BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
M.E. (Civil Engg.), 1st Semester Final Examinations, 2013
Sub: Metal Structures
(Subject Code: CE-925)

Time: 3 hours **Full Marks: 70**

*Answer any **FIVE** questions. All questions are of equal value. Assume any data reasonably, if required. All the notations used have their usual meanings.*

1. Write short notes on **any two** from the followings:
(a) Residual stress in steel sections, (b) Design philosophy of aluminum made structures, (c) Graphical representation of moment rotation capacity of semi-rigid joint, (d) effect of temperature gradient in framed structure

2. A spherical reticulated dome has a span of 80m and a rise of 7 m. It carries a total load having intensity of 0.7 KN/m^2, which is mostly a live load. Equiangular triangular mesh size of length "l" = 1.2 m is used in the dome. It is made of Aluminum alloy tube of size: 42 mm outside dia and 6 mm thick. Check the suitability of the tube, E for Aluminum = 0.7x10^{5}N/mm^2. Allowable stress is tension = 100 N/mm^2.

Given, $N_\phi = -Rq/2,\ N_\theta = Rq\left(0.5 - \cos^2\phi\right)\cdot\ T_r = \frac{l}{\sqrt{3}}\left(\sqrt{3}S + N_y\right); T_S = \frac{l}{\sqrt{3}}\left(N_y - \sqrt{3}S\right), T_x = \frac{l}{2\sqrt{3}}\left(3N_x - N_y\right)$

3. A flat double layer two way space frame grid roof for rectangular floor area 30 m x 30 m is supported on columns along all the four sides. The spacing of peripheral columns, seven in each side is 5 m. Grid arrangement is 'square on square offset set diagonally' to the sides. Assume a uniform grid spacing 'a' of either top or bottom chord which are set at 45° (i.e. diagonal) to the edges or sides. Choose appropriate height 'h' of the double layer grid. Make a neat dimensional sketch showing the general arrangement. It is given the Dead load (total)=1.5 kN/m^2 and imposed load =0.75 kN/m^2. Calculate the maximum force in the top or bottom chord. A preliminary design was made as per IS 800-2007 of tube sizes of Fe 410 grade for chord member of nominal diameter 80 mm with 88.9 mm(outer dia) x4.05 mm (thickness) and for bracing members 50 mm nominal bar with 60.3 (outerdia) x3.65 mm (thickness). Check suitability of the tube sizes, using the following data as obtained by continuum analogy (with usual notations). For aspect ratio1: Kw=372, Km=19.4,

$F_{max} = pl_x^2 a / K_M.h;\ w_{max} = pl_x^4 / k_w D;\ D = AEh^2/a.2$

Table : f_{cd} (design strength in compression) versus KL/r (effective slenderness ratio)

KL/r	20	40	50	60	70	80	100	120	140	160	180	200
f_{cd}(MP$_a$)	225	206	194	181	166	150	118	92	78	57	46	39

4. For a simply supported segment of circularly curved built up box girder flyover bridge of 20 m span in composite construction with R.C.C. slab, the following relevant data are given :-

The mean radius of curved girder = 6 0m. The c/c spacing of box girders supporting the R.C.C. slab = 2 m. The thickness of R.C.C. slab = 350 mm and of M30 grade concrete. Each steel box girder is of overall size 400 x 1000 mm, consisting of flange plates 40 mm and web plates 16 mm thickness. Each box girder carries total dead load of 20 KN/m and live load of 50 KN/m of its length. The maximum sagging B.M, twisting moment and shear force is to be taken respectively as 0.020WR^2, 0.003wR^2 and 0.3wR, where R is radius of the curve and w is the U.D.L. carried by the beam.(a) Check the moment capacity of the girder section using both working stress method and limit state method. If an I-section is

used in place of the box section, having the same overall size, flange thickness 40 mm and web thickness 32 mm, how far will it be safe?

(b) Using flexible welded headed steel stud shear connectors of 20 mm dia and 100mm height, find the spacing of the shear connector with two rows of studs, given that the characteristic shear resistance of one such stud is 140 KN.

