TERTIARY AND VOCATIONAL EDUCATION COMMISSION

Fluid Power Technology
NVQ Level 5 Semester l Examination

Mechanics of Machines and Strength of Materials – E40C00M05

Instructions to Candidates:

1. **Answer five (05) questions**

Total Time: 03 hours **Total Marks: 100**

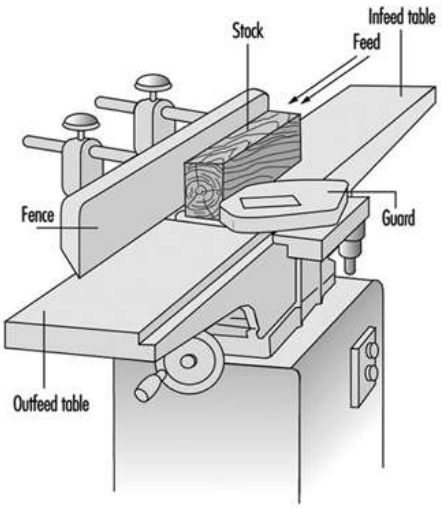
Q1

(i) The motion of a particle is given by a = t3 – 3t2 + 5, where a is the acceleration in m/s2 and t is the time in seconds. The velocity of the particle at t = 1 second is 6.25 m/s, and the displacement is 8.30 meters. Calculate the displacement and the velocity at t = 2 seconds.

(12 marks)

(ii) The cutting stroke of a planning machine is 500 mm, and it is completed in 1 second. The planning table accelerates uniformly during the first 125 mm of the stroke, the speed remains constant during the next 250 mm of the stroke and retards uniformly during the last 125 mm of the stroke. Find the maximum cutting speed.

(8 marks)

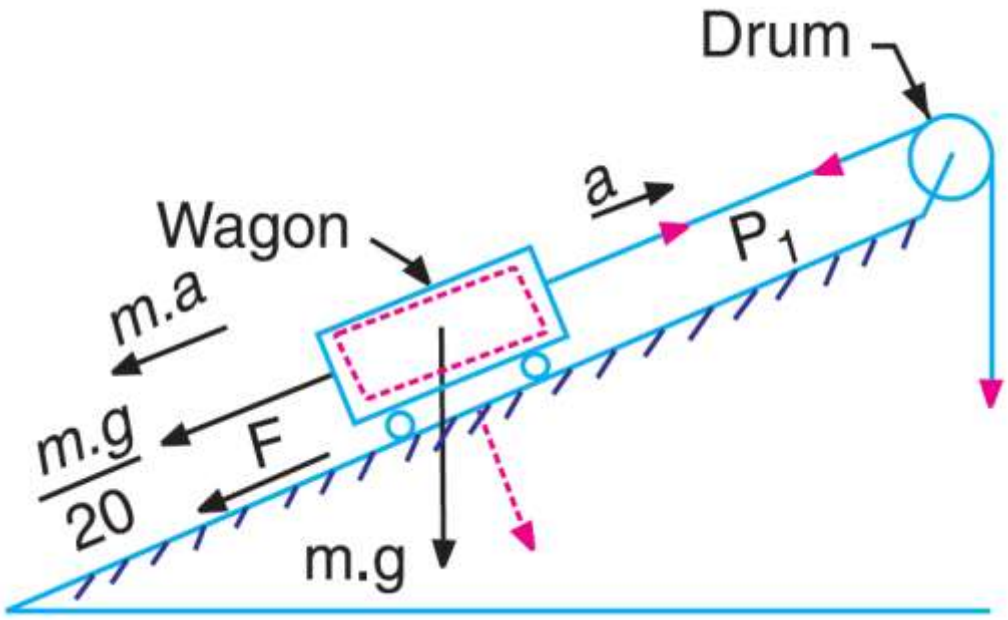


(Fig 1)

Q2

(i) horizontal bar 1.5 meters long and of small cross-section rotates about vertical axis through one end. It accelerates uniformly from 1200 RPM to 1500 RPM in an interval of 5 seconds. What is the linear velocity at the beginning and end of the interval? What are the normal and tangential components of the acceleration of the mid-point of the bar after 5 seconds after the acceleration begins?

