Indian Maritime University
B. Tech. (Marine Engineering)
Semester -IV
End Semester Examination JUNE 2022
Mechanics of Machines II
(UG11T3403)

Pass Marks – 35

Max Marks – 70

Date – 06.06.2022

Duration – 03 Hours

Part – A Q.No. 1;10 MCQs (10 X 1 Mark)

(i) Four solid spheres of mass 2 kg, 3 kg, 5kg and 6 kg respectively are suspended using strings of equal lengths. The time period of oscillations will be,

a) same in the all the cases
b) Max. in the case of 2 kg. mass
c) Max. in the case of 6 kg. mass
d) Min. in the case of 2 kg. mass

(ii) In a Semi-definite or Degenerate system one of the natural frequencies will be

a) Infinity Hz
b) Two Hz
c) One Hz
d) Zero Hz

(iii) In a Transverse vibrating system, the internal induced stresses Will be

a) Tensile stresses
b) Bending stresses
c) Torsional shear stresses
d) Compressive stresses

(iv) Vibrations of a shaft due to the weights of various components like Gears, pulleys, sprockets etc. will be

a) Longitudinal vibrations
b) Torsional vibrations
c) Transverse vibrations
d) Axial vibrations

(v)An automobile having a mass ‘m’ kg. deflects its spring 4 cms. under its load. The natural frequency of the car in vertical direction in Hz will be,

a) 2.49
b) 4.29
c) 3.78
d) 5.62

(vi) The frequency of fluctuations of secondary inertia forces of reciprocating parts of a multi cylinder engine per crank shaft rotation will be

a) Two
b) Four
c) Six
d) One

(vii) Minimum number of balancing planes required to achieve dynamic balance of number of masses rotating in non-coplanar planes will be

a) Two
b) Four
c) Six
d) One

(viii) In a under damped system with a mass of 400 Kg. Amplitude was found to be reducing by values measured on one side of equilibrium are 4.87,1.62,.54,.18,.06 etc. respectively. Number of cycles required for the amplitude to reduce to zero is

a) Zero
b) Infinity
c) Four
d) Five

(ix) In a torsional vibrating system, the internal particles of the system would be found to be moving in

a) Along the lines parallel to the axis of the vibrating system
b) Along the lines Perpendicular to the axis of the vibrating system
c) In concentric circles about the axis of the vibrating system
d) None of the options

(x) A six cylinder in-line engine directly drives a propeller through a coupling. The degree of freedom of this torsional system will be

a) 3
b) 8
c) 6
d) 4

Part B- Q.No.2; 5 Short Questions (05 X 02 Marks)

(i) A body is subjected simultaneously by two harmonic motions. They are
x1 =15 sin (ωt+π/6); x2 = 8 cos (ωt+ π/3).
Determine the amplitude and phase angle of resultant harmonic motion.

(ii) Write about the 'Barred speed range' or 'Critical speed range' as applied to a marine vessel driven by long stroke low speed marine engine

(iii) How complete secondary balance of high-speed multi-cylinder-engine is carried out? Explain.

(iv) Explain zero-node or Imaginary node, one-node, two-node frequencies with regards to Multi degree freedom Semi-definite-torsional-vibrating system

(v) Show the plots reflecting the fluctuation of primary inertia forces and secondary inertia forces due to reciprocating parts of single cylinder two stroke engine in one crank rotation

Part C – 7 Long Questions – Answer Any 5 (05 X 10 Marks)

3. The camshaft of high-speed pump consists of a parallel shaft 25 mm diameter and 480 mm long. It carries three eccentrics, each of diameter 60 mm and a uniform thickness of 18 mm. The assembly is symmetrical as shown in Figure 1 and the bearings are at A and B. The angle between the eccentrics is 120° and the eccentricity of each is 12.5 mm. The material density is 7000 kg/m^3, and the speed of rotation is 1430 rpm
Find:
   1. Dynamic load on each bearing due to the out-of-balance couple;
   2. Kinetic energy of the complete assembly.

[10 Marks]

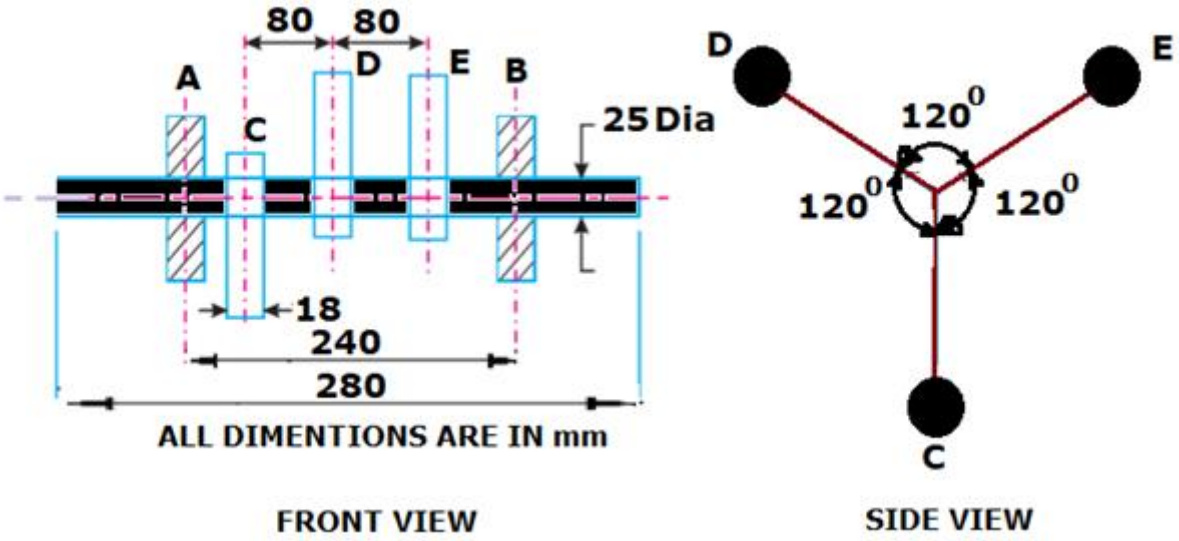

Figure 1

4. The Figure 2 shows cross sectional view of a ship undergoing rolling motion. The whole vessel is rolling about the Meta center. The mass

