Engineering Services 2013

Sl. No. **A-FRF-M-BUB**

CIVIL ENGINEERING

PAPER II

(CONVENTIONAL)

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

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions

Candidates should attempt FIVE questions in all.

Question No. 1 is compulsory. Out of the remaining SIX questions attempt any FOUR.

All questions carry equal marks. The number of marks carried by a part of a question 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.

All parts and sub-parts of a question are to be attempted together in the answer book.

Any pages left blank in the answer book must be clearly struck out.

A detachable semi-log graph sheet is attached to this question paper for use. Fasten it securely to your answer-book(s).

1. (a) The velocity distribution for flow over a plate is given by

$$u = 2y - y^2$$

in which u is the velocity in ms^{-1} at a distance y metres from the plate. Determine the shear stress in Nm^{-2} at the boundary and at 0·2 m from it. Dynamic viscosity of fluid is 0·9 Ns/m^2. 4

(b) Define

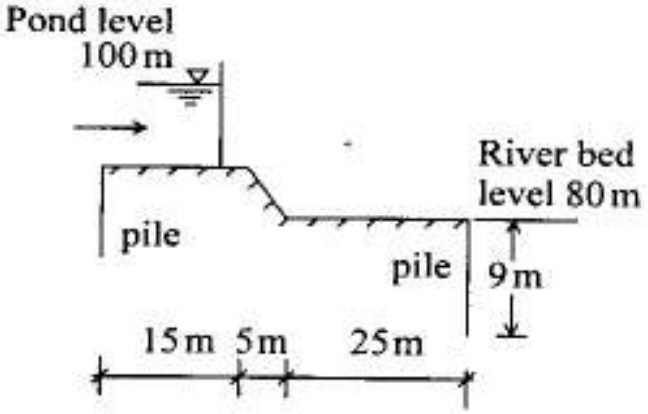
(i) shape number

(ii) NPSH in pumps

Describe the occurrence of cavitation in propeller turbine or Kaplan turbine. 4

(c) A 12-hour rainfall with uniform intensity of 4 cm/hr produces a storm hydrograph of peak discharge 1000 m^3/s. The abstractions of rainfall is at the rate of 1 cm/hr and base flow is 30 m^3/s. Compute the peak discharge of 12-hr unit hydrograph. 4

(d)



Check the safety of a barrage shown above against the piping action. The safe exit gradient is $\frac{1}{5}$. 4

(e) What are the sources and impact of hardness in water supplies ? Also mention standard of hardness in water supply. 4

(f) Discuss thermal stratification and its importance in temperature of lakes. 4

(g) The mass of saturated soil sample is 150 gm and its mass when oven dried is 90 gm, find the water content. Suppose that the sample, used for triaxial test, has a diameter of 38 mm and the height of 76 mm, find the void ratio. 4

(h) A circular concrete pier of 3 m diameter carries a gross load of 3500 kN. The supporting soil is a clayey sand having the following properties :

$C = 5$ kN/m^2, $\phi = 30°$ and $\gamma = 18{\cdot}5$ kN/m^3. Find the depth at which the pier is to be located such that a factor of safety of 3·0 is assured. The bearing capacity factor for $\phi = 30°$ are $N_C = 30{\cdot}1$, $N_q = 18{\cdot}4$ and $N_r = 22{\cdot}4$. 4

(i) Calculate the Sun's Azimuth and Hour Angle at sunset at a place in Latitude 40° N, when its declination is 20° N. 4

(j) Sketch a typical cross-section of a runway and taxiway. Explain the importance of drainage of Airport. 4

2. (a) A new 5 km long pipeline connects two reservoirs. The water surface elevation of the upper reservoir is 1100 m and that of the lower reservoir is 835 m. The pipeline is 400 mm nominal diameter of welded steel (Hazen Williams Coefficient C = 130) with a square mouth inlet (14·32 m long) and including the following fittings :

1. Gate valves	10 numbers	Each gate valve of equivalent length	0·98 m
2. Standard radius 90° elbow	19 numbers	Each elbow of equivalent length	6·4 m
3. Standard radius 45° elbow	37 numbers	Each elbow of equivalent length	4·57 m
4. Straight Tees	8 numbers	Each Tee length	2·19 m

What is the water flow rate between the reservoirs ? Use the concept of equivalent pipe.