(ii) A wagon of mass 14 Tonnes is hauled up an incline of 1 in 20 by a rope which is parallel to the incline and is being wound round a drum of 1 m diameter. The drum, in turn, is driven through a 40 to 1 reduction gear by an electric motor. The frictional resistance to the movement of the wagon is 1.2 kN, and the efficiency of the gear drive is 85 per cent. The bearing friction at the drum and motor shafts may be neglected. The rotating parts of the drum have a mass of 1.25 Tonnes with a radius of gyration of 450 mm and the rotating parts on the armature shaft have a mass of 110 kg with a radius of gyration of 125 mm. At a certain instant, the wagon is moving up the slope with a velocity of 1.8 m/s and an acceleration of 0.1 m/s2. Find the torque on the motor shaft and the power being developed.

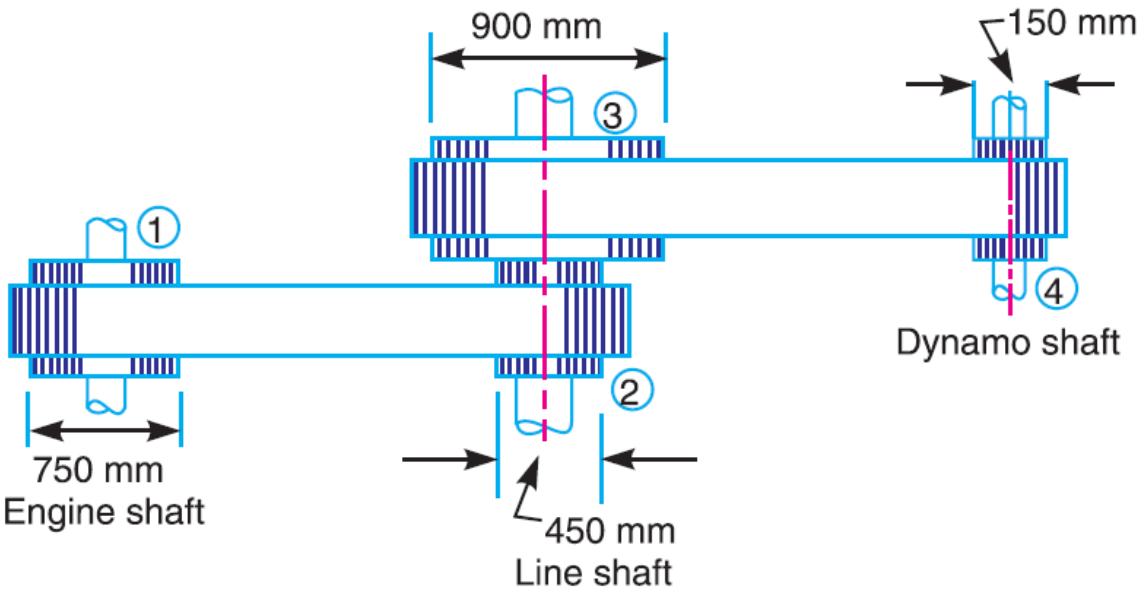


[20 Marks]

Q3

A. An engine, running at 150 RPM, drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft, when

1. there is no slip,
2. there is a slip of 2% at each drive.



