B.E / B.Tech DEGREE END SEMESTER EXAMINATIONS, APRIL/MAY 2014

MECHANICAL ENGINEERING

FOURTH SEMESTER

ME 9253 DYNAMICS OF MACHINES

(REGULATION 2009)

Time : 3 hr. Max. Mark :100

Answer ALL Questions

Part A (10 x 2 = 20 Marks)

1 What do you understand by the term 'angle of heel'? What is the significance in stability analysis?

2 Explain the term 'maximum fluctuation of energy'. How is it established from a known T.M diagram?

3 Explain the terms 'controlling force' and 'Effort' as applied to a governor mechanism.

4 Explain the term hammer blow. How it can be reduced in locomotives?

5 In the case of unbalanced masses revolving in different planes, what are the conditions to be fulfilled in order to obtain a complete balance.

6 Explain the term 'effective force' and explain D'Alembert's principle for analyzing a dynamic force/couple system.

7 Depict 'under-damped vibrations', 'over-damped vibrations' and 'critically damped vibrations' with the help of amplitude vs time plot.

8 What do you understand by whirling motion? Does it involve transverse or torsional vibrations?

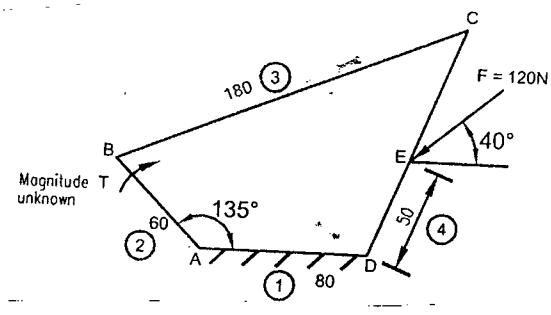
9 Why is it customary to make an assumption of small amplitude of oscillations? Give justification.

10 State the effect of gyroscopic couple on a naval ship during rolling.

PART B (5 x 16 = 80 Marks)

11 (i) For the linkage shown below, find all constraints forces and torque T required if F=120N in the direction shown. The dimensions of linkages

are as follows: (10)



(ii) A vertical petrol engine 150 mm diameter and 200 mm stroke has a connecting rod 350mm long. The mass of the piston is 1.6kg and the engine speed is 1800 rpm. On the expansion stroke with crank angle 30° from the top dead centre, the gas pressure is 750kN/m^2. Determine the net trust on the piston. (6)

12a (i) How are the cylinders arranged in uncoupled three cylinder reciprocating engine locomotive? (4)

(ii) A,B,C and D are four masses carried by a rotating shaft at radii 100mm, 150mm,150mm and 200mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and magnitude of the masses B,C and D are 9Kg,5kg, and 4kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft be in complete balance. (12)

[OR]

12b The following data apply to two cylinder locomotive with cranks at right angles:

Reciprocating mass per cylinder = 300 kg

Crank radius = 0.3 m

Distance between the driving wheel control planes = 1.55 m

Distance between cylinder centers = 0.65 m

Distance between driving wheel centers = 1.8 m

Determine :

(i) The fraction of reciprocating masses to be balanced if the hammer blow

is not to exceed 40kN at 100 km/hr.

(ii) The variation in tractive effort

(iii) The maximum swaying couple (16)

13a (i) The frequency of damped vibration is 70 per minute and the amplitude decreases by 70% of its initial value after two complete oscillations. Find the frequency of the free undamped vibrations of the system. (6)

(ii) A shaft 1.6 m long is 95 mm diameter for the first 0.6m of its length 60mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining length. The shaft carries two rotors at two ends, the first having a mass of 800kg and 0.85 m radius of gyration located at the other end. Determine the location of the node. Take $C=80GN/m^2$. (10)

[OR]

13b (i) A shaft 12.5 mm diameter rotates in long bearings and a disc of mass 16kg is secured to a shaft at the middle of its length. The span of the shaft between the bearing is 0.5m. The mass centre of the disc is 0.5 mm from the axis of the shaft. Neglecting the mass of the shaft and taking E=200GN/m find the critical speed of rotation in rpm. (6)

(ii) Mass of a single degree damped vibrations system measures 6kg and makes 25 free oscillations in 11 seconds. The amplitude of vibration reduces by 30% of its initial value after 5 oscillations. Determine

The stiffness of the spring

Logarithmic decrement

Damping factor

Critical damping coefficient and

Actual damping coefficient. (10)

14a A mass of 50kg suspended from a spring produces a statical deflection of 17 mm and when in motion experiences a viscous damping force of value 250N at a velocity of 0.3m/s. Calculate the periodic time of damped vibration. If the mass is then subjected to a periodic disturbing force of maximum value of 200N and making 2 Cycles/sec. find the amplitude of ultimate motion. (16)

[OR]

14b A machine having a mass of 100kg and supported on spring of total stiffness 7.84 x 10^5 N/m has an unbalanced rotating element which results in a disturbing force of 392 N at a speed of 3000 rpm. Assuming the damping factor as 0.2 determine the amplitude of motion due to unbalance, transmissibility and force transmitted. (16)

15a (i) A heavy turbine rotor of a sea vessel rotates at 1500 rpm clockwise looking from the stern, its mass being 800 kg. The vessel pitches with an angular velocity of 1 rad/s. Determine the gyroscopic couple transmitted to the hull when bow is rising, if the radius of gyration for the rotor is 275 mm. Also show in what direction the couple acts on the hull. (6)

(ii) A porter governor has two balls each of mass 3kg and a central load of mass 15kg. The arms area all 200mm long, pivoted on the axis. If the maximum and minimum radius of rotation of the balls is 160mm and 120mm respectively, find the minimum and maximum speeds and range of speed. (10)

[OR]

15b (i) For the same values of mass of the sleeve and height at a given instant, Proell governor requires smaller mass than that in Porter governor to obtain the same equilibrium speed. Why? (4)

(ii) A rear engine automobile is travelling along a curved track of 120m radius. Each of the four wheels has a moment of inertia of 2.2kgm^2 and an effective diameter of 600 mm. The rotating parts of the engine have a moment of inertia of 1.25kgm^2. The gear ratio of the engine to the back wheel is 3.2. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The mass of the vehicle is 2050 kg and the centre of the mass 520 mm above the road level.The width of the track is 1.6m. What will be the limiting speed of the vehicle if all the four wheels maintain contact with the road surface? (12)