ENGINEERING SERVICES EXAMINATION-2014

A-DMHH-N-DFA

CIVIL ENGINEERING

Paper I

(CONVENTIONAL)

Time Allowed : Three Hours *Maximum Marks : 200*

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

Candidates should attempt FIVE questions in all.

Question no. 1 is compulsory.

Out of the remaining SIX questions attempt any FOUR questions.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Answers must be written in ENGLISH only.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary, and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

1. (a) A steel column consisting of ISMB 400 has one end restrained against translation and rotation, while the other end is restrained against translation only. Its unsupported length is 5 m. Determine its axial load carrying capacity at service loads using the limit state design of IS : 800-2007. *10*

Design compressive strength $f_{cd} = \dfrac{f_y / \gamma_{mo}}{\varphi + [\varphi^2 - \lambda^2]^{0 \cdot 5}}$

$$\varphi = 0 \cdot 5\ (1 + \alpha(\lambda - 0 \cdot 2) + \lambda^2)$$

$$\lambda = \sqrt{\frac{f_y}{f_{cc}}}$$

Euler buckling stress f_{cc}

$$f_{cc} = \frac{\pi^2\ E}{\left(\dfrac{kL}{r}\right)^2}$$

and

$\alpha = 0 \cdot 34$ for buckling class b.

$f_y = 300$ MPa, $\gamma_{mo} = 1 \cdot 10$, $\gamma_f = 1 \cdot 5$,

E = 200 GPa

Minimum radius of gyration for ISMB 400 = 28·2 mm, area of cross-section = 7846 mm^2.

(b) Analyze the beam shown in Figure 1 using the strain energy method and draw bending moment diagram and shear force diagram. *15*

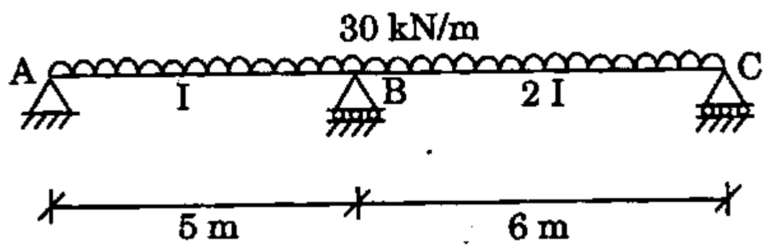

Figure 1

(c) A plane frame is shown in Figure 2. Determine the size of the reduced stiffness matrix with axial deformations and without axial deformations after introducing the boundary conditions. Also, show the active degrees of freedom in both cases. Node number is shown in circles. *10*

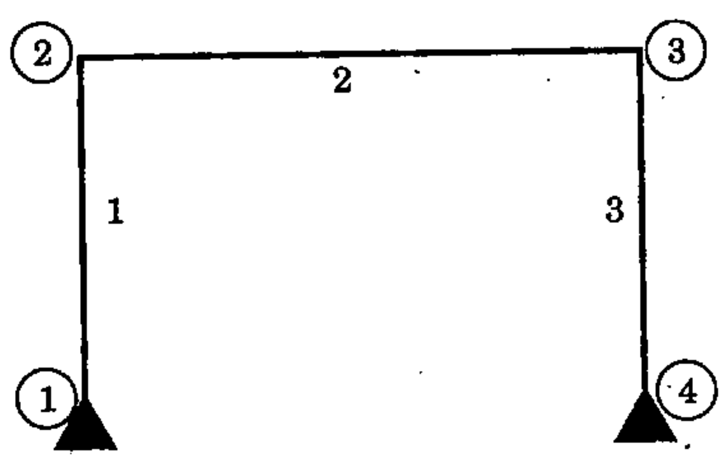

Figure 2

(d) Determine the vertical deflection at the free end of a circular cantilever frame shown in Figure 3 using the unit load method. Take EI = constant. *5*

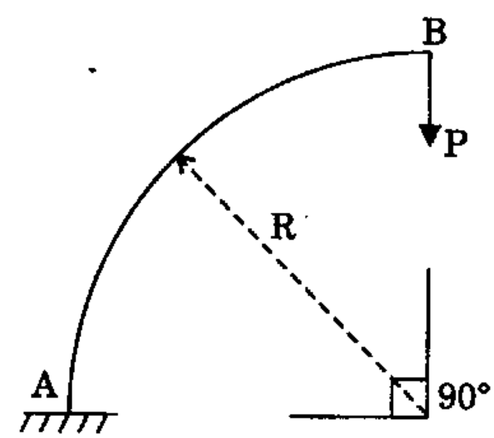

Figure 3

2. (a) A plane frame is shown in Figure 4. The stiffness matrix of elements 1 and 2 with respect to global axes are also shown. Assemble the global stiffness matrix of the frame. Node number is shown in circles. *8×5=40*

