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 :

*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.

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 have their usual standard meanings.

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.

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

SECTION A

Q1. (a) (i) Find out the pH of a mixture formed by mixing the following two water solutions : *8*

Solution A : Volume 450 mL; pH = 7·5

Solution B : Volume 550 mL; pH = 6·5

(ii) Compute the theoretical oxygen demand of 108·75 mg/*l* of glucose. *4*

(b) (i) A rectangular plate of 0·5 m × 0·5 m dimensions, weighing 500 N slides down an inclined plane making 30° angle with the horizontal at a velocity of 1·75 m/s. If the 2 mm gap between the plate and inclined surface is filled with a lubricating oil, find its viscosity in poise. *6*

(ii) A channel has two sides vertical and semi-circular bottom of 2 m diameter. Calculate the discharge of water through the channel, when depth of flow is 2 m. Take C = 70 and slope of bed as 1 in 1000. *6*

(c) A rectangular sewer with width twice its depth is hydraulically equivalent to a circular sewer. Find the relation between the width of the rectangular sewer and the diameter of the circular sewer assuming that sewer is running completely full. *12*

(d) After how many days will you supply water to soil (clay loam) in order to ensure efficient irrigation of the given crop, if : *12*

Field capacity of soil = 27%

Permanent wilting point = 14%

Density of soil = 1·5 g/cm^3

Effective depth of root zone = 75 cm

Daily consumptive use of water for the given crop = 11 mm

(e) (i) A town with a population of 3 lakh produces solid waste at a rate of 2·5 kg/capita/day. If the waste is compacted to a density of 1500 kg/m^3, how much volume of landfill site is needed in a year ? Assuming that the ratio of solid waste to cover is 4 : 1, what volume of cover soil is needed in a year ? What type of soil would you recommend as a cover ? *4*

(ii) The sound power from a voice shouting is 0·002 W. What is the Sound Power Level ? What are the Sound Intensity, Sound Intensity Level, the Sound Pressure and the Sound Pressure Level at a distance of 10 metres from the source ? Assume that sound radiates from the source in all directions. *8*

Q2. (a) (i) What is ϕ index ? How is it estimated ? What are the factors that affect ϕ index ? *8*

(ii) A storm with 10 cm precipitation produced a direct runoff of 5·8 cm. The time distribution of the storm is given below. Estimate the ϕ index of the storm. *12*

Time from start (h)	Incremental rainfall in each hour (cm)
1	0·4
2	0·9
3	1·5
4	2·3
5	1·8
6	1·6
7	1·0
8	0·5

(b) (i) A bed of uniform sand, having particle size 0·65 mm diameter and specific gravity 2·66, porosity 0·48 and depth 75 cm is to be washed hydraulically. Compute *10*

(a) Backwash rate so that expansion will be 50 percent.

(b) Head loss at this rate.

Take kinematic viscosity of water as $1{\cdot}3 \times 10^{-2}$ cm^2/sec and assume $C_D = \frac{24}{R}$.

(ii) Briefly explain various factors affecting bactericidal efficiency of chlorine in water treatment process. *10*

(c) (i) A flat plate of 2 m width and 4 m length is kept parallel to air flowing at 5 m/s velocity at 15°C. Determine the length of the plate over which boundary layer is laminar, shear at the location where boundary layer ceases to be laminar and total force on both sides on that portion of plate the boundary layer is laminar. *15*

Take $\rho = 1{\cdot}208$ kg/m^3 and $\nu = 1{\cdot}47 \times 10^{-5}$ m^2/s.

(ii) What are the functions of a surge tank ? *5*

Q3. (a) (i) In a factory, coal is burnt at a rate of 1 kg/second. Analysis of the coal reveals a sulphur content of 3 percent. The sulphur in the ash is 5 percent of the input sulphur. What is the annual rate of emission of sulphur dioxide ? *10*

(ii) Describe various functional elements of a solid waste management system. *10*

(b) (i) What are the effects of water logging ? *5*

(ii) A centrifugal pump runs at 1000 rpm against a head of 16 m and carries 145 liters/s of water discharge. The impeller diameter at the outlet is 300 mm and the width there is 60 mm. If the vane angle ϕ at the outlet is 40°, determine the manometric efficiency. *15*

(c) A municipality has directed to upgrade its primary wastewater treatment unit to a secondary unit that can meet an effluent standard of 20 mg/*l* BOD_5 and 20 mg/*l* total suspended solids. They have selected a completely mixed activated sludge system. BOD_5 of total suspended solids is 63% of TSS concentration. Estimate the required volume of aeration tank. The following data is available from existing primary plant :

Flow = $0{\cdot}150$ m^3/s, BOD_5 = 80 mg/*l*.

Assume the following values for half velocity constant = 95 mg/*l* of BOD_5; Maximum growth rate constant = 2·5/day; Decay rate of micro-organism = 0·050/day; Yield coefficient = 0·50 mg VSS per mg BOD_5 removed; MLVSS = 2000 mg/*l*. *20*

Q4. (a) An outward flow turbine running at 200 rpm, works on a discharge of 5 m^3/s under a head of 40 m. Internal and external diameters of the wheel are 2 m and 2·5 m respectively while the width at the inlet and outlet is 200 mm. Assuming the discharge to be radial at the outlet, determine angles of the turbine at the inlet and outlet. Also draw the velocity triangles for outward flow turbine. *20*

(b) (i) Explain the factors that cause sludge bulking in activated sludge process for wastewater treatment. *10*

(ii) Differentiate and compare anaerobic digestion process and composting process used for solid waste treatment. *10*

