MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 217: PRINCIPLES OF ENGINEERING DESIGN

DATE: 27/9/2019 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

This paper contains FIVE questions.

Question ONE is compulsory and carries 30 marks.

Four remaining questions carry 20 marks each.

Attempt question ONE and any other TWO.

QUESTION 1 (30 MARKS)

(a) What is the difference between a model and a prototype? **(2 Marks)**

(b) Giving examples, explain how the following design considerations influence engineering design **(10 Marks)**

(i) Corrosion

(ii) Noise

(iii) Safety

(iv) Lubrication

(v) Weight

(c) Differentiate between codes and standards **(2 Marks)**

(d) Discuss 4 things that you may do to lower the cost of an engineering design **(8 Marks)**

(e)

(i) Define product liability **(1 Marks)**

(ii) What steps can a designer take to ensure safety of product and avoid product liability? **(3 Marks)**

(f) Define the maximum normal stress theory for brittle materials **(2 Marks)**

(g) An aluminium rod has a radius of $2 \pm 0.22\ mm$. The stress analyst has calculated this rod will see a maximum tensile axial load ranging from 2000 to 2700 N. Any plastic deformation of this rod results in a loss of component functionality. The rod is part of a plane with a programme-mandated factor of safety, n = 3. The aluminium has a yield strength of $S_y = 500\ MPa$ and $S_{ut} = 580\ MPa$. Determine whether, the factor of safety meets the programme-mandated standard. **(2 Marks)**

QUESTION 2 (20 MARKS)

(a) Name and describe each of the 6 steps of the engineering design process **(12 Marks)**

(b) Highlight two design tools available to design engineers **(2 Marks)**

(c) Where can design engineers get technical information about the behaviour of the off-the-shelf engineering components? **(2 Marks)**

(d) List 4 types of audiences that you may endeavour to sell your design idea to **(4 Marks)**

QUESTION 3 (20 MARKS)

(a) Explain 5 factors that affect material selection mechanical design of an engineering component **(5 marks)**

(b) Plot a stress-strain curve of a ductile material and explain 5 points of interest to a design engineer **(6 Marks)**

(c) Other than measuring the hardness value of a material, discuss 4 other instances where a hardness test may be necessary **(4 Marks)**

(d)

(i) Differentiate between brittleness and toughness **(2 Marks)**

(ii) What 3 properties would you look for in a material to be used to design a component for a gas turbine (airplane engine)? **(3 Marks)**

QUESTION 4 (20 MARKS)

(a) Define the following dimensioning terminology

(i) Tolerance

(ii) Limits

(iii) Clearance

(iv) Interference **(4 Marks)**

(b) Why is it important to include tolerance to your designs before sending them out for manufacturing? **(1 Marks)**

(c) Distinguish between the maximum shear stress theory and the distortion theory for ductile materials **(4 Marks)**

(d) A materials has a yield strength, $S_y = 500\ MPa$ and an ultimate tensile of $S_{ut} = 750\ MPa$. For $\sigma_1 = 300\ MPa, \sigma_2 = 200\ MPa\ and\ \tau_{max} = 90\ MPa$, estimate the factor of safety using:

(i) The maximum shear stress theory **(1 Marks)**

(ii) The distortion theory **(1 Marks)**

(iii) The maximum normal stress theory **(1 Marks)**

(e) Discuss the ergonomic principles that should guide a design engineer **(6 Marks)**

(f) A rod with a cross-sectional area of A and loaded in tension with an axial force of P = 2000 N. Using a material strength $S_y = 240\ MPa$ and a design factor of 3.0. Determine the minimum diameter of a solid circular rod. **(2 Marks)**

QUESTION 5

(a) Describe 6 categories of machine elements that a mechanical engineer may be called upon to design **(12 Marks)**

(b) List 8 factors to consider when selecting a bearing for a design problem **(4 Marks)**

(c)

(i) What is a design constraint? **(1 Mark)**

(ii) Explain 3 common design constraints **(3 marks)**