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Name.....

Reg. No.....

SIXTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION
JUNE 2007

ME 04-606—DYNAMICS OF MACHINERY

(2004 admissions)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*
Missing data, if any may be suitably assumed.
Clearly mention the assumptions made. Draw neat sketches.
Drawing conventions are to be strictly followed.

I. (a) Write a brief note on force analysis spur gear and bevel gears.

(b) With a suitable example, explain "Method of virtual work".

(c) Derive an expression for gyroscopic couple of a spinning disc.

(d) Explain how flywheel size is determined for a reciprocating engine.

(e) A machine part of 10 kg. is supported on isolators with has a effective stiffness of 400 N/m and a viscous resistance of 0.02 N at a velocity of 1 mm/s. Determine the reduction of amplitude per cycle.

(f) Compute the critical speed of a rotor having a disc of 100 N weight at mid span of a steel shaft of 10 mm diameter and 300 mm long, simply supported boundary conditions.

(Properties of Steel $E = 2.1 \times 10^5$ N/mm^2, $G = 0.8 \times 10^5$ N/mm^2, $\rho = 8 \times 10^{-9}$ Ns^2/mm^4).

(g) With the help of equations and graph, differentiate between seismometer and accelerometer.

(h) Find the natural frequencies of the system shown in figure 1.

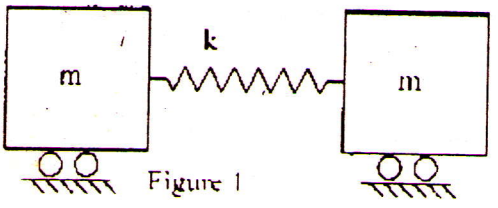

Figure 1

(8 × 5 = 40 marks)

Turn over

II. (a) A two-cylinder engine shown in Figure. 2 is in static equilibrium. The dimensions are OA = OB = 50 mm, AC = BD = 250 mm, ∠AOB = 90°. Determine the torque on the crank OAB and write the step-by-step procedure.

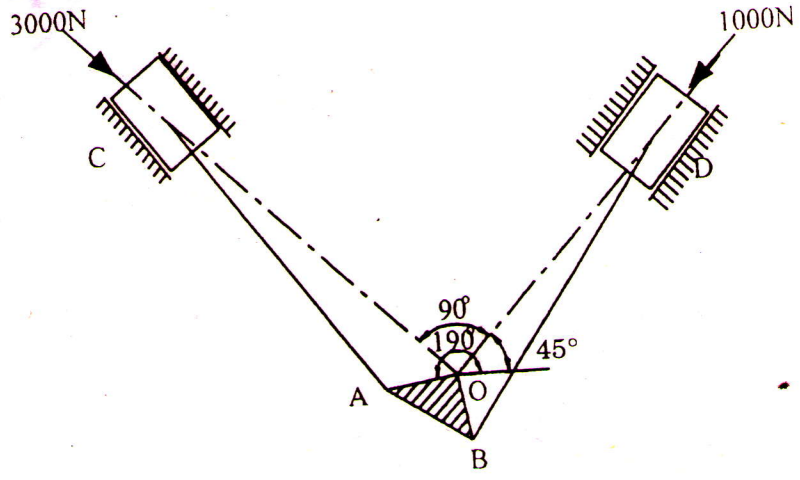

Figure. 2

Or

(b) An internal combustion engine mechanism is shown in Figure 3. The acceleration analysis results are tabulated below. Mark the dynamic forces on the configuration diagram. Also write the method used to locate the line of action, point of action and sense of the dynamic force. Assume cg of each link is at the mid point of the link itself. Linear acceleration *Ag* of cg's and angular accelerations α, mass *m* and mass moment of inertia I for all the links are also indicated. (Note : CCW – counterclockwise ; CW—clockwise)

