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D 4244

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2008.

Fourth Semester

Mechatronics Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the conditions to be satisfied to replace a rigid body by two separate concentrated masses in an equivalent dynamical system.
2. Distinguish between co-efficient of fluctuation of energy and coefficient of fluctuation of speed.
3. What is meant by swaying couple and when its value is maximum or minimum with respect to the angle of inclination of the crank to the line of stroke?
4. What is meant by secondary force in balancing of "V-engine, state its magnitude and position of the balancing mass.
5. Define "Damping factor" in the case of free damped vibration system.
6. State Denkarlay's rule to find the natural frequency of transverse vibration of a shaft carrying a number of point loads.
7. What is the order of dynamic magnification factor at resonance and when there is no damping?
8. Explain the term transmissibility ratio in Forced Vibration.
9. Define the terms effort and power of a porter Governor.
10. What is the maximum Gyroscopic couple on a Naval ship during pitching?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the equation to find the correction couple to be applied in a two mass dynamically equivalent system. (8)
- (ii) A connecting rod of an I.C. engine has a mass of 2 kg and the distance between the centre of gudgeon pin and centre of crank pin is 250 mm. The C.G. falls at a point 100 mm from the gudgeon pin along the line of centres. The radius of gyration about an axis through the C.G. perpendicular to the plane of rotation is 110 mm. Find the equivalent dynamical system if only one, the masses is located at gudgeon pin.

If the connecting rod is replaced by two masses, one at the gudgeon pin and the other at the crank pin and the angular acceleration of the rod is 23000 rad/s^2 clockwise, determine the correction couple applied to the system to reduce it to a dynamically equivalent system. (8)

Or

- (b) A multi-cylinder engine is to run at a speed of 600 r.p.m. On drawing the turning moment diagram to a scale of $1 \text{ mm} = 250 \text{ N-m}$ and $1 \text{ mm} = 3^\circ$, the areas above and below the mean torque line in mm^2 are :

+ 160, -172, + 168, -191, + 197, -162

The speed is to be kept within $\pm 1\%$ of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel. Determine the suitable dimensions of a rectangular flywheel rim if the breadth is twice its thickness. The density of the cast iron is 7250 kg/m^3 and its hoop stress is 6 MPa. Assume that the rim contributes 92% of the flywheel effect.

12. (a) The three cranks of a three cylinder locomotive are all on the same axle and are set at 120° . The pitch of the cylinders is 1 meter and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance weights are 0.8 m from the inside crank. If 40% of the reciprocating parts are to be balanced, find the magnitude and position of the balancing masses required at a radius of 0.6 m. The speed is 360 r.p.m.

Or

- (b) The following data refer to an uncoupled locomotive in which the cranks are 90° apart. Wheel centres 1.25 m, cylinder centres 0.5 m, Diameter of tread of driving wheels 1.5 m, Radius of centre of gravity of balance mass 0.70 m, Crank radius 0.35 m, Reciprocating parts per cylinder 300 kg, Revolving parts per cylinder 250 kg.

Find (i) The balancing masses both in magnitude and position in planes of driving wheels to balance all the revolving and two-third of reciprocating parts; and (ii) The hammer blow at a speed of 100 kmph.

13. (a) A coil of spring stiffness 4 N/mm supports vertically a mass of 20 kg at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Determine the damping force per unit velocity. Also find the ratio of the frequency of damped and undamped vibrations.

Or

- (b) A steel shaft ABCD 1.5 m long has flywheel at its ends A and D. The mass of the flywheel A is 600 kg and has a radius of gyration of 0.6 m. The mass of the flywheel D is 800 kg and has a radius of gyration of 0.9 m. The connecting shaft has a diameter of 50 mm for the portion AB which is 0.4 m long; and has a diameter of 60 mm for the portion BC which is 0.5 m long; and has a diameter of d mm for the portion CD which is 0.6 m long Determine :

(i) the diameter ' d ' of the portion CD so that the node of the torsional vibration of the system will be at the centre of the length BC; and (ii) the natural frequency of the torsional vibrations. The modulus of rigidity for the shaft material is 80 GN/m^2 .

14. (a) Derive an expression to find the frequency of under developed forced vibrations.

Or

- (b) A mass of 500 kg is mounted on supports having a total stiffness of 100 kN/m and which provides viscous damping, the damping ratio being 0.4. The mass is constrained to move vertically and is subjected to a vertical disturbing force of the type $F \cos \omega t$. Determine the frequency at which resonance will occur and the maximum allowable value of F , if the amplitude at resonance is to be restricted to 5 mm.

15. (a) In a governor of the type shown in Fig.15 (a), the two springs attached directed to balls each has a stiffness of 8 N/cm and a free length of 10 cm. The mass of each ball is 4 kg, the length of the ball arm of each bell crank lever is 8 cm, and that of the sleeve arm is 6 cm, the lever is pivoted at its mid-point. When the radius of rotation of the ball is 8 cm, the equilibrium speed is 240 r.p.m. If the sleeve is to lift 0.75 cm for an increase of speed of 5%, determine the required stiffness of the auxiliary spring.

Or

- (b) A racing car of mass 2500 kg has a wheel base of 2 m and track width of 105 cm. The centre of gravity lies mid-way between the front and the rear axles and is 0.4 m above the ground. The engine rotating parts are equivalent of a flywheel of M.I. of 50 kg-m² rotating at 6000 r.p.m. in clockwise direction when viewed from the front. If the car speeding at 50 km/hr rounds a curve of 15 metre radius, determine the reaction between the wheels and the ground. Consider the gyroscopic effect of the flywheel, the dead weight of the car and the centrifugal effects. Neglect the effect due to rotating wheels.

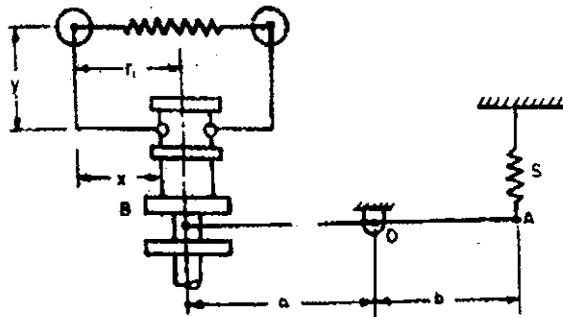


Fig. 15 (a)