

# GUJARAT TECHNOLOGICAL UNIVERSITY

7<sup>th</sup> Semester Civil Engineering - PDDC

**Subject Code & Name:** X70601 - Design of Hydraulic Structures

Sr. No.	Course content
1.	<b>Elements of Dam engineering:</b> Introductory perspectives, Embankment types and Characteristics - Concrete dams and characteristics - Spillways and ancillary works – site assessment and selection of type of dam
2.	<b>Embankment dam engineering:</b> Nature and classification of soil - engineering characteristics of soil, principles of design – Material and construction - Internal seepage – Stability and stresses, Settlement and deformation in rock fill embankments
3.	<b>Concrete dam engineering:</b> Loading -Concepts and criteria, Gravity dam analysis design features and stability - elementary profile of gravity dam- Concrete for dams – roller compacted concrete gravity dams
4.	<b>Dam outlet works:</b> Spillways – Ogee spillway - cavitation on spillway – design feature - design principles and design of spillways – Chute spillways – Energy dissipation – stilling basins – plunge pools
5.	<b>Drop structures:</b> Sarda fall – Glacis fall –Design principles- Cross regulator, head regulator and functions

**Note:** Each module carries equal weight age

**Term Work:** Term work shall be based on above mentioned syllabus

**Text Books:**

1. Introduction to Water Resources and Waterpower Engineering, By Dr. P N Modi, Standard Publication, Delhi
2. Irrigation and Water Resources Engineering, By G L Asawa, Pub - New Age Int. Ltd.
3. Irrigation Engineering and Hydraulic Structures by S.K. Garg, Khanna Publishers

**References Books:**

1. Hydraulic Structures, By P. Novak, Pub. Unwin Hyman, London
2. Handbook of Dam Engineering, By Golze, Pub - Van Nostrand Reinhold
3. Engineering for Dams, By Creager WP, Justin J D and Hinds J, Wiley Pub. New York

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER-VII EXAMINATION – SUMMER 2016**

**Subject Code: X70601****Date: 10/05/2016****Subject Name: Design of Hydraulic Structures****Time: 02:30 PM to 05:00 PM****Total Marks: 70****Instructions:**