5. Design a double layer cable suspended roof for a stadium roof over a circle of diameter 80 m, using 100 nos. of radial cables in each layer, stretched between two peripheral rings. The outer ends of the set of top and bottom cables are anchored into an outer compression ring of internal dia 80 m and inner ends of the cables are fastened with internal tension ring of 5 m dia. Cable struts 16 mm dia, spaced 5 m apart, connect the two set of cables and maintain suitably rotationally symmetric surface profile and also control vibration damping. The roofing materials weighing 1.7 KN/m^2 placed directly on the top layer cable. Live load may be taken as 1.5 KN/m^2. Draw a neat sketch of the system. If 64 mm diameter bridge strands (P_u=3292 kN, weight=0.187 kN/m) are used for the cables, check the adequacy of the cable system. Find the natural frequencies of the top and bottom cables and comment on the collapse of the system due to vibration resonance. Given, $l_{cable} = l\left[1+8/3(h/l)^2\right]$, $T = wl^2/8h\sqrt{\left[1+16(h/l)^2\right]}$

6. Draw the column strength curve for the stress-strain diagram shown in Fig. Q. 6. The cross-section of the column is rectangular of dimension 50 mm x 30 mm. Also, calculate the critical load based on the derived column-strength curve when unsupported length of the column is 8 m. One end of the column is fixed and other end hinged. Given, E=2.1x10^{5}MPa, $f_y = 250MPa, E_r = (4E_tE)/\left(\sqrt{E}_t + \sqrt{E}\right)^2$.

7. Find the allowable load for a column as shown in Fig. Q. 7. The effective length of the column is 6 m. Take σ_Y =355 MPa, E=2.05x10^{5}MPa, $I_{yy,gross}$=420 cm^4, A_{gross}=2600 mm^2, $r_{yy,gross}$=40.1 mm, $b_{eff}/t = \frac{664}{\sqrt{\sigma}}\left[1-\frac{131.5}{(w/t)\sqrt{\sigma}}\right]$, If $l_{eff}/r > \frac{C_c}{\sqrt{\theta}}$, $\sigma_{al} = \frac{12\pi^2E}{23(l/r)^2}$, $C_c = \sqrt{\left(2\pi^2E/\sigma_y\right)}$.

8. In a cable stayed bridge, one of the cables is fastened to the tower at a height of 100 m above the deck slab and the other end is tied with the deck slab at a horizontal distance of 150 m from the tower. The cable is to carry vertical load of 800 KN of the portion of the deck slab at this point of attachment. Find the properties of the cable, using the available cables given in the table below. Use factor of safety = 3. Given (single strand with multiple wires) :-

Dia(mm)	19	22	25	28	35	41	44	48	50	64	100
Weight (KN/m)	0.017	0.023	0.031	0.039	0.058	0.081	0.094	0.108	0.123	0.187	0.490
P_U(KN)	294	397	527	673	1014	1410	1637	1887	2144	3292	8105

(b) A TV antenna of 250 m height is supported by two pairs of guy cables in the same vertical plane at 100 m level and 200 m level from the ground level. Each pair of cable is anchored at same point on ground at a horizontal distance of 100 m from the base of antenna. If the horizontal force acting on the plane of cables at 200 m level is 120 kN, design the pair of cables at 200 m level. Use available cables given in Q.8(a). Given, $T_{max} = \frac{wl^2}{8h}\left(1+\tan^2\theta+16\left(\frac{h}{l}\right)^2+\frac{8h}{l}\tan\theta\right)^{0.5}$ and $s = L\left[1+\frac{8}{3}\left(\frac{h}{l}\right)^2\right]$.

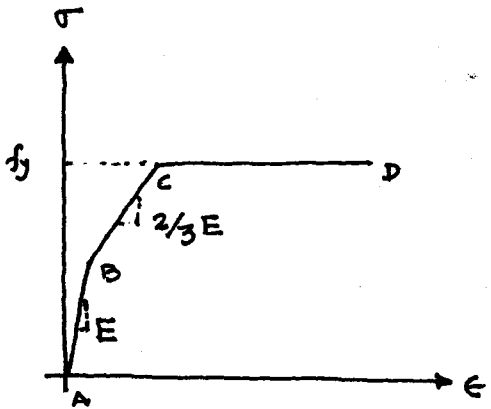

Fig. Q.6

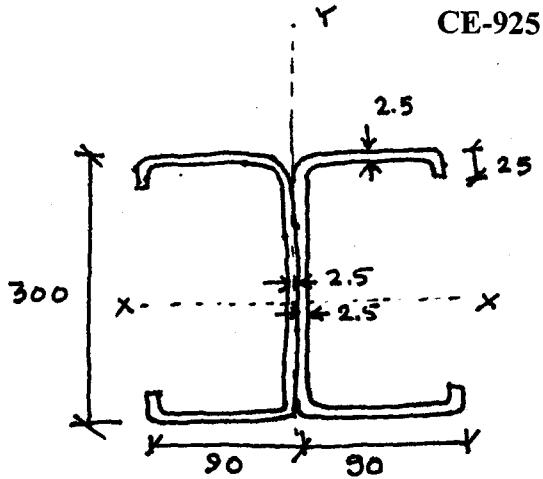

Fig. Q.7