IES 2018

Main

Civil Engineering – Paper 2

Actual Question Paper

Source: http://www.upsc.gov.in/examinations/previous-question-papers

CIVIL ENGINEERING

Paper – II

Time Allowed : Three Hours

Maximum Marks : 300

Question Paper Specific Instructions

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

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

*There are **EIGHT** questions divided in **TWO** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*Questions no. **1** and **5** are **compulsory** and out of the remaining **THREE** are to be attempted choosing at least **ONE** question from each section.*

The number of marks carried by a question / part is indicated against it.

Answers must be written in the medium authorized in the Admission Certificate which must be stated clearly on the cover of this Question-cum-Answer (QCA) Booklet in the space provided. No marks will be given for answers written in a medium other than the authorized one.

Wherever any assumptions are made for answering a question, they must be clearly indicated. Diagrams / figures, wherever required, shall be drawn in the space provided for answering the question itself.

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

SECTION A

Q1. (a) There are two reservoirs, A and B, with the water surface elevation in A 10 m higher than that in B. These are connected through two pipes in series with pipe 1 starting from A and pipe 2 ending in B. Lengths of both the pipes are 100 m, diameter of pipe 1 is 30 cm and diameter of pipe 2 is 25 cm. At the junction of these pipes, water is being withdrawn at the rate of 0·02 m^3/s. Friction loss in the pipes is given by $h_f = f \frac{L}{D} \frac{v^2}{2g}$ and the Darcy friction factor, f, for both pipes is 0·02. Neglecting the head losses at the entrance and at the junction, estimate the total water withdrawal from reservoir A. *12*

(b) A circular cylinder is placed in a uniform flow with its axis perpendicular to the flow direction. The drag force on the cylinder per unit length, F_D, depends on the flow velocity, V, fluid density, ρ, fluid viscosity, μ, and the cylinder diameter, D. Obtain the non-dimensional sets (Pi numbers) which could be used to analyse this problem. *12*

(c) Design a most economical trapezoidal canal section for carrying discharge of 45 cumecs and side slope of $1\frac{1}{2}$: 1 at a velocity of 0·9 m/sec. Assume value of n = 0·022 (Manning's coefficient). *12*

(d) (i) A water treatment plant is to treat water at the rate of 6000 m^3/day. If there are two rectangular sedimentation tanks (27 × 5 × 3·8 m) with total weir length of 50 m, determine *6*

(i) Detention time

(ii) Overflow rate

(iii) Weir loading

(ii) A treatment plant disposes 50 MLD of treated effluent into a river. The river flow rate is 20 m^3/s and its DO is 8 mg/L before the mixing point. If the BOD of the effluent is 50 mg/L, find the BOD and DO of the river water at the d/s of mixing point. Assume BOD of river water as 0 and DO in WW effluent as 0. *6*

(e) What is sludge and how is it classified ? With the help of flow chart, explain different processes/operations involved in sludge treatment and indicate the objectives of each process/operation. *12*

Q2. (a) The circular base of a cylindrical tank is of 1 m diameter and has an orifice of 10 cm diameter. The discharge coefficient, C_d, for the orifice is 0·6. Initially the tank is empty and then it is filled from the top using a pipe discharging 0·025 m^3/s. How long will it take to fill the tank up to a height of 1 m ? What will be the maximum height to which the tank can be filled ? *20*

(b) Give the characteristics of different formations in which groundwater exists. A fully penetrating artesian well is discharging at a rate of 25 litres/sec. The storage coefficient and transmissivity of the aquifer are $4{\cdot}5 \times 10^{-4}$ and 0·15 m^2/min respectively. Find the drawdown at *20*

(i) A radius of 5 m distance after 2 hours pumping.

(ii) A radius 150 m distance after one day pumping.