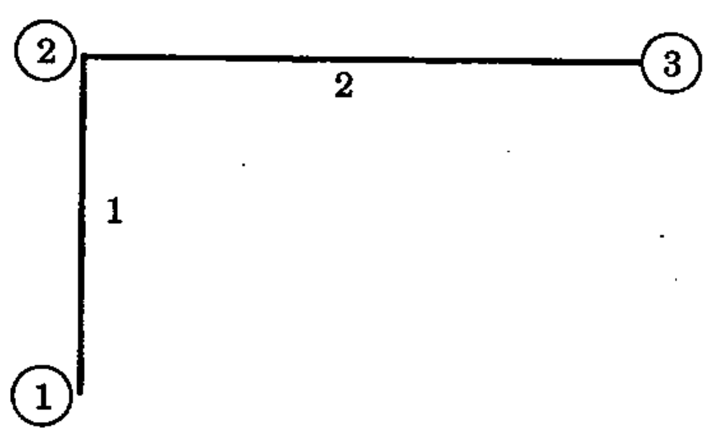

Figure 4

$$\text{Member 1, } K_{6\times 6} = \begin{bmatrix} K11 & K12 \\ K21 & K22 \end{bmatrix}_{6\times 6}$$

$$\text{Member 2, } K_{6\times 6} = \begin{bmatrix} K'11 & K'12 \\ K'21 & K'22 \end{bmatrix}_{6\times 6}$$

where, each of the K_{ij} is a 3×3 sub-matrix.

For Member 1,

$$\text{sub-matrix K11} = \begin{bmatrix} k11 & k12 & k13 \\ k21 & k22 & k23 \\ k31 & k32 & k33 \end{bmatrix};$$

For Member 2,

$$\text{sub-matrix K'11} = \begin{bmatrix} k41 & k42 & k43 \\ k51 & k52 & k53 \\ k61 & k62 & k63 \end{bmatrix}$$

(b) What do you understand by the initial and final setting times of cement ? What are the typical initial and final setting times of 43 grade OPC cement and Portland pozzolana cement (PPC) as per IS code ?

(c) What are the various limit states of design for a steel structure as per IS : 800-2007 ?

(d) What do you understand by static indeterminacy and kinematic indeterminacy of a 2-D framed structure ? Explain with an example of a fixed end beam.

(e) State the assumption in the limit state of collapse in compression in flexure regarding strain at the highly compressed extreme fibre in concrete. Show with the help of a neat sketch.

(f) State the assumptions made for designing riveted connections in steel.

(g) Describe the defects in timber with the help of neat sketches.

(h) Describe briefly five different types of earthwork equipment (rollers) used for compacting soils.

3. (a) Determine the vertical deflection of joint L_2 of the truss shown in Figure 5. The area of cross-section of the members is 20 cm^2 each. Take E = 200 GPa. *15*

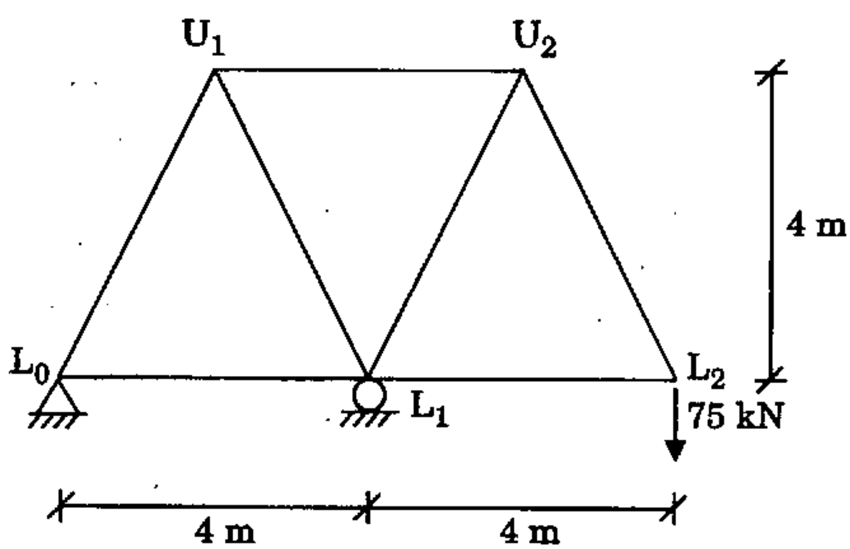

Figure 5

(b) If member U_1L_1 is fabricated 10 mm too short, determine the vertical deflection at L_2. 5

