Engg. Services Exam, 2011.

010901

D-RSR-L-PRB

CIVIL ENGINEERING

Paper II

(Conventional)

Time Allowed : Three Hours | *Maximum Marks : 200*

INSTRUCTIONS

Attempt any FIVE questions.

Each question carries 40 marks.

The number of marks carried by each subdivision of a question is indicated at the end of the subdivision/question. Wherever a question is attempted, all its subdivisions must be attempted.

Answers must be written only in ENGLISH.

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

Unless indicated otherwise, notations and symbols have their usual meanings.

Neat sketches to be drawn, wherever required.

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1. (a) (i) The areas between the isohyets are given in table below. Obtain the Equivalent uniform depth. What is the depth of flow if

the coefficient of runoff is 0·4 ? Find the volume of runoff. 3

What are the limitations of the isohyetal method ? 1

What is coefficient of variation ? 1

Isohyets mm	75	90	100	125	140	150	165	180
Area between Isohyets (sq. km)	60·0	275	260	150	380	215	120	

(ii) Define the following : 5

(1) Field irrigation requirement

(2) Water application efficiency

(3) Water storage efficiency

(4) Water distribution efficiency

(5) Consumptive use

(b) (i) The watershed at a particular site on a river has 77000 ha. The mean annual precipitation is 950 mm. About 25% of precipitation reaches the basin outlet as stream flow. Estimate the mean flow rate Q at this site in m^3s^{-1}. 3

(ii) If the head available at the site is 150 m and assuming the transmission loss of 10%, what would be the power that can be generated in MW ? 2

(iii) A power plant is having 6 units and producing 18 MW. The speed of the turbine is 650 rpm. The gross head is 300 m. A loss of 26 m head is estimated. The coefficient of velocity is 0·97. The discharge is 1·099 m^3s^{-1}. Obtain the specific speed and the non-dimensional flow coefficient. *5*

(c) In a water treatment plant, raw water undergoes the following treatment processes viz. coagulation, flocculation, sedimentation and filtration. A plant of capacity to treat 3×10^4 m^3/d of raw water is installed for a township. The raw water source is having a suspended solid concentration of 400 ppm. Alum [$Al_2(SO_4)_3$ 14 H_2O] is used as a primary coagulant at a dose of 45 ppm. Compute the daily production of sludge if 95% of the total suspended solids are removed by the treatment processes. Neglect aluminium hydroxide quantity formed due to Alum dose. *10*

(d) An oven dry soil sample of volume 225 cm^3 weighs 390 g. If the specific gravity is 2·72, determine the void ratio and shrinkage limit.

What will be the water content which will fully saturate the sample and cause an increase in volume equal to 8% of the original dry volume ? *10*

2. (a) (i) Write a detailed note on track ballast. Also write the recommended ballast depth. *5*

(ii) With a neat labelled sketch, write a note on points or turnouts. *5*

(b) The velocity distribution v(y) in a wide channel is given by $v(y) = 5{\cdot}75\sqrt{g\, y_o\, S_o}\ \log\left(\frac{30y}{k}\right)$

in which y is the distance from the bottom and y_o is the depth of flow, S_o is the bed slope of the channel, k is the roughness height at the bed. Estimate the shear stress at 1 cm above the bottom of a channel on a slope of 0·5%. The depth of flow is 2·5 m and the characteristic roughness is 1 cm. If the critical shear stress required to move the bed material in the channel is 1 N/m^2, find whether the channel is in stable condition. The viscosity of the water is 0·001 N s m^{-2}. *10*

(c) A 45° sector gate is located on the crest of spillway. The water is upto the mid-point of the gate when closed. The width of the gate is 10 m. The radius of the sector gate is 2 m. Determine the hydrostatic force on the gate. Mass density 1000 kg/m^3, g = 9·79 ms^{-2}. *10*

(d) Draw the total stress, pore pressure and effective stress diagrams for a sand stratum having a thickness of 10 m. The water table is at a depth of 2 m below the ground level and there is a capillary rise of 1 m above the water table. Assume the dry and saturated unit weights of the sand as 17 kN/m^3 and 21 kN/m^3 respectively. *10*

