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 any 4 (four) from Group B to E, taking one 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) 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) $\bar{e} = \Delta y - \Delta x$

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

(iii) When error term in Bresenham rasterizing of a line have slope more than 45° is greater than zero than which of the following is correct for next step of the iteration.
(a) $x_{n+1} = x_n \pm 1, y_{n+1} = y_n \pm 1$ and initial error term would be modified
(b) $x_{n+1} = x_n, y_{n+1} = y_n \pm 1$ and initial error term would be modified
(c) $x_{n+1} = x_n \pm 1, y_{n+1} = y_n \pm 1$ and initial error term would not be modified
(d) $x_{n+1} = x_n \pm 1, y_{n+1} = y_n$ and initial error term would not be modified.

(iv) Full form of NURBS is
(a) Non-Uniform Rational Beta Spline
(b) Non-Uniform Regular Bezier Spline
(c) Normalizing Uniform Rational Bezier Spline
(d) Non-Uniform Rational Bezier Spline

(v) Which of the following is not a solid primitive.
(a) Bezier surface (b) B-spline surface
(c) Coon surface (d) Surface of revolution

(vi) Nodal degree of freedom of a BEAM element is
(a) 'u' and 'θ' (b) 'v' and 'θ'
(c) 'u' and 'v' (d) 'v' and 'w'

(vii) For a straight cantilever beam problem, if it is discretized with 6 Beam elements, then the global stiffness matrix would be a
(a) 6×6 matrix (b) 10×10 matrix
(c) 12×12 matrix (d) 14×14 matrix

(viii) During the execution of a CNC part program block NO20 GO2 X45.0 Y25.0 R5.0 the type of tool motion will be
(a) Circular Interpolation – clockwise
(b) Circular Interpolation – counter clockwise
(c) Linear Interpolation
(d) Rapid feed.

(ix) G91 code is used for
(a) Absolute co-ordinate system (b) Incremental co-ordinate system
(c) Linear Interpolation (d) Rapid Interpolation.

(x) Which of the following G code is used for Clock Wise Circular Interpolation?
(a) G00 (b) G01 (c) G02 (d) G03

Fill in the blanks with the correct word

(xi) If a line is to be rasterized between points (3,4) to (12, 21) then, value of 'Interchange' will be _____.

(xii) If a point with coordinate (12, 23) is to be rotated by 45^{o} counter clockwise about the origine, then its new coordinate would be _____.

(xiii) Elemental stiffness matrix of a 2-node BAR element transformed into global coordinate system of a Truss structure having length 'L', cross-sectional area 'A', Young's modulus of elasticity 'E' and angle of inclination 'θ' with global X-axis is _____.

(xiv) Bezier Curve is a type of _____ curve.

(xv) In case of CNC turning machine the axis about which job rotates is universally denoted by _____ axis.

Group - B

2. (a) Mention all the Graphics Standards starting from primitive one to the latest one.
[(CO1)(Remember/LOCQ)]

(b) Rasterize a line from (4, 7) to (7, 10) mm on a display, which is mapped to approximately (500 × 400 mm). The resolution of the screen is 640 × 480 pixels. Use Generalized Bresenham algorithm to generate all the intermediate pixels. Finally represent stepwise coordinates of all the pixels in tabular form and show all those pixels graphically through manual drawing of pixels in enlarged form.
[(CO1)(Analyse/IOCQ)]

3 + (6 + 3) = 12

3. A straight-line PQ having vertices 'P' at (-7, -11) and 'Q' at (15, 18) has been translated by 9 unit along positive X-direction and by 2 unit in positive Y-direction. Then it has been rotated by an angle of 55^0 in counter clockwise about the current position of vertex 'P'. Find the coordinates of the vertices 'P' and 'Q' at its final position after executing all the transformations mentioned above. Represent the line PQ in a graph paper at its initial position as well as at its final position. *[(CO1)(Analyse/HOCQ)]*

(9 + 3) = 12

Group - C

4. There are two lines 'L1' and 'L2'. 'L1' is from (5, 11) to (19, 27) and 'L2' is from (12, 4) to (7, 30). 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. *[(CO3)(Analyse/HOCQ)]*

(2 + 6 + 4) = 12

5. A line AB runs from point A at (7, 4) to point B at (26, 12). There is another point 'C' at (12, 23). Write down parametric equations of the straight-line AB and determine its gradient vector. Also calculate parametrically the perpendicular distance from the point 'C' to the line AB. *[(CO3)(Analyse/HOCQ)]*

(2 + 3 + 7) = 12

Group - D

6. (a) Fig. 1 depicts an assembly of two bar elements made of two different materials. Draw the FEA model of the given problem out of its physical model. Write down the global stiffness matrix of the problem. Also write down the final FEA formulation of the given problem.