Given $h_f = \dfrac{10{\cdot}7\, Q^{1{\cdot}85}\, L}{C^{1{\cdot}85}\, D^{4{\cdot}87}}$ 8

(b) Rainfall over a basin in three consecutive hours are 4 cm, 5 cm and 3 cm respectively. Estimate the surface runoff from the basin assuming negligible surface retention and evaporation losses. The infiltration loss can be estimated using the following Horton's equation

$$f = 1{\cdot}2 + 4{\cdot}2e^{-2{\cdot}5t}$$

Here f = infiltration in cm/hr and t = time in hour from start of rainfall. 8

(c) Why a circular section is most widely adopted for sewer pipes ? Discuss the hydraulic characteristics of circular sewer sections running partially full. 8

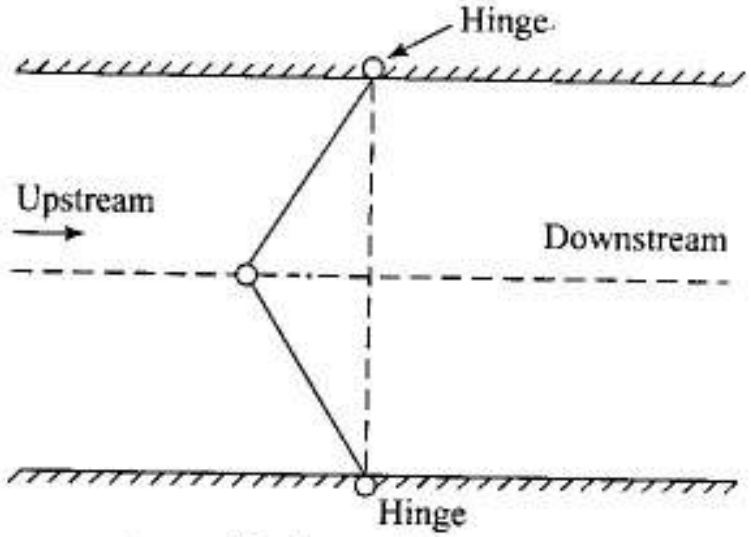
(d) (i) An earth dam is built on an impervious foundation with a horizontal filter at the base near the toe. The permeability of the soil in the horizontal and vertical directions are 3×10^{-2} mm/sec and 1×10^{-2} mm/sec respectively. The full reservoir level is 30 m above the filter. A flow net constructed for the transformed section of the dam, consists of 4 flow channels and 16 head drops. Estimate the seepage loss per metre length of the dam. 4

(ii) For a flexible foundation with sides 2 m and 3 m and an axial load of 750 kN, determine the elastic settlement under one of the corners. The soil has properties $\nu = 0{\cdot}37$ and $E = 9{\cdot}8$ MPa. 4

(e) (i) Calculate the safe stopping distance for a vehicle travelling at 90 kmph, on an upward gradient of 3 per cent, given total reaction time is 2·5 seconds and the coefficient of friction for the road surface as 0·35. 4

(ii) Discuss the cause and effects of "Creep of Rails". 4

3. (a)



Lock gate in plan

The gates of lock are 5 cm wide by 6 m and when closed, at an angle of 120°. Each gate is held on by two hinges placed at the top and bottom of the gate.

