University of Swaziland
Faculty of Science and Engineering
Department of Electrical and Electronic Engineering

Supplementary Examination – July 2017

Title of paper: Engineering Mechanics and Materials Science

Course Number: EEE201/EE201

Time allowed: 3 hours

Instructions:

1. Answer any FOUR (4) questions
2. Each question carries 25 marks
3. Marks for each question are shown at the right hand margin

This paper contains 5 pages including this one.

This paper should not be opened until permission has been granted by the invigilator.

Question 1

a) A 100 N force acts as shown in **Figure 1** on a 300 N block placed on an inclined plane. The coefficients of friction between the block and plane are $\mu_s = 0.25$ and $\mu_k = 0.20$. Determine whether the block is in equilibrium and find the value of the friction force.

[13 marks]

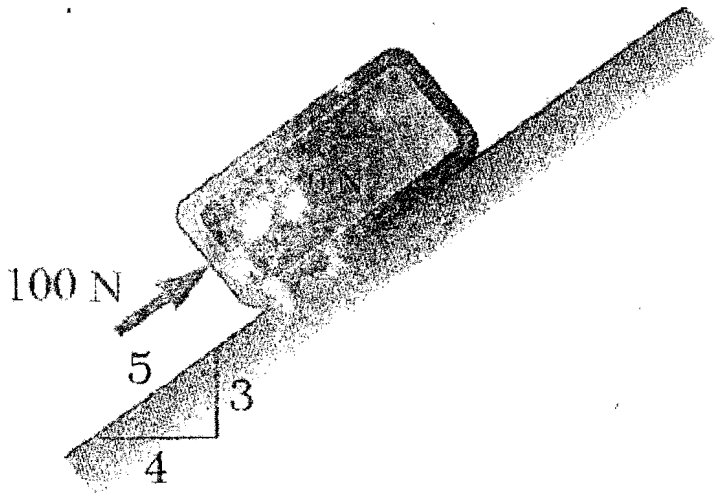

Figure 1

b) Give two types of Alloys [2 marks]

c) List 3 examples of steels [3 marks]

d) List 3 examples of cast irons [3 marks]

e) Give two examples of copper alloys and their uses [4 marks]

Question 2

a) Define the following terms

i) Direct Stress [2 marks]

ii) Shear stress [2 marks]

iii) Thermal stress [2 marks]

iv) Strain [2 marks]

v) Shear strain [2 marks]

b) In **Figure 2** below the force F is 36 N, L is 4 m and the diameter of the rod is 30mm. for given that the young's modulus for steel is 210 GPa and for aluminium is 69 GPa. For each of the elements, find the following:

i) The stress

ii) The stretched length x

iii) The strain [15 marks]

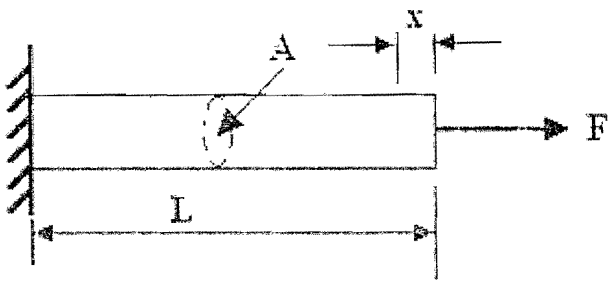

Figure 2

Question 3

a) **Figure 3 a)** shows forces acting on a point **A**

i) Determine the direction and magnitude of the resultant force at A [8 marks]

ii) Draw the resultant force diagram of the solution above [4 marks]

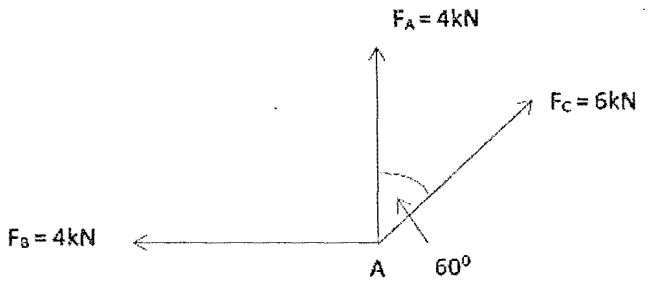

Figure 3 a)

b) **Figure 3 b)** below a bar consisting of two elements, steel and aluminium, joined together. A force F=12kN is applied on both sides. The young's modulus of steel is E = 210GPa, and aluminium is E = 69GPa. The diameter of the steel bar is 5cm and the diameter of the aluminium bar is 7cm

