INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

CIVIL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**Prestressed concrete structures**			
Course Code	A80150			
Regulation	R15 (JNTUH)			
Course Structure	**Lecturers**	**Tutorials**	**Practical's**	**Credit's**
	4	**-**	**-**	**4**
Course Coordinator	Dr.Venu M, Professor, Department of Civil Engineering			
Team of Instructors	Dr.Venu M, Professor, Department of CivilEngineering Mr G Rama Krishna, Assistant Professor, Department of Civil Engineering			

COURSE OBJECTIVES:

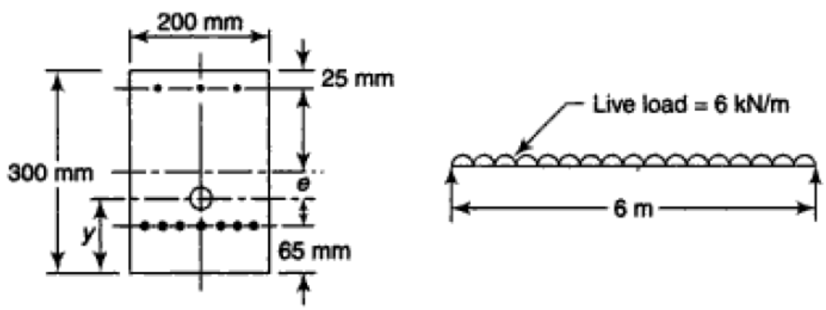
The objectives of this course are to impart knowledge and abilities to the students to:

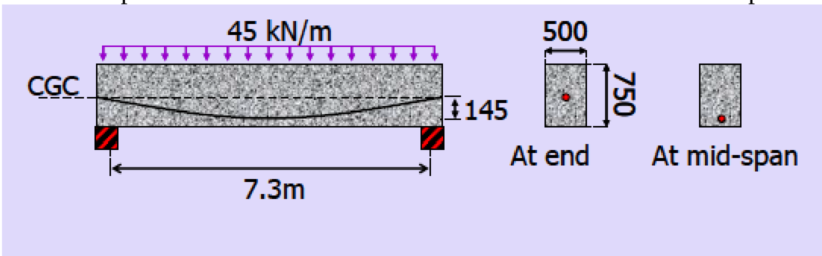
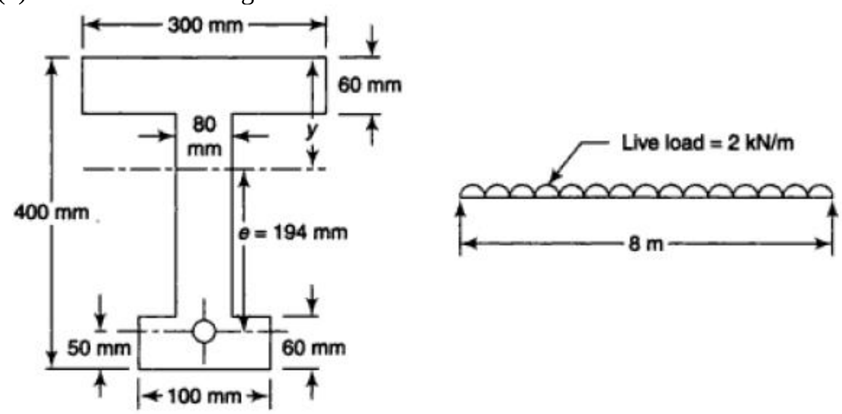
I. Understand the importance of prestressed concrete and the evolution of prestressing to overcome the shortcoming of reinforced concrete.
II. Acquire knowledge about the methods of prestressing and prestressing devices for pre-tensioning and post-tensioning.
III. Assess the losses of prestress in PSC members due various causes like friction, elastic shortage of concrete, shrinkage, creep, etc.
IV. Analyse sections of PSC beams with straight, concentric, eccentric, bent and parabolic tendons and design PSC beams of rectangular and I sections for flexure.
V. Design shear reinforcements, structural elements for shear, torsion and anchorage as per the provisions of BIS.
VI. Interpret the transmission mechanism of prestressing force by bond and compute deflection for beams under loads.

S. No	QUESTION	Blooms Taxonomy Level	Course Outcomes
UNIT-I INTRODUCTION			
Part - A(Short Answer Questions)			
1	Define prestressed concrete.	Remember	1
2	What are the advantages of PSC construction?	Remember	1
3	Define Pre tensioning and Post tensioning.	Remember	1
4	What is the need for the use of high strength concrete and tensile steel in prestressed Concrete?	Understand	1
5	Define Kern Distance.	Remember	1
6	What is Relaxation of steel?	Remember	1
7	What is concordant prestressing?	Remember	2
8	Define bonded and unbounded prestressing concrete.	Remember	2

9	Define Axial prestressing.	Remember	2
10	Explain the principle of post tensioning.	Understand	2
11	What are the various methods of prestressing the concrete?	Remember	2
12	Enumerate load balancing concept.	Remember	2
13	What are the sources of prestress?	Remember	2
14	Differentiate full prestressing and partial prestressing.	Remember	2
15	What is the permissible limit for shrinkage of concrete in pretensioned and post tensioned members as per IS code?	Remember	3
16	State any two advantages of prestressed concrete over reinforced concrete?	Understand	3
17	What are the advantages of pretensioned concrete over post tensioned concrete?	Understand	3
18	What are the grades of concrete to be used in pre tensioned and post tensioned works?	Understand	3
19	What is meant by pressure line?	Understand	3
20	What are tendon splices? Sketch some common types of tendon splices.	Understand	3
Part - B (Long Answer Questions)			
1	A rectangular concrete beam 100mm wide & 250mm deep spanning over 8m is prestressed by a straight cable carrying a effective prestressing force of 250kN located at an eccentricity of 40mm. The beam supports a live load of 1.2kN/m. a) Calculate the resultant stress distribution for the centre of the span cross section of the beam assuming the density of concrete as 24kN/m2 b) Find the magnitude of prestressing force with an eccentricity of 40mm which can balance the stresses due to dead load & live load at the soffit of the centre span section.	Understand	1
2	(i) Explain why high strength concrete and high strength steel are needed for PSC construction. (ii) State different types of prestressing.	Understand	1
3	Discuss the advantages and disadvantages of partial prestressing.	Remember	1
4	(i) Discuss the load deflection behaviour of under prestressed, partially prestressed and over prestressed members in detail. (ii) Explain concept of limit states, partial safety factor.	Understand	1
5	a) What is meant by partial prestressing? Discuss the advantages and disadvantages when partial prestressing is done. b) Explain about the types of flexure failure occurs in prestressed concrete section.	Understand	1
6	A PSC beam of 120mm wide and 300mm deep is used over a span of 6m to support a UDL of 4kN/m including its self weight. The beam is prestressed by a straight cable carrying a force of 180kN& located at an eccentricity of 50mm. Determine the location of the thrust line in beam & plot its position at quarter & central span sections.	Remember	2
7	A PSC beam of 230mm wide and 450mm deep is used over an span of 4m is prestressed by a cable carrying a force of 650kN & located at an eccentricity of 75mm. The beam supports three concentrated loads of 25kN at each quarter span points. Determine the location of the pressure line in beam at centre, quarter & support sections. Neglect the moment due to self weight of the beam.	Remember	2
8	A PSC beam supports an imposed load of 5kN/mm^2 over a simply supported span of 10m.The beam has an I section with an overall depth of 450mm.Thickness of flange and web are 75mm and 1000mm respectively. The flange width is 230mm. the beam is prestressed with an effective prestressing force of 350kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at mid span is zero. Find the eccentricity required for the force.	Understand	2

