



# **NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF INDUSTRIAL TECHNOLOGY**

**DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING**

**COMPUTER AIDED DESIGN/COMPUTER AIDED MANUFACTURING (CAD/CAM) I**

**TIE 5111**

**First Semester Supplementary Examination Paper**

**July/August 2015**

This examination paper consists of 6 printed pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Special Requirements: None**

**Examiner's Name: Nicholas Tayisepi**

## **INSTRUCTIONS AND INFORMATION TO CANDIDATE**

1. Answer any four (4) questions.
2. Each question carries 25 marks.
3. Use of calculators is permissible.

## **MARK ALLOCATION**

<b>QUESTION</b>	<b>MARKS</b>
1.	25
2.	25
3.	25
4.	25
5.	25
6.	25
<b>TOTAL MARKS ATTAINABLE BY CANDIDATE</b>	<b>100</b>

### QUESTION ONE

(a) Briefly explain the four main hardware, of CAD/CAM equipment, networking arrangements possible for Computer Aided Designing (CAD) and Computer Aided Manufacturing (CAM) systems. [8]

(b) Describe the steps of the design process according to the Pahl and Beitz model. Show, on the diagram, all the stages and indicate the input and outputs for each stage. [17]

### QUESTION TWO

(a) Computer Aided Design provides the designer with a rich variety of techniques for the definition of Geometric entities. Describe with the aid of illustrative sketches the methods available for the definition (construction) of:

(i) point, [5]

(ii) line, [5]

(iii) arc, [5]

(iv) surface representation. [5]

(b) Identify and explain any five solid modelling primitives that are found on the AutoCAD modelling platform that you have used. [5]

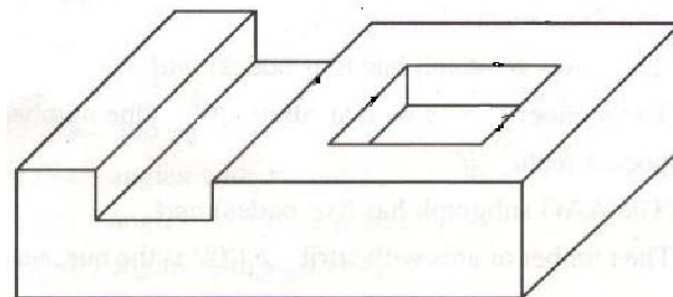
### QUESTION THREE

(a) What is geometric modeling? [3]

(b) Name and explain the main categories of solid modeling approaches.

(c) Create the CSG model of the solid represented in Figure QU3. [18]

(d) What is the height of the binary tree in each case? [4]



**Figure QU3. Lug sit**

#### QUESTION FOUR

- (a) State the two main types of Euler Operators used in the development and manipulation of solid CAD Models like a Polyhedron. [3]
- (b) Once a polyhedron model is available a CAD modeller may edit it into many other topologically valid solid models by the finite process of adding or deleting vertices, edges and faces to create a new polyhedron using the Euler Mantyla operators, which form a complete set of modelling primitives for manifold solids. Complete the Table TQ4 by entering the relevant Euler Operators and the corresponding parameter entries where required. [11]

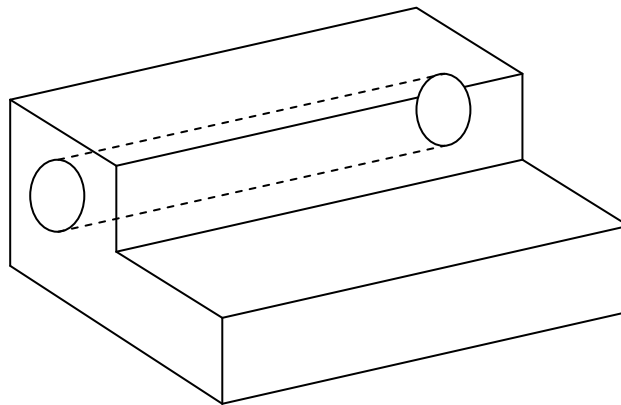
**Table TQ4 Euler Operator and Parameters**

Operator Name	Meaning	V	E	F	L	S	G
MSFV							
MEV	Make and Edge and a Vertex						
MFV							
MFE							
MSG							
MEKL							
KEV		-1	-1				
KFE							
KSFV							
KSG							
KEML							

Q4b) (i) Given the Inverse Euler Matrix ( $M^{-1}$ ) below determine the Euler coordinates for the feature shown in Figure QU4. [9]