Use the following approximation well function

$$W(u) = -0{\cdot}5772 - ln(u) - u.$$

(c) Present the permissible drinking water quality standards of the following parameters. Also, explain the effects of presence of these parameters in water bodies : *20*

(i) Fluorides

(ii) Total Hardness

(iii) Iron

(iv) Nitrates

Q3. (a) (i) A pelton wheel turbine bucket deflects the water jet by an angle θ. Show that if friction losses are ignored, the maximum power will be developed when the bucket speed is half of the jet speed. If friction on the bucket surface reduces the relative velocity of the jet by 10% at the exit, find the ratio of the bucket speed and jet speed for maximum power. *14*

(ii) When does cavitation occur in a pump and what are its harmful effects ? How is the available net positive suction head defined and used in the analysis of cavitation ? *6*

(b) What are the basic assumptions of a unit hydrograph ? Six hour unit hydrograph of a watershed having a drainage area equal to 393 km^2 is as follows :

Time (hours)	0	6	12	18	24	30	36	42	48
Unit hydrograph (cumec/cm)	0	1·8	30·9	85·6	41·8	14·6	5·5	1·8	0

For a storm over the watershed having excess rainfall of 5 cm for first six hours and 15 cm for second six hours, compute the stream flow hydrograph assuming constant base flow of 100 m^3/sec. *20*

(c) Explain the phenomena responsible for self purification in rivers. Discuss the factors influencing the self purification capacity. *20*

Q4. (a) A hydraulic jump occurs in a horizontal rectangular channel, which is 1 m wide. The pre-jump depth is 5 cm and the post-jump depth is 20 cm. Assuming the channel to be frictionless, estimate the discharge of water. If the friction is not neglected, and the friction force is estimated to be 20 N over the jump-length, what will be the estimated discharge ? *20*

(b) Find the capacity of a reservoir for irrigating an area having G.C.A. = 40,000 ha. The cropping pattern consists of mainly the following crops :

Crop	Period	Base period (days)	Outlet factor (ha/cumec)	Intensity of cropping (%)	Crop ratio
Sugarcane	Oct – Sept	360	800	60	4
Cotton	May – Nov	180	1200	60	3
Wheat	Dec – April	120	1800	70	2
Gram	Dec – April	120	2000	70	3

The area has 25% non-culturable area.

Assume

(i) Time factor = 7/10

(ii) Extra allowance for period of peak water use = 20%

(iii) Conveyance losses = 20%

(iv) Reservoir losses = 10%

Also calculate design discharge and capacity factor of the main canal. *20*

(c) (i) Explain in detail how landfills are environmentally safe over open dumps. Explaining landfill operations, state the problems associated with landfills. *10*

(ii) With the help of line sketches, explain the working principles of gravity settlers and electrostatic precipitators used for air pollution control. Also, list their applications and limitations. *10*

SECTION B

Q5. (a) A conventional consolidated drained (CD) triaxial test was conducted on saturated clean sand sample by using the following steps :

(1) Set cell pressure to 250 kPa and allow the sample to consolidate with its drainage valve open at 100 kPa back pressure.

(2) Shear the sample without any change in the drainage condition.

The sample failed when the deviator stress reached 300 kPa. Use analytical solution to determine :

(i) The slope of failure envelope in degrees. Assume c′ to be zero.

(ii) Slope of the failure plane in degrees.

(iii) Shear stress and normal stress on the failure plane (in kPa).

(iv) The maximum shear stress at failure (in kPa). *12*

(b) Determine the ultimate load capacity of a 600 mm diameter and 12·5 m long concrete pile driven through a uniform clay layer. The pile is made to rest on top of dense silica sand layer. The water table is at the surface.

What will happen to the above ultimate load capacity if the water table level is lowered by 5 m without any change in the soil property ?

The properties of the two soil layers are :

Clay : Undrained shear strength = 40 kN/m^2,

Unit weight = 20 kN/m^3, Adhesion factor = 0·8, N_c = 0·9.

Dense silica sand : ϕ' = 36°, Unit weight = 18 kN/m^3. Use N_q = 88. Assume that the unit weight of water is 10 kN/m^3. *12*

(c) Briefly describe planning surveys for highways. How are these used and interpreted ? *12*

(d) Explain single layer system in brief. Determine the total thickness of flexible pavement over subgrade having elastic modulus of 180 kg/cm^2. Assume following data :

Design wheel load = 5100 kg

Tyre pressure = 7 kg/cm^2

Permissible deflection = 0·25 cm *12*

(e) (i) A pair of overlap aerial photographs was taken with a camera from an altitude of 3000 m above datum. The focal length of camera was 120 mm and the mean distance between two principal points, both of which lie on the datum, was 71·20 mm. In the common overlap area, a tall chimney 200 m high with its base in the datum surface was observed. Find out the difference of parallax for the top and bottom of the chimney. *6*

(ii) Explain briefly about the spatial and spectral resolution in Remote Sensing. *6*

Q6. (a) An 8 m thick saturated clay layer lies above a permeable dense sand layer. The clay settles by 40 mm in 2 years when subjected to a widespread load of 50 kN/m^2 at its surface.