9	A PSC beam of section 120mm wide and 300mm deep is used over an effective span of 6m to support an UDL of 4kN/m including self weight. The beam is prestressed by a straight cable with a force of 180kN and located at an eccentricity of 50mm. Determine the location of thrust line in the beam and plot its position.	Understand	2
10	Explain in detail the pre-tensioning and post-tensioning systems with neat diagrams.	Remember	3
11	Show the stress distribution in a section of PSC beam for concentric and eccentric tendons.	Remember	3
12	A rectangular concrete beam of cross-section 30cm deep and 20cm wide is prestressed by means of 15 wires of 5mm diameter located 6.5cm from the bottom of the beam and 3 wires of diameter of 5mm, 2.5cm from the top. Assuming the prestress in the steel as 840N/mm^2, calculate the stresses at the extreme fibres of the mid-span section when the beam is supporting its own weight over a span of 6m. If a uniformly distributed live load of 6kN/m is imposed, the maximum working stress in concrete. The density of concrete is 24kN/m^3.	Understand	3
13	(i) Explain shrinkage of concrete in PSC members. (ii) Explain durability, fire resistance and cover requirements of PSC members.	Remember	3
14	A prestressed concrete beam of section 150mm wide by 360mm deep is used over an effective span of 8 m to support a uniformly distributed load of 4.5kN/m, which includes the self weight of the beam. The beam is prestressed by a straight cable carrying a force of 280kN& located at an eccentricity of 60mm. Determine the location of the thrust-line in the beam and plot its position at quarter and central span sections.	Understand	3
15	A PSC beam 500 x 800mm deep has S.S span of 10m. It is prestressed with the linear bent tendon with zero eccentricity and an eccentricity of 200mm below the axis of mid span. The beam carries a concentrated load of 150kN at centre besides its self-weight. compare the extreme fibre stress at mid span using stress concept and load balancing concept?	Understand	3
16	Describe briefly Freyssinet system of post tensioning.	Understand	3
Part - C (Problem Solving and Critical Thinking Questions)			
1	A prestressed concrete beam with a rectangular section 150 mm wide by 350 mm deep supports a uniformly distributed load of 6kN/m, which includes the self weight of the beam. The effective span of the beam is 8 m. The beam is concentrically prestressed by a cable carrying a force of 200kN. Locate the position of the pressure line in the beam.	Remember	1
2	A rectangular concrete beam 300 mm wide, 800 mm deep supports two concentrated loads of 20 kN each at third point of a span of 9m. a) Suggest a suitable cable profile. If eccentricity of the cable profile is 100 mm for middle third portion of the beam, calculate the prestressing force required to balance the bending effect of the concentrated loads neglecting the self weight. b) For the same cable profile find effective force in cable if the resultant stress due to self wt., imposed load, and prestressing force is zero at the bottom fiber of mid span section.(Assume density of concrete = 24 kN/m^3).	Understand	1
3	A PSC beam supports a live load of 4kN/m over a simply supported span of 8m. The beam has an I-section with an overall depth of 400mm. the thickness of flange and web are 60mm and 80mm respectively. The beam is to be prestressed by an effective prestressing force of 234kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at the centre span is zero. i) Find the eccentricity required for the force. ii) If tendon is concentric, what should be the magnitude of the prestressing force for the resultant stress to be zero at the bottom fibre of central span section?	Understand	1

4	A rectangular beam of cross section 30cm deep and 20cm wide is prestressed by means of 15 wires of 5mm diameter located 6.5cm from the bottom of the beam and 3 wires of diameter 5mm, 2.5cm from the top. Assuming the prestress in steel as 840N/mm2, calculate the stresses at the extreme fibres of the mid span section when the beam is supporting its own weight over a span of 6m. If a uniformly distributed live load of 6kN/m is imposed, the maximum working stress in concrete. The density of concrete is 24kN/m^3. 	Understand	1
5	A PSC beam 550 x 750mm deep has S.S span of 12m. It is prestressed with the linear bent tendon with zero eccentricity and an eccentricity of 250mm below the axis of mid span. The beam carries a concentrated load of 250 KN at centre besides its self-weight. compare the extreme fibre stress at mid span using stress concept and load balancing concept.	Remember	2
6	A rectangular concrete beam 250 mm wide by 300 mm deep is prestressed by a force of 540 kN at a constant eccentricity of 60mm.The beam supports a concentrated load of 68 kN at the centre of the span of 3 m. Determine the location of the pressure line at the centre, quarter span and support sections of the beam. Neglect the self weight of the beam.	Understand	2
7	A prestressed concrete beam of rectangular section 375mm wide and 750mm deep has the span of 12.5m. The effective prestressing force is 1520 KN at an eccentricity of 150mm.The dead load of the beam is 7 KN/m and the beam carry the live load of 12.5 kN/m. Determine the extreme stresses in concrete.	Understand	2
8	A prestressed concrete beam 250mm wide and 350mm deep is used over an effective span of 6m to support an imposed load of 4 kN/m. the density of concrete is 24 kN/m^3. Find the magnitude of the eccentric pre-stressing force located at 100 mm from the bottom of the beam which would nullify the bottom fibre stress due to loading.	Understand	3
9	A concrete beam with a single overhang is simply supported at *A* &*B* over a span of 8 m & the overhang *BC* is 2 m. The beam is of rectangular section 300 mm wide 900 mm deep & supports a uniformly distributed live load of 3.52kN/m over the entire length in addition to its self-weight. Determine the profile of the prestressing cable with an effective force of 500 kN which can balance the dead & live loads on the beam. Sketch the profile of the cable along the length of the beam. The single overhang beam ABC supporting the UDL is shown in the figure below.	Remember	3
10	A beam of symmetrical I-section spanning 8 m has a flange width of 150m m & flange thickness of 80 mm respectively. The overall depth of the beam is 450 mm. Thickness of the web is 80 mm. The beam is prestressed by a parabolic cable with an eccentricity of 150 mm at the centre of the span & zero at the supports. The LL on the beam is 2.5kN/m. (a) Determine the effective force in the cable for balancing the DL & LL on the beams. (b) Sketch the distribution of resultant stress at the centre of span section for the above case. (c) Calculate the shift of the pressure line from the tendon–centre–line.	Understand	3

11	A concrete beam prestressed with a parabolic tendon is shown in the figure. The prestressing force applied is 1620kN. The uniformly distributed load includes the self weight. Compute the extreme fibre stress at the mid-span by Understand the three concepts. Draw the stress distribution across the section at mid-span.  	Understand	3
12	An unsymmetrical I-section beam is used to support an imposed load of 2kN/m over a span of 8m. The sectional details are top flange, 300mm wide and 60mm thick; bottom flange, 100mm wide and 60mm thick; thickness of web=80mm; overall depth of the beam=400mm. At the centre of the span, the effective prestressing force of 100kN is located at 50mm from the soffit of the beam. Estimate stresses at the centre of span section of the beam for following load conditions: (a) Prestress+self weight (b) Prestress + self weight + live load.  	Understand	3
13	A prestressed concrete beam with a rectangular section 120 mm wide by 300mm deep supports a uniformly distributed load of 4kN/m, which includes the self weight of the beam. The effective span of the beam is 6m. The beam is concentrically prestressed by a cable carrying a force of 180kN. Locate the position of the pressure line in the beam.	Understand	3
14	A PSC beam supports an imposed load of 10kN/mm2 over a simply supported span of 15m. The beam has an I section with an overall depth of 550mm.Thickness of flange and web are 85mm and 1100mm respectively. The flange width is 250mm. the beam is prestressed with an effective prestressing force of 380kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at mid span is zero. Find the eccentricity required for the force.	Understand	3
15	A PSC beam of 350mm wide and 550mm deep is used over an span of 4m is prestressed by a cable carrying a force of 750kN & located at an eccentricity of 80mm. The beam supports three concentrated loads of 35kN at each quarter span points. Determine the location of the pressure line in beam at centre, quarter & support sections. Neglect the moment due to self weight of the beam.	Understand	3
UNIT-II **LOSSES OF PRESTRESS**			
Part - A (Short Answer Questions)			
1	Why loss due shrinkage is more for pretensioned member compared to post tensioned member?	Remember	4
2	List the losses of prestress.	Remember	4