center G is at a distance of h from Meta center. Develop the governing equation of motion of the vibrating system by D'Alembert's principle and by principle of conservation of energy. Also determine natural frequency.

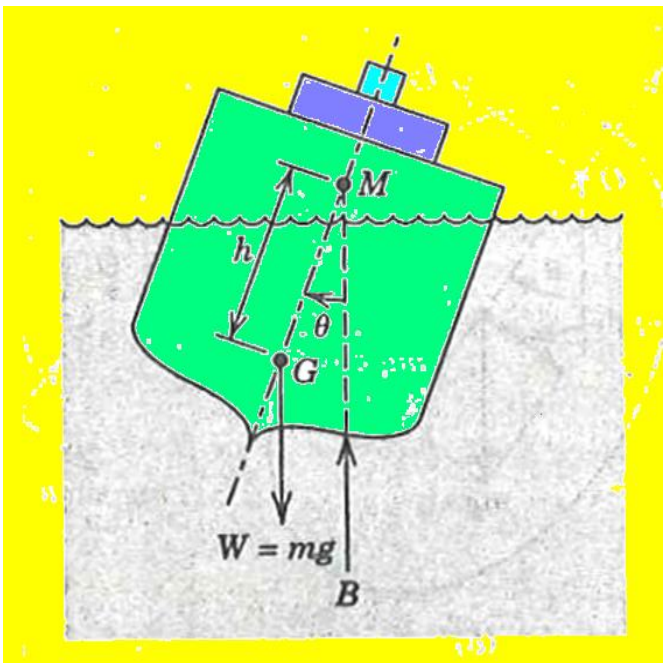

Figure 2

[10 Marks]

5. a) A marine machine has it's shaft simply supported at the ends and carries three masses of 90 kg, 140 kg, 60 kg at the distances of .8 m, 1.5 m, 2 m from Left end support. it of 40 mm diameter and 2.5 m length is subjected to UDL (Uniformly distributed load) of 147.15 N/m for entire length of 2.5 m. Find the lowest natural frequency of transverse vibrations by Dunkerley's method. Assume E=200 GPa.

[5 Marks]

b) A Flywheel weighing of 58.86 N is mounted midway on a simply supported shaft of diameter 10 mm and length 400 mm. The center of gravity of rotor is 0.02 mm away from the geometric center of rotor. If the Flywheel rotates at 2500 rpm find the critical speed or whirling speed, the amplitude of steady state vibrations. Assume for the shaft material E = 200 GPa

[5 Marks]

6. A ship is driven by diesel engine. The diesel engine running at 450 rpm is to drive the propeller of ship at 100 rpm through a reduction gear drive. The mass moment of inertia of the engine and propeller, pinion, gear are 2400 kg-m^2 and 6000 kg-m^2, 60 kg-m^2, 250 kg-m^2 respectively. The shaft connecting the engine with the pinion has a diameter of 0.32 m and length of 4 m. The shaft connecting the Gear with the propeller is hollow for the length of 5 .2 m with outer diameter of 0.46 m and inner diameter of 0.31 m. Assume G = 84 X 109 N/ m^2. Determine the natural frequencies and position of nodes considering the inertia of the gears. **[10 Marks]**

7. The moment of inertia of a torsional pendulum immersed in a viscous fluid is 600 kg-m^2 and is. The brass shaft attached to it is of 10 cm diameter and 40 cm long. When the pendulum is vibrating, the ratio of second amplitude to ninth amplitude was observed to be 17.08. Determine i) logarithmic decrement ii) damping torque at unit velocity iii) the periodic time of vibrations. Assuming for the brass shaft, G=4.4 $x10^{10}$ N /m^2 What would be the frequency, if the disc is removed from the viscous fluid.

With the above values write down Governing equation or Differential equation and also equation for its solution in terms of system parameters.

[10 Marks]

8. An engine having 101.93 kg is supported on four springs. It has a stroke length of 0.08 m and runs at 1000 rpm. If the springs are symmetrically placed with respect to CG of the engine, find neglecting the damping the combined stiffness of the springs in order that the force transmissibility would be 0.04. It is found that the damping however small, reduces the amplitude of successive vibrations by 25%.

i) Force transmitted to the foundation at 1000 rpm
ii) Force transmitted to the foundation at resonance and
iii) the amplitude of vibration if the mass of the reciprocating parts is 2.2 kg

[10 Marks]

9. A four stroke five cylinder in-line Engine is required to be examined for static and dynamic balance. It has a firing order of 1-4-5-3-2-1. The distance between centre lines is 150 mm and the weight of the reciprocating part for each cylinder is 14.715 N, the engine stroke length is 10 cm and the connecting rod length is 17.5 cm. The engine runs at 600 rpm. Examine the engine for balance and determine primary and secondary unbalance couples. Determine the angle when maximum value of primary couple would occur.

[10 Marks]