3. (a) A 20 mm thick laboratory soil sample reaches 60% consolidation in 32·5 seconds under double drainage condition. How much time will be required for a 10 m thick layer in the field to reach the same degree of consolidation, if the clay layer is sandwiched between a sandy layer and an impermeable layer ? *10*

(b) Write a detailed note with neat labelled sketches on drainage as an integral part of geometric design for highway, for any five cases. *10*

(c) (i) What is crop calendar ? Illustrate the same. *3*

(ii) Determine the discharge of a distributary at the tail end from the following data :

Gross Command Area (GCA) = 20000 ha

Cultivable Command Area (CCA) = 70%

Losses beyond the tail end = 1 m^3s^{-1}

Kharif	Rice	Irrigation Intensity 15%	Kor depth 19 cm	Kor period 2·5 weeks
Rabi	Wheat	Irrigation Intensity 30%	Kor depth 13·5 cm	Kor period 4 weeks
	Sugarcane	Irrigation Intensity 10%	Kor depth 16·5 cm	Kor period 4 weeks

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(d) (i) What are the advantages of differential surge tanks over simple and restricted orifice surge tanks ? *4*

(ii) Estimate the maximum water hammer pressure generated in a rigid pipe of a 3 m dia pipe with an initial velocity of 3·0 ms^{-1} and the pipe is 8 km long. The downstream valve at the pipe end is closed in 4 seconds. The bulk modulus of water is $2{\cdot}25 \times 10^6$ kPa and the mass density is 995·7 kg/m^3. Also determine the critical time of closure. *6*

4. (a) Explain the processing operations that are generally carried out for handling and disposal of solid wastes accumulated at the bottom from individual apartments of a high rise apartment building with the help of solid waste chute. *10*

(b) Consolidated undrained triaxial tests were performed on two identical specimens of saturated clay with pore pressure measurements. The observations are

Cell pr. at failure (kPa)	Deviator stress at failure (kPa)	Pore pressure at failure (kPa)
250	179	101
350	242	145

Determine the shear strength parameters in terms of both total and effective stresses (by analytical method). *10*

(c) (i) Explain the procedure of conducting Impact test as per IS 2386 part IV.
What are the limits for the material to be used for
(1) Sub-base
(2) Base course
(3) Surface course *5*

(ii) Write a detailed note on sleeper density for railways. *5*

(d) A hydraulic jump is formed in a 5 m wide outlet at a short distance downstream of control gate. If the flow depths are 10 m and 2 m in the u/s and d/s respectively of the sluice gate and the Q = 150 m^3s^{-1}, determine
(i) Flow depth downstream of the jump
(ii) Thrust on the gate
(iii) Head losses in the jump *10*

5. (a) (i) Drawdown from multiple observation well in a confined aquifer under steady state flow condition when 100 m^3/day is pumped is given below. Determine the transmissivity assuming the linear variation semi log graph on the given data :

r (m) distance	s (m) drawdown
30	2·79
40	2·505
50	2·38
100	1·83
200	1·28
400	0·73

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(ii) Water flows at a velocity of $1\ ms^{-1}$ in a 150 mm dia new ductile iron pipe. Estimate the head loss over 500 m using Darcy-Weisbach formula for the given $k_S = 0{\cdot}26$ mm. *6*

Assume viscosity $= 1{\cdot}00 \times 10^{-6}\ m^2 s^{-1}$.

Hint : $\frac{1}{\sqrt{f}} = -2 \log \left[\frac{k_S}{3{\cdot}7D} + \frac{2{\cdot}51}{Re\sqrt{f}} \right]$

(b) What are the four tests to be carried out for physical examination of water quality in a natural river flowing over an alluvial bed ?

