# 2007

# CIVIL ENGINEERING (Paper III)

006532

**Time allowed : 3 Hours }** **{ Maximum Marks : 200**

**Note :**
*(i) Solve one question from each section.*
*(ii) If more than one questions are attempted in a section, the excess will be ignored.*
*(iii) Figures to the right indicate the number of marks for the question / sub-question.*
*(iv) Make suitable assumptions, if necessary and state the same.*
*(v) Use of log-tables, non-programmable calculators is permitted.*
*(vi) Use of any kind of I.S. Codes and Steel Table Codes is NOT permitted.*
*(vii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he will be penalised.*

## SECTION - A

**1.** (a) Define 'Viscosity' of fluid. A cylindrical shaft of 90 mm diameter rotates about a vertical axis inside a fixed cylindrical tube of length 50 cm. and 92 mm internal diameter. If the space between the tube and the shaft is filled by an oil of dynamic viscosity 1.8 poise, calculate the power required to overcome the viscous resistance when the shaft is rotated at a speed of 240 rpm. **12**

(b) A solid cone of diameter 24 cm and height 20 cm floats with its vertex downwards in water. Find the metacentric height of the cone and comment on its equilibrium. Assume the specific gravity of cone = 0.80. **11**

(c) Define streamline and equipotential line. A closed tank, kept on ground level, containing water is partly filled with water and the air space above it is under pressure. A 5 cm hose, connected to the tank, discharges water to atmosphere on to the roof of a building 3m above the level of water in the tank. If frictional losses are 1.5 m of water, what air pressure must be maintained in the tank to deliver 15 *l/s* to the roof ? Neglect minor losses except the velocity head at exit. Assume specific weight of water as 9.79 $kN/m^3$. **11**

**P.T.O.**

2. (a) In an open channel flow define the specific energy of flow. In a hydraulic jump occuring in a horizontal, rectangular, frictionless channel the energy loss and Froude number after the jump are 9.0m and 0.12 respectively. Calculate the discharge intensity and initial depth of the jump.

(b) A straight 25cm diameter pipeline, 5km long, is laid between two reservoirs having a difference in water levels of 40m. To increase the capacity of the system, an additional 25cm diameter pipe, 2.5km long, is laid parallel from the first reservoir to the midpoint of the original pipeline. Assuming $f = 0.025$ for both the pipes find the increase in discharge due to installation of the new pipe. Assume $hf = flv^2/2gD$. **11**

(c) State Buckingham ***pi*** theorem. A pipe of diameter 1.5m is required to transport an oil of relative density 0.9 and kinematic viscosity 0.03 stoke at a rate of 3.0 $m^3/s$. If a 15cm diameter pipe with water having kinematic viscosity of 0.01 stoke is used to model the above flow, calculate the velocity and discharge in the model. **11**

## SECTION - B

3. (a) What is hydrologic cycle ? Describe, briefly, with a neat sketch, the different processes involved in it. Explain briefly the man's interference in various parts of this cycle. **12**

(b) A catchment has six raingauge stations. In a year, the annual rainfall recorded by the gauges are as follows :

| Station | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Rainfall (cm) | 82.6 | 102.9 | 180.3 | 110.3 | 98.8 | 136.7 |

For a 10% error in the estimation of the mean rainfall, calculate the optimum number of stations in the catchment. **11**

(c) Discuss the importance of evaporation control of reservoirs and possible methods of achieving the same. **11**

## SECTION - D

7. (a) Explain with sketches any five factors controlling the alignment of roads. **11**

(b) What is the need of providing superelevation on horizontal curves ? **11**

Under the mixed traffic condition a highway horizontal curve has a radius of 250 m. in plain terrain. Design the superelevation with the design speed of 100 km/h. Calculate the restricted speed, if any.

(c) State four objects of carrying out traffic volume studies. Briefly explain the methods of traffic volume counts. **11**

8. (a) Explain the relationship between speed, travel time, volume, density and capacity. Support your answer with sketches. **11**

(b) Define stopping sight distance as per IRC norms. **11**

Calculate the stopping sight distance for a design speed of 60 km/h for :

(i) Two way traffic on a two lane road,

(ii) Two way traffic on a single lane road.

(c) Draw a sketch of flexible pavement cross section and show the component parts. Briefly explain the functions and importance of any four important components of the pavement. **11**

## SECTION - E

9. (a) State five ideal characteristics of a bridge site. **11**

Define the following :

(i) Effective linear waterway

(ii) Afflux

(iii) Economic span

(iv) Scour

(b) Explain briefly the rational method for the determination of flood discharge. **11**

Calculate the peak runoff from following data :

Catchment area : Sandy soil with thick vegetation cover and area is 12000 ha. Length and fall : Length of catchment = 23 km

Fall = 175 m.

Severmost storm recovered : 24 cm in 3 hrs.

(c) Enumerate the various forces, loads and stresses considered in the design of bridges. Explain in brief the forces due to water currents. **11**

**P.T.O.**

(c) Details of a non-overflow section of a concrete gravity dam are given below :

(i) R.L. of deepest foundation level = 100 m.

