# INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)

MAY/JUNE 2018 END SEMESTER EXAMINATION

**B.TECH (MARINE ENGINEERING)**

**SEMESTER: IV**

**MECHANICS OF MACHINES – II(UG11T1403/UG11T2403)**

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Date :13-06-2018 Maximum Marks : 100

Time : 3 Hrs Pass Marks. : 50

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## PART – A

**(All Questions are compulsory)**

**Marks:10×3 = 30**

1. a) Explain the term dynamic balancing, and rocking couple when several masses are rotating at several planes on a shaft

   b) Explain partial balancing of locomotive and hammer blow of locomotive wheel.

   c) Draw the vibrational sketch of undamped free vibration. Show the free body diagram and find the differential equation of motion. Draw displacement vs. time curve and find time period.

   d) Draw a sketch of torsional pendulum and find differential equation of motion by energy method.

   e) Draw suitable sketches and define torsionally equivalent shaft.

   f) Explain with sketch two node and single node torsional vibration of 3 – rotor system, also show imaginary node.

   g) Define whirling of shaft, and draw dynamic deflection curve with angular velocity.

   h) Derive by energy method natural frequency of transverse vibration of a beam when several concentrated loads act on the beam.

   i) Draw a sketch of forced damped vibration and write down differential equation of motion from free body diagram, name relevant type of forces.

   j) Explain the term “damping factor" and its relation with"critical damping co-efficient”. At what conditions of damping factor , the motion is aperiodic.

**PART – B** **Marks: 5×14=70**

**(Answer any 5 of the following 7 questions)**

2. A shaft of 2.5 m span between the bearing, Carries two masses of 3 Kg and 4 Kg having arm length of 150 mm and 200mm respectively. The plane in which the masses rotate at 1.0 m and 1.5m respectively from left hand side of bearing. The shaft rotate at 1000 rpm clockwise looking from left side bearing and 3 Kg mass is ahead of 4 Kg mass. The angle between the arm is 60°.

   a) Find the dynamic forces on two bearings and their relative angle with arm of 3Kg mass in anticlockwise direction.

   b) The system is being dynamically balanced by putting two different masses at radius 250 mm and placed at 500 mm from each bearing. Determine magnitude of two balance masses and their relative angle setting with arm of 3Kg mass. [14]

3. a) Two spring in parallel, having stiffness 500 N/m and 600 N/m are fixed at one end, a mass of 20 kg is hanging from otherend. Derive from first principle differential equation of motion of free vibration considering initial velocity of mass 20 cm/sec. created by hammering. Find the differential equation of motion,and also equation of displacement, velocity and acceleration ,and draw their curve with time. Find the time period and natural frequency. [7]

   b) A body of mass 30 kg is hanging from a spring having a stiffens 1000 N/m and mass of 5Kg. Find the differential equation of motion and natural frequency by energy method. [7]

4. a) A steel beam is simply supported over a span of 4 m and Carries loads of 4KN at midpoint and 2KN at 0.8 m from left support and 0.9 m from right support. Calculate the natural frequency of transverse vibration of beam by energy method. The static deflection at 4KN load is 1.3mm, at 2KN left side is 0.84mm and 2KN right support is 0.86mm when all loads are acting together. Neglect weight of beam. [7]

   b) A shaft 1.5 m long, supported on spherical bearing Carries two rotors, each of 50 Kg mass. One rotor is situated at the centre of the shaft and other at a distance of 375 mm from the centre towards right. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of shaft material is 7700 Kg/ $m^3$ and its modulus of elasticityis 200 GN/$m^2$. Find whirling speed of the shaft. [7]

5. Three rotors are fitted on a uniform diameter shaft. The rotor A and C are fitted at two ends, B is intermediate rotor. The distance between A and B is 700mmand between B and C is 1200 mm. The moment of inertia of rotor A,B,C are 20, 40, 30 Kg.$m^2$ respectively, shaft diameter is 80mm. Derive and find frequencies of free torsional vibration at single node and two node vibration. Take G=80GN/$m^2$. [14]

6. a) A mass of 15Kg hangs from the spring and makes damped oscillation. The time of 55 complete oscillation requires 35 sec., the ratio of second to nineth consecutive amplitude is 3.5 . Find spring stiffness and critical damping coefficient of the system.
   b) With above evaluated numerical value,write down the differential equation of motion and displacement verses time equation with relevant arbitrary constant. [14]

7. A mass attached to a spring of stiffness 600 N/m has a viscous damping device. When the mass was pulled and released the period of vibration found to be 1.8sec. and ratio of consecutive amplitude was 4.2 . (a) Determine steady state amplitude and (b) phase angle when the excitation force F=4 sin3t N acts on the system. (c) Find steady state displacement equation, (d)mass of body, (e) damping coefficient. [14]

8. A vertical engine having 5 cylinder in-line has successive crank 144° apart, the distance between cylinder centre lines being 450 mm. The reciprocating mass of each cylinder is 16 Kg, the crank radius is 135 mm and the connecting rod length is 540mm. The engine runs at 600 rpm. (a) Draw primary and secondary crank angle position. (b)Find primary and secondary unbalanced forces. (c) Find Primary and secondary unbalanced couples and it's direction with vertical. [14]

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