Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) (FT/WP/S4PT) Examinations April 2026 (2019 Scheme)

Course Code: MET304
Course Name: DYNAMICS AND DESIGN OF MACHINERY

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions, each carries 3 marks. Marks

1	Provide a mathematical expression for D'Alembert's principle and explain its significance.	(3)
2	What is a turning moment diagram? How is it useful in the analysis of a four-stroke internal combustion engine?	(3)
3	Derive an expression for the natural frequency of a spring mass system using energy method?	(3)
4	How is vibration isolation done for heavy machines?	(3)
5	Explain the significance of normal modes in the vibration of a two degree of freedom system?	(3)
6	Define shear stress and torsional stress. Where do they typically occur?	(3)
7	What are shock and impact loads? How do they affect machine components?	(3)
8	How is the efficiency of a riveted joint defined and what factors affect it?	(3)
9	What are the possible failure modes in a butt weld under tension?	(3)
10	Explain the concept of critical frequency in helical springs?	(3)

PART B

Answer any one full question from each module, each carries 14 marks.

Module I

11	A single cylinder vertical engine has a bore of 300 mm and a stroke of 400 mm. The length of the connecting rod is 1 m, and the engine runs at 250 rpm. The gas pressure on the piston is 0.8 MPa at a crank angle of 45° from TDC. The mass of reciprocating parts is 18 kg. Calculate: a) Piston side thrust on the cylinder wall. b) Resultant force on the connecting rod c) Net force on the piston at the given crank angle	(14)

OR

12 a) Draw and explain how turning moment diagrams are used in the design of flywheels for multi-cylinder engines? (7)

b) A two-cylinder, four-stroke engine delivers the following torques: (7)

- Cylinder 1: 20 Nm at 0°, 50 Nm at 180°, 20 Nm at 360°
- Cylinder 2 (offset by 180°): 20 Nm at 180°, 50 Nm at 360°, 20 Nm at 540°

a) Draw the combined turning moment diagram representing one full revolution. b) If the average work done per cycle is 400 Nm, determine the coefficient of fluctuation of energy

Module II

13 a) The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Find(i)Stiffness of spring (ii) Logarithmic Decrement (iii) Damping Factor and Damping Coefficient (iv)Critical Damping Coefficient (7)

b) Determine the time in which the mass in a damped vibrating system would settle down to 1/50 th of its initial deflection for the following data m=200 kg, k=40N/mm, =0.22. Also find the number of oscillations completed to reach this value of deflection? (7)

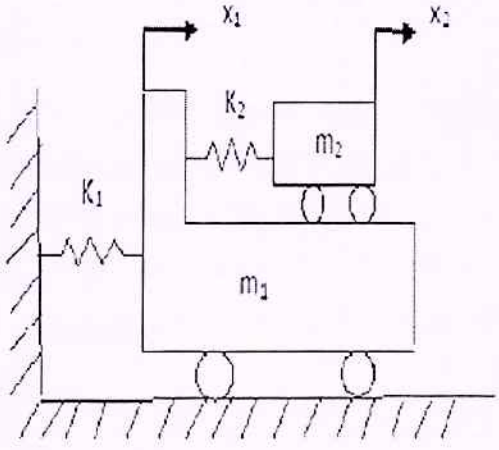
OR

14 a) Derive an expression for the forced response of a damped single degree of freedom vibrating system subjected to a harmonic excitation? (7)

b) A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under weight of the mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion aperiodic at a speed of 1 mm/s? If when damped to this extent, a disturbing force having a maximum value of 100 N and vibrating at 6 hertz is made to act on the body, determine the amplitude of the ultimate motion? (7)

Module III

15 Derive the equations of motion and determine the natural frequencies of the vibratory system shown in the figure, where two masses $m_1 = 200$ kg, $m_2 = 60$ kg are connected by springs with stiffness $k_1 = 100000$ N/m and $k_2 = 20000$ N/m. (14)



OR

16 a) Compare ductile and brittle behaviour of metals. How do temperature and strain rates affect this behaviour? (7)

b) A flat rectangular aluminium plate of width 100 mm and thickness 20 mm has a central circular hole of diameter 20 mm. The plate is subjected to an axial tensile load of 25 kN. Find the maximum stress induced in the plate considering the stress concentration effect. Assume the stress concentration factor for the hole in this geometry is 2.7? (7)

Module IV

17 A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m2 and – 150 MN/m2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2. (14)

OR

18 Design a double riveted lap joint with zigzag riveting for joining two steel plates each 10 mm thick. The working stresses are: Tensile stress = 90 MPa, Compression stress = 140 MPa, Shear stress = 550 MPa. State how the joint will fail and calculate the strength and efficiency of the joint? (14)

Module V

19 a) How do you calculate the shear stress in a fillet weld subjected to torsion? (4)

b) Determine the length of the weld run for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by means of (10)

1. A single transverse weld
2. Double parallel fillet welds when the joint is subjected to variable loads

OR

20 a) Classify springs and list common materials used for spring manufacturing? (4)

b) Design a helical compression spring made of oil-tempered carbon steel is subjected to a load varying from 300 N to 900 N. The spring deflects by 25 mm under the maximum load. The spring index is 7, and a factor of safety of 1.3 is to be used. Given: Yield strength in shear $\tau_y = 750$ Mpa Endurance strength in shear $\tau_e = 360$ MPa, Modulus of rigidity $G = 80$ GPa (10)

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