3	List the various types of losses of prestress in pretensioned and post tensioned member.	Remember	4
4	How do you compute loss of stress due to elastic deformation of concrete?	Remember	4
5	"Post tensioned members do not suffer the loss of prestress due to elastic deformation", Why?	Understand	4
6	How do you compute loss of stress due to shrinkage of concrete as per IS: 1343 code recommendations?	Remember	5
7	What is slip anchorage? How do you compute loss of stress due to anchorage slip?	Understand	5
8	Explain the provisions made in IS: 1343 for relaxation loss.	Understand	5
9	What are the factors affecting loss of stress due to creep of concrete?	Understand	5
10	What is Relaxation of steel?	Understand	5
11	What is the permissible limit for shrinkage of concrete in pretensioned and post tensioned members as per IS code?	Remember	5
12	Explain the reasons for different strains specified by the Indian standards for pretensioned and post tensioned members.	Understand	5
13	How do you compute the losses of stress in steel due to curvature and wobble effect?	Remember	5
14	Explain the loss of stress due to friction with the help of neat sketch.	Understand	5
15	State the values for the coefficient of friction.	Understand	5
Part - B (Long Answer Questions)			
1	A pretensioned concrete beam, 100mm wide and 300mm deep, is prestresssed by straight wires carrying an initial force of 225kN at an eccentricity of 55mm. The modulus of elasticity of steel and concrete are 210 and 35kN/mm^2 respectively. Estimate the percentage loss of stress in steel due to elastic deformation of concrete if area of steel wires is 188mm^2.	Understand	4
2	A rectangular concrete beam, 360mm deep and 200mm wide, is prestressed by means of fifteen 5mm diameter wires located 65mm from the bottom of the beam and three 5mm wires, located 25mm from the top of the beam. If the wires are initially tensioned to a stress of 840kN/mm^2, calculate the percentage loss of stress in steel immediately after transfer, allowing for the loss of stress due to elastic deformation of concrete only.	Understand	4
3	A post-tensioned concrete beam, 100mm wide and 300mm deep, is prestressed by 3 cables, each with a cross sectional area of 50mm^2 and with an initial stress of 1200N/mm^2. All the three cables are straight and located 100mm from the soffit of the beam. if the modular ratio is 6, calculate the loss of stress in the three cables due to elastic deformation of concrete for only the following cases: (a) Simultaneous tensioning and anchoring of all three cables; (b) Successive tensioning of the three cables.	Remember	4
4	A pretensioned beam 200mm x 300 mm is prestressed by 10 wires each of 7mm diameter, initially stressed to 1200MPa with their centroid located 100mm from the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation. Assume relaxation of steel stress=60MPa, E_S=210GPa, E_C=36.9GPa, creep coefficient =1.6 and residual shrinkage strain =3 x 10^{-4}.	Understand	4
5	A concrete beam is prestressed by a cable carrying an initial prestressing force of 300kN. The cross sectional area of the wires in the cable is 300mm^2. Calculate the percentage of loss of stress in the cable only due to shrinkage of concrete using IS: 1343 recommendations assuming the beam to be (a) pretensioned (b) Post tensioned. Assume Es= 210kN/mm^2 and age of concrete at transfer=8 days.	Understand	4

6	A concrete beam of 10m span, 100mm wide and 300mm deep is prestressed by 3 cables. The area of each cable is $200mm^2$ and the initial stress in the cable is $1200N/mm^2$. Cable 1 is parabolic with an eccentricity of 50mm above the centroid at the supports and 50mm below at the centre of span. Cable 2 is also parabolic with zero eccentricity at supports and 50mm below the centroid at the centre of span. Cable 3 is straight with uniform eccentricity of 50mm below the centroid. If the cables are tensioned from one end only. Estimate the percentage loss of stress in each cable due to friction. Assume $\mu = 0.35$ and $k = 0.0015$ per m.	Understand	5
7	A rectangular concrete beam 360mm deep and 200mm wide is prestressed by means of fifteen 5mm diameter wires located 65mm from the bottom of the beam and three 5mm wires, located 25mm from the top of the beam. If the wires are initially tensioned to a stress of $840N/mm^2$, calculate the percentage loss of stress due to elastic deformation of concrete only. E_S = 210 kN/mm2 and E_C = 31.5 kN/mm^2.	Remember	5
8	A straight pretensioned prestressed concrete member 12 m long with a cross section of 400 mm wide and 500 mm deep is concentrically post tensioned by four tendons of 250 mm^2 each. The tendons are stressed one after another to the stress of 1000 N/mm^2. The eccentricity of prestressing force is 100 mm at the centre of the span. Compute the loss of prestress due to elastic shortening of concrete. How can the loss be counteracted?	Remember	5
9	A Prestressed pretensioned beam of 200mm wide and 300mm deep is used over an span of 10m is prestressed with a wires of area $300mm^2$ at an eccentricity of 60mm carrying a prestress of $1200N/mm^2$ Find the percentage of loss of stress, $Ec=35kN/mm^2$, Shrinkage of concrete=300x10-6 , creep coefficient =1.6.	Understand	5
10	A concrete beam is post tensioned by a cable carrying an initial stress of $1000N/mm^2$. the slip at the jacking end was observed to be 5mm. The modulus of elasticity of steel is $210kN/mm^2$. Estimate the percentage of loss of stress due to anchorage slip if the length of beam is (a) 20m; (b) 5m.	Understand	5
11	A pretensioned beam 300mm x 450mm is pretensioned by 12 wires each 7mm diameter, initially stressed to 1200MPa with their centroids located 100 mm from the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation. Assume relaxation of steel stress=90MPa. Ec =35GPa, creep co-efficient=1.6 and residual shrinkage strain $=3 \times 10^{-4}$.	Remember	5
12	A post-tensioned beam with a cable of 4 wires = $600mm^2$ is tensioned with 1 wire at a time. The cable with zero eccentricity at the ends and 100 mm at the centre and is on a parabolic curve. The span of the beam is 10m. The cross -section is 200mm wide and 550mm deep. The wires are to be stressed from one end so that immediately after anchoring, the initial prestress of 940 N/mm^2 would be obtained. Compute the final design stress in steel after all the loss ,Coefficient of friction is 0.6, Coefficient for wave effect is 0.003, deformation and slip of anchorage is 1.25mm, $Es=210kN/mm^2$, $Ec=28kN/mm^2$, Shrinkage of concrete is 0.0002 and relaxation of stress in steel is 3% of initial stress.	Understand	5
13	A cylindrical concrete tank, 40m external diameter, is to be prestressed circumferentially by means of a high-strength steel wire ($Es=210kN/mm^2$) jacked at 4 points, 90 degrees apart. If the minimum stress in the wires immediately after tensioning is to be $600N/mm^2$ and the coefficient of friction is 0.5, calculate (a) The maximum stress to be applied to the wires at the jack; (b) The expected extension at the jack.	Understand	5

14	A simply supported concrete beam of uniform section is post tensioned by means of two cables, both of which have an eccentricity of 100mm below the centroid of the section at mid-span. The first cable is parabolic and is anchored at an eccentricity of 100mm above the centroid at each end. The second cable is straight and parallel to the line joining the supports. If the cross sectional area of each cable is $100mm^2$, the concrete beam has a cross sectional area of 2x104 mm^2 and a radius of gyration of 120mm, calculate the loss of stress in the first cable when the second is tensioned to a stress of $1200N/mm^2$. Take the modular ratio as 6 and neglect friction.	Understand	5
15	A concrete beam of rectangular cross section, 200 mm wide and 400 mm deep prestressed 8 wires of 8 mm diameter located at an eccentricity of 50 mm, the initial stress in the wires being 1300 N/mm^2. Estimate the loss of stress in steel due to creep of concrete using the ultimate creep strain method and the creep coefficient method. Use the following data Es=$210KN/mm^2$, Ec=$35KN/mm^2$, A=3x104 mm^2, Ultimate creep stain = 41 $x10^{-6}$ mm/mm per N/mm^2. Creep coefficient = 1.6.	Remember	5
16	A rectangular concrete beam 560mm deep and 250mm wide is prestressed by means of 18-5 mm diameter wires located 85 mm from the bottom of the beam and 6-5mm wires, locating 35mm from the top of beam. If the wires are initially tensioned to a stress of $1040N/mm^2$, calculates the percentage loss of stress in steel immediately after transfer, allowing loss of stress due elastic deformation of concrete only.	Understand	5
Part - C (Problem Solving and Critical Thinking Questions)			
1	A pretensioned concrete beam of rectangular cross section, 150mm wide and 300mm deep, is prestressed by 8 high tensile wires of 7 mm diameter located at 100 mm from the soffit of the beam. if the wires are tensioned to a stress of $1100N/mm^2$,calculate the percentage loss of stress due to elastic deformation assuming the modulus of elasticity of concrete and steel as 31.5 kN/mm^2 and $210kN/mm^2$.	Understand	4
2	A rectangular concrete beam 360mm deep and 200mm wide is prestressed by means of 15 5 mm diameter wires located 65 mm from the bottom of the beam and 3 5mm wires, locating 25mm from the top of beam. If the wires are initially tensioned to a stress of $840N/mm^2$, calculates the percentage loss of stress in steel immediately after transfer, allowing loss of stress due elastic deformation of concrete only.	Understand	4
3	A concrete beam of rectangular cross section, 100 mm wide and 300 mm deep prestressed 5 wires of 7 mm diameter located at an eccentricity of 50 mm, the initial stress in the wires being 1200 N/mm2. Estimate the loss of stress in steel due to creep of concrete using the ultimate creep strain method and the creep coefficient method. Use the following data Es=$210kN/mm^2$, Ec=35kN/mm2, A=3x104 mm^2, Ultimate creep stain = 41 x10-6 mm/mm per N/mm^2. Creep coefficient = 1.6.	Understand	4
4	A post tensioned concrete beam of rectangular cross section, 100mm wide and 300 mm deep, stressed by parabolic cable at zero eccentricity near the support and 50 mm eccentricity at the centre of span. The area of cable is 200 mm^2 and initial stress in cable is 1200 N/mm^2. The ultimate creep strain = 30 X10 -6mm/mm per N/mm^2 of stress and modulus of elasticity of steel is 210 kN/mm^2, compute the loss of stress only due to creep of concrete.	Understand	4
5	A concrete beam is post tensioned by a cable carrying an initial stress of 1000 N/mm^2. The slip at the jacking end was observed to be 5mm. Es=210 KN/mm^2. estimate the loss of stress due to anchorage slip if the length of beam is (a) 50 m (b) 5m.	Understand	4

