BE MECH | Sem VII | R19 | ATKT | SH 2025 | 20/11/25

Paper / Subject Code: 42878 / Advanced Vibration (DLOC - IV)

QP Code 95985

(3 hours) **Total Marks: 80**

NB 1) Question No. 1 is compulsory
2) Attempt any three questions out of the remaining five questions.
3) Figures to the right indicate full marks.
4) Assume suitable data wherever required but justify the same.

Q1. Attempt any four **(20)**

A. Explain phase plane method for studying second-order autonomous system.

B. Explain probability distribution function for random variables.

C. Explain the difference between passive and active isolation.

D. Determine the phase plane of a single degree of freedom oscillator $\ddot{x} + \omega^2 x = 0$

E. Explain working principle of an accelerometer.

Q2 A. The three blocks slide on a frictionless surface, as shown in Figure Q2(A). Use Lagrange's equations to derive the differential equations governing the vibrations of the system using x_1 , x_2 , and x_3 as generalized coordinates. **(12)**

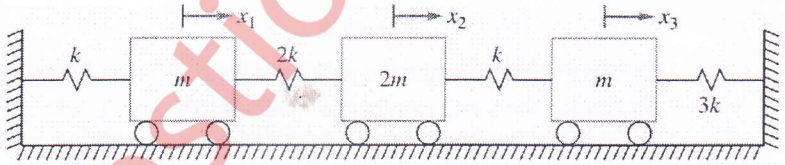

Figure Q2 (A)

B. Explain frequency measuring instruments. **(08)**

Q3 A. What is the required tension in a transmission line of length 15 m and linear density of 5 kg/m such that the transmission line's lowest natural frequency for transverse vibrations is 100 rad/s? Assume the line is simply supported. **(12)**

B. Write the general matrix form of the differential equations governing the undamped and forced vibrations of a linear *n* DOF system. **(08)**

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Q4 **A.** A punch press of mass 500 kg sits on an elastic foundation of stiffness 1.25 x 10^6 N/m and damping ratio 0.2. The press operates at a speed of 120 rpm. The punching operation occurs over 40 percent of each cycle and provides a force of 5000 N to the machine. The excitation force is approximated as the periodic function of Figure Q4 (A). The punch press is to be mounted on an isolator such that the maximum of the repeating force transmitted to the floor is 1000 N. Determine the required static deflection of an isolator, assuming a damping ratio of 0.1. What is the resulting maximum deflection of the isolator during the punching operation? **(14)**

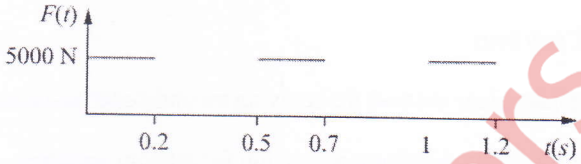

Figure Q4 (A) Periodic force developed during punching operation

B. Explain time averaging and expected value. **(06)**

Q5 **A.** A velometer is to be designed to limit the maximum error to 1% of the true velocity. The natural frequency of the velometer is to be 80 Hz and the suspended mass is to be 0.05 kg. Find the damping constant and the spring stiffness of the velometer. **(12)**

B. Derive the equation for longitudinal vibration of rod. **(08)**

Q6 **A.** The nondimensional form of the nonlinear equation governing the motion of a pendulum is **(10)**

$$\ddot{\theta} + sin\theta = 0$$

i) Derive the general equation defining the phase plane for this motion.
ii) Determine the trajectory for the condition that $\dot{\theta} = 1$ when $\theta = 0$.
iii) What is the maximum angle through which the pendulum will swing?

B. Explain power spectrum and power spectral density. **(10)**