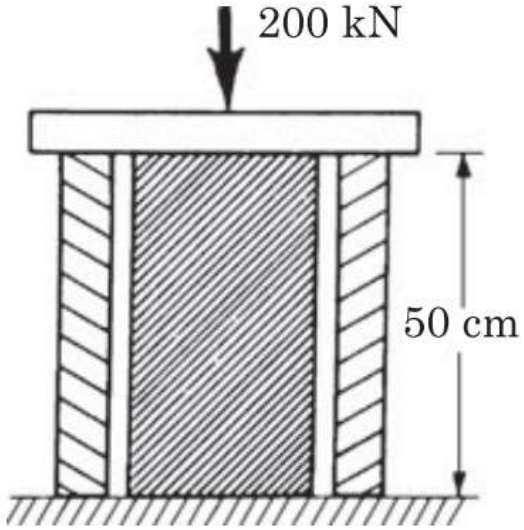
B. Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is 1.2 m/s, assuming addendum as standard and equal to one module, find:

(i) The angle turned through by pinion when one pair of teeth is in mesh.
(ii) The maximum velocity of sliding.

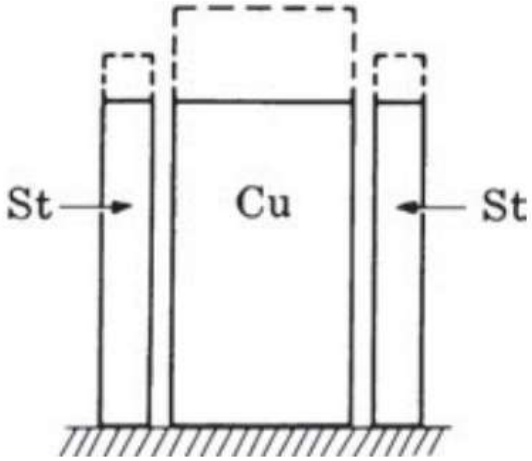
[20 Marks]

Q4

A hollow steel cylinder surrounds a solid copper cylinder, and the assembly is subjected to an axial loading of 200 kN as shown in Fig (a). The cross-sectional area of the steel is 20 cm2 , while that of the copper is 60 cm2 . Both cylinders are the same length before the load is applied. Determine the temperature rise of the entire system required to place all of the load on the copper cylinder. The cover plate at the top of the assembly is rigid. For copper E = 100 GPa, a = 1.7 × 10–6/°C, while for steel E = 200 GPa, a = 12 × 10–6/°C.



(a)

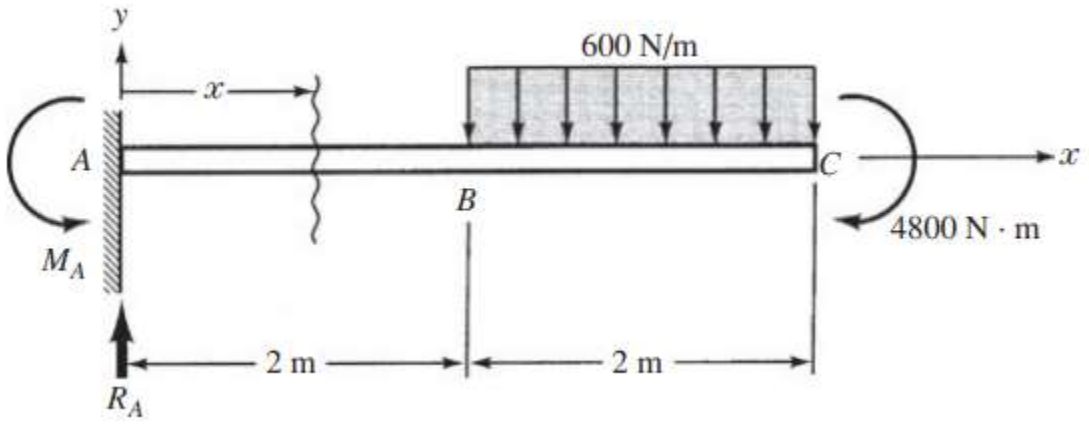


(b)

[20 Marks]

Q5

The cantilever beam AC in Figure is loaded by the uniform load of 600 N/m over the length BC together with the couple of magnitude 4800 Nm at the tip C. Determine the shearing force and bending moment diagrams.



[20 Marks]