Explain briefly the procedure and instruments required to carry out the tests. *10*

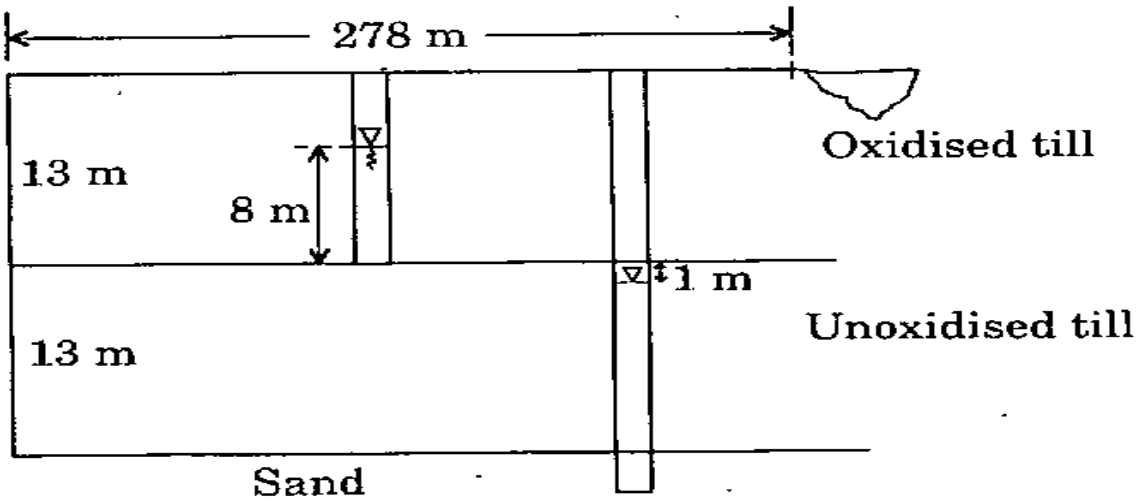
(c) A retaining wall 6 m high, with a smooth vertical back is pushed against a soil mass having $c' = 40\ kN/m^2$, $\phi' = 15°$ and $\gamma = 19\ kN/m^3$. Using Rankine's theory, compute the total pressure and the point of application of the resultant thrust, if the horizontal soil surface carries a uniform surcharge load of $50\ kN/m^2$. *10*

(d) (i) Runway length required for landing at sea level in standard atmospheric condition is 2100 m. Runway length required for take off at a level site at sea level in standard atmospheric condition is 2500 m. Aerodrome elevation is 200 m and reference temperature is 24°C. Temperature in the standard atmosphere for 200 m is 15°C and runway slope is 0·5%. Determine the length of the runway after applying correction to runway length. *5*

(ii) Discuss the five steps involved in the setting up of a Theodolite. *5*

6. (a) The measured loss of head in a 50 mm diameter pipe conveying water at 0·6 ms^{-1} is 800 mm of water per 100 m length. Calculate the loss of head in mm of water per 400 m length when air flows through a 200 mm diameter pipe at the corresponding speed. Assume that the pipes have geometrically similar roughness and assume the densities of air and water as 1·23 and 1000 kg/m^3 and the absolute viscosities as $1·8 \times 10^{-5}$ and 0·12 Pa.s respectively. *10*

(b) (i) A waste disposal facility is to be constructed in glacial soil. The sand aquifer occurs immediately below. The facility is 278 m long and 200 m wide. The trenches extend upto 13 m into oxidised till and penetrate water table which is 5 m below the land surface. The hydraulic conductivities of upper till and lower till are respectively 10^{-7} ms^{-1} and 10^{-8} ms^{-1}. Average gradient of water table is 0·72 across the site. The material on the right hand side is to be excavated to the top of unoxidised till. The trench will be filled by the gravel. Calculate the ground water flow velocity in the tills, the volumetric rate of flow into the trench and the travel time for waste to reach the sand aquifer.



Effective porosity 0·1

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(ii) What is the intrinsic permeability of a water saturated medium that has hydraulic conductivity of 15·24 m/day ? Assume the ground water is at atmospheric pressure at 20°C and has a density of 998·2 kg/m^3 and viscosity of 1·002 × 10^{-3} kg/ms. *4*

(c) (i) The following observations were made to determine the sensitivity of two bubble tubes. Determine which bubble tube is more sensitive. The distance of the staff from the instrument was 100 m and the length of one division of both bubble tubes is 2 mm.

Bubble Tube		Bubble Reading		Staff Reading
		LHS	RHS	
A	i	13	05	1·681
	ii	08	12	1·767
B	i	15	03	1·635
	ii	06	14	1·788

5

(ii) Following data pertains to a cross-section :

Foundation width is 20 m, depth of cut at mid-point is 4 m, transverse slope on the right side to the mid-point is 10 to 1 and transverse slope on the left hand side of mid-point is 7 to 1. The side slope is 2·5 to 1.

