Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VII SEM. B.TECH. (MECH. ENGG.) MAKE-UP EXAMINATIONS, DEC 2015

SUBJECT: MECHANICAL VIBRATIONS [MME-403]

(REVISED CREDIT SYSTEM)

Time: 3 Hours. MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Additional data, if any, may be appropriately assumed.
- Assumptions made must be clearly mentioned.
- Sketches are to be drawn wherever necessary.

1A) Derive an expression to determine natural frequency of a pendulum, taking into consideration the mass of the pendulum rod. 05

1B) By Holzer's method, determine the length L of the shaft, shown in Fig. (Q1B), given that it's fundamental natural frequency is 200 rad/s.

Use the values, $k_t = 3\times10^6$ Nm/rad

$J_1 = 100$ kgm^2 $J_2 = 80$ kgm^2

$J_3 = 50$ kgm^2 $J_4 = 10$ kgm^2

G = 80 GPa

Shaft diameter = 70 mm. 05

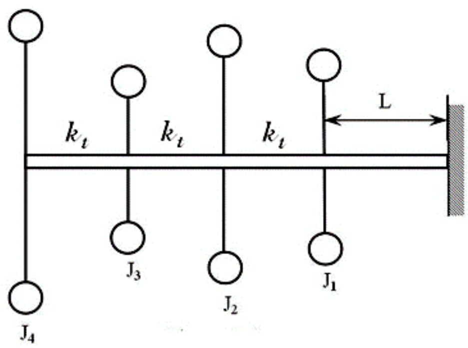

Fig. (Q1B)

2A) Derive the equation of motion of a viscous damped spring-mass system. Obtain its solution if the system is critically damped. Also define (i) *Critical Damping Coefficient* and (ii) *Damping Ratio* 05

2B) In a refrigeration plant, a section of pipe carrying the refrigerant vibrates violently at a compressor speed of 500 rpm. To eliminate this difficulty, it was proposed to clamp a cantilever spring mass system to the pipe to act as an absorber. For a trial test, a 2 kg absorber tuned to 500 rpm, resulted in two natural frequencies of 450 and 555.6 cpm.

(i) Determine the mass and stiffness of the main system.

(ii) If the absorber system is to be designed so that the natural frequencies lie outside the region 430 and 581.4 cpm, determine the mass and stiffness of the absorber system. 05

3A) Derive an expression to determine the steady state amplitude of vibration of an IC engine due to the reciprocating unbalanced force excitation. 05

3B) A horizontal spring-mass system consists of a single spring and a single mass of 40 kg. The mass slides horizontally on a dry surface whose coefficient of friction is 0.25. The mass makes 6 oscillations in 1 second when allowed to oscillate over the dry surface. If the mass is pulled 27 mm to the left side of its mean position and allowed to oscillate freely, find

(i) Stiffness of the spring.

(ii) The final rest position of the mass.

(iii) The number of half cycles required to bring the mass to rest position. 05

4A) Define *Flexibility/Displacement Influence Coefficient*. State and prove the Maxwell's Reciprocal Theorem. 05

4B) A single cylinder vertical petrol engine of total mass 500 kg is mounted upon a steel chassis frame and causes a vertical static deflection of 3 mm. The reciprocating parts of the engine have a mass of 6 kg and move through a vertical stroke of 150 mm with simple harmonic motion. A dashpot is provided, the damping resistance of which is directly proportional to the velocity and amounts to 30 kN at 1.5 m/s. If a steady state vibration has been reached, determine,

(i) The amplitude of forced vibrations when the driving shaft of the engine rotates at 800 rpm.

(ii) The maximum dynamic force transmitted to the ground.

(iii)The speed of the driving shaft (in rpm) at which resonance will occur 05

5A) For the system shown in Fig. (Q5A), find the two natural frequencies of the system. State whether it is a semi-definite system. Justify your answer.

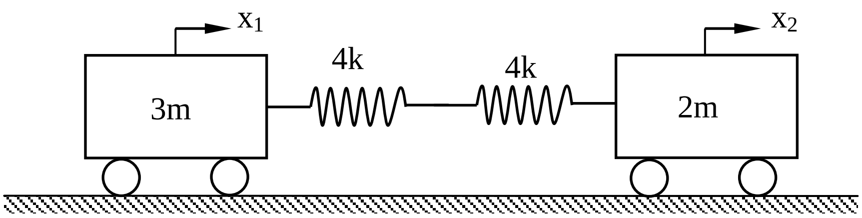

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Fig. (Q5A)

5B) A disc of mass 6 kg is mounted on a shaft mid-way between short bearings, which may be assumed to be simple supports. The bearing span is 600 mm. The steel shaft is horizontal and is 8 mm in diameter. The center of gravity of the disc is displaced 3 mm from its geometric center. The equivalent viscous damping coefficient at the center of disc-shaft arrangement is 60 Ns/m. If the shaft rotates at 1000 rpm, determine

(i) The dynamic load on bearings.

(ii) The bending stress acting on the shaft.

(iii) The power required to overcome the damping in the system. 05

Take modulus of elasticity for shaft material = 200 GPa.

6A) Determine the flexibility/displacement influence coefficients of the triple pendulum shown in Fig. (Q6A).

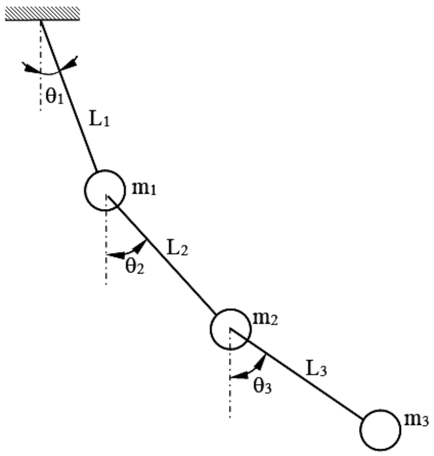

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Fig. (Q6A)

6B) The shaft-disc arrangement shown in Fig. (Q6B) undergoes small amplitude-torsional vibrations. The mass moment of inertia of the disc is 2 kgm^2. The modulus of rigidity for the shaft material is 80 GPa.

(i) Find the equivalent torsional stiffness of the system.

(ii) Determine the natural frequency of torsional vibrations, neglecting the inertia effect of the shaft.

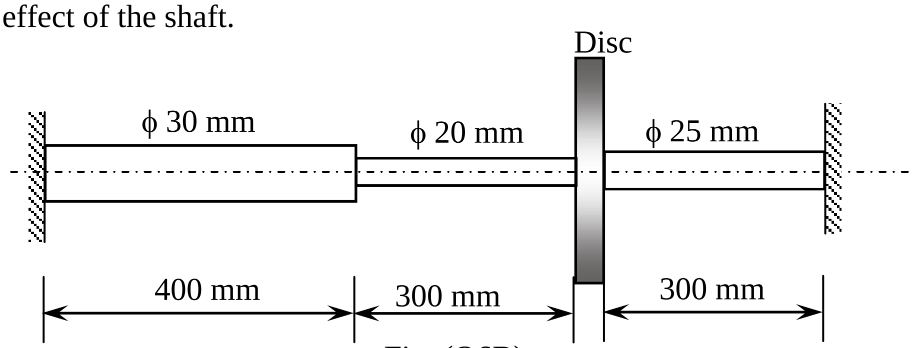

Fig. (Q6B)

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