Given:

$$M^{-1} = \frac{1}{12} \begin{bmatrix} 9 & -5 & 2 & -2 & 3 & 1 \\ 3 & 5 & -2 & 2 & -3 & -1 \\ -3 & 7 & 2 & -2 & 3 & 1 \\ -6 & 2 & 4 & 8 & -6 & 2 \\ 3 & 5 & -2 & 2 & 9 & -1 \\ -6 & -2 & 8 & 4 & -6 & -2 \end{bmatrix}$$

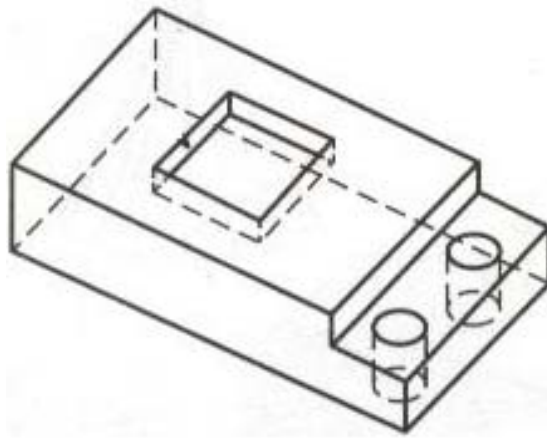


**Figure QU4**

(ii) Briefly explain how the Euler coordinates determination can be of significance in commercial draughting packages. [2]

## QUESTION FIVE

- (a) Explain the concept of boundary representation in modelling. [3]  
 (b) Generate the boundary representation of the solid shown in Figure QU5 below. [12]



**Figure QU5. Drilled stepped block**

Q5(c) Briefly discuss two CAD/CAM data exchange standards and state their benefits. [4]

(d) Describe the following modelling techniques, using diagrams as appropriate:

- i) pure primitive instancing [2]
- ii) cell decomposition [2]
- iii) spatial occupancy enumeration [2]

### QUESTION SIX

(a) A point P (100, 100, 200) is to be translated by 50 units in X-direction, 60 units in they-direction and 40 units in the Z-direction. It was then given a rotation of 10 degrees about the x-axis, 15 degree about the y-axis and 15 degrees about the Z-axis. Find the transformation matrix and co-ordinates of the final position of the point. [6]

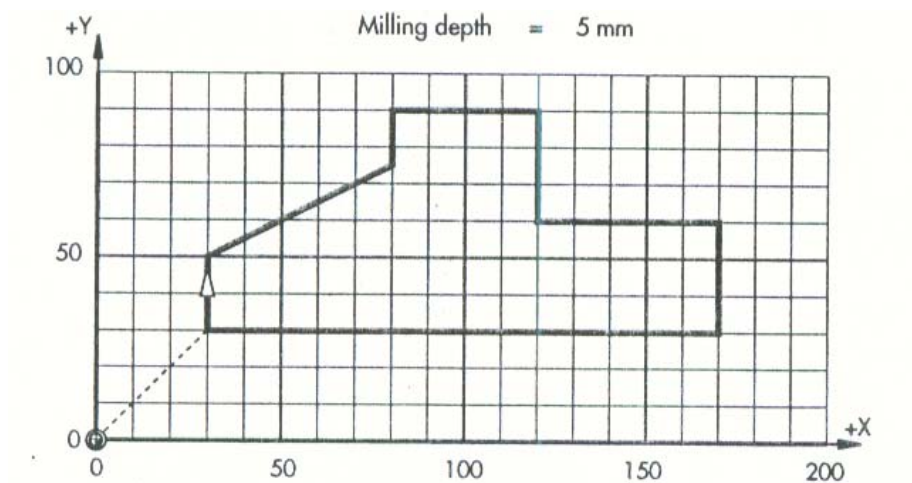
(b) Given four control points A(4,8), B(7, 9), C(8, 1), and D(10, 4) for a Bezier curve

$$\bar{p} = \bar{p}(u) = p_0(1 - 3u + 3u^2 - u^3) + \bar{p}_1(3u - 6u^2 + 3u^3) + \bar{p}_2(3u^2 - 3u^3) + \bar{p}_3(u^3).$$

Compute the gradients at start, mid and end point of the curve. [6]

(c) Explain briefly when AutoLISP programming may be the best relevant CAD Models generating design domain in an engineering and manufacturing environment. [4]

(d) Write an AutoLISP code for auto-drawing the profile defined on Figure QU6, below, upon the entry of a variable dimension and picking up a start point by the operator. Also the program output should include the area represented (covered) by the outline drawn. [9]



**Figure QU6. Machine Plate**

**End of Examination**

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