B.E / B. Tech(Full Time) END SEMESTER EXAMINATIONS, Apr / May 2011

FOURTH SEMESTER MECHANICAL ENGINEERING Regulation 2008

ME 9253 DYNAMICS OF MACHINES

Time : 3 hr Max Mark : 100

Drawing sheet will be provided on request

Part A (10 X 2 = 20 mark)

1. A link of mass 5 kg , with its mass centre located at a distance of 100 mm from the axis of its rotation , revolves at a angular speed of 100 rpm ccw. Find the x and y component of the inertia force at an instant when the link is 30 ° from the + X axis.
2. State precisely the application of D'Alemberts concept in the dynamic analysis.
3. Sketch the turning moment diagram of a typical single cylinder 4-stroke cycle reciprocating engine and indicate the various phases on the same.
4. What do you understand by direct and reverse cranks in the balancing of reciprocating engines?
5. Define i. hammer blow ii. Variation in the tractive effort
6. What is the need for evaluating the natural frequency of a vibrating system? What is frequency ratio?
7. Prove that for the springs connected in parallel, the equivalent spring stiffness is equal to sum of the individual stiffness.
8. What is meant by dynamic magnification in forced vibrating systems? What is the method of reducing dynamic magnification at resonance?
9. State the relation between the directions of spin vector, precession vector and gyroscopic torque vector.
10. State clearly the functions of governor mechanism in the operation of prime movers.

Part-B (5 X16 = 80 mark)

11. The torque on the crank shaft of a two stroke engine is given by the equation:

$T(\theta) = 25{,}320 + 12{,}600 \sin 2\theta - 15{,}650 \cos 2\theta$ N.m where θ is the crank angle. The load torque is uniform. The moment of inertia of the flywheel is 16,000 kg m^2 and the mean speed of the engine is 150 rpm. Calculate

i. total variation of energy stored in the flywheel (10 mark)

ii. variation in the angular velocity in the flywheel (6 mark)

12 (a)Using appropriate free body diagrams , derive equation for the following due to the inertia of the piston alone, in the reciprocating engines,. Ignore the mass of the connecting rod and friction effect

i. inertia torque on the crank shaft (6 mark)

ii. force on the crank pin (3 mark)

ii. force on the crankshaft bearing (4 mark)

iii. force on the cylinder wall (3 mark)

Contd..2

OR

(b) i. A connecting rod of mass 37.5 kg is suspended from a point 25 mm above the small end centre and 350 mm above its mass centre. When it is allowed to perform small oscillation, the period is found to be 1.87 seconds. Find two equivalent masses of this rod ,with one mass positioned at small centre. Find also the position of the other mass. (8 mark)

ii. Derive an expression for the correction torque to be applied on the connecting rod , when it is replaced by two masses, one at crank pin and other at gudgeon pin. (8 mark)

13(a) . A shaft rotating at uniform speed carries two discs A and B of mass 5 kg and 4 kg respectively. The centre of gravity of each disc is 2.7 mm from the axis of rotation and angle between them is 90 ° . The shaft has bearings at C and D between A and B such that AC = 250 mm and AD = 500 mm and AB = 1000 mm. It is desired to make the dynamic forces on the bearings equal and opposite and to have minimum value for a given speed by means of a mass in plane E at a radius of 20 mm. Determine the magnitude of the mass to be attached at E and its angular position with respect to that of A . and the distance of plane of plane E from A.

OR

(b) i. During field balancing of a thin disc using trail mass , the vibration amplitude measured is 0.60 mm ,without trial mass and angle between the sine wave generator signal and vibration signal is 30 ° ccw . When a trail mass of 250 gram is used, the vibration amplitude measured is 1.0 mm its phase angle with sine wave generator signal is 75° ccw. Determine the magnitude and the position of the balancing mass to be attached to the disc to bring to it to balanced condition. (8 mark)

ii. Explain with sketch , the working principle of any one type of dynamic balancing machine. (8 mark)

14 (a) In a two cylinder locomotive engine , the cylinder centre lines are 0,70 m apart and has a stroke of 0.60 m. The rotating masses per cylinder is 150 kg at the crank pin and reciprocating masses per cylinder is 180 kg. The planes of driving wheel are 1.5 m apart and wheel diameter is 0.9 m. The cranks of the cylinders are at right angles. The whole of the revolving masses and 2/3 of the reciprocating masses are to be balanced by masses at a radius of 0.6 m. Find the magnitude and direction of balancing masses. Find also maximum fluctuation of pressure between the wheel and the rail when the locomotive is running at speed of 80 km/ h

OR

Contd..3

(b) i A railroad bumper is designed as a spring in parallel with a viscous damper. The stiffness of the damper is 2 X 10^5 N /m and damping constant is 1.58 X 10 5 N .s / m . If the bumper is used to engage a 20 Mg railroad car , is the resulting motion under damped , critically damped or over damped ? Why ?

(6 mark)

ii.. A 200 kg mass is placed at the end of the 1.8 m long steel cantilever beam . The system is observed to vibrate with natural frequency of 21 Hz . Find the moment of inertia of the cross section of the beam about its neutral axis. (10 mark)

15(a) A small high speed turbine has single wheel of mass 6 kg mounted at the mid point of a 10 mm diameter steel shaft. The span of the short support bearings is 450 mm. Owing to slight manufacturing defect, the c.g of the wheel is 25 μm away from centre of rotation. . E of the shaft material is 200 GN / m^2 . If the turbine rotates at 3000 rpm , determine

i. critical speed of this turbine system (6 mark)

ii. amplitude of steady state vibration of the shaft, (4 mark)

iii. dynamic load transmitted to the support bearing (6 mark)

OR

(b) i. Derive an expression for finding the equilibrium speed of a Porter governor (8 mark)

ii. A disc with mass 4.0 kg and radius of gyration 60 mm is mounted on a horizontal shaft of 80 mm length between bearings. It rotates at a speed of 800 rpm counterclockwise when viewed from the right hand side bearing. The shaft also makes precessional motion about vertical axis at 50 rpm in the clockwise direction when viewed from the top. Determine the total force transferred to each support bearing due to mass and gyroscopic effect. (8 mark)

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