6	A pretensioned concrete sleeper 300mm wide and 250 mm deep is pre stressed using 9 wires of 7 mm diameter. Four wires are located at top and five wires near the soffit. The effective cover being 40 mm. The initial stress in the wire is 1256 N/mm^2. Assuming the modular ratio as 6, estimate the percentage loss of stress in the top and bottom wires due to elastic deformation of concrete.	Remember	4
7	A prestress concrete girder is post tensioned using a cable concentric at supports and having an eccentricity of 400 mm at centre span. The effective span of girder is 25 m. The initial force in the cable is 400 kN at the jacking end. determine the loss of force in the cable due to friction and wave effect and the effective force in the cable at the further end assume co efficient of friction= 0.3 and co efficient for wave effect K= 0.0043/m	Understand	4
8	A simply supported concrete beam of uniform section is post tensioned by means of two cables, both of which have an eccentricity of 150mm below the centroid of the section at mid-span. The first cable is parabolic and is anchored at an eccentricity of 160mm above the centroid at each end. The second cable is straight and parallel to the line joining the supports. If the cross sectional area of each cable is $200mm^2$, the concrete beam has a cross sectional area of $2x10^4$ mm^2 and a radius of gyration of 140mm, calculate the loss of stress in the first cable when the second is tensioned to a stress of $1400N/mm^2$. Take the modular ratio as 6 and neglect friction.	Remember	5
9	A post-tensioned beam with a cable of 4 wires=$700mm^2$ is tensioned with 1 wire at a time. The cable with zero eccentricity at the ends and 200mm at the centre and is on a parabolic curve. The span of the beam is 12m. The cross -section is 300mm wide and 650mm deep. The wires are to be stressed from one end so that immediately after anchoring, the initial prestress of $1050N/mm^2$ would be obtained. Compute the final design stress in steel after all the loss Coefficient of friction is 0.6, Coefficient for wave effect is 0.003, deformation and slip of anchorage is 1.25mm, E_s=$210kN/mm^2$, E_c=$28kN/mm^2$, Shrinkage of concrete is 0.0002 and relaxation of stress in steel is 3% of initial stress.	Understand	5
10	A post-tensioned concrete beam, 200mm wide and 450mm deep, is prestressed by 5 cables, each with a cross sectional area of $80mm^2$ and with an initial stress of $1100N/mm^2$. All the three cables are straight and located 200mm from the soffit of the beam. if the modular ratio is 6, calculate the loss of stress in the three cables due to elastic deformation of concrete for only the following cases: (a) Simultaneous tensioning and anchoring of all three cables; (b) Successive tensioning of the three cables.	Remember	5
11	A pretensioned beam 400mm x 350mm is pretensioned by 12 wires each 8mm diameter, initially stressed to 1150MPa with their centroids located 200 mm from the soffit. Estimate the final percentage loss of stress due to elastic deformation, creep, shrinkage and relaxation. Assume relaxation of steel stress=70MPa. Ec=35GPa, creep co-efficient=1.6 and residual shrinkage strain = $3 X10^{-4}$.	Understand	5
12	A prestressed concrete sleeper produced by pre-tensioning method has a rectangular cross-section of 300mm×250mm (b × h). It is prestressed with 9 numbers of straight 7mm diameter wires at 0.8 times the ultimate strength of 1570 N/mm^2. Estimate the percentage loss of stress due to elastic shortening of concrete. Consider m = 6.	Remember	5
13	A concrete beam of dimension 100 mm × 300 mm is post-tensioned with 5 straight wires of 7mm diameter. The average prestress after short-term losses is $0.7f_{pk}$ = 1200 N/mm^2 and the age of loading is given as 28 days. Given that Ep = 200 × 103 MPa,Ec = 35000 MPa, find out the losses of prestress due to creep, shrinkage and relaxation. Neglect the weight of the beam in the computation of the stresses.	Understand	5
14	A post-tensioned beam 100 mm × 300 mm (b × h) spanning over 10 m is stressed by successive tensioning and anchoring of 3 cables A, B, and C respectively as shown in figure. Each cable has cross section area of 200 mm2 and has initial stress of 1200 MPa. If the cables are tensioned from one end, estimate the percentage loss in each cable due to friction at the anchored end. Assume μ = 0.35, k = 0.0015 / m.	Understand	5

UNIT-III FLEXURE ANDSHEAR			
Part - A (Short Answer Questions)			
1	What are the stages to be considered in the design of prestressed concrete section under flexure?	Remember	6
2	What are the types of flexural failure encountered in prestressed concrete member?	Understand	6
3	What is strain compatibility method?	Remember	6
4	Write the assumptions in strain compatibility method of prestressed concrete sections.	Remember	6
5	Compare the flexure failure of conventional RC beam with PSC beam.	Remember	6
6	Explain with neat sketches the IS1343 code method of computing the moment of resistance of rectangular section.	Understand	6
7	How do you compute the ultimate flexural strength of section with tensioned and untensioned reinforcement in tension zone of concrete sections?	Remember	6
8	Distinguish between web shear and flexural shear cracks in PSC concrete beams with neat sketch.	Understand	6
9	Write a short notes on straight and concentric tendons in prestressed concrete beams.	Understand	6
10	Differentiate parabolic tendon and straight tendon with diagrams.	Remember	6
11	What are the assumptions in prestressed concrete members under flexure?	Remember	6
12	List some examples for structures subjected to combined bending, shear and torsion.	Remember	7
13	What are the different ways of improving shear resistance in concrete members?	Remember	7
14	How do you estimate the ultimate shear strength of PSC sections with flexure shear cracks?	Understand	7
15	Write the IS code provisions in the shear design of PSC members.	Remember	7
16	What is effective reinforcement ratio?	Understand	7
17	Sketch the cross section of PSC beam showing reinforcement designed for shear.	Remember	7
18	Show the failure modes of under reinforced and over reinforced prestressed beams.	Understand	7
19	How does the effective reinforcement ratio influence the stress in tendons and the neutral axis depth at limit state of collapse of PSC sections?	Understand	7
20	Under what situations and types of structures would you recommend the use of unbonded tendons?	Remember	7
21	What is the effect of using untensioned reinforcement in the compression and tension zones of PSC sections?	Remember	7
22	How do you compute the moment of resistance for a rectangular section?	Understand	7
23	How will you improve the shear resistance of concrete beam using prestressing techniques?	Understand	7
Part - B (Long Answer Questions)			
1	A pretensioned T section has a flange width of 1200mm and 150mm thick. The width and depth of the rib are 300mm and 1500mm respectively. The high tension steel has an area of 4700mm^2 and is located at an effective depth of 1600mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600Mpa respectively; calculate the flexural strength of the section.	Understand	6

