SCHOOL OF ENGINEERING

MECHANICAL ENGINEERING DEPARTMENT

END OF SEMESTER TWO EXAMINATIONS

BIE2, BEE2, BME2, BAE2, BCES2, BCET2, BCEW2, BECE2, BBME2, BEEE2, BETE2, BGEN2, BMEN2, BMMP2

STATICS AND DYNAMICS

(MEC-STD-221)

16 OCTOBER 2024 Time Allowed: 3 hours

Instructions

1. This paper contains **seven (7)** questions.
2. Answer any **five (5)** questions.
3. Answer each question on a separate page.
4. Your examination number should appear on all pages of the answer script.

DO NOT TURN OVER THE QUESTION PAPER UNTIL YOU ARE TOLD TO DO SO

QUESTION ONE

Determine the values and draw to scale the shearing force and bending moment diagrams due to the imposed load for the beam shown in **Figure Q1**, marking thereon all the principal values. Find the position and magnitude of the maximum bending moment. **(20 marks)**

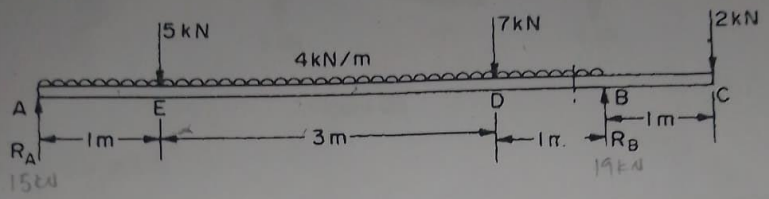

Figure Q1

QUESTION TWO

(a) A compound bar consists of four brass wires of 2.5 mm diameter and one steel wire of 1.5 mm diameter. Determine the stresses in each of the wires when the bar supports a load of 500 N. Assume that all the wires are of equal lengths. **(10 marks)**

(b) Calculate the "equivalent" or "combined modulus for the compound bar and determine its total extension if it is initially 0.75 m long. Hence check the values of the stresses obtained in part (a). For brass E = 100 GN/m^2 and steel E = 200 GN/m^2. **(10 marks)**

QUESTION THREE

The frame of **Figure Q3** comprises members of equal length, rests freely on rollers at B and is supported by a pin-joint at A. Find the forces in members marked 1 and 2.

(20 marks)

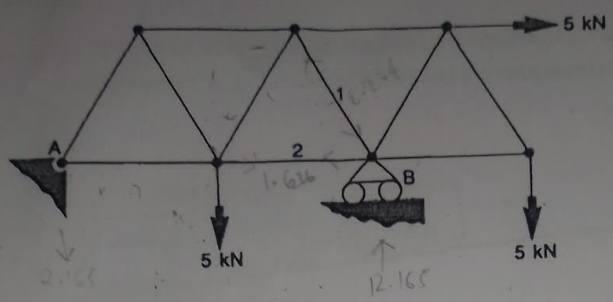

Figure Q3

QUESTION FOUR

Four masses m1, m2, m3, and m4 are 200 kg, 300 kg, 240 kg, and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m, and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°.

(a) Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m **(16 marks)**

(b) Determine the out-of-balance force on the shaft bearing at 12 rev/s, if no balance mass is used. **(4 marks)**

QUESTION FIVE

A rope was tied to a steel drum of a lifting machine. The drum has a diameter of 3 m, a mass of 60 kg, and a radius of gyration of 0.5 m. The lifting machine is used to lift the load of 100 kg with acceleration of 2.6 m/s^2. The load is balanced with a 40 kg balancing mass. Calculate the:

(a) Tension in the ropes. **(8 marks)**

(b) Driving torque to lift the 100 kg load if the friction couple at the bearing is 1.3 kN.m. **(8 marks)**

(c) Linear velocity of the masses when the power produced from the drum is 12 kW. **(4 marks)**

QUESTION SIX

A 75t locomotive pulls a train of eight (8) 32t coaches up an incline of 10° as shown in **Figure Q6**. The tractive effort, E, at 72 km/h is 650 kN and the track resistance is 60N/t of total mass.

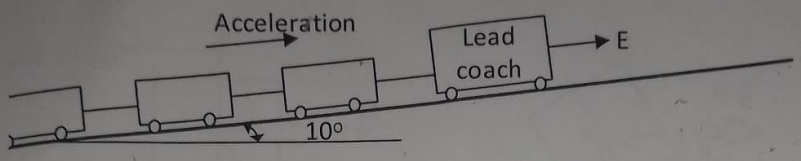

Figure Q6: Part of a train on an inclined track

(a) Calculate the acceleration produced. **(9 marks)**

(b) Determine the draw-bar pull on the leading coach. **(7 marks)**

(c) What would be the required tractive effort required to achieve the same acceleration as calculated in Q6(a), if the track is level and the locomotive is subjected to the same resistance per mass? **(4 marks)**

QUESTION SEVEN

The geometric design of a road may involve, among others, limiting vehicular speed, and vertical and horizontal curves. Consider two sections of a road both having a horizontal curve of 120 m radius, one section is on a level surface while the other is banked at 30° to the horizontal.

A vehicle with a track width of 1.35 m and a centre of gravity at 600 mm from above the road surface in the centre plane is traversing through these two road sections both of which have a limiting coefficient of friction between the tyres and road of 0.6.

(a) For the road section with level track, determine whether the vehicle will first overturn or side slip when rounding the curve of 120 m radius at a constant speed on level track (see **Figure Q7(a)**) and indicate the maximum permissible speed on the curve. **(8 marks)**

(b) For the road section with track banked at 30° to horizontal, calculate the maximum permissible speed on the banked curve (see **Figure Q7(b)**).

(12 marks)

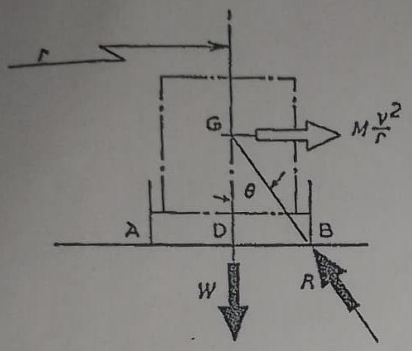

Figure Q7 (a): Level track

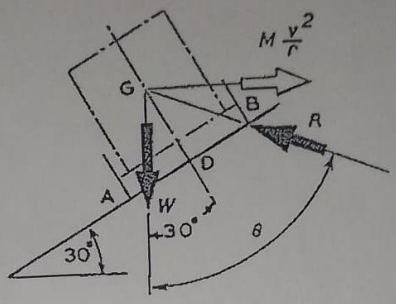

Figure Q7(b): Banked track

End of Examination Paper