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**B 2274**

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

Fourth Semester

Mechanical Engineering

ME 236 — DYNAMICS OF MACHINES

(Common to Mechatronics Engineering)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is Kutzbach criterion for the mobility of a planar motion?
2. Identify any four mechanisms for quick return operation.
3. What is the need for free body diagrams?
4. Differentiate between the static and dynamic balancing.
5. What is the reason for partial balancing (instead of complete balancing) in reciprocating engines?
6. What is the effect of inertia on frequency of longitudinal and transverse vibration?
7. Differentiate under damped system from the over damped system of vibration.
8. What is the significance of transmissibility?
9. What is hunting of a governor? What is the cause & consequences of hunting?
10. What is the effect of gyroscopic couple on Aeroplane?

PART B — (5 × 16 = 80 marks)

11. (a) In a four bar mechanism OABC (marked clockwise), Crank OA is of 100 mm length and makes  $125^\circ$  with the positive horizontal X axis. AB and BC makes  $25^\circ$  and  $70^\circ$ , respectively, with the positive horizontal X axis. O and C lie on the same horizontal X axis and the distance OC is 125 mm. The crank is operated by a moment M; in the above position, an external force of 600 N acts at the middle point of the link at  $45^\circ$  with the positive horizontal X axis. Draw the free body diagram of all links and find the constraint forces and their reactions necessary for this position to be a point of equilibrium. (16)

Or

- (b) Certain machine requires a torque of  $(1500 + 200 \sin \theta)$  N.m to drive it, where  $\theta$  is the angle of rotation of the shaft. The machine is directly coupled to an engine which produces a torque of  $(1500 + 250 \sin 2\theta)$  N.m. The flywheel and the other rotating parts attached to the engine has a mass of 300 kg at a radius of gyration of 200 mm. If the mean speed is 200 rpm, find the fluctuation of energy, the total % fluctuation of speed and the maximum & minimum angular acceleration of the flywheel and the corresponding shaft positions. (16)
12. (a) The cranks of a three-cylinder locomotive are set at  $120^\circ$ . The reciprocating masses are 450 kg for the inside cylinder and 390 kg for each outside cylinder. The pitch of the cylinders is 1.2m and the stroke of each piston 500mm. The planes of rotation of the balance masses are 960mm from the inside cylinder. If 40% of the reciprocating masses are to be balanced, determine the magnitude and position of the balancing masses required at a radial distance of 500mm and the hammer-blow per wheel when the axle rotates at 450 rpm. (16)

Or

- (b) The following table is a tabulation (with usual notations) of the dimensions, masses, and the locations of the mass centers of a four-bar mechanism having link 2 as the input and link 4 as the output. Complete force balancing is desired by adding counterweights to the input and output links. Find the mass-distance values and the angular locations of each counterweight. (16)

Parameters of an unbalanced four-bar Linkage

Link i	1	2	3	4
$r_i$ , mm	140	50	150	75
$a_i^o$ , mm	-	25	80	40
$\Phi_i^o$	-	$0^\circ$	$15^\circ$	$0^\circ$
$a^o$ , mm	-	-	75.6	-
$\Phi_i^o$	-	-	164.1	-
$m_i^o$ , kg	-	0.046	0.125	0.054

13. (a) (i) Explain the critical speed of a shaft and deduce the expression for the same. (2+8)
- (ii) A shaft of 50 mm diameter and 2750 mm long has a mass of 17.5 kg per m length. It is simply supported at the ends and carries three masses 110 kg, 150 kg and 75 kg at 750mm, 1500mm and 2000mm respectively from the left support. Taking  $E = 200\text{GPa}$ , find the frequency of the transverse vibrations. (6)

Or

- (b) (i) Develop an equation for the natural frequency of transverse vibration. (6)
- (ii) An unknown mass of  $m$  kg attached to the end of an unknown spring with stiffness  $k$  has a natural frequency of 95 cycles per minute. When 1 kg mass is added to mass, the natural frequency is lowered to 77 cycles per minute. Determine the unknown mass  $m$  and the spring constant  $k$ . (10)
14. (a) A single cylinder engine has an out of balance force of 500 N at an engine speed of 300 rpm. The complete mass of the engine is 155 kg and it is carried on a set of springs of total stiffness 30 N/mm. Calculate the amplitude of the motion of the mass and the maximum oscillating force transmitted to the foundation. If the viscous damper is interposed between the mass and the foundation, the damping force being 3000 N at 3 m/s, find the amplitude of the force damped oscillation of the mass and its angle of lag with disturbing force. (16)

Or

- (b) A high speed turbine of moment of inertia  $9 \text{ kg.m}^2$  is connected by a shaft of stiffness  $22000 \text{ Nm/radian}$  to a pinion of inertia of  $0.54 \text{ kg.m}^2$ . The pinion drives a wheel of moment of inertia  $360 \text{ kg.m}^2$  with a speed reduction of 8:1 which is connected by a shaft of stiffness  $30 \times 10^5 \text{ N.m/radian}$  to a generator of inertia  $125 \text{ kgm}^2$ . Find the frequencies of torsional oscillation of the generator shaft, the amplitude ratio between the turbine and the generator when vibration begins. (16)
15. (a) A four wheeled trolley car of total mass  $2000 \text{ kg}$  running on the rails of  $1.6 \text{ m}$  gauge, rounds a curve of  $30 \text{ m}$  radius at  $54 \text{ km/hr}$ . The track is banked at  $8^\circ$ . The wheels have an external diameter of  $0.7 \text{ m}$  and each pair with axle has a mass of  $200 \text{ kg}$ . The radius of gyration for each pair is  $0.3 \text{ m}$ . The height of center of gravity of the car above the wheel base is  $1 \text{ m}$ . Determine, allowing for centrifugal force and gyroscopic couple actions, the pressure on each rail. (16)

Or

- (b) A Proell governor has all the four arms of length  $250 \text{ mm}$ . The upper and lower ends of the arms are pivoted on the axis of rotation of the governor. The extension arms of the lower links are each  $100 \text{ mm}$  long and parallel to the axis when the radius of the ball path is  $150 \text{ mm}$ . The mass of each ball is  $4.5 \text{ kg}$  and the mass of the central load is  $36 \text{ kg}$ . Determine the equilibrium speed of the governor. If the sleeve height is increased by  $10 \text{ mm}$  from the present position, calculate the new equilibrium speed. (10+6)