I.F.S. EXAM-(M) 2018

FSI-P-CVLE

CIVIL ENGINEERING

Paper – I

Time Allowed : ***Three*** *Hours*

Maximum Marks : ***200***

Question Paper Specific Instructions

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

There are ***EIGHT*** *questions in all, out of which* ***FIVE*** *are to be attempted.*

Questions no. ***1*** *and* ***5*** *are* ***compulsory****. Out of the remaining* ***SIX*** *questions,* ***THREE*** *are to be attempted selecting at least* ***ONE*** *question from each of the two Sections A and B.*

Attempts of questions shall be counted in sequential 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 Question-cum-Answer Booklet must be clearly struck off.

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

Answers must be written in ***ENGLISH*** *only.*

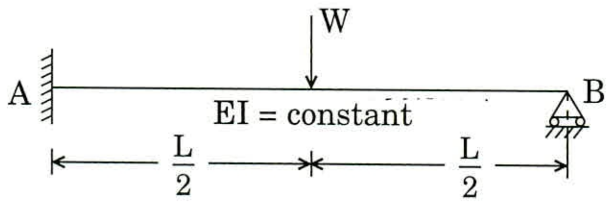
Unless otherwise mentioned, symbols and notations have their usual standard meanings.

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

Neat sketches may be drawn, wherever required.

SECTION A

Q1. (a) Using column analogy method, determine the bending moment at fixed end in the propped cantilever beam as shown in the figure below : *8*



(b) Calculate the quantities of ingredients required to produce one cubic metre of concrete for the following details : *8*

Mix ratio – 1 : 1·29 : 2·88 by volume.

Nominal size of aggregate = 20 mm

Water cement ratio = 0·48

Bulk density of cement = 1440 kg/m^3

Bulk density of sand = 1850 kg/m^3

Bulk density of coarse aggregate = 1600 kg/m^3

The percentage of entrained air = 2%

Sp. gravity of cement = 3·15

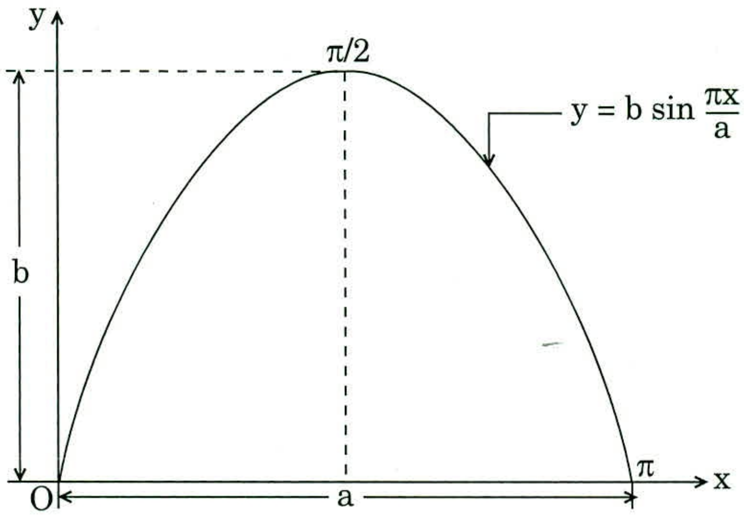
Sp. gravity of sand = 2·68

Sp. gravity of coarse aggregate = 2·74

(c) A leaf spring of semi-elliptical type has 11 plates each 9 cm wide and 1·5 cm thick. The length of spring is 1·5 m. The plates are made of steel having a proof stress (bending) of 650 MN/m^2. To what radius should the plates be bent initially ? From what height can a load of 600 N fall on to centre of the spring, if maximum stress is to be one-half of the proof stress ? Take E = 200 GN/m^2. *8*

(d) In a roof truss, a diagonal consists of a single equal angle tension member. It is 4·2 m long and subjected to a tensile load of 280 kN. Design the section if it is connected to a gusseted plate through one leg only by 18 mm diameter rivets. The permissible stress in axial tension is $\sigma_t = 150$ N/mm^2. Also check the slenderness ratio if $r_{min} = 19{\cdot}4$ mm. *8*

(e) Determine the second moment of area about x-axis of a section bounded by x-axis and a curve $y = b \sin \frac{\pi x}{a}$ as shown in the figure below : *8*



Q2. (a) A prestressed concrete beam supports an imposed load of 5 kN/m over an effective span of 12 m. The beam has a rectangular section with a width of 250 mm and a depth of 700 mm. Find the effective prestressing force in the cable if it is parabolic with an eccentricity of 110 mm at the centre and zero at the ends, for the following conditions : *10*

(i) if the bending effect of prestressing force is nullified by the imposed load for the mid-span section by neglecting the self weight of the beam.

