NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF TEXTILE TECHNOLOGY
END OF SEMESTER EXAMINATIONS JUNE 2004
APPLIED MECHANICS TXT 1209
TIME: 3 HOURS

INSTRUCTIONS

Answer **ALL** questions from Section A and **ANY 3** from section B. Section A carries 40 marks and each question in section B carries 20 marks. Allocate 60 minutes to section A and 120 minutes to section B.

SECTION A
Answer **ALL** questions in this section.

1. A stone thrown horizontally from the top of a tower hits the ground at a distance 18 m from the blue of the tower.
   (a) Find the speed at which the stone was thrown if the tower is 24 m high.
   (b) Find the speed of the stone just before it hits the ground. (6 marks)

2. A disc A shown in Figure 1 starts from rest and rotates with a constant angular acceleration of $\propto_A = 2$ rad/s^2.
   (a) How much time is needed for it to turn 10 revolutions.
   If disk A is in contact with disk B and no slipping occurs between the disks determine the angular velocity and angular acceleration of B just after A turns 10 revolutions. (5 marks)

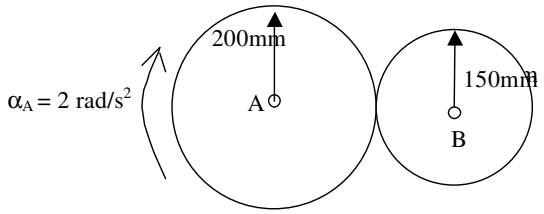

Figure 1

3. (a) What is static friction
   (b) What is kinetic friction
   (c) The crate shown in figure 2 has a mass of 3m kg. Show that $\mu s = \tan\theta_c$ and determine the critical angle θ_c such that the crate is on the verge of moving down the plane. (7 marks)
   The coefficient of static friction is $\mu s = 0,3$

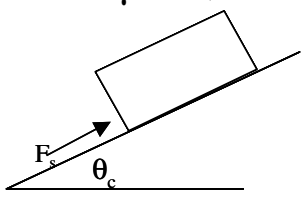

Fig. 2

4 Explain the following terms and draw a neat sketch/graph of the stress strain characteristics of a ductile steel clearly showing the following points:
   (b) ultimate stress
   (c) yield point

(d) limit of elasticity
(e) elastic range (8 marks)

5 A compound belt and counter shaft drive is shown in Figure 3. The pulley diameters are A 72 cm, B 27 cm, C 54 cm, D 24 cm.

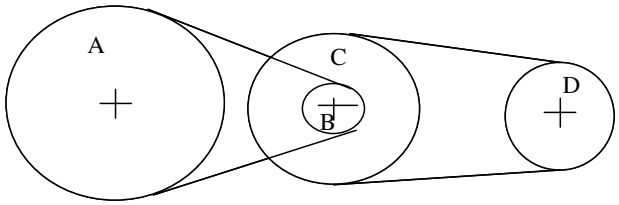

Fig 3

The power input to the pulley is 10 kw at a speed of 100 rev/min.
If the belt drive is 85% efficient, calculate
(a) the output power (kw) at D
(b) the speed of rotation of D
(c) the torque exerted at D (9 marks)

6 State the first law of Thermodynamics, defining all the quantities in your equation. Explain the sign convention you use. (5 marks)

SECTION B

1 (a) determine the axial force, shear force and bending moment acting at points B and C of the cantilever beam loaded as shown in Figure 4. The 600 N axial force is applied along the central axis of the beam.

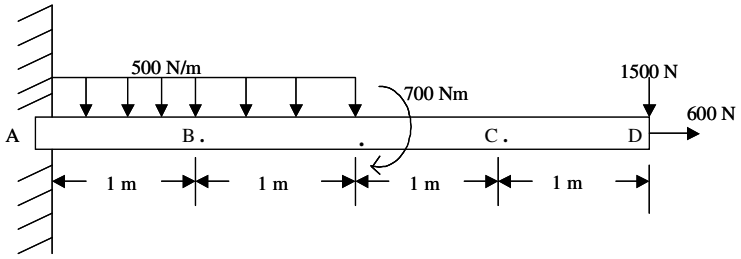

Figure 4

(b) Draw the shear and bending moment diagrams for the beam shown in Figure 5.

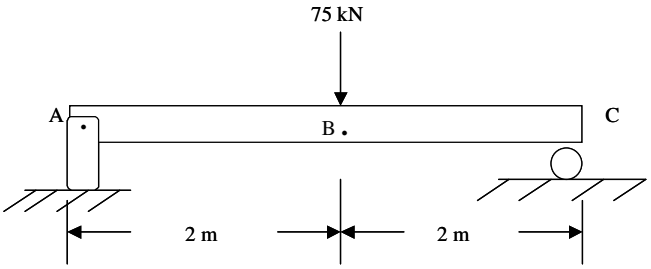

Figure 5

2. (a)A 1-kg piece of copper (specific gravity 9) is submerged in water and suspended from a spring balance as shown in Figure 6.

(i) What force does the balance read?

(ii) The whole system is dropped out of the window. Describe the initial motion of the copper block relative to the jar.

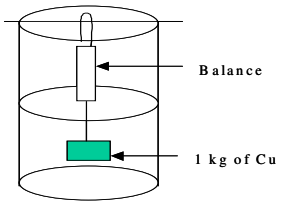

Figure 6

(b) Water flows though a 3 cm diameter horse at 65m/s. The diameter of the nozzle is 0,30cm.

(i) At what speed does the water pass through the nozzle.

(ii) If the pump at one end and the nozzle at the other end are at the same height and the pressure at the nozzle is atmospheric, what is the pressure at the pump

3. (a) Steel alloy components of total mass 6 tonne at a temperature of 25 ^{o}C are heated in a gas fired furnace to 825 ^{o}C prior to quenching. If 25% of the heat available from the gas is absorbed by the components find the total heat supplied in the gas. The specific heat capacity of the steel alloy is 0,5 kJ/kg^{o}C (10 marks)

(b) A mass of 40g of oxygen is cooled in a closed vessel from 16 ^{o}C to –44 ^{o}C. The same mass of oxygen is cooled through the same temperature range in a cylinder so that the pressure is maintained constant. Compare the heat removed in the two cases.
For oxygen Cv = 0,66 kJ/kg^{o}C and Cp = 0,92 kJ/kg^{o}C (10 marks)

4. (a) Define (i) Moment of Inertia
(ii) Radius of Gyration (4 marks)

(b) Find the moment of inertia of a uniform a disk about the axis through its centre and perpendicular to the plane of the disk shown in Figure 7 below. (8 marks)

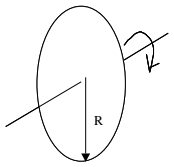

Figure 7

(c) Find the moment of inertia of a uniform stick about an axis perpendicular to the stick through one end. (8 marks)

END OF QUESTION PAPER