Link	A_g Mm/s^2	α rad/s^2	Mass M kg.	*Mass moment of inertia* I $kg/mm.^2$
AB	60	2 (CCW)	2	120
BC	90	4 (CW)	5	3375
C (Slider)	100	0	2	150

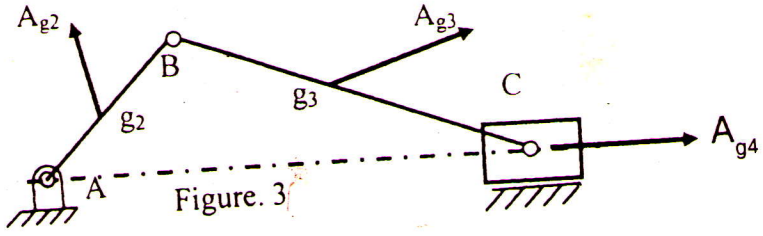

Figure. 3

III. (a) A 2.5 m shaft is supported in deep groove ball-bearings at 300 mm from each end and carries three pulleys. One at each end and one at the mid point. The pulleys are out of balance to the extend 0.6, 0.8, 0.9 kg m in order to form one end. But the pulleys are keyed to the shaft so as to achieve static balance. Find (i) relative angular settings of three pulleys ; (ii) the dynamic load on each bearing when shaft rotates at 1440 r.p.m.

(15 marks)

Or

(b) The crank and connecting rods of a four-cylinder in line engine running at 3000 r.p.m. are 70 mm and 280 mm each respectively. And the cylinder spaced 200 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appears at intervals of 90 in an end view in the order 1-4-2-3. The reciprocating mass corresponding to each cylinder is 2 kg. Determine the unbalance primary and secondary forces, if any. And unbalanced primary and secondary couples with reference to central plane of the engine.

(15 marks)

IV. (a) A 1500 mm long steel beam is simply supported at ends. Beam has cross-section of 25 × 50 mm. Mass of 3.75×10^{-2} Ns^2/mm is assumed to be acting at the cg of the beam. Determine the natural frequencies of transverse vibration in two mutually perpendicular directions. (Properties of Steel $E = 2.1 \times 10^5$ N/mm^2, $G = 0.8 \times 10^5$ N/mm^2, $\rho = 8 \times 10^{-9}$ Ns^2/mm^4).

(7 marks)

(b) In a mechanism used for a bottling plant has a lumped mass of 3 kg and a stiffness of 0.1 N/mm. A viscous damper of $C = 3 \times 10^{-3}$ Ns/mm is connected with the system. Find (i) damped natural frequency of the system ; (ii) ratio of two consecutive amplitudes ; (iii) time taken to reduce original amplitude of vibration to 20 per cent.

(8 marks)

Or

(c) A SDOF system with a mass m and spring constant k is excited by force from a rotating unbalance. Derive an equation to show displacement of the mass as a function of time.

(8 marks)

(d) A gun barrel weighing 7000 N has a recoil spring of stiffness 1500 N/mm. If the barrel recoils 1.5 m after firing, find the damping coefficient of the dashpot if the system is critically damped. Also find the time required for the barrel to return to 30 mm from its initial position.

(7 marks)

V. (a) In a turned dynamic vibration absorber which is connected to a SDOF system having a mass of 90 kg, the mass of the absorber is 4.5 kg and amplitude of disturbing force is 300 N. If the main mass is at rest when the forcing frequency is 100 Hz. Find the amplitude of vibration of the absorber mass and stiffness of the absorber. Also find the stiffness of the SDOF system.

(15 marks)

Or

An automobile weighing 4500 N has a mass moment of inertia of 2.25×10^6 N/mms^2 about an axis passing through CG. The front and rear suspension can be approximated to springs with 8.1 N/mm stiffness. CG of the vehicle is 750 mm from the front axle. Wheel base is 2000 mm. Find the natural frequencies and mode shape.

(15 marks)

[4 × 15= 60 marks]