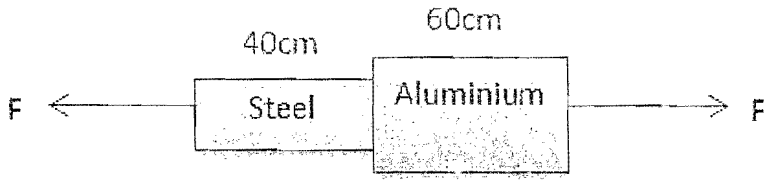

Figure 3 b)

i) Draw the free body diagrams of the bar. [3 marks]

ii) Find

a) The stress in the steel bar [2 marks]
b) The stress in the aluminium bar [2 marks]
c) The extension steel bar [3 marks]
d) The extension of the aluminium bar [3 marks]

Question 4

a) In the diagram **Figure 4** below, the pin-jointed structure supports a block E of weight 14.4 N by a Pulley D. the distances AF = 150, FC = 50, BC = 150, and CD = 300. Neglecting the weights of the members of the structure;

i) Draw the free body diagrams of each member of the structure and show all the forces acting at points A, F, C, B, D. [6 marks]

ii) Determine the vertical and horizontal components, and the magnitudes of the resultant forces at pin joints A, and C, and on member AFC. [13 marks]

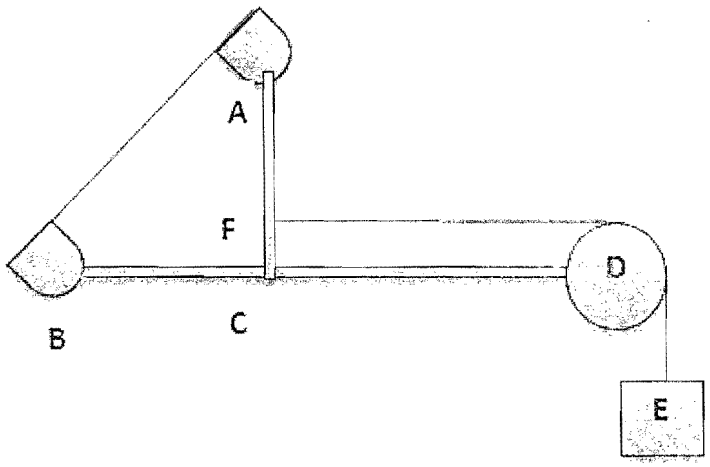

Figure 4

b) Define the following properties

i) Ductility [2 marks]
ii) Hardness [2 marks]
iii) Toughness [2 marks]

Question 5

If the solid cylinder shown in **Figure 5** weighs 2kN, its radius r is 60 cm, and its centroidal moment of inertia I_C is 500m.N.sec^2. It rolls without slipping down the incline. Assume rolling friction to be negligible and g = 9.806 m/s^2

a) Draw the free body diagram [5 marks]

b) Write the expressions of all the forces acting on the cylinder [5 marks]

c) Calculate

i) The translational acceleration $\ddot{x}$ [8 marks]

ii) The angular acceleration $\ddot{\theta}$ [3 marks]

iii) The friction force **F** [4 marks]

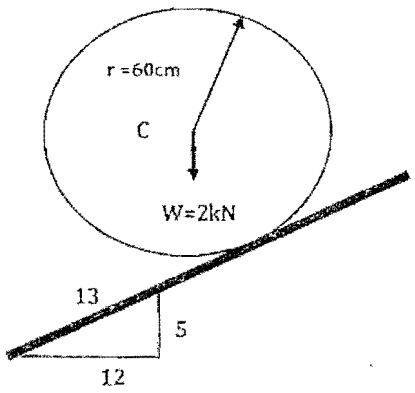

Figure 5