ENGINEERING SERVICES
EXAMINATION-2016

Sl. No. 0053843 **A–HUF–P–EEB**

CIVIL ENGINEERING

Paper—II

(Conventional)

Time Allowed : Three Hours	Maximum Marks : 200

INSTRUCTIONS

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

There are SEVEN questions in the paper.
Candidates are required to attempt FIVE questions in all.
Question No. 1 is compulsory.
Out of the remaining SIX questions, attempt any FOUR questions.
The number of marks carried by a question/part is indicated against it.
Unless otherwise mentioned, symbols and notations have their usual standard meanings.
Assume suitable data, if necessary and indicate the same clearly.
Neat sketches are to be drawn to illustrate answers, wherever required.
All parts and sub-parts of a question are to be attempted together in the answer book.
Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.
Answers must be written in ENGLISH only.
Any page or portion of the page left blank in the answer book must be clearly struck off.

1. Answer *all* of the following :

(a) A trapezoidal channel has bed width = 4 m, side slope = 1·5, bed slope = 0·01 and Manning's n = 0·012. If it is carrying a discharge = 40 m^3/s at normal depth = 1·5 m, then classify its slope by computing critical depth. 4

(b) What is centrifugal pump efficiency? Describe the important factors influencing centrifugal pump efficiency. 4

(c) What is precipitation in hydrology? Describe briefly various forms of precipitation. 4

(d) Design a circular primary settling tank for a sewage treatment plant. Given data are : 4

Flow rate = 27000 m^3/d

Retention time = 2·5 hr

Weir length = 30 m

Total number of tanks = 2

Surface loading rate = 30 $m^3/m^2/d$

(e) A 500 mm diameter sewer pipe has been installed with an invert slope of 0·008. Determine the capacity of flow when the sewer pipe is flowing half-full. The number of sewer pipes used is 2. Manning's roughness coefficient is 0·012. Assume that flow in the sewer pipe is uniform. 4

(f) Draw a neat sketch of a vane shear apparatus. Also derive the relationship between undrained shear strength, C_u and torque, T. 4

(g) For which geotechnical application does the static cone penetration test have distinct advantage over any other field tests? Why? 4

(h) What are meant by 'face left' and 'face right' of theodolite? How would you change face? What instrumental errors are eliminated by 'face left' and 'face right' observations? 4

(i) A two-lane national highway passing through rolling terrain has horizontal curve of 450 m radius. Assuming design speed of 90 kmph, pavement width of 7 m, with a wheel base of 6·1 m, determine extra width of the pavement required for this curve. Assume other parameters as per relevant IRC recommendations. 4

(j) Describe briefly the environmental factors considered in designing a landfill. 4

2. (a) Water (bulk modulus of elasticity = $2{\cdot}2\times10^3$ MPa) is flowing with a velocity of 2 m/s through an elastic pipe (modulus of elasticity = $2{\cdot}1\times10^5$ MPa) of diameter = 500 mm, thickness = 5 mm and length = 2 km. If a valve provided at the end of the pipe is closed in 2 s, what will be the rise in pressure due to the resulting water hammer? 8

(b) What are hydraulic turbines? Describe different types of hydraulic turbines with their characteristics and suitability of use. Differentiate between 'Pelton' and 'Francis' turbines. 8

(c) What is hydrograph? Explain different types of hydrograph depending upon unit of time involved and their corresponding applications. 8

(d) Differentiate between 'low gravity' and 'high gravity' dams. Calculate the limiting height of low concrete gravity dam with the following data : 8

Compressive strength of the concrete = 2500 kN/m^2

Unit weight of water = 9·81 kN/m^3

Specific gravity of the concrete = 2·4

(e) Define air pollution as per OECD definition. Differentiate between 'natural' and 'anthropogenic' air pollution sources, with examples. What are the effects of ambient ozone, PM_{10}, $PM_{2.5}$ and lead on human health? 8

3. *(a)* The base of a 20 m × 50 m raft rests on ground surface and applies a stress of 100 kPa to the subsoil. The ground strata consist of dense sand up to 4 m depth followed by a clay layer of 2 m thickness having compression index of 0·40 and initial void ratio of 1·0. The clay is followed by more dense sand. Find the maximum settlement that will occur due to consolidation of clay. Water table is at the ground surface and the total unit weight of sand is 20 kN/m^3 and of clay is 18 kN/m^3. Calculations should be based on two equal divisions. Use 2 : 1 stress distribution. 8

(b) Discuss in brief the essentials of rural sanitation. Explain how you dispose off *(i)* dry refuse, *(ii)* sullage and *(iii)* excretal waste in rural area. 8

(c) A traffic survey conducted on four-lane single carriageway road reported traffic of 1400 CVPD (in both directions). Assuming growth rate of 5%, design life of 20 years and vehicle damage factor of 3·5, calculate design traffic to be used in pavement design in terms of million standard axles (msa). As per IRC, lane distribution factor = 0·75. 8

(d) The following records are obtained in a traverse survey where the length and bearing of the last line were not recorded :

Line	*Length* (in m)	*Bearing*
AB	75·50	30° 24′
BC	180·50	110° 36′
CD	60·25	210° 30′
DA	?	?