(c) A reinforced concrete beam, having a simply supported span of 6 m, carries a dead load of 15 kN/m (incl. its dead load) and an imposed load of 20 kN/m at service. Design the cross-section of the beam at its mid-span only for flexure and shear at the limit state of collapse. Assume moderate exposure condition and grade of steel as Fe 415. Draw a neat sketch showing the reinforcement details. 15

(d) Explain under reinforced and over reinforced failure of a reinforced concrete beam. 5

4. (a) A simply supported beam has a span of 10 m. A 7 m long u.d.l. of 10 kN/m intensity crosses the beam from left to right. When the head of the load is 1 m from the right support, find the support reactions, BM and SF at the mid-span using the influence line diagram. 10

(b) At a certain cross-section, a circular shaft 90 mm in diameter is subjected to a BM of 3 kNm and twisting moment of 6 kNm. Find the principal stresses induced in the section using maximum normal stress theory. 15

(c) 2 ISA 75 × 75 × 8 carry a load of 150 kN and are placed back to back through a 6 mm gusset plate. The permissible shear stress is 100 MPa and bearing stress is 300 MPa. Design the riveted connection and show the arrangement with a neat sketch. 10

(d) What is the principle of design of a splice in a steel member subjected to an axial tensile force ? Explain with the help of a neat sketch. 5

5. (a) A cable suspends across a gap of 250 m and carries a u.d.l. of 10 kN/m horizontally. Calculate the maximum tension if the maximum sag is 1/25. Also compute sag at 50 m from one end. 10

(b) A simply supported beam carries two point loads W each at its one-third sections as shown in Figure 6. Determine the maximum deflection at its mid-span and slope at an end using the conjugate beam method. 15

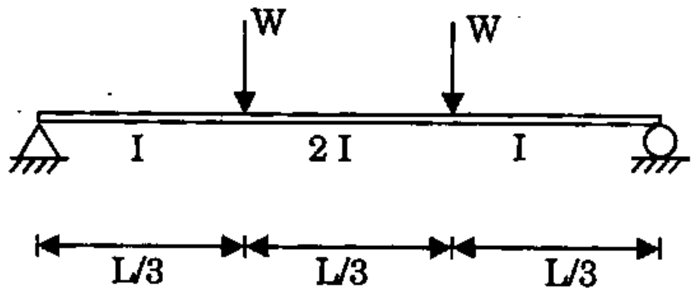

Figure 6

(c) A 3-hinged parabolic arch of 16 m span has its abutments A and B at a depth of 4 m and 8 m respectively below the crown C. It is loaded as shown in Figure 7. Determine the horizontal thrust and the vertical reactions at the supports. *15*

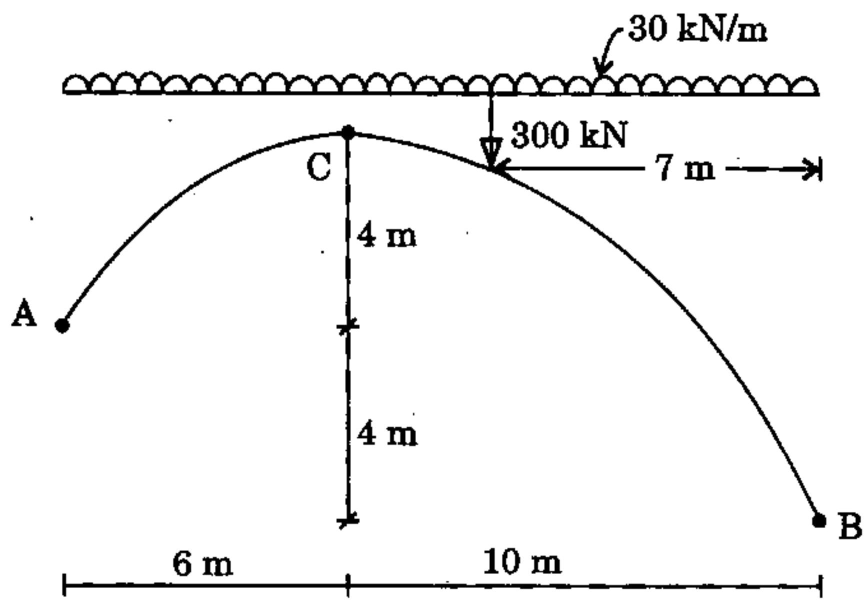

Figure 7

6. (a) In a 2-D body, normal stress $\sigma_x = -10$ MPa, $\sigma_y = -10$ MPa, and shear stress $\tau_{xy} = 8$ MPa. Draw the Mohr circle and determine the principal stresses, principal planes, maximum shear stresses and their planes. *10*