(ii) if the resultant stress due to self-weight, imposed load and prestressing force is zero at the soffit of the beam for the mid-span section. Assume the density of concrete is 25 kN/m^3.

(b) (i) A shaft is subjected to a maximum torque of 10 kNm and a maximum bending moment of 7·5 kNm at a particular section. If the allowable equivalent stress in simple tension is 160 MN/m^2, find the diameter of the shaft according to the maximum shear stress theory. *10*

(ii) State maximum principal stress theory. *5*

(c) (i) The effective length of compression flange of a simply supported beam ISMB 600 @ 1·225 kN/m is 10 m. Determine the safe uniformly distributed load per metre length which can be placed over the beam having an effective span of 10 metres. The ends of the beam are restrained against rotation at the bearing. The maximum permissible stresses are given below. $\sigma_y = 250$ Mpa. *10*

Properties of ISMB 600 @ 1·225 kN/m.

$$\text{Area} = 15600 \text{ mm}^2$$

$$Z = 3060 \times 10^3 \text{ mm}^3$$

Mean thickness of compression flange, $t_f = 20{\cdot}8$ mm

Thickness of web, $t_w = 12$ mm

Maximum thickness of flange, $h_2 = 45{\cdot}15$ mm

Radius of gyration $r_{xx} = 242$ mm

$$r_{yy} = 41{\cdot}2 \text{ mm}$$

Maximum permissible bending stress σ_{bc} N/mm^2 in equal flange I-beams

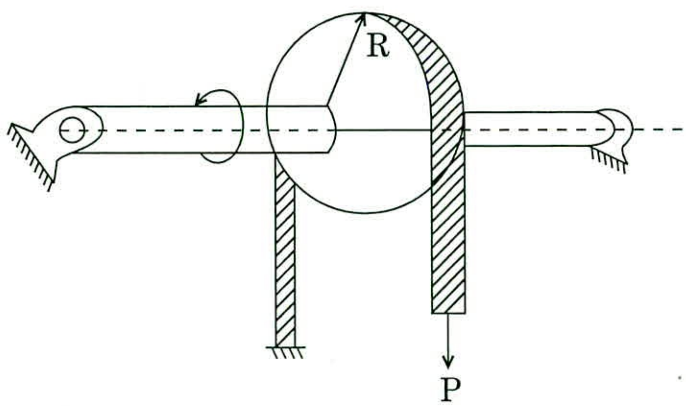
D/t_f → l/r_{yy} ↓	16	18	20	25	30
120	126	122	119	113	109
130	121	118	114	108	103
140	118	113	110	103	97
150	114	109	105	98	92
160	110	106	101	93	87
170	107	102	98	89	83
180	104	99	94	85	79
190	101	95	91	82	75

(ii) An RC wall of 200 mm thickness and 3·6 m effective height is needed for a compressive load of 1250 kN. Design the wall using M 15 grade of concrete and Fe 415 steel reinforcement. *5*

Q3. (a) Draw the influence line diagram (ILD) for bending moment and shear force for a section at 5 m from the left hand support of a simply supported beam, 20 m long. Hence calculate the maximum bending moment and shear force at the section, due to uniformly distributed rolling load of length 8 m and intensity 10 kN/m run. *10*

(b) Design the vertical wall of a cantilever retaining wall to retain earth embankment 4·5 m above ground level. The density of earth is 16 kN/m^3 and its angle of repose is 30°. Top of the embankment is levelled one. The safe bearing capacity of the soil may be taken as 210 kN/m^2 and the coefficient of friction between soil and concrete is 0·58. Adopt M 20 grade concrete and Fe 415 grade steel. *15*