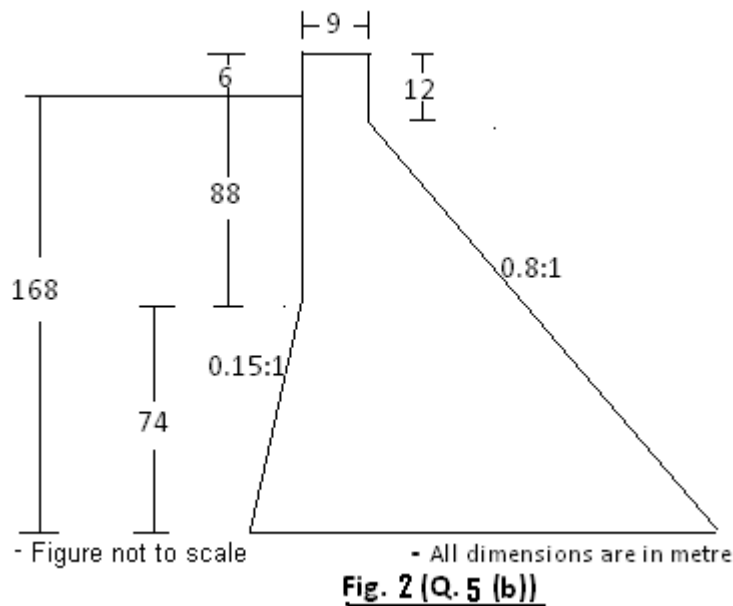
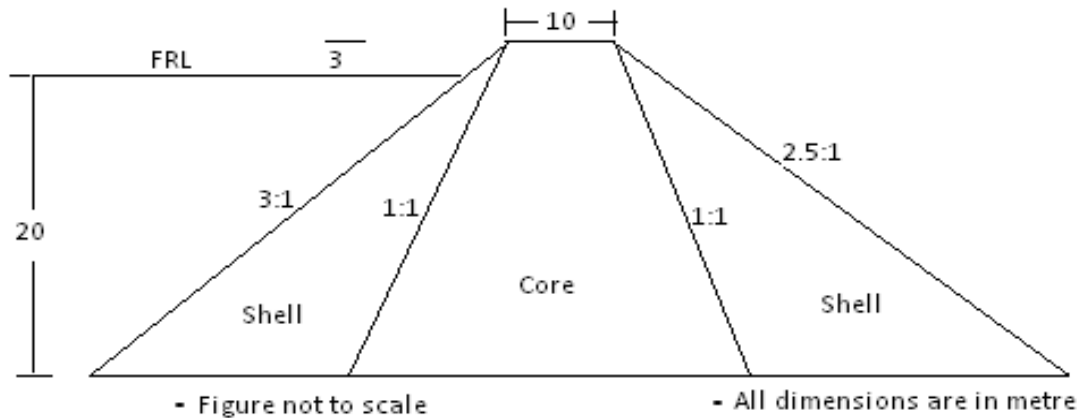
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Discuss the factor affecting the selection of the suitable site for a dam. **07**  
(b) What are the different modes of failure of an earth dam? Explain them in detail. **07**
- Q.2** (a) Determine the ordinates of the seepage line through the dam section, as shown in Fig. 1, using Casagrande method. Assume that the outer shell is made of pervious material while the central core section is made of relatively impervious material having coefficient of permeability  $2.1 \times 10^{-5}$  m/sec. Draw the correct nature of the seepage line. Also, workout the seepage discharge per meter length of the dam when reservoir is full. **07**  
(b) Explain the Swedish slip circle method for the stability analysis of the upstream slope under sudden drawdown condition of an earth dam. **07**
- OR**
- (b) What is pore water pressure? Discuss the effects of pore water pressure on the stability of an earth dam. **07**
- Q.3** (a) What may be the different foundation problems encountered in the dam construction? Suggest their remedial measures. **07**  
(b) What are the different forces likely to act on a gravity dam? Suggest the methods of reduction of uplift pressure on the dam. **07**
- OR**
- Q.3** (a) Explain the functions of the following in the gravity dam: Galleries, Joints, Keys. **06**  
(b) Discuss the criteria for the safe design of a gravity dam. **08**
- Q.4** (a) "Spillway is a safety valve in the dam"--Discuss. What are the different types of spillway and explain the working of Chute spillway, with a neat sketch. **07**  
(b) What are the functions of the energy dissipating structures in the dam? List the different types of energy dissipating structures constructed with the dam and explain any one of them with a suitable sketch. **07**
- OR**
- Q.4** (a) Discuss various factors affecting the selection of a type of dam. **06**  
(b) Explain the following terms, in respect of Ogee spillway: Design head, Effective length of crest, Cavitation **08**  
Compute the discharge over an Ogee weir at a head of 2.0 m. The length of the weir is 300 m and the weir crest is 7 m above the bottom of the approach channel having the same width as that of the weir. Take constant of discharge  $C = 2.3$ .
- Q.5** (a) Derive the expression for the limiting height of a low gravity dam. Also, differentiate between the high dam and low dam. **06**

- (b) The section of a concrete gravity dam is shown in Fig. 2. Calculate the normal stresses at the heel and toe of the dam for reservoir empty and full conditions. Consider the self-weight, water pressure and uplift pressure forces only. Also, calculate the factor of safety against overturning and shear friction factor. Take shear strength = 3.5 kPa, coefficient of friction  $\mu = 0.75$  and specific weight of concrete = 24 kN/m<sup>3</sup>. 08

**OR**

- Q.5 (a) Discuss the design criteria for the Sarda fall. 07  
 (b) With neat sketch, explain the location of cross regulator and distributary head regulator. What are their functions in the canal system? 07



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**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER-VII EXAMINATION – WINTER 2015**