Compute the length and bearing of line *DA*. 8

(e) A hydraulic jump is formed in a horizontal rectangular channel. If post-jump flow depth = 5 m for a discharge per unit width = 5 $m^3/s/m$, then compute the pre-jump depth of flow and energy dissipated in the hydraulic jump. 8

4. (a) Describe briefly the following in a well with neat sketches : 8

(i) Cone of depression

(ii) Area of influence

(iii) Drawdown

(iv) Radius of influence

(b) What is the purpose of intake structure? What factors should be considered in locating an intake structure and what are the main considerations in the design of an intake structure? 8

(c) Differentiate between BOD and COD in wastewater.

20 mL of sewage sample was added directly into a 300 mL BOD incubation bottle. The initial DO of the diluted sample was 7·8 mg/L and the final DO after 5 d was 1·3 mg/L. The corresponding initial and final DO of the seeded dilution water were 8·1 and 6·9 respectively. What is the BOD_5 of the sewage sample? 8

(d) In a consolidated undrained test with pore pressure measurement on a normally consolidated clay, a sample consolidated under a stress of 200 kPa failed at an additional axial stress of 150 kPa. The pore pressure at failure was 75 kPa. Determine analytically the shear strength parameters in terms of effective stresses. 8

(e) Describe any two laboratory methods to measure 'swelling pressure' of soils. 8

5. (a) Determine the actual length of runway after applying necessary corrections for elevation, temperature and gradient (as per relevant ICAO, FAA recommendations) for the data given below : 8

(i) Basic runway length = 2500 m

(ii) Elevation of airport = 500 m

(iii) Monthly mean of average daily temperature for the hottest month of the year = 15 °C

(iv) Monthly mean of maximum daily temperature for the same month = 22 °C

(v) Effective gradient = 0%

(b) (i) Define remote sensing and briefly explain the principle of remote sensing. Explain the terms 'passive remote sensing' and 'active remote sensing'.

(ii) Explain the concept of global positioning system. 8

(c) Draw a neat diagram of under-reamed pile foundation. Label different parts and give typical dimensions of different parts. Also explain the mechanism involved in resisting the uplift in swelling soils. 8

(d) Describe the method of sampling suspended particulate matter by high volume sampler. Also explain how the mass concentration of particulates is determined. 8

(e) Explain briefly with neat sketches different systems of layout of water distribution network. Also mention for which town or city, each of the above distribution networks is suitable with their advantages/disadvantages. 8

6. *(a)* The weights of a cube (side = 1·2 m) and a sphere (diameter = 1·25 m) are 20 kN and 5 kN respectively. Both cube and sphere are connected together by a short rope in a water reservoir. Compute the tension in the rope and percentage of sphere that will be above water surface. 8

(b) A single-acting reciprocating pump discharges 0·018 m^3 of water per second when running at 60 r.p.m. The stroke length is 50 cm and the diameter of piston is 22 cm. If the total lift is 15 m, determine the following : 8

(i) Theoretical discharge of the pump

(ii) Slip and percentage slip of the pump

(c) What is hydrologic cycle? Describe with equation that is used to quantify water going through various individual paths of the cycle. Give a neat diagram too. 8

(d) Using Lacey's theory, design an irrigation canal to carry a discharge of 30 m^3/s with silt factor = 1·05. 8

(e) Describe different causes responsible for water-borne diseases. Name the diseases caused by presence of various impurities. What are the preventive measures that can be taken to stop the spreading of these diseases? 8

7. *(a)* An isolated three-phase signal is being designed for optimum cycle length of 90 s. The total lost time from all the three phases is 15 s. The critical flow ratios for phase I and II are 0·2 and 0·3 respectively. Determine the critical flow ratio for phase III as per Webster's method of traffic signal design. Given that saturation flow for volume in phase III is 500 pcu. 8

(b) State which type of foundation you would adopt in the following cases and then give the reasons : 8

(i) Transmission line tower

(ii) Four-storey hospital building on erratic soil

(iii) Two-storey residential building of load-bearing walls resting on medium dense sand

(iv) Twenty-storey commercial building

(c) *(i)* When is the dilatancy correction not applied to the *N*-value in a standard penetration test and why?

(ii) Discuss instrumental landing system and air navigation aids. 8

(d) An unlined channel having bed slope 1 in 4000, carries a certain discharge at flow depth = 5 m with hydraulic radius = 3·5 m. Determine the concentration of the suspended sediment load at 1·5 m above the channel bed if the concentration at 0·25 m above the bed is 400 ppm and the fall/settling velocity of the suspended particle is 0·3 m/s. Assume that von Karman universal constant = 0·4. 8

(e) (i) Define the following :

(1) Potential evapotranspiration

(2) Actual evapotranspiration

(3) Field capacity

(4) Permanent wilting point

How can evapotranspiration be measured for a given vegetation type?

(ii) Explain 'full-face' and 'drift' methods of driving tunnel in rocks. 8

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