(c) A flywheel of diameter 0·7 m has a mass of 80 kg as shown in the figure below. The coefficient of friction between the band and the flywheel is 0·40. If the initial rotating velocity of the flywheel is 400 rpm clockwise, determine the magnitude of the force P required to stop the flywheel in 5 seconds. *15*



Q4. (a) Calculate the load carrying capacity of a rolled steel section ISMB 600. The height of the column is 8 m; fixed at base and pinned at top. The yield stress of steel is 250 MPa. The permissible compressive stresses are as given in the table below : *10*

Slenderness ratio (λ)	90	100	110	120	130	140	150	160	170	180
Allowable compressive stress in MPa (σ_{ac})	90	80	72	64	57	51	45	41	37	33

The cross-section properties of ISMB 600 section are as follows :

Area of the cross section = 15600 mm^2

Flange width = 210 mm

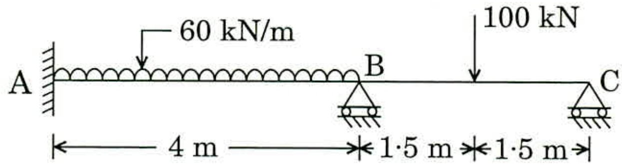
Flange thickness = 20·8 mm

Web thickness = 12 mm

$I_{xx} = 918{\cdot}13 \times 10^6 \ mm^4$

$I_{yy} = 26{\cdot}5 \times 10^6 \ mm^4$

(b) Analyse the continuous beam shown in the figure below by flexibility method and draw the bending moment diagram. Take EI = Constant. *15*



(c) Design an RC floor slab for a room of internal dimensions of 3·5 m × 8·5 m. Assume the slab to be simply supported on 230 mm thick masonry walls. The slab is to support a live load of 4 kN/m^2 and a floor finish load of 1·5 kN/m^2. Use M 25 grade of concrete and Fe 415 grade steel. Draw the details of reinforcements. The band strength for M 25 concrete (τ_{bd}) is 1·26 N/mm^2. The design shear strength of concrete τ_c is given as follows for different values of $P = \frac{100 \ A_{st}}{bd}$. *15*

$\frac{100 \ A_{st}}{bd}$	$\leq 0{\cdot}15$	0·25	0·50	0·75
τ_c N/mm^2	0·29	0·36	0·49	0·57

SECTION B

Q5. (a) What are important clay minerals ? Why do clays exihibit plasticity ? *8*

(b) A granular soil was tested in the laboratory and found to have maximum and minimum void ratios of 0·82 and 0·38 respectively. The specific gravity of soil solids was 2·66. A natural deposit of the same soil has 10% moisture and its moist unit weight is 19 kN/m^3. Determine the relative density of the soil in the field. *8*

(c) What are the merits and demerits of the stone column method of soil improvement ? *8*

(d) Water is moving through a pipe. The velocity profile at a particular section is given mathematically as *8*