(ii) R.L. of roadway at top of dam = 160 m.

(iii) Maximum water level = 157 m.

(iv) Roadway width at top = 8 m.

(v) Downstream face vertical upto R.L. = 152 m.

(vi) Upstream face vertical upto R.L. = 140 m.

(vii) Slope of downstream face = 0.85 H : 1 V

(viii) Slope of upstream face = 0.1 H : 1 V

(ix) Horizontal seismic coefficient, $\alpha H$ = 0.15

Calculate the hydrodynamic pressure force due to earthquake and its moment about toe of dam. There is no tail water.

**6.** (a) Design an Ogee spillway (downstream profile of crest of spillway only) of a gravity dam by USWES method using following data : **11**

(i) Maximum discharge = 3500 $m^3/s$

(ii) Net length of spillway = 170 m.

(iii) R.L. of maximum water level = 526 m.

(iv) R.L. of bed of river at spillway = 465 m.

(v) Slope of downstream face = 0.75 H : 1V

(vi) Upstream face is vertical

(vii) Coefficient of discharge of spillway, C = 2.21

Neglect end contractions and velocity of approach. Also state the crest level of spillway. Spillway is ungated spillway.

(b) Design a trapezoidal shaped concrete lined channel to carry a discharge of 200 cumec at a slope of 30 cm/km. Assume side slope of 1.5 H : 1 V, Manning's $n = 0.017$, limiting velocity in the channel as 2.0 m/s. **11**

(c) What is meant by river training ? What are the objectives of river training ? State the various methods adopted for river training. **11**

**P.T.O.**

4. (a) The peak of a flood hydrograph due to a 3-hour duration isolated storm in a catchment is 270$m^3/s$ . The total depth of rainfall is 5.9cm. Assuming an average infiltration loss of 0.3cm/h and a constant baseflow of 20 $m^3/s$ estimate the peak flow of the 3-hour unit hydrograph of this catchment. If the area of the catchment is 567 $km^2$, determine the base width of the 3-hour unit hydrograph by assuming it to be triangular in shape. **1**

(b) Give the detailed list of various methods of estimating flood peak from a catchment and explain the rational method and its use. **11**

(c) A 30cm diameter well completely penetrates an unconfined aquifer of saturated depth 40m. After a long period of pumping at a steady rate of 500 *lpm*, the drawdown in two observation wells, 25m and 75m from the pumping well were found to be 3.5m and 2m respectively. Determine the transmissivity of the aquifer. Also calculate the drawdown at the pumping well. **11**

## SECTION - C

5. (a) Following table gives the necessary data about the crops, duty and area under each crop commanded by a canal taking off from a storage reservoir. Assuming a time factor for the canal to be (12/20), calculate the discharge required at the head of the canal. If the capacity factor is 0.80, determine the design discharge. **11**

| | Crop | Base period (days) | Area (ha.) | Duty of water at the head of the canal (ha/cumec) |
|---|---|---|---|---|
| (1) | Sugarcane | 320 | 900 | 580 |
| (2) | Overlap for sugarcane in hot weather | 90 | 150 | 580 |
| (3) | Wheat (Rabi) | 120 | 750 | 1600 |
| (4) | Bajra (Kharif) | 120 | 600 | 2000 |
| (5) | Vegetables (Hot weather) | 120 | 320 | 600 |

(b) Define duty of irrigation water and mention any six methods of improving duty. **11**

10. (a) Explain the various techniques adopted to strengthen the bridge substructure and superstructure.

(b) Write short notes on the following : **11**

(i) Classification of bridges.

(ii) Erection of supension bridges.

(c) Discuss in brief any four methods of erection of steel bridges. State the conditions under which each type is used. **11**

## SECTION - F

11. (a) State the various types of water demands of a city. **11**

Compute the population of the year 2010 and 2016 for a city whose population in the year 1940 was 25,000, and in the year 1980 was 47,000. Use geometric increase method.

(b) The $BOD_5$ of a waste is 600 mg/$l$. The deoxygenation constant, $K_1 = 0.23$/day(base e.). Find the ultimate $BOD_4$ of the waste. What proportion of the $BOD_4$ would remain unoxidised after 20 days ? **11**

(c) Define ecosystem. Give an account of the structure and function of an ecosystem. **11**

12. (a) A settling basin is designed to have a surface overflow rate of 32.6 m/day. Find the overall removal obtained for a suspension with size distribution given below. **11**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Particle size(mm) | : | 0.10 | 0.08 | 0.07 | 0.06 | 0.04 | 0.02 | 0.01 |
| Weight fraction greater than size (percent) | : | 10 | 15 | 40 | 70 | 93 | 99 | 100 |

The specific gravity of particles is 1.2 and the water temperature is 20°C at which, the dynamic viscosity is 1.027 centipoise and density is 0.997 gm/cm$^3$.

(b) What is meant by activated sludge ? **11**

Explain briefly the activated sludge process. Describe briefly the types of aeration systems in an activated sludge process.

(c) Define air pollution. What are the sources of air pollutants ? State any ten pollutants generally found in air. **11**

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