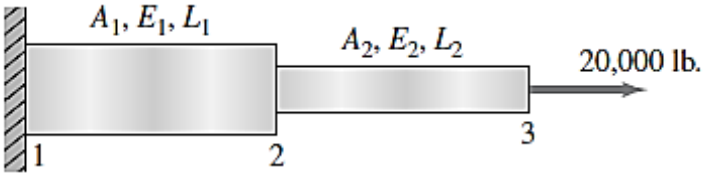

Fig. 1

Given $A_1 = 4$ in^2, $A_2 = 2.25$ in^2, $E_1 = 15 \times 10^6$ lb/in^2, $E_2 = 10 \times 10^6$ lb/in^2 and $L_1 = L_2 = 20$ in. *[(CO4)(Analyse/HOCQ)]*

(b) Schematically represent all the 3D elements used for Finite Element analysis clearly showing their Nodal Degree of Freedom (NDOF). Also mention Elemental Degree of Freedom (EDOF) of each element. *[(CO4)(Understand/IOCQ)]*

(1 + 3 + 2) + 6 = 12

7. (a) The plane truss shown in the following Fig. 2 is subjected to a downward vertical load at joint 2. Draw the FEA model of the given problem out of its physical model. Write down the global stiffness matrix of the problem. Also write down the final

FEA formulation of the given problem. For all elements consider A = 100 mm^2 and E = 210 GPa. Take length of the horizontal member 1000mm.

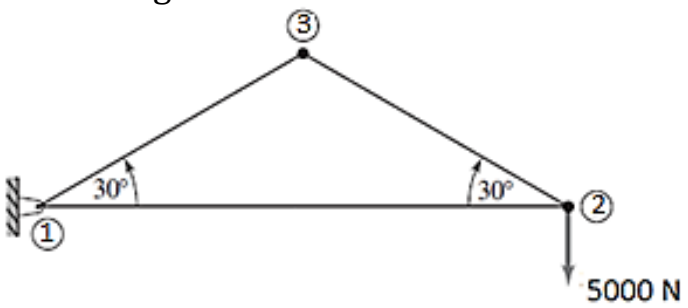

Fig. 2

All dimensions shown in the figure are in mm. *[(CO4)(Analyse/HOCQ)]*

(b) Schematically represent all the 1D elements used for Finite Element analysis clearly showing their Nodal Degree of Freedom (NDOF). Also mention Elemental Degree of Freedom (EDOF) of each element. *[(CO4)(Understand/IOCQ)]*

(1 + 4 + 2) + 5 = 12

Group - E

8. (a) Explain the method used in CNC programming for tool specification along with cutter radius compensation. *[(CO5)(Remember/LOCQ)]*

(b) Define the function of the following G Code- (i) G00 (ii) G01 (iii) G02 (iv) G70 (v) G71 (vi) G90 *[(CO5)(Remember/IOCQ)]*

6 + 6 = 12

9. For the following component shown in Fig. 3 (all dimensions are in mm), make a part program on a CNC turning machine using FANUC controller with work material - Aluminium and Tool material - HSS. Work size Ø30x90 mm, Tool Type-Single point cutting tool, Turret no. 1, Machine Tool used - CNC Turning.

(i) Draw NC drawing

(ii) Prepare coordinate table

(iii) Calculate cutting speed and feed rate

(iv) Prepare program manuscript using required and relevant G-codes and M-codes

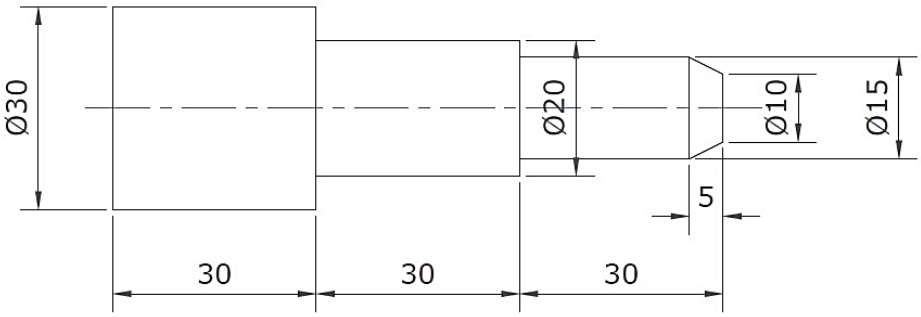

Fig. 3

[(CO6)(Evaluate/HOCQ)]

(2 + 2 + 2 + 6) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	9.38	27.08	63.54