UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION, JULY 2015

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER:	ENGINEERING MECHANICS AND MATERIALS SCIENCE
COURSE CODE:	EE201
TIME ALLOWED:	THREE HOURS

INSTRUCTIONS:

1. There are seven questions in this paper. Answer Question 1 and any other four questions, making a total of five questions
2. Each question carries 20 marks.
3. Marks for different parts of a question are shown in the right hand margin.

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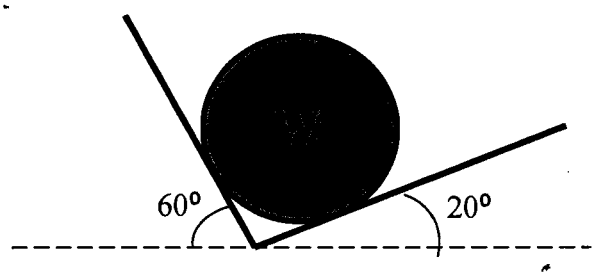
THIS PAPER CONTAINS EIGHT (8) PAGES INCLUDING THIS PAGE

QUESTION ONE (COMPULSORY) ***(20 marks)***

(a) A smooth sphere of weight 200 N is supported on a V groove made up of planes inclined at angles 60° and 20° to the horizontal as shown in Fig. Q1a. Find the reactions at the points of contact of the sphere and the planes. Assume all surfaces are smooth so that the reactions are perpendicular to the planes. *(8 marks)*



(b) What is meant by each of the following terms as used in the description of properties of a material:

(i) Hardness *(2 marks)*

(ii) Ductility *(2 marks)*

(iii) Plasticity *(2 marks)*

(iv) Elasticity *(2 marks)*

(v) Rigidity *(2 marks)*

(vi) Creep *(2 marks)*

QUESTION TWO ***(20 marks)***

(a) An electric light fixture weighing 15 kN hangs from a point C on two strings AC and BC as shown in Fig. Q2a. The inclination angles of the strings to the horizontal are as indicated. Determine the tension on each string. *(6 marks)*

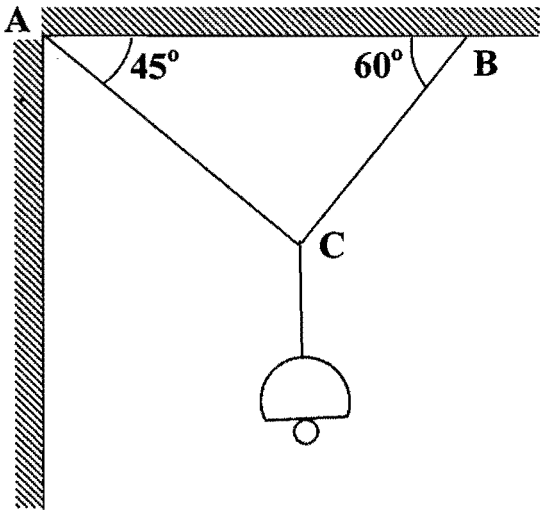


Fig. Q2a

(b) A truss shown in Fig. Q2b carries a load of 5 kN at point E. Find the forces in each of the members DE, CE, CD, and BD of the truss, specifying whether the member is in tension or compression. *(14 marks)*

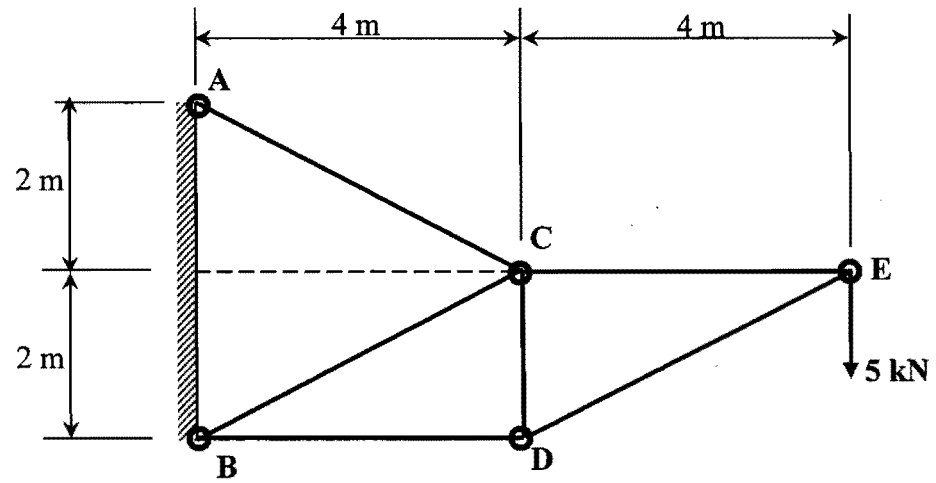


Fig. Q2b

QUESTION THREE ***(20 marks)***

An elevator (lift) of mass 900 kg when empty is lifted or lowered vertically by means of a single wire rope. A person of mass 72.5 kg enters the elevator. Take acceleration due to gravity as 9.81 m/s^2.