(c) (i) What do you understand by galleries and shafts and why are they provided in gravity dams ? *12*

(ii) During a recuperation test, the water in an open well was depressed by 2·5 m by pumping and it recuperated 1·8 m in 80 minutes. Find yield from a well of 4 m diameter under a depression head of 3 m. *8*

SECTION B

Q5. (a) The soil profile in a particular site consists of 7 m thick sandy layer overlain by a layer of clay. The water table is at 1 m below the ground surface. Above the water table, the sand is saturated with capillary moisture. The dry unit weight of sand is 17 kN/m^3 and its saturated unit weight is 20 kN/m^3. Plot the total stress, neutral stress and effective stress with depth up to a depth of 7 m. *12*

(b) What is meant by N value ? Why should we apply corrections for the N value obtained from the field ? Briefly explain the corrections. *12*

(c) Define optimum signal cycle time. Design two phase traffic signal with pedestrian crossing by Webster's method for an average normal flow of traffic on cross roads A and B during design hour as 480 PCU and 250 PCU per hour, the saturation flows on roads A and B are given as 1200 PCU and 1000 PCU per hour respectively. All red time required for pedestrian crossing is 12 seconds and amber times of 2 seconds for clearance in each phase is to be provided. *12*

(d) Calculate lead and radius of a turnout on a Broad Gauge railway track with the following data :

Heel divergence = 130 mm

Straight length between theoretical nose of crossing and tangent point of crossing = 1·3 m

Angle of crossing = 4° 45′ 49″

Angle of switch = 1° 08′ 00″

Broad Gauge Width = 1·676 m

Show the values on a neat sketch of turnout. *12*

(e) In a running fly level from a benchmark of RL 187·215, the following readings were obtained.

BS	1·115	2·135	1·880	2·725
FS	0·865	3·930	0·880	–

From the last position of the instrument, five pegs at 20 m intervals are to be set out on a uniformly falling gradient of 1 in 40. The first peg is to have an RL of 185·670. Work out the staff readings required for setting the tops of the pegs on the given gradient. *12*

Q6. (a) Consolidated undrained type Triaxial tests were carried out to failure on two identical specimens of silty clay with pore water pressure measurements, as given below :

Sl No.	Confining pressure (kPa)	Deviator stress (kPa)	Pore pressure (kPa)
1.	100	150	40
2.	200	220	75

Determine the shear strength parameters, if

(i) construction is done at a faster rate,

(ii) construction is done slowly. *20*

(b) The soil profile in a particular site consists of a 1·5 m thick filled up soil (N = 3, γ = 17 kN/m^3) followed by 2 m thick very soft clay layer (N = 0, C_u = 5 kN/m^2, γ = 15 kN/m^3). This is followed by 6 m thick sandy layer (av. N value = 8 and γ = 17 kN/m^3), which is followed by 11 m thick stiff clay layer (av. cohesion = 25 kN/m^2, γ = 15 kN/m^3). This is followed by dense sand upto 30 m (av. N value = 50, γ = 19 kN/m^3). The water table is at 1·5 m below GL. Calculate the safe load that a 25 m long 600 mm dia bored cast in situ pile can carry. *20*

Take for N = 3, $\phi = 24°$; N = 8, $\phi = 28°$

for N = 50, $\phi = 41°$, $N_q = 140$ and $N_\gamma = 152$.

(c) Mention standard conditions assumed for basic runway length. Design the runway length for a proposed airport site at an altitude of 420 m above mean sea level. Use the following data : *20*

Basic runway lengths for take-off and landing are 2000 m and 2400 m respectively.

Airport reference temperature is 23°C.

Effective gradient along the proposed runway is 0·4%.

Q7. (a) (i) What is the basis for classifying foundations into shallow and deep ? Briefly explain the situations in which different types of shallow foundations are adopted. *8*

(ii) A square footing (2 m × 2 m) founded at a depth 1 m below GL has to support a column load of 400 kN. The soil profile consists of fine sand (γ = 17 kN/m^3) up to a depth of 3 m, followed by a 4 m thick layer of silty clay (γ = 15 kN/m^3, NMC = 92%, C_c = 1·05). This is followed by dense sandy layer up to 12 m. The WT is at 2 m below the GL. Compute the possible consolidation settlement and state whether it is within permissible limits. *12*

(b) Determine the correct magnetic bearings of the lines of closed traverse having the following bearings as observed : *20*

Line	AB	BC	CD	DE	EA
FB	81°05′	100°20′	171°35′	210°50′	300°50′
BB	260°20′	282°35′	351°45′	30°05′	121°10′

(c) Describe tunnel lining and various materials used for it. *10*

(d) Classify wet docks and write advantages and disadvantages of each of them. *10*

Q8. (a) (i) Comment on the statement "The net bearing capacity of a shallow foundation in clayey soil is unaffected by the position of water table, whereas in sandy soil, it is very much affected". *5*

(ii) With respect to a compaction curve, explain how one can plot the zero air voids line, 90% saturation line and 10% air voids line. *10*

(b) Discuss the geological characteristics necessary for the design and construction of reservoirs. *10*

(c) Discuss how the sensors are classified in Remote Sensing and briefly explain their salient features. *10*

(d) Design the length of transition curve to be provided on a horizontal curve of radius 484 m on a National Highway with double lane passing through heavy rainfall area. Following design data is given : *25*

Ruling design speed = 80 kmph

Type of terrain = Rolling terrain

Rate of introduction of superelevation = 1 in 150

Wheel base of design vehicle = 6 m