



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 217: PRINCIPLES OF ENGINEERING DESIGN

DATE: 23/5/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer question one and any other two questions

QUESTION ONE (30 MARKS)

- a) What is the difference between a model and a prototype? (2 marks)
- b) Explain how the following design considerations influence engineering design (7 marks)
 - i. Corrosion
 - ii. Wear
 - iii. Safety
 - iv. Lubrication
 - v. Weight
 - vi. Aesthetics
 - vii. Ergonomics
- 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 mark)
 - 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 $2 \pm 0.22 \text{ mm}$. 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 $S_y = 500 \text{ MPa}$ and $S_{ut} = 580 \text{ MPa}$. Determine whether, the factor of safety meets the programme-mandated standard. (5 marks)

QUESTION TWO (20 MARKS)

- a) Name and explain 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 THREE (20 MARKS)

- a) Explain 5 factors that affect material selection in the 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 FOUR (20 MARKS)

- a) Define the following dimensioning terminology
- i. Tolerance
- ii. Limits
- iii. Clearance
- iv. Interference

- v. Fit (5 marks)
- b) Why is it important to include tolerance to your designs before sending them out for manufacturing? (2 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, $S_y = 500 \text{ MPa}$ and an ultimate tensile of $S_{ut} = 750 \text{ MPa}$. For $\sigma_1 = 300 \text{ MPa}$, $\sigma_2 = 200 \text{ MPa}$ and $\tau_{max} = 90 \text{ MPa}$, estimate the factor of safety using:
- The maximum shear stress theory (2 marks)
 - The distortion theory (3 marks)
 - The maximum normal stress theory (2 marks)
- e) 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 $S_y = 240 \text{ MPa}$ and a design factor of 3.0. Determine the minimum diameter of a solid circular rod. (2 marks)

QUESTION FIVE (20 MARKS)

- 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)