Draw a neat labelled figure and compute the area of the cross-section. *5*

(d) The subsoil at a building site consists of medium sand with $\gamma = 18$ kN/m^3, $c' = 0$, $\phi' = 32°$ and water table at the ground surface. A 2·5 m square footing is to be placed at 1·5 m below the ground surface. Compute the safe bearing capacity of the footing.

What will be the safe bearing capacity, if the water table goes down to 3 m below the ground surface ? *10*

[For $\phi = 32°$, $N_q = 20·3$ and $N_\gamma = 19·7$]

7. (a) Design the pavement section by triaxial test method using the following data :

Wheel load = 5100 kg

Radius of contact area = 15 cm

Traffic coefficient, X = 1·5

Rainfall coefficient, Y = 0·9

Design deflection, $\Delta = 0·25$ cm

E-value of subgrade soil $E_s = 100$ kg/cm^2

E-value of base course material $E_b = 400$ kg/cm^2

E-value of 7·5 cm thick bituminous concrete surface course = 1000 kg/cm^2.
Also draw the pavement section with base course. Assume the pavement to consist of single layer of base course material. *10*

(b) (i) Analyses of the maximum annual flood over the past 150 years in a small river indicates the following cumulative distribution : *5*

Number	Q	$P(X < x_n)$
1	0	0
2	25	0·19
3	50	0·35
4	75	0·52
5	100	0·62
6	125	0·69
7	150	0·88
8	175	0·92
9	200	0·95
10	225	0·98
11	250	1·00

Estimate 10, 50, 100 years flood.

(ii) A 25 cm pipe is compressed by a tree root into an elliptical section until its inside height is 18 cm. Determine the hydraulic mean radius when the pipe is half full. *5*

(c) A turbine for the following site condition is to be designed :

Head is 120 m, Power produced = 5 × 120 MW. No. of turbines 5. Head loss due to friction as 3% the gross head. Length of the penstock 1300 m each. Overall Efficiency 0·87. Number of pairs of poles 18. Speed 166·7 rpm. Breadth to Diameter 0·3. Darcy-Weisbach f = 0·020.

Determine the diameter of the penstock, Runner and the type of turbine. $\phi = 0{\cdot}75$. *10*

(d) Explain the following terms generally adopted in waste water collection system :

(i) (1) Sewage (2) Sewers (3) Sewerage system.

Briefly mention the principles involved in 'Combined sewer design'. *5*

(ii) A site adjacent to a river is considered for the location of a municipal waste water treatment plant having an average inflow of 2500 m^3/day. The selected treatment process sequence is as follows : (1) grit channel (2) primary sedimentation (3) activated sludge and (4) secondary sedimentation.

Design the grit channels assuming maximum hydraulic loading as twice the average inflow rate. Assume other appropriate design parameters, if required. *5*

8. (a) Nine piles of 300 mm dia and 8 m length are arranged in a square pattern for the foundation for a column in a uniform deposit of medium stiff clay (q_u = 100 kN/m^2). If the centre to centre spacing of piles is 900 mm and adhesion factor = 0·9, calculate the capacity of the pile group assuming a F.S. of 2·5. *10*

(b) Explain in detail the eight requirements of airport pavement. *10*

(c) (i) What is priming ? *1*

(ii) A siphon has a rectangular throat section 2·2 m wide and the radius of the crown and crest are 3 m and 1·6 m respectively. The energy losses are 0·2, 0·2, 0·6 and 0·5 times the mean velocity head at throat respectively in the inlet, upper leg, lower leg and outlet portion. The kinetic energy coefficient is 1·03. Local atmospheric pressure is 10 m of water. Determine

a. the discharge when the reservoir level is 0·3 m above the crest and the tail water level (outlet submerged) 6 m below it.

b. the minimum pressure at the throat section.

For submerged condition outlet velocity is 50% of throat velocity. *9*

(d) (i) Explain the function of governor in Impulse type of turbine. *2*

(ii) A Pelton wheel develops 3500 kW under a head of 120 m with an overall efficiency of 85%. Find the diameter of the nozzle if the coefficient of velocity is 0·98. *8*