UNIVERSITY OF SWAZILAND

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FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION, FIRST SEMESTER DECEMBER 2017

TITLE OF PAPER:	**ENGINEERING MECHANICS AND MATERIALS SCIENCE**
COURSE CODE:	**EEE201/EE201**
TIME ALLOWED:	**3 HOURS**

INSTRUCTIONS:

1. Answer all **four (4) questions**
2. Each question carries 25 marks.
3. Marks for different sections are shown in the right-hand margin.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

Question 1

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a) Define ductility and malleability of a material. (4 marks)

b) State four properties of copper (4 marks)

c) State two uses of high conductivity copper. (2 marks)

d) State three uses of arsenical tough pitch and phosphorous deoxidized copper (3 marks)

e) A copper rod of diameter 2 cm and length 4 m has a tensile force of 5 kN applied to it.
If the modulus of elasticity for copper is 96 GPa, determine

i) the stress in the rod, and (6 marks)

ii) by how much the rod extends when loaded. (6 marks)

Question 2

a) Give a definition of torsion of a shaft. (2 marks)

b) A diesel engine of 67 hp transmits power to a generator at 300 revolutions per minute. Neglecting any transmission losses.

i) Determine the torque applied to the shaft connecting the engine and the generator. (6 marks)

ii) Determine the minimum permissible diameter of a solid circular section steel shaft. (9 marks)

iii) What would be the resulting angle (in degrees) of twist of the shaft due to the applied torque of 1.5708 kN m, given that the maximum shear stress in the shaft is limited to 64 MPa, the shaft is 1 metre long and 0.055 meter in diameter, and the rigidity modulus is 70 GPa.

[Note that 1 hp = 745.7 W and $J = \frac{\pi r^4}{2}$]. (8 marks)

Question 3

a) The shaft of an electric motor, initially at rest accelerates uniformly for 0.4 seconds at 15 rad/s^2. Determine the angle, in radians, turned through by the shaft in this time. (5 marks)

b) i) What do you understand by the term "smart materials". (4 marks)

ii) State the properties of shape-memory alloys and piezoelectric materials. (6 marks)

c) Determine the reaction forces, R1 and R2, and the internal forces, F1, F2, and F3, that occur in the plane pin-jointed truss of Figure 3, due to the externally applied vertical load of 5 kN. (10 marks)

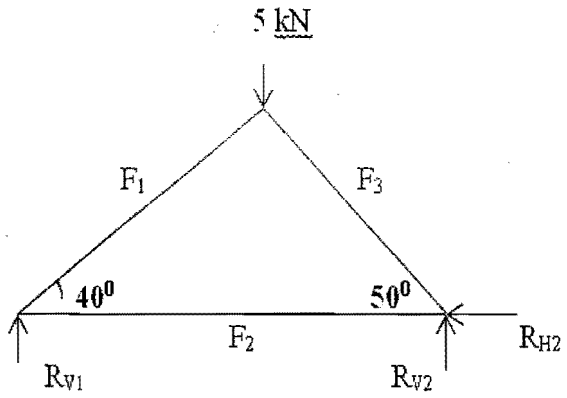

Figure 3

Question 4

a) Obtain the **mass, in kg,** required to balance a single plane unbalanced system as shown in Figure 4 and given below. The balance mass is to be placed at a radius of 10 cm . (19 marks)

b) Write the necessary equations for dynamic balancing of different masses rotating in different planes (multi-plane system). (6 marks)

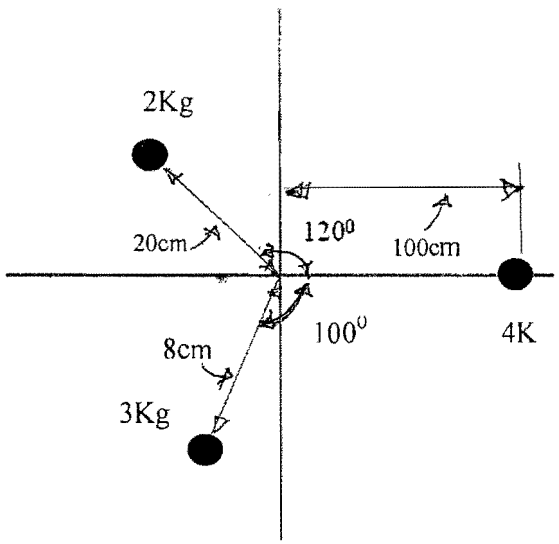

Figure 4