2	A PSC beam of effective span 16m is of rectangular section 400mm wide and 1200mm deep. A tendon consists of 3300mm^2 of strands of characteristic strength of 1700N/mm^2 with an effective prestress of 910N/mm^2. The strands are located 870mm from the top face of the beam. If f_{cu}=60N/mm^2. estimate the flexural strength of the section as per IS1343 provisions for the following cases: (i) Bonded tendons (ii) Unbonded tendon	Understand	6
3	A post tensioned bridge girder with unbonded tendons is of size 1200mm wide by 1800mm deep is of box section with wall thickness of 150mm. The high tensile steel has an area of 4000mm^2 and is located at an effective depth of 1600mm. The effective prestress in steel after loss is 1000N/mm^2& effective span is 24m. If f_{ck} = 40 N/mm^2, f_p=1600N/mm^2 Estimate the flexural strength.	Understand	6
4	Enumerate the Permissible stresses in steel and concrete as per I.S.1343 Code.	Understand	6
5	The cross section of a prestressed concrete beam is an unsymmetrical T-section with an overall depth of1300mm. thickness of web is 150mm. Distance of top and bottom fibres from the centroid are 545mm and 755mm respectively. At a particular section, the beam is subjected to an ultimate moment M = 2130kNm and a shear force V=237kN. Effective depth d = 1100mm, f_{ck}= 45N/mm^2, f_{ep}=19.3 N/mm^2 ,I=665x10^{8}mm^4, A_p= 2310mm^2, f_p=1500N/mm^2, f_{ep}=890N/mm^2. Estimate the flexural-shear resistance using IS code.	Remember	6
6	A symmetrical I-section prestressed beam of 300mm wide and 750mm overall depth with flanges and web 100mm thick. The beam is post tensioned with the cables containing 48 wires of 5mm diameter high strength steel wires at an eccentricity of 250mm. the compressive strength of concrete is 40N/mm^2 and the ultimate tensile strength of wire is 1700N/mm^2. Assuming that the grout of tendons is 100% effective, determine the ultimate moment of section as per IS: 1343: 1980.	Understand	6
7	What do you understand by Type I and Type II members? Explain in details.	Understand	6
8	Discuss the Basic assumptions for calculating flexural stresses. Explain concept of limit states.	Understand	6
9	The cross-section of a symmetrical I-section prestressed beam is 400mm by 750mm (overall), with flanges and web 250mm thick. The beam is post-tensioned by cables containing 45 wires of 5mm diameter high-tensile steel wires at an eccentricity of 350mm. The 28-days strength of concrete in compressing is 40 N/mm^{2}and the ultimate tensile strength of wires is 16500N/mm^2. Assuming that the grouting of the tendons is 100 percent effective, determine the ultimate moment of the section as per IS 1343.	Remember	6
10	Discuss in detail the strain compatibility method with neat sketch.	Understand	6
11	Write the recommendations for Design for shear based on I.S. 1343 Code.	Understand	7
12	A pretensioned T section has a flange width of 300mm and 200mm thick. The width and depth of the rib are 150mm and 350mm respectively The effective depth of cross section is 500mm. Given A_p=200 mm^2, f_{ck}=50N/mm^2 and f_p=1600N/mm^2. Estimate the ultimate moment capacity using the IS code regulations.	Understand	7
13	A post tensioned concrete T beam with unbounded tendons is made up of a flange 300mm wide and 150mm thick and width of rib is 150mm. The effective depth of section is 320mm. The beam is prestressed by 24 wires each of 5 mm diameter having the characteristic strength of 1650N/mm^2.The effective stress after loss is 900 N/mm^2.If the cube strength of concrete is 56 N/mm^2. Estimate the flexural strength of the section using (a) IS code (b) British code. Take L/d =20.	Remember	7

14	A bonded post tensioned beam of rectangular section 400mm wide and 1200mm deep is stressed by $6000mm^2$ of high tensile steel at an effective depth of 1000mm. Given $f_{pu}=1600mm^2$, $f_{ck}=40N/mm^2$, $f_c'=32N/mm^2$. Estimate the ultimate flexural strength of the section using (a) ACI method (b) strain compatibility method. Assume $Es=210\ KN/mm^2$.	Understand	7
15	A pretensioned beam of rectangular section 300mm wide by 650mm deep is stressed by $800mm^2$ of high tensile steel at an effective depth of 600mm. The beam is provided with two 25mm diameter, high yield strength deformed bars both at the tension and compression faces with an effective cover of 50mm. Given $f_c=40N/mm^2$, $f_{pu}=1600N/mm^2$, $f_y=460N/mm^2$ and (f_{py}/f_{pu}) =0.9, estimate the ultimate moment capacity of the section using ACI provision.	Understand	7
16	Explain about the types of shear cracking occurring in prestressed concrete section.	Remember	7
17	The support section of prestressed concrete beam, 100 mm wide by 250 mm deep, is required to support an ultimate shear force of 80 kN. The compressive pre stress at the centroidal axis is 5 N/mm^2. The characteristic cube strength of concrete is 40 N/mm^2. The cover to the reinforcement is 50 mm. if the characteristic tensile strength of stirrups is 415 N/mm^2, design suitable shear reinforcement in the section using IS code recommendations.	Understand	7
Part - C (Problem Solving and Critical Thinking Questions)			
1	A post tensioned bridge girder with unbonded tendons is of size 1500mm wide by 1800mm deep is of box section with wall thickness of 250mm. The high tensile steel has an area of $3000mm^2$ and is located at an effective depth of 1200mm. The effective prestress in steel after loss is $800N/mm^2$& effective span is 20m. If f_{ck} = 40 N/mm^2, f_p = 1600 N/mm^2 Estimate the flexural strength.	Understand	6
2	A pre-tensioned T section has a flange width of 1000mm and 200mm thick.The width and depth of the rib are 350mm and 1250mm respectively. The high tension steel has an area of $4000mm^2$ and is located at an effective depth of 1400mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 38 and 1500Mpa respectively; calculate the flexural strength of the section**.**	Remember	6
3	The cross-section of a symmetrical I-section prestressed beam is 700mm by 550mm (overall), with flanges and web 250mm thick. The beam is post-tensioned by cables containing 35 wires of 7mm diameter high-tensile steel wires at an eccentricity of 300mm. The 28-days strength of concrete in compressing is $45N/mm^2$and the ultimate tensile strength of wires is $16500N/mm^2$. Assuming that the grouting of the tendons is 100 percent effective, determine the ultimate moment of the section as per IS 1343.	Understand	6
4	A pre-tensioned beam of rectangular section 350mm wide by 750mm deep is stressed by $950mm^2$ of high tensile steel at an effective depth of 600mm. The beam is provided with two 30mm diameter, high yield strength deformed bars both at the tension and compression faces with an effective cover of 55mm. Given $fc=45N/mm^2$, $f_{pu}=1650N/mm^2$, $f_y=460N/mm^2$ and (f_{py}/f_{pu}) =0.9, estimate the ultimate moment capacity of the section using ACI provision.	Understand	6
5	The support section of prestressed concrete beam, 100mm wide and 250mm deep is required to support an ultimate shear force of 60 kN.the compressive pre stress at the centroidal axis is 5 N/mm2. The characteristic cube strength of concrete is 40 $N/mm^{2.}$ The cover to the tension reinforcement is 50mm. If the characteristic tensile strength of steel in stirrups is 250 N/mm^2, design suitable reinforcements at the section using the IS: 1343 recommendations.	Understand	6