**Subject Code: X70601****Date: 09/12/2015****Subject Name: Design of Hydraulic Structures****Time: 10:30pm to 1:00pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Explain Buttress Dam. Mention advantages & disadvantages for the same. **07**  
(b) Explain briefly the factors affecting in selection of type of dam. **07**
- Q.2** (a) Describe the method for plotting a phreatic line for homogeneous earth dam with a horizontal drainage filter. **07**  
(b) Define Flow net. **07**  
A flow-net is plotted for homogeneous earthen dam of height 22 m and free board 2.0 m. Number of potential drops and flow channels are 10 and 4 respectively. The dam has a horizontal filter of 30 m length at a downstream end and the coefficient of permeability of the dam material is  $5 \times 10^{-4}$  cm/sec. Calculate the discharge per m run of the dam.
- OR**
- (b) Explain the procedure to adopt for stability analysis of slopes of earthen dam by Swedish slip Circle Method. **07**
- Q.3** (a) Derive expression for principal stress and shear stress at the heel and toe of dam **07**  
(b) Enlist various forces acting on a dam. Explain wave pressure and silt pressure. **07**
- OR**
- Q.3** (a) Explain different types of galleries of concrete dam. **07**  
(b) Design the practical profile of a concrete gravity dam for the given data : **07**  
RL of base of dam = 65 m  
RL of HFL = 130 m  
Safe compressive stress in concrete = 3000 KN/m<sup>2</sup>  
Specific gravity of concrete = 2.4  
Height of waves = 1.0 m
- Q.4** (a) Give classification of spillway. Explain design features of ogee spillway. **07**  
(b) What is stilling basin ? discuss various types of stilling basin. **07**
- OR**
- Q.4** (a) Describe characteristics of hydraulic jump. Explain types of jumps. **07**  
(b) What is Bucket type energy dissipator ? **07**
- Q.5** (a) Write short note on (1) Sharda type fall (2) Cross regulator **07**  
(b) Describe (1) design of crest (2) design of cistern for straight glacis fall. **07**
- OR**
- Q.5** (a) What are the Factors affecting the location of fall ? **07**  
(b) Discuss various functions of distributary head regulator. **07**

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**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER-VII • EXAMINATION – SUMMER • 2015**

**Subject Code: X70601****Date: 08/05/2015****Subject Name: Design of Hydraulic structures****Time: 02:30 pm - 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Describe the characteristics of Embankment dams. **07**  
(b) Discuss the advantages and disadvantages of Gravity dams. **07**
- Q.2** (a) Describe the factors governing the selection of site for a dam. **07**  
(b) Describe the various engineering characteristics of soil. **07**
- OR**
- (b) Explain the following terms: - **07**  
Slope protection in earth dams  
Upstream impervious blanket  
Filters in earth dams.
- Q.3** (a) Write short note on settlement of rock fill dams. **07**  
(b) For a homogeneous earth dams 50 m high, and 2.0 m free board, a flow net was constructed and following results were obtained: **07**  
Number of potential drops = 22  
Number of flow channels = 4  
The dam has a horizontal filter of 40 m length at its downstream end. Calculate the discharge per meter length of the dam if the coefficient of permeability of the dam is  $3 \times 10^{-3} \text{cm/sec}$ .
- OR**
- Q.3** (a) Enlist various forces acting on a gravity dam. Explain any one in detail. **07**  
(b) Describe the elementary profile of a gravity dam. **07**
- Q.4** (a) Explain roller compacted concrete gravity dams. Describe the advantages of roller compacted concrete gravity dam. **07**  
(b) Describe the combination of loading for design of gravity dams as per IS recommendations. **07**
- OR**
- Q.4** (a) What is a spillway? Discuss briefly different types of spillways. **07**  
(b) Describe cavitation in an ogee spillway. **07**
- Q.5** (a) Define chute spillway with a sketch. Where would you prefer a chute spillway over an ogee spillway? **07**  
(b) Write a short note on energy dissipation below spillway. **07**
- OR**
- Q.5** (a) What is Head regulator and Cross regulator in the canal network? Enlist function of each with neat sketch. **07**  
(b) Write a short note on Sarda type fall. **07**