(i) What will be the ultimate settlement of the clay ?

(ii) Calculate the compression index, C_c of the clay.

Assume that the water table is below the dense sand layer and will not influence the settlement. Properties of clay : Average bulk unit weight, γ_{bulk} = 18 kN/m^3, Coefficient of consolidation, C_v = 1 m^2/yr and Specific gravity, G_s = 2·65. Unit weight of water is equal to 9·81 kN/m^3. *20*

(b) (i) List four major uses of geotextiles. What is the difference between permittivity and transmissivity ? *6*

(ii) Indian Standard (IS) Light Compaction test is usually conducted in 3 layers in a 1000 cc mould. How many blows per layer would be necessary if the above test is conducted in a 2250 cc mould ? *4*

(iii) In a falling head permeability test on a 120 mm high and 100 mm diameter cylindrical sample, the water level in the standpipe dropped from a height of 750 mm to 250 mm in one hour. Determine the coefficient of permeability. Take the internal diameter of the standpipe equal to 6 mm. *10*

(c) Draw a typical diagram showing all important features of a crossover with intermediate portion straight and crossing angles equal for two parallel railway tracks. Find intermediate straight distance and overall length of crossover for Broad Gauge tracks of same crossing number 1 in 12. The distance between centres of tracks is 5 m. *20*

Q7. (a) (i) A long natural slope in overconsolidated fissured clay of saturated unit weight 22 kN/m^3, is inclined at 14 degrees to the horizontal. The water table is at the surface and seepage is approximately parallel to the slope. A slip surface has developed on a plane parallel to the surface at a depth of 4 m. Determine the factor of safety along the slip plane using the residual strength parameter, ϕ'_r = 20 degrees. *10*

(ii) A plate load test was conducted using a square plate of 30 cm side, at 2 m depth on loose sand. The plate settled by 8 mm at load intensity of 12 t/m^2. Determine the settlement of 2 m × 2 m square footing if it has to carry the same load intensity at 2 m depth at this site. Ignore the effect of embedment. *10*

(b) What are the elements that are considered in the geometric design of a taxiway ? Explain them in brief. Design the turning radius of a taxiway for a class B airport handling supersonic aircrafts with a wheel base of 30 m and a tread of main landing gear as 7·2 m. The aircraft design speed to negotiate the curve is given as 60 kmph and coefficient of friction as 0·13. *20*

(c) (i) The following consecutive readings were taken with auto level and a staff of length 4 m along the centre line of under constructed road having continuously sloping ground at a constant interval of 20 metres :

3·105, 2·120, 1·115, 0·410, 3·655, 2·310, 1·275, 0·310, 3·310, 2·310, 1·200, 0·430

The reduced level of last station was 200·200 m. Rule out the page of level book and enter the readings.

Calculate the reduced level of the points by rise and fall method. Also, find the gradient of the line joining the first and last points. *15*

(ii) Explain various geological considerations for selection of tunnel sites. *5*

Q8. (a) A 6 m deep excavation in sand is supported by a smooth vertical wall. The backfill is horizontal and supports a surcharge of 10 kN/m^2 on its surface.

(i) Determine the active thrust on the wall if the water table is far below the bottom of the excavation.

(ii) What should be the embedment depth if the wall in the above case is cantilever sheet pile wall ?

Properties of the sand are : $c' = 0$, $\phi' = 30$ degrees and $\gamma_{bulk} = 16\ kN/m^3$. *20*

(b) (i) Design the length of a valley curve which is formed by a descending grade of 1 in 30 meeting an ascending grade 1 in 40 for a design speed of 100 kmph. Assume : Driver's reaction time = 2·5 sec, Coefficient of friction = 0·35 and Allowable Rate of Change of Centrifugal Acceleration = 0·6 m/sec^3. *15*

(ii) State the functions of docks. Compare floating dock and dry dock. *5*

(c) (i) Two straights AB and BC falling to the right at gradients 12% and 6% respectively, are to be connected by a vertical parabolic curve of length 240 m. Chainage and reduced level of point B are 3000 m and 60·00 m respectively. Calculate the chainage and reduced level of the first three and last three points of the curve by tangent correction method. Take peg interval as 20 m. *15*

(ii) Discuss the various methods of relative positioning in GPS. *5*