6	The cross-section of a symmetrical I-section prestressed beam is 500 mm by 650 mm (overall), with flanges and web 150 mm thick. the beam is post-tensioned by cables containing 45 wires of 5 mm diameter high-tensile steel wires at an eccentricity of 250 mm. The 28-days strength of concrete in compressing is 40 $N/mm^2$and the ultimate tensile strength of wires is 16500 N/mm^2. Assuming that the grouting of the tendons is 100 percent effective, determine the ultimate moment of the section as per IS 1343.	Understand	7
7	A pre-tensioned T section has a flange width of 1200mm and 150mm thick. The width and depth of the rib are 300mm and 1500mm respectively. The high tension steel has an area of $4700mm^2$ and is located at an effective depth of 1600mm. if the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600Mpa respectively; calculate the flexural strength of the section.	Understand	7
8	The end block of a post tensioned bridge girder is 500mm wide by 1000mm deep. Two cables, each comprising 90 high tensile wires of 7mm dia are anchored using square plates of side length 400mm with their centres located at 500mm from the top and bottom of the edges of the beam. The jacking force in each cable is 4000kN. Design a suitable anchorage reinforcement using Fe 415 grade HYSD bars conforming to IS: 1343 provision.	Understand	7
9	The end block of a PSC beam with rectangular cross section is 100mm wide and200mm deep. The prestressing force of 100kN is transmitted to the concrete by a distribution plate of 100mm x 50mm concentrically loaded at the ends. Calculate the position and the magnitude of tensile stress on the horizontal section through thecentre and edge of the anchor plate. Compute the bursting tension on the horizontal planes.	Understand	7
10	A PSC beam 250mm wide and 650mm deep is subjected to an effective pre stressing force of 1360kN along the centroidal axis. The cable is placed symmetrically over the mild steel anchor plate of area 150mmx 350mm. Design the end block. Take fck=30N/mm2.Assume initial prestressing force is 1.2 times the effective pre stressing force.	Understand	7
UNIT-IV **TRANSFER OF PRESTRESS IN PRETENSIONED MEMBERS**			
Part - A (Short Answer Questions)			
1	Mention the functions of end block.	Understand	8
2	What is the zone of transmission in the end block of prestressed concrete structures?	Understand	8
3	Define anchorage zone.	Remember	8
4	Define Bursting tension.	Understand	8
5	Define degree of prestressing.	Understand	8
6	What are the code provisions for bond and transmission length?	Understand	8
7	What is effective reinforcement ratio?	Understand	8
8	What is meant by end block in a post tensioned member?	Understand	8
9	Sketch the pattern of reinforcement in anchorage zone.	Understand	9
10	What are the methods of stress analysis in anchorage zone?	Understand	9
11	Draw the neat sketches of arrangements of reinforcement of end blocks.	Remember	9
12	Write the expression for the bursting tension in guyon’s method.	Remember	9
13	Define Guyon’s method.	Understand	9
14	List the method of investigation the anchorage zone stresses.	Remember	9
15	Define end zone reinforcement.	Remember	9
16	Define the stress distribution in the end block.	Remember	9

17	Explain bond stresses with neat diagrams.	Remember	9
18	What is flexural bond stress?	Understand	9
19	Discuss briefly the IS:1343 provisions for bond and transmission length.	Understand	9
20	Outline the methods by which the bond between concrete and steel tendons can be improved.	Understand	9
	Part - B (Long Answer Questions)		
1	The end block of a PSC beam with rectangular cross section is 100mm wide and 200mm deep. The prestressing force of 100kN is transmitted to the concrete by a distribution plate of 100mm x 50mm, concentrically loaded at the ends. Calculate the position and the magnitude of tensile stress on the horizontal section through the centre and edge of the anchor plate. Compute the bursting tension on the horizontal planes.	Understand	8
2	The end block of a post tensioned concrete beam 300mm X 300mm is subjected to a concentric anchorage force of 800kN by a freyssinet anchorage system of area 1100mm^2. Discuss and detail the anchorage reinforcement for the end block.	Understand	8
3	A PSC beam 250mm wide and 650mm deep is subjected to an effective prestressing force of 1360kN along the centroidal axis. The cable is placed symmetrically over the mild steel anchor plate of area 150mm x 350mm. design the end block. Take fck= 30N/mm^2. Assume initial prestressing force is 1.2 times the effective prestressing force.	Understand	8
4	Write about the Magnel's method and Guyon's method for end block .	Understand	8
5	A post tensioned concrete rectangular beam, 240mm wide by 500mm depth, is grouted before the application of live loads. The steel consists of three tendons, each made of 12 numbers of 7mm diameter wire encased in a thin metallic hose of 30 mm diameter with an effective cover of 50mm. the modulus of elasticity of steel and concrete are 210 and 35kN/mm^2 respectively. The beam spans 10m and supports two concentrated loads of 250kN each at the third points. Compute the unit bond stress.	Understand	8
6	Define the terms (a) end block (b) Anchorage zone (c) Bursting tension	Understand	8
7	A pre-tensioned rectangular beam width of 200mm and 500mm overall depth, is prestressed by 5 wires of 7mm diameter located 100mm from the soffit. The maximum shear force at a particular section is 100kN. If the modular ratio is 6, calculate the bond stress developed assuming (a) the section as uncracked, (b) the section as cracked.	Understand	8
8	A PSC beam 250mm wide and 650mm deep is subjected to an effective prestressing force of 1360kN along the centroidal axis. The cable is placed symmetrically over the mild steel anchor plate of area 150mmx 350mm. Design the end block. Take f_{ck}=30N/mm^2. Assume initial prestressing force is 1.2 times the effective prestressing force.	Understand	8
9	A pre-tensioned rectangular beam width of 200mm and 450mm overall depth, is prestressed by 10 wires of 5mm diameter located 150mm from the soffit. The maximum shear force at a particular section is 120kN. If the modular ratio is 6, calculate the bond stress developed assuming (a) the section as uncracked, (b) the section as cracked.	Understand	9
10	Explain with sketches the effect of varying ratio of depth anchorage to the depth of end block on the distribution of bursting tension.	Understand	9
11	The end block of a post tensioned concrete beam 300mm X 300mm is subjected to a concentric anchorage force of 2800kN by a freyssinet anchorage system of area 117200mm2. Discuss and detail the anchorage reinforcement for the end block.	Understand	9

12	The end block of a post tensioned bridge girder is 500mm wide by 1000mm deep. Two cables, each comprising 90 high tensile wires of 7mm diameter are anchored using square plates of side length 400mm with their centres located at 500mm from the top and bottom of the edges of the beam. The jacking force in each cable is 4000kN. Design a suitable anchorage reinforcement using Fe415 grade HYSD bars conforming to IS: 1343 provision.	Understand	9
13	The end block of a PSC beam with rectangular cross section is 100mm wide and 200mm deep. The prestressing force of 100kN is transmitted to the concrete by a distribution plate of 100mmx50mm, concentrically loaded at the ends. Calculate the position and the magnitude of tensile stress on the horizontal section through the centre and edge of anchor plate. Compute the bursting tension on the horizontal planes.	Understand	9
14	Calculate the transmission length at the end of a pre-tensioned beam as per Hoyer's method with the following data: Span of beam=50m, Diameter of wires=7mm, Coefficient of friction between steel and concrete=0.1, Poisson's ratio for steel=0.30, Poisson's ratio for concrete=0.15, Es=210kN/mm2 and Ec=30kN/mm^2, F_{pu}=1500N/mm2.	Understand	9
15	Estimate the transmission length at the ends of a pre-tensioned beam prestressed by 8mm diameter wires. Assume the cube strength of concrete at transfer as 42N/mm2.	Understand	9
16	A pre-tensioned beam is prestressed using 5mm diameter wires with an initial stress of 80% of the ultimate tensile strength of steel=1600N/mm^2. The cube strength of concrete at transfer is 30N/mm^2. (a) Calculate the transmission length (b) Compute the bond stress at ¼ and ½ transmission length from the end, (c) Calculate the overall average bond stress.	Understand	9
17	A pre-tensioned beam of 8m span has a symmetrical I-section. The flanges are 200mm wide and 60mm thick. The web thickness is 80mm and the overall depth of girder is 400mm. The member is prestressed by 8 wires of 5mm diameter located on the tension side such that the effective eccentricity is 90mm. The initial stress in the wires is 1280N/mm^2 and the cube strength of concrete at transfer is 42N/mm^2. (a)Determine the maximum vertical tensile stress developed in the transfer zone; (b) Design suitable mild steel reinforcement, assuming the permissible stress in steel as 140N/mm2.	Understand	9
Part - C (Problem Solving and Critical Thinking Questions)			
1	Design a composite PSC beam for the following data: Span=12m; live load = 5kN/m^2; σ_{ci} = 14 N/mm^2; η =85%; Depth of the slab =150mm; f_{pe}= 950 N/mm^2 ; m=0.6; spacing of beam= 3.5m;Breadth of the web = 150mm; b_f= 1500mm. Assume post tension.	Understand	8
2	A simply Supported PSC beam of span 5m and size l50mm x 300mm has 15MpaPre stress at soffit and Zero at top after all loses is Prestress. A slab of 450mmwideand 60 mm deep is cast on the top of the beam to induce composite T-beam action. the maximum udl that can be supported without any tensile stress at soffit for the following conditions. (i) Slab is externally supported during casting. (ii) Slab is supported by the PSC beam during casting.	Understand	8

