



# 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 200: COMPUTER AIDED DRAWING AND DESIGN

**DATE: 16/5/2019**

**TIME: 8.30-11.30 AM**

**INSTRUCTIONS: Answer Question One and Any Other Two Questions**

## QUESTIONS ONE (30 MARKS)

- a) Define the terms CAD, CAM and describe the relationship between CAD and CAM giving rise to CAD/CAM (5 marks)
- b) State two benefits and two limitations of CAD/CAM. (4 marks)
- c) Describe five ways in which the computer is used to assist in design (5 marks)
- d) Describe briefly the following components of a CAD system.
  - i. Hardware (2 marks)
  - ii. Application software (2 marks)
  - iii. Operating system (2 marks)
- e) Describe the major advantages of numerical control over conventional methods of machine control (5 marks)
- f) With the aid of a sketch, describe how a CAD data exchange file may be used between two CAD systems (3 marks)
- g) Define Finite Element Analysis (2 marks)

## QUESTIONS TWO (20 MARKS)

- a) Describe the three stages in Finite Element Analysis (6 marks)
- b) A cantilever beam with a rectangular cross-section is to be analysed for stress and deformation using a CAD software with a FEA module. Using sketches where necessary, describe the workflow in carrying this analysis. (7 marks)
- c) What is the importance of carrying out analysis of a mechanical part or assembly in the design phase? (3 marks)
- d) Describe two methods available for pre-processing while using a CAD system in conjunction with a FEA package (4 marks)

## QUESTIONS THREE (20 MARKS)

- a) Briefly describe the following solid representation schemes used in CAD systems
  - i. Constructive solid geometry (CGS) (2 marks)
  - ii. Boundary representation (B-rep) (2 marks)
  - iii. Primitive instancing (2 marks)
- b) A line with end points A(2, 3, 2) and B(10, 12, 8) is rotated  $60^\circ$  counter-clockwise about the z-axis, then translated by a vector  $[5 \ 4 \ 8]^T$  and finally scaled by (2, 2, 3). Determine the final coordinates of the line (8 marks)
- c) State two applications of wire frame models (1 mark)
- d) State two advantages and two disadvantages of surface modelling (2 marks)
- e) Figure Q3(e) shows a solid model represented using B-rep. Verify whether it satisfies modified Euler's formula,

$$V - E + F - H = 2(C - G)$$

(3 marks)

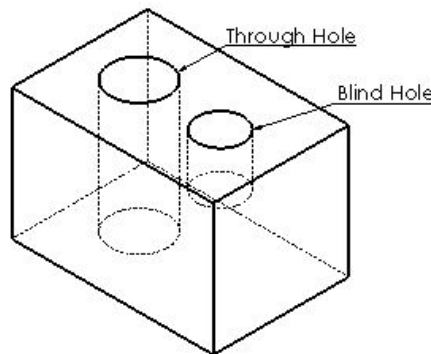


Figure Q3(e)

#### QUESTIONS FOUR (20 MARKS)

- With the aid of sketches, describe two (2) motion control systems used in numerical control (NC) systems (4 marks)
- List five factors used in rating NC machines (2.5 marks)
- Figure Q4(c) is an illustration of a billet that is to be milled on a three axis CNC machine. Using the program table format provided in Table 1, write a program that can be used to effectively mill the profile. (13.5 marks)

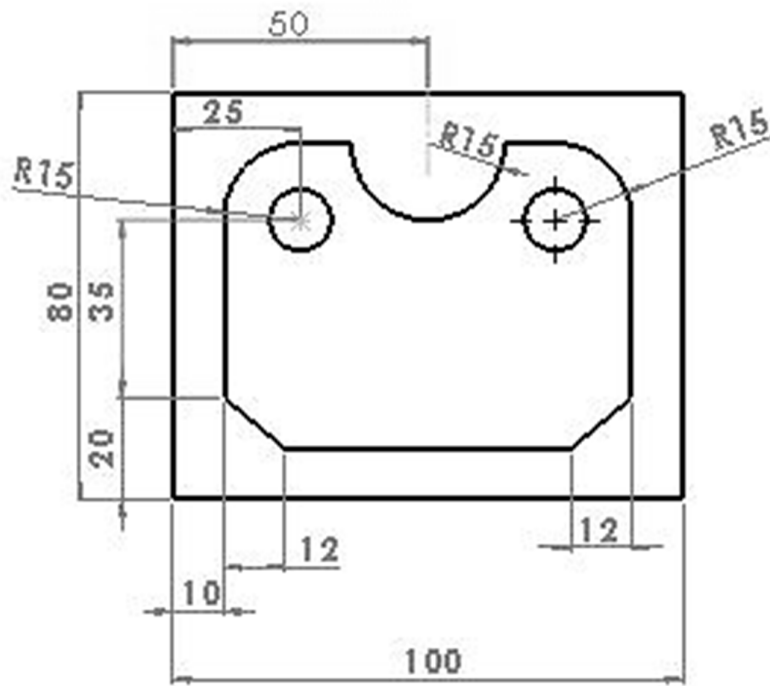


Figure Q4(c)

Billet size 100 x 80 x 40  
 Profile depth 10mm  
 Spindle speed 1500 rpm  
 Feed rate 100 mm/min (for both milling and drilling)

Table 1. NC part program manuscript

| Description | N | G | G | G | X | Y | Z | R | I | J | K | M | T | D | S | F |
|-------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

### **QUESTION FIVE (20 MARKS)**

- a) Briefly describe the basic components of an industrial robot and show their relationship using a schematic diagram (8 marks)
- b) Define the following terms used in relation to precision in robotics:
  - i. Accuracy (1 mark)
  - ii. Repeatability (1 mark)
- c) Describe the three (3) methods used to program robots (3 marks)
- d) A recently established organisation is considering the acquisition of a robot to speed up production. The robot is to pick up crates of small gas cylinders from a conveyer and stack them onto a waiting Automatically Guided Vehicle (AGV), which docks at a fixed position. Stacking is done such that the crates have to fit into each other precisely. Each crate weighs 250 kgs. The cost of the preferred robot must be kept at a minimum.  
Give a technical description of the most ideal robot to be used in the set-up described above. (7 marks)