CAD/CAM
(MECH 4121)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which of the following G code will give rapid linear movement?
    (a) G00   (b) G01   (c) G56   (d) G94.

(ii) Most primitive graphics standard among the followings is
    (a) VGA   (b) XVGA   (c) PHIGS   (d) GKS.

(iii) For difference between final and initial x-coordinates Δx and final and initial y-coordinates Δy, Initial error term $\bar{e}$ in generalized Bresenham is denoted as
    (a) $\bar{e} = 2\Delta x - \Delta y$ (b) $\bar{e} = \Delta x - \Delta y$
    (c) $\bar{e} = 2\Delta y - \Delta y$ (d) $\bar{e} = \Delta y - \Delta x$.

(iv) Which one of the following is true about Bresenham Algorithm?
    (a) It is a Surface generation algorithm
    (b) It is a Parametric Line drawing algorithm
    (c) It is a Solid model generation algorithm
    (d) It is a Non-parametric Line drawing algorithm.

(v) 3×3 homogeneous transformation matrix for scaling of an object about origin by S_x factor along x-axis and by S_y factor along y-axis is

(a) $\begin{bmatrix} S_x & 0 & 0 \\ S_y & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & S_x & 0 \\ S_y & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & S_x & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$

(vi) Full form of NURBS is
    (a) Non-Uniform Rational Beata Spline
    (b) Non-Uniform Regular Bezier Spline
    (c) Normalizing Uniform Rational Bezier Spline
    (d) Non-Uniform Rational Bezier Spline.

(vii) Stiffness matrix of a BAR element transformed to global coordinate for solving truss problem is a
(a) 3 × 3 matrix
(b) 4 × 4 matrix
(b) 2 × 2 matrix
(d) single column matrix.

(viii) M-codes are also known as
(a) preparatory codes
(b) spindle speed codes
(c) tool selection codes
(d) miscellaneous codes.

(ix) Stiffness of a BEAM element having length 'L', moment of inertia of the beam cross-section 'I' and modulus of elasticity of beam material 'E' is
(a) $\frac{EI}{L^3}$
(b) $\frac{EI}{L^2}$
(c) $\frac{EI}{L}$
(d) EIL.

(x) Full form of MCU is
(a) Machine computer unit
(b) Machine control unit
(c) Machine control universal
(d) Machine computer universal.

Fill in the blanks with the correct word

(xi) _____ G-code is used to cancel offset compensation for cutter radius.

(xii) Parametric representation of a line between point 1 (x_1, y_1) and 2 (x_2, y_2) with respect to a parameter 'u' is _____.

(xiii) Transformation matrix for the process of reflection about x-axis is given by _____.

(xiv) _____ G-code is used to give input of cutter offset data.

(xv) _____ G-code will produce dwell for a specified time.

Group - B

2. (a) Write a detailed note on STEP graphic exchange format. *[(CO1)(Remember/LOCQ)]*
   (b) Rasterize a line from (0, 0) to (-3, -4) mm on a display which is mapped to approximately (500 × 400) mm. The resolution of the screen is 640×480 pixels. Calculate the intermediate pixel positions of this rasterization using generalized Bresenham algorithm and represent them schematically, drawing a suitable pixel matrix. *[(CO1)(Analyse/IOCQ)]*
   4 + 8 = 12

3. A triangle PQR with vertices at 'P'= (-19, 15), 'Q'= (-19, 23) and 'R'= (-11, 23) is to be mirrored about a line of reflection passing through a point (0,5) and making an angle of 40^0 with 'X' axis. After reflection it is to be scaled by a factor of 2 along 'X' and 'Y' both about the current position of vertex 'P'. Determine coordinates of the vertices 'P', 'Q' and 'R' at their final position. Represent the triangle PQR graphically at its initial and at its final position in a graph paper. *[(CO1)(Apply/HOCQ)]*
   12

Group - C

4. There are two lines 'L₁' and 'L₂'. 'L₁' is from (3, 7) to (12, 21) and 'L₂' is from (10, 5) to (4, 18). Write down parametric equations of these two straight lines and determine parametrically the co-ordinate of intersecting point of these two lines. Also, justify parametrically whether these two lines are perpendicular to each other or parallel to each other. *[(CO2)(Analyse/IOCQ)]*

    (4 + 6 + 2) = 12

5. (a) Write a note on parametric representation of Bezier Curve with its mathematical and graphical details. *[(CO3)(Understand/IOCQ)]*

    (b) Compare CSG method and B-rep method of solid building. Briefly explain CSG method. *[(CO3)(Understand/IOCQ)]*

    5 + (3 + 4) = 12

Group - D

6. The plane truss shown in Fig. 1 is subjected to a downward vertical load at joint 2. Determine the deflection of joint 2 in the global coordinate system and the axial stress in each element. For both elements A = 0.5 in² and E = 30 ×10⁶ psi.