3	The cross-section of a composite beam consists of a 300mm x 900mm precast stem and cast-in-situ flange 900mm x 150mm. The stem is a post-tensioned unit with an initial pre stressing force of 2500 kN. The effective pre stress available after making deduction for losses is 2200 kN. The dead load moment at mid span due to the weight of the precast section is 250 kNm. The dead load moment due to the weight of the flange is 125 kNm. After hardening of the flange concrete, the composite section has to carry a live load which produces a bending moment of 700 kNm. Examine the stress distribution in concrete at the various stages of the loading.	Understand	8
4	A precast pre tensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam with an effective span of 5m is pre stressed by the tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150kN. The loss of pre stress is 15%. The top flange width is 400mm with the thickness of 40mm.If the composite beam supports a live load of 7kN/m2 calculate the resultant stresses developed if the section is un propped. M40 and M20 concrete are used for pre tensioned and in situ concrete.	Understand	8
5	The cross-section of a composite beam consists of a 300mm x 900mm precast stem and cast-in-situ flange 900mm x 150mm. The stem is a post-tensioned unit with an initial prestressing force of 2500 kN. The effective prestress available after making deduction for losses is 2200 kN. The dead load moment at mid span due to the weight of the precast section is 250 kNm. The dead load moment due to the weight of the flange is 125 kNm. After hardening of the flange concrete, the composite section has to carry a live load which produces a bending moment of 700 kNm. Examine the stress distribution in concrete at the various stages of the loading.	Understand	8
6	A composite pre stressed concrete beam consists of a prefabricated stem of 300mm X800mm and a cast insitu slab of 800mm X 150mm. If the differential shrinkage is 1.2X 10-4 mm/mm, the shrinkage stresses at the extreme edges of the slab and the stem. Take Ec = 2.75 X 104 N/mm^2.	Understand	9
7	A composite T-girder of span 5m is made up of a pre-tensioned rib, 100mm wide by 200mm depth, with an insitu cast slab, 400mm wide and 40mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33 mm and carrying initial force of,150kN.The loss of prestress is 15%. Check the composite T-beam for the limit state of deflection if its supports an imposed load of 3.2kN/m for (i) unpropped (ii) propped. Assume modulus of Elasticity of 35kN/mm2 for both precast &insitu cast elements.	Understand	9
8	A prestressed beam with rectangular cross section with a width of 120mm and depth of 300mm is continuous over two spans AB=BC= 8m. The cable with zeroeccentricity at the ends and an eccentricity of 50mm towards the top fibres of thebeam over the central support, carries an effective force of 500kN.Calculate the secondary moments developed at B. If the beam supports the concentrated load of 20kN each at mid points of the span, the resultant stresses at the central support section B.Also locate the position of pressure line at the section.	Understand	9
9	A continuous beam ABC (AB=BC=10m) is pre stressed by a parabolic cable carrying an effective force of 200kN. The beam supports dead load and live load of 0.24kN/m and 2.36 kN/m respectively. Calculate the resultant moments developed in the beam and locate the pressure line.	Understand	9
UNIT-V COMPOSITE BEAMS AND DEFLECTIONS			
Part - A (Short Answer Questions)			
1	Define propped construction in composite PSC construction?	Remember	10
2	Describe how to achieve compositeness between precast and cast in-situ part?	Remember	10
3	List the effects of differential shrinkage in composite beams?	Remember	10
4	Differentiate between propped and unpropped composite construction?	Understand	10
5	Describe about shear connectors in composite construction?	Remember	11

6	List the advantages of composite prestressed concrete beams.	Understand	11
7	How do you the shrinkage and resultant stresses in composite member?	Remember	11
8	What are the advantages of continuous members in prestressed concrete structures?	Remember	11
9	Explain the term primary moment, secondary moment and resultant moment.	Remember	11
10	What are cap cables and where they are used?	Understand	12
11	List the commonly used methods to analyse the secondary moments in prestressed concrete continuous members.	Understand	12
12	Draw any four types of composite prestressed concrete sections.	Remember	12
13	List out the effects of prestressing the indeterminate structures?	Understand	12
14	Write about redundant reaction with respect to prestressed concrete continuous members?	Remember	12
15	Sketch a typical concordant cable profile in a two span continuous prestressed concrete beam.	Remember	12
16	Explain how do you form the bonding between prestressed units and reinforced units?	Understand	12
17	Explain the method of computing the ultimate shear strength in composite PSC members.	Remember	12
18	Explain the tendon reaction with neat sketches.	Understand	12
	Part - B (Long Answer Questions)		
1	Explain Mohr's theorem to determine the short term deflections of uncracked members.	Understand	10
2	Discuss effect of various tendon profiles on deflection and derive the equations for deflection.	Understand	10
3	A precast pre tensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam with an effective span of 5m is pre stressed by the tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150kN. The loss of prestress is 15%. The top flange width is 400mm with the thickness of 40mm.If the composite beam supports a live load of 7kN/m^2 calculate the resultant stresses developed if the section is unpropped. M40 and M20 concrete are used for pre tensioned and in-situ concrete.	Remember	10
4	Design a composite slab for the bridge deck using a standard inverted T-section. The top flange is 300mm wide and 110mm thick. The bottom flange is 550mm wide and 250mm thick. The web thickness is 100mm and the overall depth of the inverted T. Section is 655mm. The bridge deck has to support a characteristic imposed load of 50kN/m^2, over an effective span of 12m. Grade 40 concrete is specified for the precast pretensioned T-with a compressive strength at transfer of 36 N/mm^2. Concrete of grade-30 is used for the in situ part. Calculate the minimum pre stress necessary and check for safety under serviceability limit state.	Understand	10
5	Explain the advantages of using precast prestressed elements along with in-situ concrete.	Understand	10
6	The cross-section of a composite beam consists of a 300mm x 900mm precast stem and cast-in-situ flange 900mm x 150mm. The stem is a post-tensioned unit with an initial prestressing force of 2500kN. The effective prestress available after making deduction for losses is 2200kN. The dead load moment at mid span due to the weight of the precast section is 250kNm. The dead load moment due to the weight of the flange is 125kNm. After hardening of the flange concrete, the composite section has to carry a live load which produces a bending moment of 700kNm. Examine the stress distribution in concrete at the various stages of the loading.	Understand	11

7	A prestressed beam with rectangular cross section with a width of 120mm and depth of 300mm is continuous over two spans AB=BC=8m. The cable with zero eccentricity at the ends and an eccentricity of 50mm towards the top fibres of the beam over the central support carries an effective force of 500kN.	Remember	11
8	A continuous beam ABC (AB=BC=10m) is prestressed by a parabolic cable carrying an effective force of 200kN. The cable profile is shown in Fig. The beam supports dead load and live load of 0.24kN/m and 2.36kN/m respectively. Calculate the resultant moments developed in the beam and locate the pressure line.	Understand	11
9	Explain how long term deflections are predicted in prestressed members.	Understand	11
10	Write step by step design procedure for composite construction.	Understand	11
11	A composite T-beam is made up of a pretension rib 100mm wide and 200mm deep, and a cast in situ slab 400mm wide and 40mm thick having a modulus of elasticity of 28kN/mm^2. If the differential shrinkage is 100x10^{-6} units, determine the shrinkage stresses developed in the precast and cast in situ units.	Remember	11
12	Discuss in detail about the factors which influence flexural strength and shear strength of composite prestressed section.	Understand	11
13	A prestressed concrete beam of rectangular section 120mm wide and 300mm deep, spans over 6m.the beam is prestressed by a straight cable carrying an effective force of 200kNat an eccentricity of 50mm. the modulus of elasticity of concrete is 38kN/m2.ompute the deflections at centre span for the following case: (i) deflection under prestress and self-weight; (ii) Find the magnitude of udl live load which will nullify the deflection due to prestress and self weight.	Remember	11
14	A per stressed concrete beam having a cross sectional area of 3x 104 mm^2 is a simply supported over a span of 10m. Its supports a uniformly distributed imposed load of 3kN/m, Half of which is not permanent. The tendons follow a trapezoidal profile with an eccentricity of 100mm with in the middle third of the span and vary linearly from the third span points to zero at the supports. The area of the tendons A_p=350mm^2 having effective pre stressed of 1290N/mm2 immediately after transfer. Calculate the short term and long term deflection.	Understand	12
15	Explain the types of composite construction.		12
16	Discuss in detail the phenomenon of differential shrinkage in prestressed concrete members.	Understand	12
17	Discuss about the importance of control of deflection and the factors influencing the deflection of PSC beams.	Understand	12
18	A rectangular concrete beam of cross section 150mm wide and 300mm deep is simply supported over a span of 8m and is prestressed by means of a symmetric parabolic cable at a distance of 75mm from the bottom of the beam at mid span and 125mm from the top of the beam at support sections. If the forces in the cable is 350kN and the modulus of elasticity of concrete is 38kN/mm^2 calculate, the deflection at mid span when the beam is supported its own weight and the concentration load which must be applied at mid span to restore it to the level of supports.	Remember	12
19	(i) Explain the types of composite construction with neat sketch. (ii) Explain the precast prestressed concrete stresses at serviceability limit state.	Remember	12
20	Design a precast prestressed inverted T–section to be used in a composite slab of total depth 600mm and width 300mm. the composite slab is required to support an imposed load of 16kN/m^{2}over a span of 14m. the compressive stress in concrete at transfer and the tensile stress under working loads may be assumed to be 20 and 1 N/mm^2 respectively. The loss ratio is 0.85. Determine the prestressing force required for the section.	Understand	12