$$v = \left(\frac{\beta}{4\mu}\right)\left(\frac{d^2}{4} - r^2\right)$$

where

v = velocity of water at any position r

β = constant

μ = viscosity of water

d = pipe diameter

r = radial distance from centreline of pipe

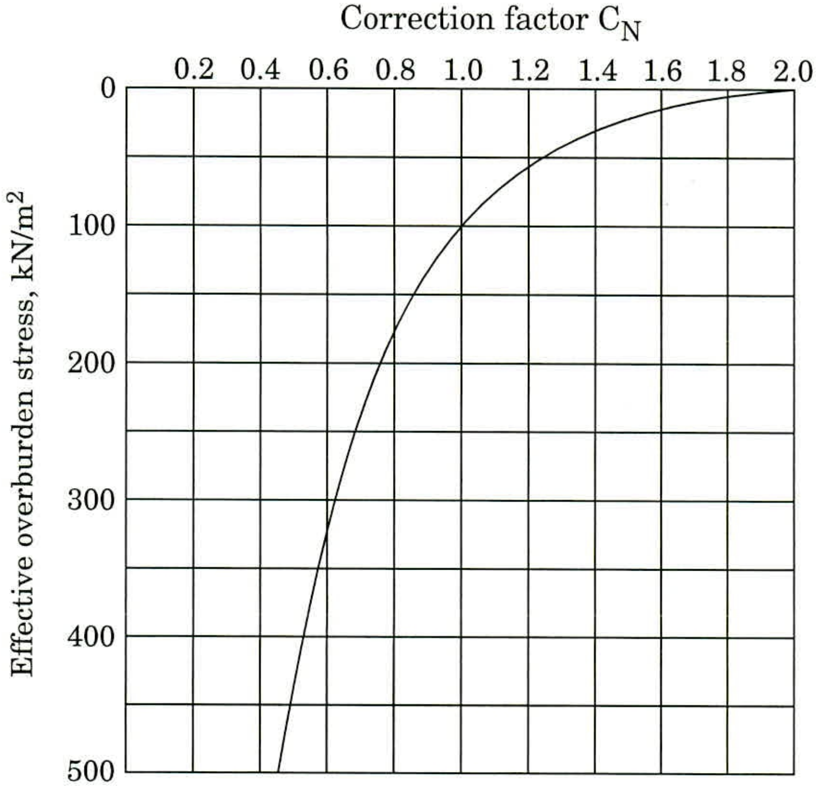
(i) What is the shear stress at the wall of the pipe due to the water ?

(ii) What is the shear stress at a position r = d/4 ?

(iii) If the given profile persists a distance L along the pipe, what drag is induced on the pipe by the water in the direction of flow over this distance ?

(e) Water flows in a trapezoidal channel having a bottom width of 4·57 m and side slopes of 1 vertical to 1·5 horizontal at a rate of 5·66 m^3/s. If the depth of flow is 0·61 m, determine whether the flow is subcritical or supercritical. Take $g = 9{\cdot}81\ m/s^2$. *8*

Q6. (a) An SPT test was conducted in a sand deposit at 12 m depth. The unit weight of sand is 20 kN/m^3 and water table is at 2 m below natural ground surface. If the observed SPT value is 24; what will be the corrected N value ? Use the figure below to apply overburden correction. *10*



Correction factor for N-values for overburden correction

(b) Forest areas usually have freshwater ponds and lakes in which small animals such as crayfish, shrimp, etc. live. One such animal has an average diameter of 1 mm. We want to know the drag force on this animal when it moves slowly in freshwater. As it is difficult to measure this drag force on such a small animal, a scale model 100 times larger is made and tested in glycerin in a laboratory at V = 30 cm/s. The measured drag on the model is 1·3 N. For similar conditions, find the velocity and drag of the actual animal in water. Given that *15*

$\mu_{water} = 0{\cdot}001$ kg/(m-s) $\rho_{water} = 999$ kg/m^3

$\mu_{glycerin} = 1{\cdot}5$ kg/(m-s) $\rho_{glycerin} = 1263$ kg/m^3

(c) (i) Sketch the general layout of a hydropower system with a reaction turbine.

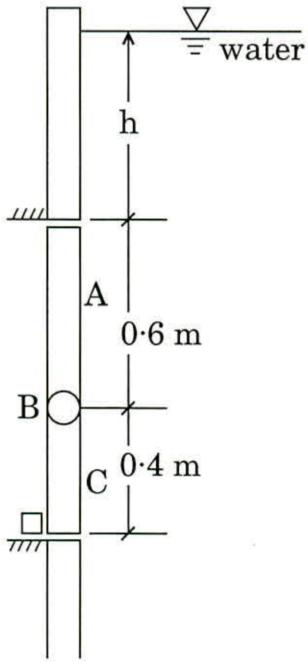
(ii) A reaction turbine is supplied with water through a 150 cm pipe (penstock) (e = 1·0 mm) that is 40 m long. The water surface in the reservoir is 20 m above the draft tube inlet, which is 4·5 m above the water level in the tailrace. If the turbine efficiency is 92% and the discharge is 12 m^3/s, what is the power output of the turbine in kilowatts ? Use f = 0·0185, g = 9·81 m/s^2. *15*

Q7. (a) A square footing of 2 m × 2 m is placed in a soil deposit at 1·5 m depth. The soil properties are c = 60 kN/m^2, ϕ = 22°, γ = 20 kN/m^3. What maximum vertical load can this footing carry with FOS = 3 ? If the footing is subjected to moment of 160 kN-m in one direction and 130 kN-m in the other direction, what will be the revised factor of safety ? Adopt bearing capacity factors from the table given below : *15*

