Full Marks – 70   Time Allowed – 3 Hours

Answer any *Five* questions.

1. Explain plastic hinge, shape factor and different types of mechanisms of plastic collapse. Determine the shape factor for a steel I-section made of 180 mm x 32 mm thick top flange plate, 450 mm x 12 mm thick web plate and 120 mm x 32 mm thick bottom flange plate.

2. State and explain Static and Kinematic theorems used in plastic analysis. A beam of length L and fully plastic moment capacity M_p is simply supported at one end and fixed at the other end. The beam is subjected to a concentrated load W at a distance of 2L/3 from the fixed end. Find the collapse value of load W and show the positions of plastic hinges indicating their chronological development.

3. A continuous beam ABC is simply supported at the three supports A, B and C. AB = 6.0 m and BC = 10.0 m with a central concentrated load of 2W on span AB and an uniformly distributed load of W/5 on the entire span of BC. The beam has a uniform section with fully plastic moment M_p = 400 kNm. Determine the loads at the formation of the first and second plastic hinges in the continuous beam ABC.

4. In a rectangular portal frame ABCD the support A and the support D are fixed. The columns AB and CD are vertical with heights 4.0m and 5.0m respectively. The beam BC is horizontal with a span of 10.0m. The fully plastic moment capacities of AB, BC and CD are M_p, $3M_p$ and $1.5M_p$ respectively. A vertical load of 2P acts at mid span of BC and a horizontal load P acts at B towards C. Find the collapse load P and draw the Bending Moment Diagram at collapse.

5. An inclined portal frame PQRS has P and S fixed. Column PQ is vertical with height 4.0m. Beam QR is horizontal with span 7.0m and RS is 5.0m long with an inclination of 60^0 with vertical. A vertical load 2W acts on QR at 4.0m distance from Q and a horizontal load W acts at Q towards R. Determine the collapse load and draw the bending moment diagram at collapse. Assume fully plastic moment capacity M_p all through.

6. Coordinates of the joints of a fixed base doubly inclined portal frame are given in metres as (0, 0), (3, 6), (13, 6) and (16, 1) respectively. A vertical load of P acts on the top beam at 4m distance from the left end of the beam and a horizontal load of P/2 acts from left to right at the top beam level. Find the collapse load and draw the collapse bending moment diagram. Assume M_p as constant.

7. A two span portal with left span 1.25L and right span 0.75L has equal column heights L and bottom ends fixed. Left column and left beam are with 2.0Mp where other beam and columns are with 1.5Mp. Two vertical loads of P each act at mid-point of beams and a horizontal load P/2 acts from left to right at the beam level. Find the collapse load and draw the plastic bending moment diagram to check wheather it is a true collapse load or not.

8. Find the minimum weight of a portal with span 1.5L and height L having bottom ends fixed and Mp value for the beam and two columns as Ma and Mb respectively. The portal is subjected to a vertical load P at the centre of the beam and another load P from left to right at the beam level.