoted to the axis of rotation. The mass of each ball is 7 kg and the sleeve has a mass of 21 kg. Determine the minimum and maximum speeds of the governor and so, the range of speed if the radius of rotation of the ball is 120 mm when the governor sleeve begins to lift and 160 mm when the governor is at maximum speed. **07**

OR

Q.4 **(a)** Write the detailed classification of governor. **03**

(b) Find out the vertical height of a Watt governor when it rotates at 75 rpm. Also calculate the change in vertical height when its speed increases to 79 rpm. **04**

(c) Derive the expression for natural frequency f_n by equilibrium method with all notations for free undamped longitudinal vibrations of a spring-mass-damper system. **07**

Q.5 **(a)** Define the following terms: **03**
Resonance, Dynamic Magnification Factor, Whirling speed of shaft.

(b) Derive the expression for the height of a Watt governor with usual notations. **04**

(c) A vibrating system consists of a mass of 75 kg and a spring of stiffness 45 kN/m, and a damper. The damping provides only 25% of its critical value. Find: **07**
(i) Damping factor (ii) Critical damping coefficient (iii) Logarithmic decrement (iv) Ratio of two consecutive oscillations (v) Natural frequency of damped vibrations.

OR

Q.5 **(a)** Define, in short, the free vibrations, forced vibrations and damped vibrations. **03**

(b) Explain the terms with necessary diagrams: (i) Under damping (ii) Critical damping and (iii) Over damping. **04**

(c) A mild steel shaft 4 m long is simply supported between two bearings. It carries three discs having mass of 120 kg, 160 kg and 100 kg situated at a distance of 1 m, 2 m and 3 m from one end of the shaft. If the shaft diameter is 120 mm, and $E = 2.1 \times 10^5$ MPa for shaft material, find the natural frequency of transverse vibrations of the shaft using Dunkerley's method. Neglect the weight of the shaft. **07**

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