If the water levels are 6 m and 4·5 m on the upstream and downstream sides respectively, determine the magnitude of the forces on the hinges due to the water pressure. 20

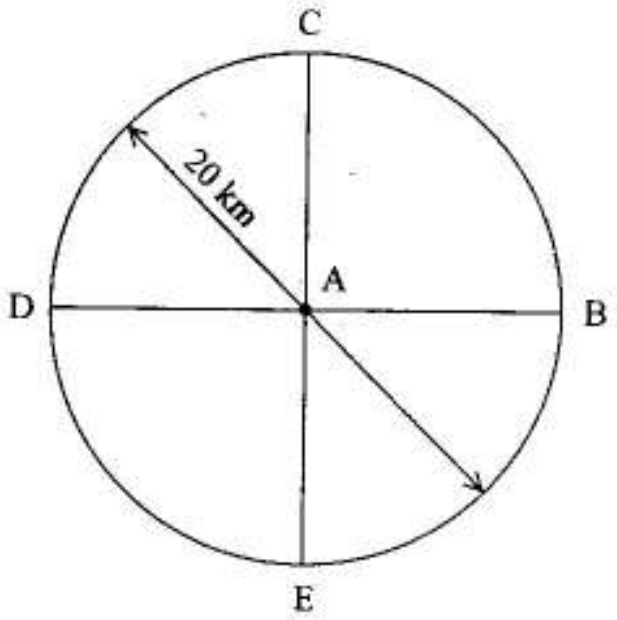
(b) A trapezoidal channel (slope = 0·006, n = 0·014) has a bed width of 4 m and is with a side slope of 1 : 2 (V : H). The flow rate is 100 m^3s^{-1}. At a particular point canal confluences with a stream of 3·5 m depth. The invert elevations of the stream and the canal are same.

Determine whether the flow in the channel is subcritical or supercritical flow.

What is the type of control the stream represents the channel ? 20

4. (a) (i) The velocity distribution in a stream is generally governed by one by seventh law, i.e. $\frac{V}{V_0} = \left(\frac{Y}{Y_0}\right)^{\frac{1}{7}}$, where V and V_0 are point velocities at heights Y and Y_0 from the stream bed. Show that point velocity at 0·6 depth from free surface is equal to average velocity. 5

(ii)



Five rain-guage stations namely *A*, *B*, *C*, *D* and *E* are located on a circular shape basin of diameter 20 km as shown in the above figure. Compute the mean areal rainfall over the basin using Thiessen Polygon method, if the rainfall at stations *A*, *B*, *C*, *D* and *E* are 100 cm, 90 cm, 110 cm, 120 cm and 80 cm, respectively. 5

(b) An overflow ogee spillway has six bays each of 8 m clear length and five rounded nose piers (K_p = 0·01) each of 2·5 m thick. Both the abutments are sharp edged (K_a = 0·2). The upstream face of the spillway is vertical. Compute the discharge that will pass over the spillway at the design head, H_d = 3 m. The discharge coefficient for design head C_o = 2·1.

Also compute the passing discharge over spillway for head over the crest H = 3·45 m. Neglect the approach velocity to the spillway. Discharge coefficients for head other than design head are given below :

H/H_d	C/C_o
0·6	0·94
0·85	0·98
1·15	1·02
1·50	1·06

C is discharge coefficient for head H. 10

(c) (i) Derive the following Lacey's regime equations

$$V = \left[\frac{Qf^2}{140}\right]^{\frac{1}{6}}$$

and $P = 4{\cdot}75\sqrt{Q}$

with the use of following basic equations of Lacey

$$V = \sqrt{\frac{2}{5} fR}$$

$$Af^2 = 140\ V^5$$

Here V = velocity;
Q = discharge;
f = silt factor;
P = wetted perimeter; and
R = hydraulic mean radius. 10

(ii) Annual maximum flood data in a river at a station have been processed to estimate the maximum flood for different return periods using the Gumbel's method. If the estimated maximum flood for return periods 100 and 50 years are 450 m^3/s and 400 m^3/s, respectively, estimate the flood discharge for return period of 500 years. 10

5. (a) (i) Discuss various methods of landfilling and its operation. Also discuss control of gas movement and leachate movement in landfill sites. 10

(ii) What are various secondary air pollutants ? Discuss sources, origin and hazardous effect of sulphur dioxide and carbon monoxide on human body. 10