(b) Derive the flexibility matrix of the plane beam shown in Figure 8 with respect to the degrees of freedom shown. Take EI = constant. *15*

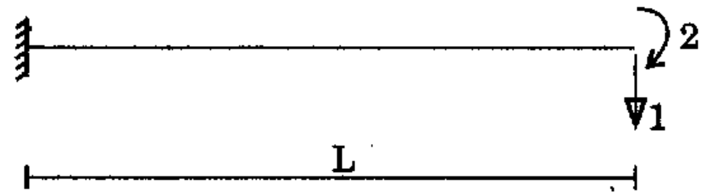

Figure 8

(c) Analyze the plane box frame shown in Figure 9 using the moment distribution method and making use of symmetry. Also, draw bending moment diagram. *15*

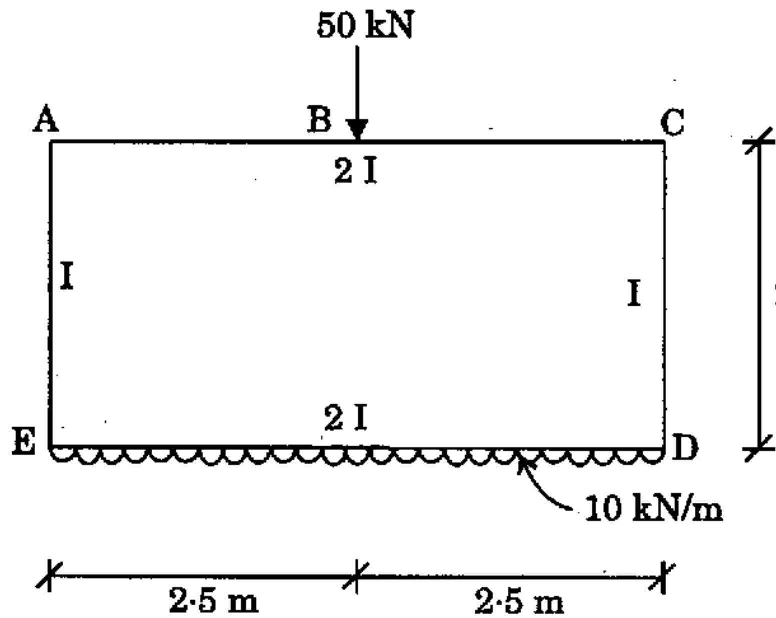

Figure 9

7. (a) Details of a construction project comprising of three activities are given in the following table :

S. No.	Activity	Unit	Estimated Quantity	Estimated rate per unit	Rate of award
1	A	M^3	5000	1000	850
2	B	MT	4500	4000	4200
3	C	M^2	7000	5000	4800

Based on the information provided in the table, answer the following questions :

(i) What should be the cost of the project for which an "approval" is obtained from the competent authority before proceeding with the advertisement for the job etc. ?

(ii) If at a certain point in time, the work done for the activities A, B and C is 2700, 3000 and 4000 in the corresponding units, what is the percentage of the financial completion of the project ?

(iii) Clearly state the assumptions in calculating (ii) above. *2+4+2=8*

(b) What is the difference between "security deposit" and "mobilization advance" in a construction contract ? *4*

(c) In PERT network, how is the "expected time" of completion of an activity related to most likely optimistic and the pessimistic times of completion of that activity ? *4*

(d) Define the following terms briefly in the context of construction contracts :

(i) Beta distribution in PERT 4

(ii) EPC contract 2

(iii) PPP 2

(iv) Escalation 2

(e) List some of the important factors that are known to affect the readings taken while carrying out non-destructive testing of concrete using Schmidt rebound hammer and explain the effects briefly. 5

(f) What do you understand by bulking of sand ? How does it affect quantity of sand by volume batching ? 5

(g) Show that development length of a steel bar of dia ϕ embedded in concrete is given by 4

$$L_d = \frac{0 \cdot 87 \, \sigma_y \, \phi}{4 \, \tau_{bd}}$$

where,

τ_{bd} = bond strength of concrete

σ_y = yield strength of steel

ϕ = bar dia.