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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2014.

Fourth Semester

Mechatronics Engineering

ME 3212/080210012 — DYNAMICS OF MACHINERY

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the turning moment diagram of a single cylinder double acting steam engine.

2. What is the function of a flywheel? How does it differ from that of a governor?

3. Explain briefly the terms 'static balancing' and dynamic balancing'. State the necessary conditions to achieve them.

4. Explain why only a part of the unbalanced force due to reciprocating masses is balanced by revolving mass.

5. What are the causes and effects of vibrations?

6. Explain briefly the term dynamic magnifier'.

7. Write the effect of inertia of a shaft of the free torsional vibrations.

8. What is stability of a governor? Sketch the controlling force versus radius diagrams for a stable, unstable and isochronous governor.

9. State the different types of governors. What is the difference between centrifugal and inertia type governors?

10. State the applications of gyroscopic principles to aircrafts.

PART B — (5 × 16 = 80 marks)

11. (a) In the four bar linkage shown below the shaft at O_2 exerts a torque of 0.6 Nm on link O_2B. Also there is a 15N force acting vertically downward on link 3 midway between B and C. Determine the resisting torque which the shaft at O_4 exerts on crank 4 and find the forces exerted on the frame at O_2 and O_4. The lengths of O_2O_4 = 90 mm. O_2B = 50mm. BC = 55 mm. and O_4C = 30mm. (16)

Or

(b) A single cylinder vertical engine has a bore of 300 mm and a stroke of 400mm. The connecting rod is 1m long. The mass of the reciprocating parts is 150 kg. The gas pressure is 0.7 MPa with the crank at 30° from the top dead centre during expansion stroke. The speed of crank is 250 rpm. Determine:

(i) The net force acting on the piston. (6)

(ii) Resultant load on the gudgeon pin. (6)

(iii) Thrust on the cylinder wall. (4)

12. (a) An inside cylinder locomotive has its cylinder centre lines 0.8 m apart and has a stroke of 0.6m. The rotating masses are equivalent to 150kg at the crank pin and the reciprocating masses per cylinder are 300kg. The wheel centre lines are 1.8m apart. The cranks are at right angles. The whole of the rotating and 2/3rd of the reciprocating masses are to be balanced by masses placed at a radius of 0.5 m. Find

(i) The magnitude and direction of the balancing masses, (4)

(ii) The fluctuation in rail pressure under one wheel, (4)

(iii) The variation of tractive effort and (4)

(iv) The magnitude of swaying couple at a crank speed of 200 rpm. (4)

Or

(b) Four masses A, B, C and D as shown below are to be completely balanced

	A	B	C	D
Mass (kg)	–	25	40	35
Radius (mm)	150	200	100	180

Two planes containing masses B and C are 250 mm apart. Masses C and D make angles of 90° and 195° respectively with B in the same sense. Find the magnitude and the angular position of mass A and the position of planes A and D. Assume the location of the planes in the sequence A-B-C-D. (16)

13. (a) A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moments of inertia of the pump impeller and the motor are 1500 kg-m^2 and 450 kg-m^2 respectively. The lengths of the pumps shaft and the motor shaft are 500 and 200 mm and their diameters are 100 and 50mm respectively. Neglecting the inertia of the gears, find the frequency of torsional oscillations of the system G=85 GN/m^2. (16)

Or

(b) In a single degree damped vibratory system, the suspended mass of 4kg makes 24 oscillations in 20 seconds. The amplitude decreases to 0.3 of the initial value after 4 oscillations. Find the stiffness of the spring, the logarithmic decrement, the damping factor and damping coefficient. (16)

14. (a) A loaded governor of the Porter type has equal links 25 cm long pivoted at the axis; weight of each ball is 30N and the weight of the central load is 140N. The ball radius is 15 cm when the governor begins to lift and 20 at the maximum speed. Determine the maximum speed and range of speed. If the friction at the sleeve is equivalent to 15N find the maximum and minimum speed and the range of speed. (16)

Or

(b) A car is of total mass 200kg. it has wheel base equal to 2.5m and track width is 1 .5m. The centre of gravity lies at 500 mm above ground level and 1.5 m from the rear axle. The effective diameter of each wheel is 800 mm and moment of inertial of each wheel is 1.0kg-m^2. The rear axle ratio is 4. The equivalent mass of engine rotating parts (i:e drive shaft, engine flywheel and transmission etc.) is 140kg with radius of gyration of 150mm. The spin axis of the rotating engine parts is perpendicular to the spin axis of wheels. The engine parts are rotating in clockwise direction when viewed from the front. Determine the reaction at each wheel if car takes a right turn of 100 m radius at 90 km/hr speed. Also find the reaction at each wheel if car takes a left turn. (16)

15. (a) A damped single degree of freedom mass-spring system is excited at resonance by a harmonic forcing function which has amplitude of 80N. It was observed that the steady state amplitude of the forced vibration is 6mm. It was also observed that when the frequency of excitation is three times the natural frequency of the system, the amplitude of the steady state vibration becomes 1 mm. Determine the stiffness coefficient and the damping factor. (16)

Or

(b) A machine has a mass of 100 kg and unbalanced reciprocating parts of mass 2 kg which move through a vertical stroke of 80 mm with simple harmonic motion. The machine is mounted on four springs, symmetrically arranged with respect to centre of mass, in such a way that the machine has one degree of freedom and can undergo vertical displacements only. Neglecting damping, calculate the combined stiffness of the spring in order that the force transmitted to the foundation is 1 / 25 th of the applied force, when the speed of rotation of machine crank shaft is 1000 r.p.m. When the machine is actually supported on the springs, it is found that the damping reduces the amplitude of successive free vibrations by 25%. Find:

(i) The force transmitted to foundation at 1000 r.p.m., (6)

(ii) The force transmitted to the foundation at resonance, and (6)

(iii) The amplitude of the forced vibration of the machine at resonance. (4)