(b) What is type I settling ? How analysis of type I settling is done ? Find the settling velocity of a discrete particle in water having diameter 4×10^{-3} cm and specific gravity 2·65. Take kinematic viscosity of water = $1{\cdot}02 \times 10^{-2}$ cm^2/sec. 10

(c) What are different zones of pollution in river stream ? Explain the importance of reoxygenation, deoxygenation and oxygen deficit in problems of stream sanitation. 10

6. (a) A liquid limit test conducted on a soil sample in the cup device gave the following results :

Number of blows	10	19	23	27	40
Water content (%)	60·00	45·20	39·80	36·50	25·20

Two determinations for the plastic limit gave water content of 20·30% and 20·80%.

Determine

(i) the liquid limit and plastic limit

(ii) the plasticity index

(iii) the liquidity index if the natural water content is 27·40% and

(iv) the void ratio at the liquid limit, if the sp. gravity, G_s = 2·7. If the soil were to be loaded to failure, would you expect a brittle failure ? 10

(b) At a vertical stress of 200 kPa, the void ratio of a saturated soil sample tested in an oedometer is 1·52 and lies on the normal consolidation line. An increment of vertical stress of 150 kPa in the second stage compress the sample to a void ratio of 1·43.

(i) Determine the compression index C_c of the soil.

(ii) The sample was unloaded to a vertical stress of 200 kPa and the void ratio increased to 1·45. Determine the slope of the recompression index C_r.

(iii) What is the over consolidation ratio of the soil at second stage ?

(iv) If the soil were reloaded to a vertical stress of 500 kPa, what void ratio would be attended ? 10

(c) (i) High displacement concrete piles, 15 m long are to be installed in loose sand. The choice is between 450 mm square precast driven piles and 500 m diameter driven cast in situ piles. Which type of pile should be used for (a) building that imposes a very small lateral load on the piles and (b) building that imposes high lateral load on the piles ? The two buildings apply the same axial load on the piles. Give the answer with suitable explanation. 10

(ii) A cut is to be made in a soil that has $\gamma = 16\ kN/m^3$, $C' = 28\ kN/m^2$ and $\phi' = 20°$. The side of the cut slope will make an angle of 45° with the horizontal. What should be the depth of the cut that will have a factor of safety F_s of 3·5 ? 10

7. (a) In a city property survey, following observations were made. Calculate the latitude, departures and closing error, prior to computation of the area enclosed in the traverse. Adjust the coordinates using Bowditch's Rule.

Line	*Length in m*	*Whole Circle Bearing*
AB	89·31	45°10′
BC	219·76	72°05′
CD	151·18	161°52′
DE	159·10	228°43′
EA	232·26	300°42′

10

(b) (i) Determine the minimum non-passing sight distance that should be provided for a vehicle coming down a 6 per cent gradient, using the following data :

1. Design speed, V = 56 kmph

2. Reaction time of the driver = 2 seconds

3. Coefficient of friction between Tyre and Road surface = 0·5. 5

(ii) A descending gradient of 1 in 30 meets an ascending gradient of 1 in 40 to form a valley curve. Find the length of the curve if the stopping sight distance is 120 m. 5

(c) Calculate the Maximum Permissible load that a B.G. steam locomotive with three pairs of driving wheels with axle load of 22 tons each, on a straight level track at a speed of 80 kmph.

Also calculate the reduction in speed, if the train has to run on a rising gradient of 1 in 200.

What would be the further reduction in speed, if the train has to negotiate a 4° curve on the rising gradient ?

Assume, coefficient of friction as 0·20. 10

(d) (i) What is a breakwater ? Classify different types of breakwaters. Under what condition a rubble mound breakwater is preferred ? 2

(ii) Describe Beanfort Scale. 2

(iii) What is dredging ? Classify different types of dredging work. 2

(iv) What are navigational aids ? Why are they necessary ? 2

(v) What is a dock ? Classify the docks and explain the purpose of each type. 2