(a) Find the tension in the rope, while the elevator is stationary. *(4 marks)*

(b) Find the reaction of the elevator cage on the person, while the elevator is stationary. *(4 marks)*

(c) Find the force exerted by the person on the cage when the elevator is moving up at an acceleration of 3 m/s^2. *(5 marks)*

(d) Find the tension in the rope when the elevator is moving up at an acceleration of 3 m/s^2. *(5 marks)*

(e) Find the tension in the rope when the elevator is moving up at a constant speed. *(1 mark)*

(f) Find the reaction of elevator cage on the person when the elevator is moving down at a constant speed. *(1 mark)*

QUESTION FOUR ***(20 marks)***

A block M of weight 250 N lies on a horizontal surface. The block is kept at rest by two weights P and W attached to two strings passing over two pulleys A and B respectively, anchored as shown in Fig. Q4. If the P is 100 N, find the range of W required to keep the block from moving along the surface in either direction left or right. Take the coefficient of friction between the block and surface as 0.35.

(20 marks)

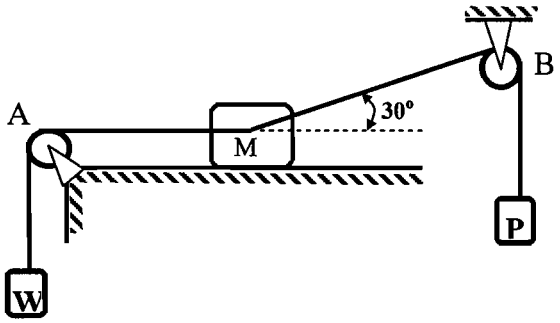


Fig. Q2

QUESTION FIVE ***(20marks)***

Two blocks of masses 3 kg and 5 kg are connected by an inextensible cord and pulleys as shown in Fig. Q5 . If the mass of the cord and the pulleys assumed negligible, determine the velocity of each block 3 seconds after the blocks are released from rest.

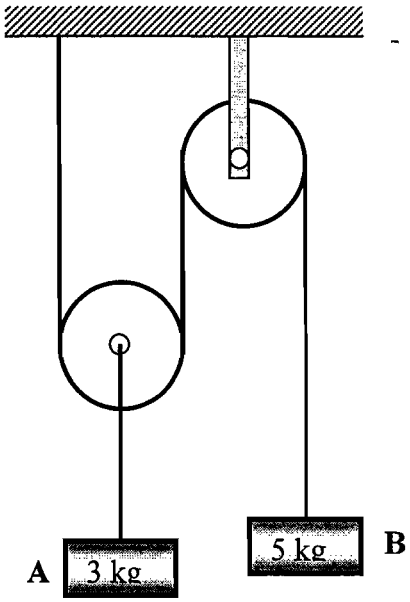


Fig. Q5

QUESTION SIX ***(20 marks)***

(a) A sling shot has two linear elastic cords. Each cord has a round cross-section of diameter 3 mm and length of each cord is 15 cm. For the material of the cord take E = 0.025 GPa. If the cords are extended to twice their original length, find the amount of elastic energy stored in the sling before release. Assume the cross-sectional dimensions of the sling do not change.

(b) A concrete pillar which is reinforced with steel rods supports a load of 3 MN.

For steel rods the total cross-section area is 0.006 m^2 and $E = 2\times10^{11}$ N/m^2.

For concrete the total cross-sectional are is 0.25 m^2 and $E = 2\times10^{10}$ N/m^2.

(i) Determine the stresses in the concrete and in the steel rods.

(ii) Determine the percentage of total load taken by the steel rods.

QUESTION SEVEN (*20 marks*)

(a) In engineering, friction is both desirable and undesirable. Explain this statement *(4 marks)*

(b) (i) What is meant by the moment of inertia of a rigid body? *(2 marks)*

(ii) A motor rotates at 1500 r.p.m. and develops a power of 3 kW. Calculate the torque it develops. *(4 marks)*

(iii) A solid flat disc is made of steel whose density is 8000 kg/m3. The disc has diameter 50 cm and uniform thickness 2 cm. If the disc rotates about its centre at 300 rpm, calculate its kinetic energy. For a solid flat disc of mass m and radius R, $I = \frac{mR^2}{2}$. *(5 marks)*

(c) Briefly discuss the properties common to ceramics class of materials *(5 marks)*