Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–IV • EXAMINATION– WINTER • 2015

Subject Code: 741501 **Date: 05/12/2015**

Subject Name: Structural Optimization

Time: 2:30 PM TO 5:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 Explain following in detail. **14**

(1) Function
(2) Variables
(3) Constraints
(4) Saddle Point
(5) Local Minima
(6) Global Maxima
(7) Stationary Points

Q.2 **(a)** Enlist various engineering applications of optimization. **07**

(b) Analyze the function, $f(x) = 12x^2 - 45x^4 + 40x^3 + 5$ and classify the stationary points as maxima, minima and points of inflection. **07**

OR

(b) Considering the function, $f(x) = 2x_1^3/3 - 2\,x_1x_2 - 5x_1 + 2x_2^2 + 4x_2 + 5$, find out if the function is convex, concave or neither at the points of optima based on the testing rules. **07**

Q.3 **(a)** Minimize the function **07**

$f(x,y) = kx^{-1}\,y^{-2}$ Subjected to

$g(x,y) = x^2 + y^2 - a^2$ using Lagrange's multiplier method.

(b) Minimize $f = x_1^2 + 5x_2^2 + 8x_3^2$ subjected to the constraints, **07**

$g_1 = x_1 - 2x_2 - x_3 \leq 30$

$g_1 = x_1 + x_2 - 3x_3 \leq 12$ Using Kuhn Tucker's condition.

OR

Q.3 **(a)** Use simplex method to minimize, **07**

$Z = 3x_1 + 5x_2 + 4x_3$ subjected to

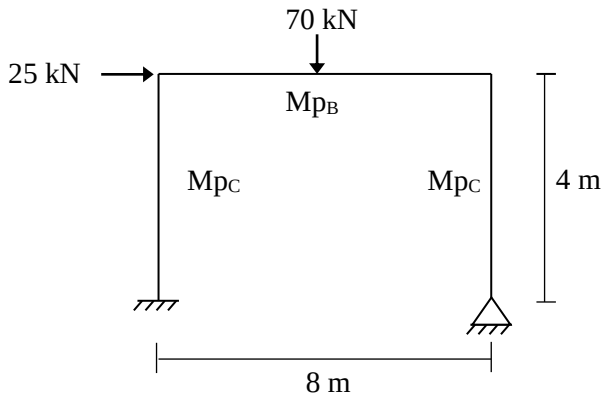
$2x_1 + 3x_2 \leq 8,\ \ 2x_2 + 5x_3 \leq 10,\ \ 3x_1 + 2x_2 + 4x_3 \leq 15,\ \ x_1, x_2, x_3 \geq 0$

(b) Derive Kuhn Tucker's condition to maximize **07**

$f(x_1, x_2) = 6x_1^2 - 4x_2$ Subject to:

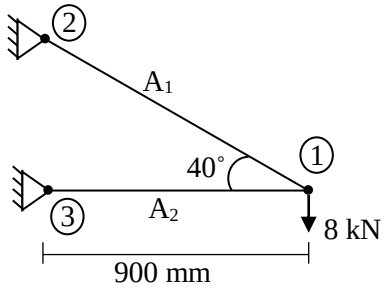
$2\,x_1 + x_2 = 8,\ \ x_1^2 + x_2^2 \leq 19.4,\ \ 3x + y \leq 24,\ x_1 \geq 0$

Q.4 Formulate constraint equations & objective function for following structure using plastic method. Obtain solution for minimum weight by graphical method. **14**

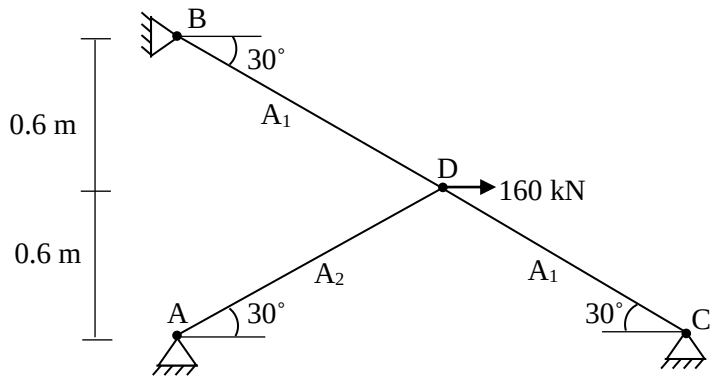


OR

Q.4 Design a following statically determinate pin jointed truss structure using force or deformation method. Take: $E = 210\ kN/mm^2$, $\sigma_t = 0.16\ kN/mm^2$, $\sigma_c = 0.14\ kN/mm^2$, $\sigma_{at\ 1} = 6$ mm. **14**

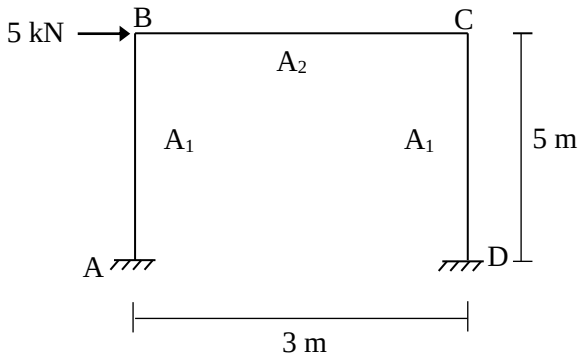


Q.5 Design the following pin jointed statically determinate truss structure for minimum weight. The horizontal and vertical deflections at joint D are both limited to 5 mm and the numerical value of stress in any member is limited to $1.2 \times 10^6\ kN/m^2$. Use matrix force method. **14**



OR

Q.5 Design the following fixed based portal frame structure for minimum volume. The permissible sway is 8 mm and permissible bending stress is $0.10\ kN/mm^2$. Use matrix force method. Axial deformation may be neglected. **14**



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