ϕ°	N_c	N_q	N_γ
10	8·35	2·47	1·22
15	10·98	3·94	2·65
20	14·83	6·40	5·39
25	20·72	10·66	10·88

(b) A rectangular area of 4 m × 2 m is uniformly loaded with a pressure of 100 kPa at the ground surface. Calculate the vertical pressure at a point 3 m below one of its corners by equivalent-area method. Compare the stress at the same point by Boussinesq's 2 : 1 approximate stress distribution method. *15*

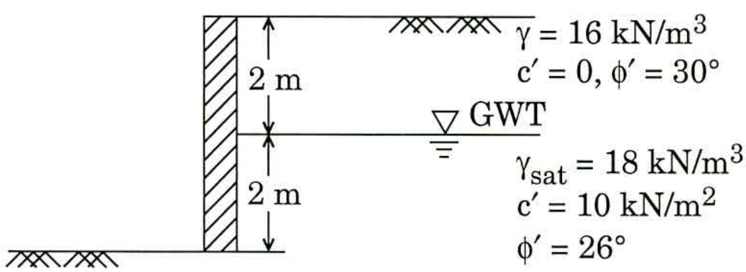
(c) It is frequently desirable to install automatic gates to prevent a flood. One such gate ABC is shown in the figure.



(Not to scale)

The gate ABC is 1 m square and hinged at B. It will open automatically when water depth h becomes high enough. Determine the minimum value of h at which the gate will open. *10*

Q8. (a) A 4 m high wall is shown in the figure. Determine the Rankine passive force per unit length of the wall. *15*

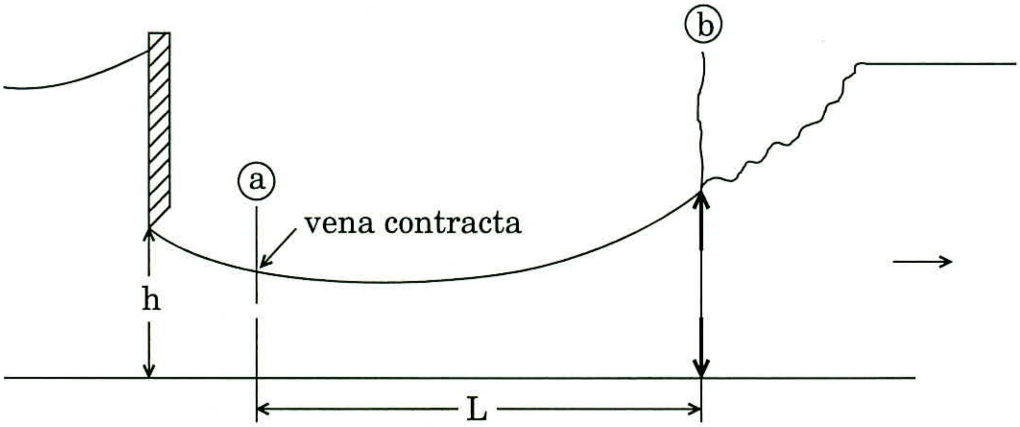


(b) A cast iron pipe with 20 cm diameter and 15 mm wall thickness is carrying water when the outlet is suddenly closed. Given that $E_{water} = 2{\cdot}17 \times 10^9$ N/m^2, $E_p = 16 \times 10^{11}$ N/m^2, $\rho = 1000$ kg/m^3 and design discharge is 40 l/s, calculate the water hammer pressure rise for *15*

(i) rigid pipe walls, assuming sudden valve closure, and

(ii) consider stretching of pipe walls, neglecting the longitudinal stress.

(c)



Consider a vertical sluice gate in a wide rectangular channel. The depth of flow at the vena contracta is 0·457 m for a flow rate of 4·646 m^3/s per metre of width. The channel bed slope is 0·0003 and Manning's roughness factor is n = 0·020. The depth of flow at point b is 0·5 m.

(i) Determine whether a jump occurs.

(ii) What is the type of water surface profile ? *10*

Take $g = 9{\cdot}81\ m/s^2$.