Fig. 1

[(CO4)(Analyse/HOCQ)]
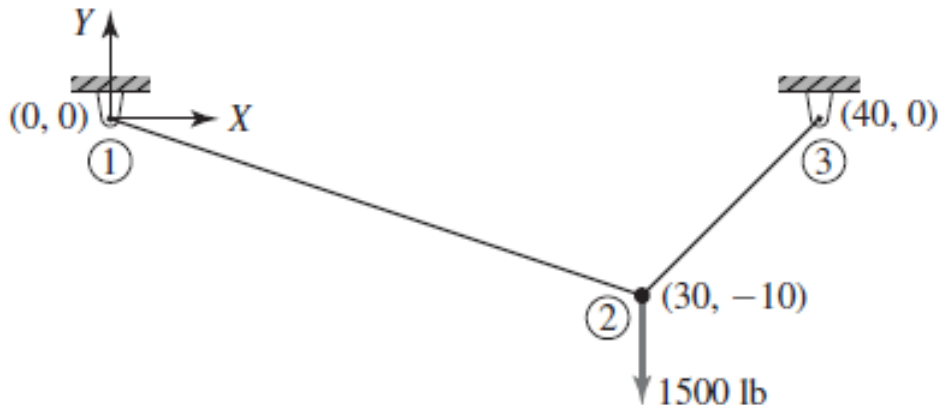
(8 + 4) = 12

7. Discuss in detail about various 1 dimensional, 2 dimensional and 3 dimensional elements used in Finite Element Analysis method showing their nodal and elemental degree of freedom. *[(CO4)(Understand/IOCQ)]*

    (6 + 6) = 12

Group - E

8. (a) Briefly explain the basis of designating the coordinate axes in CNC machine tools. *[(CO5)(Remember/LOCQ)]*

   (b) Explain Canned Cycle in CNC programming with the help of an example. *[(CO5)(Understand/LOCQ)]*

    (c) Explain the method used in CNC programming for tool specification along with cutter radius compensation. *[(CO5)(Apply/IOCQ)]*

    3 + 4 + 5 = 12

9. It is required to do a CNC turning operation to manufacture a component, drawing of which is given in Fig. 2 below. This part is to be machined from a rolled stock of 20-mm diameter. Prepare the process plan and represent them in tabular form and then write down a complete NC Program to execute the machining in CNC turning machine.

Fig. 2

[(CO6)(Analyse/HOCQ)]
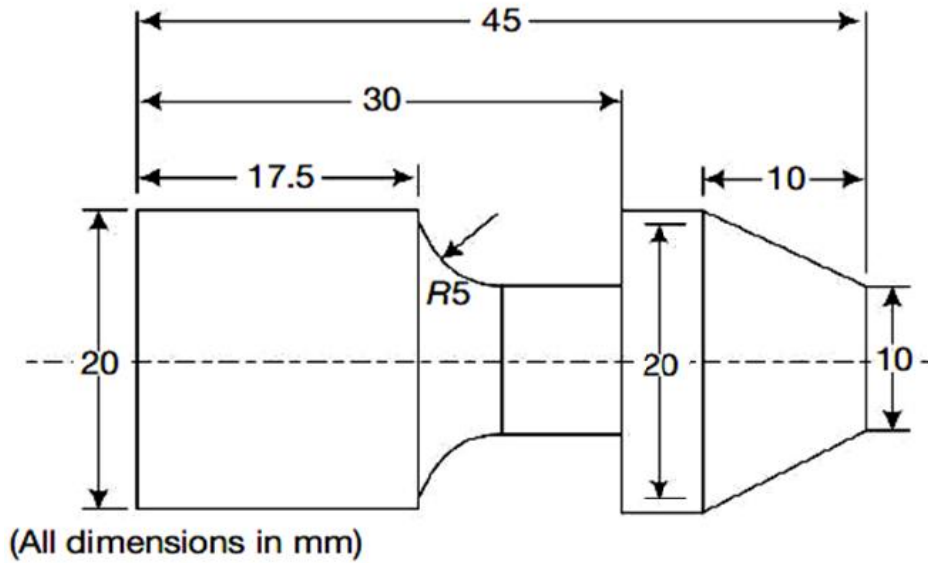
12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	11.5	51	37.5

Course Outcome (CO):

After the completion of the course students will be able to
CO1: Demonstrate general processes involved in CAD/CAM and formation of graphical primitives in any non-parametric CAD system.
CO2: Interpret the process of creation and modifications of 1D entities in parametric CAD software with better logical and mathematical understanding behind it.
CO3: Apply theoretical conceptions behind parametric modelling of curves, surfaces and solids in a CAD software.
CO4: Analyse the process of numerical simulations under various structural and thermal loadings along with different boundary conditions using finite element method.
CO5: Evaluate the technical viability of any product from the view point of manufacturing in the process of CAM and CIM.
CO6: Build any CNC machine programming with confidence and ease.

LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.