Part - C (Problem Solving and Critical Thinking Questions)			
1	A composite T-girder of span 5 m is made up of a pre-tensioned rib, 100 mm wide by 200 mm depth, with an in situ cast slab, 400 mm wide and 40 mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33 mm and carrying initial force of, 150 kN. The loss of prestress is 15%. Check the composite T-beam for the limit state of deflection if its supports an imposed load of 3.2 kN/m for (i) unpropped(ii) propped. Assume modulus of Elasticity of 35kN/mm2 for both precast & in-situ cast elements.	Remember	10
2	A PSC beam of cross section 150 mm x 300 mm is SS over a 6pan of 8m and is prestressed by means of symmetric parabolic cables @ a distance of 76 mm from the soffit @ mid span and 125 mm @ top @ support section. If the force in the cable i.e 350 KN. Calculate deflection @ midspan the beam is supporting its own weight The point load which must be applied at midspan to restore the beam to the level of its support.	Understand	10
3	A PSC beam with rectangular section, 150mm wide 300mm deep is prestressed by three cables each carrying a effective prestress of 200kN. The span of the beam is 12m. The first cable is parabolic with an eccentricity of 50m below the centroidal axis at the centre of the span and 50mm above the centroidal axis at the supports. The second cable is parabolic with an eccentricity of 50mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 50mm below the centroidalaxis. If the beam supports an UDL of 6kN/m and Ec=38kN/mm^2 Estimate the instantaneous deflection for the following stages (i) Prestress + self weight of the beam. (ii) Prestress + self weight of the beam + live load.	Remember	10
4	A prestressed concrete beam of span 8 m having a rectangular section 150 mm x 300 mm. the beam is prestressed by a parabolic cable having an eccentricity of 75 mm below the centroid axis at the centre of span and an eccentricity of 25 mm above the centroid axis at support section. The initial force in the cable is 350 KN. The beam support three concentrated loads of 10 kN each at intervals of 2 Es = 38 kN/mm^2. Neglecting losses of prestress, estimate the short term deflection due to(prestress+ self weight) Allowing for 20 % loss in prestress, estimate long term deflection under (prestress + self weight +live load), assume creep co-efficient as 1.8.	Understand	10
5	A PSC beam of cross section 150 mm x 300 mm is simply supported over a span of 8m and is prestressed by means of symmetric parabolic cables @ a distance of 76 mm from the soffit @ mid span and 125 mm @ top @ support section. If the force in the cable i.e 350 kN. Calculate deflection @ midspan the beam is supporting its own weight The point load which must be applied at midspan to restore the beam to the level of its support.	Understand	11
6	A prestressed concrete beam of rectangular section 150mm wide and 350mm deep, spans over 8m.the beam is prestressed by a straight cable carrying an effective force of 400kNat an eccentricity of 55mm. the modulus of elasticity of concrete is 40kN/m^2. Compute the deflections at centre span for the following case: (i) deflection under prestress and self-weight; (ii) Find the magnitude of UDL live load which will nullify the deflection due to prestress and self weight.	Understand	11
7	A composite beam of rectangular section is made up of a pre-tensioned inverted T-beam having a thick slab of 150mm and width of 1050mm.The rib size is 160mm×800mm. the cast in-situ concrete has a thickness and width of 1050mm with a modulus of elasticity of 35kN/mm^2. If the differential shrinkage is 100x10^{-6} units, estimate the shrinkage stresses developed in the precast and cast in-situ units.	Understand	11

8	A PSC beam with rectangular section, 250mm wide 400mm deep is prestressed by three cables each carrying a effective prestress of 250kN. The span of the beam is 15m. The first cable is parabolic with an eccentricity of 50mm below the centroidal axis at the centre of the span and 55mm above the centroidal axis at the supports. The second cable is parabolic with an eccentricity of 50mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 55mm below the centroidalaxis. If the beam supports an UDL of 9kN/m and Ec=40kN/mm2 Estimate the instantaneous deflection for the following stages i) Prestress + self weight of the beam. ii) Prestress + self weight of the beam + live load.	Remember	12
9	A precast pre-tensioned beam of rectangular section has a breadth of 100mm and a depth of 200mm. the beam with an effective span of 5 m is prestressed by tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150kN. The loss of prestress may be assumed to be 15 percent. The beam is incorporated in a composite T – beam by casting a top flange of breadth 400 mm and thickness 40 mm. if the composite beam supports a live load of $8kN/m^2$. Calculate the resultant stresses developed in the precast and in-situ concrete assuming the pre-tensioned beam as: (a) Unpropped, (b) propped during the casting of the slab. Assume the same modulus of elasticity for concrete in precast beam and in-situ cast slab.	Understand	12
10	A composite beam of rectangular section is made up of a pretensioned inverted T-beam having a thick slab of 150mm and width of 1000mm.The rib size is 150mm×850mm. the cast in-situ concrete has a thickness and width of 1000mm with a modulus of elasticity of $30kN/mm^2$. If the differential shrinkage is $100x10^{-6}$ units, estimate the shrinkage stresses developed in the precast and cast in-situ units.	Understand	12
11	A precast PSC beam of rectangular section has a breadth of 100 mm and a depth of 200 mm. The beam with an effective span of 5 m is prestressed by tendons with their centroids coinciding with bottom kern. The initial force in the tendon is 150 kN. The loss ratio = 0.85. The beam is incorporated in a composite T beam by casting a top flange of breadth 400 mm and thickness 40 mm. If the composite beam supports a live load of 8 kN/m^2. Calculate the resultant stresses developed in the precast and insitu cast concrete assuming the pretensioned beam as unpropped during the casting of the slab. Precastpsc = 35 kN/mm^2, Einsitu con = 28 kN/mm^2.	Understand	12
12	Design a composite PSC beam for the following data: Span=12m; live load = $5kN/m^2$; $ó_{ci}$ = 14 N/mm^2; ç =85%; Depth of the slab =150mm; f_{pe}= 950 N/mm^2 ; m=0.6; spacing of beam= 3.5m; Breadth of the web = 150mm; b_f= 1500mm. Assume post tension.	Understand	12
13	Design a composite slab for the bridge deck using a standard invested T-section. The top flange is 250mm wide and 100mm thick. The bottom flange is 500mm wide and 250mm thick. The web thickness is 100 mm and the overall depth of the inverted T-section is 655mm. The bridge deck has to support a characteristic imposed load of $50kN/m^2$over an effective span of 12m. Grade 40 concrete is specified for the precast pre-tensioned T-section with a compressive strength at transfer of $36N/mm^2$. Concrete of grade 30 is used for the in-situ part. Determine the minimum prestress necessary and check for safety under serviceability limit state. Section properties: Area = 180500mm2, position of centroid = 220mm from the soffit. I = 81.1 x 108 mm^4, Z_t=18.7 x 106 mm^3, Z_b = 37 x 106 mm^3. Loss ratio = 0.8, M_{min}= 0.	Understand	12
14	A composite T - beam is made up of a pre-tensioned rib 100mm wide and 200mm deep and cast in situ slab 400mm wide and 40mm thick having a modulus of elasticity of $28kN/mm^2$. If the differential shrinkage is $100x10^{-6}$ units, estimate the shrinkage stress developed in the precast and cast in situ units.	Understand	12

15	A composite beam of rectangular section is made of inverted T-beam having a slab thickness of 150 mm and width of 1000 mm. the rib size in 150 mm x 850 mm. The in situ concrete slab has EC = 30kN/m^2 and the thickness of cast in situ slab is 1000 mm. If the differential shrinkage in 100 x 10-6 units, estimate the shrinkage stress developed in the precast and cast in situ units.	Understand	12

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