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**GUJARAT TECHNOLOGICAL UNIVERSITY****PDDC - SEMESTER-VII • EXAMINATION – WINTER • 2014****Subject Code: X 70601****Date: 28-11-2014****Subject Name: Design of Hydraulic Structures****Time: 10:30 am - 01:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Explain various classifications of dam. **07**  
 (b) Explain briefly how the stability of earthen slopes is checked by the slip circle method. **07**
- Q.2** (a) Discuss the causes of failure of earth dams. **07**  
 (b) Enlist various types of spillways and discuss any one in detail. **07**
- OR**
- (b) Explain ski-jump bucket type energy dissipater. **07**
- Q.3** (a) Discuss in brief merits & demerits of a gravity dams. **07**  
 (b) A trapezoidal concrete Gravity dam having top width 8m, U/S face vertical & D/S face 0.7H : 1V, total height 60m. & water is stored up to 57m. If the co-efficient of friction is 0.75, is the dam safe against sliding? **07**
- OR**
- Q.3** (a) Discuss the various purposes for which galleries are provided in dams. **07**  
 (b) A gravity dam 30m high is trapezoidal in section with a top width of 3m, upstream face vertical and downstream face has a better of 0.7H:1V. Find vertical, principal and shear stresses at heel and toe. **07**
- Q.4** (a) What is a spillway? What are the essential requirements? Describe the various components of a spillway. **07**  
 (b) Draw seepage line and calculate discharge through homogeneous section of an earth dam having following data. **07**  
 -Top width of dam = 6 m  
 -u/s slope = 3H : 1V  
 -d/s slope = 2.5H : 1V  
 -Total height of dam above base = 30 m  
 -Maximum water level above base = 27 m  
 -Horizontal filter length from toe = 25 m  
 -Co-efficient of permeability =  $8 \times 10^{-3}$  cm/sec
- OR**
- Q.4** (a) Discuss the Geological and Topographical features which affect the selection of the type of dam. **07**  
 (b) Design a suitable section for the overflow section of a concrete gravity dam having D/S 0.7H:1V. The design discharge for the spillway is 6000 m<sup>3</sup>/s. The effective length of spillway may be taken as 50m. **07**
- Q.5** (a) What are the falls and why are they constructed? Discuss the comparative merits and demerits of Notch and Sarda type falls. **07**  
 (b) Classify various types of cross-drainage works. Explain any one type in detail. **07**
- OR**
- Q.5** (a) Explain functions of head regulator and cross-regulator. **07**  
 (b) Write short note on canal Escape. **07**

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**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER-VII • EXAMINATION – SUMMER • 2014**

**Subject Code: X 70601****Date: 28-05-2014****Subject Name: Design of Hydraulic Structures****Time: 02:30 pm - 05:00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) What is meant by gravity dams? What are the advantages and disadvantages of a gravity dam over the other types? **07**
- (b) Explain briefly with neat sketches the different forces that may act on a gravity dam. Indicate their magnitudes, directions and locations. **07**
- Q.2** (a) What are the main points to be considered while selecting a site for a gravity dam construction? **07**
- (b) Calculate (neglecting earthquake effect) the maximum and minimum vertical stresses at the heel and toe of the non-overflow section of the dam. **07**
- 1) Base width of dam = 56 meters
  - 2) Top width = 6 meters
  - 3) u/s slope = vertical
  - 4) d/s slope = 2 horizontal and 3 vertical
  - 5) starting of d/s slope from top of the dam = 9 meters
  - 6) location of drainage gallery from u/s heel = 8 meters
  - 7) height of dam = 84 meters
  - 8) height of water in dam = 80 meters
  - 9) Free board = 4 m.
  - 10) weight of concrete = 24 kN/cubic meter
  - 11) Weight density of water = 10 kN/cubic meter.

**OR**

- (b) Calculate (neglecting earthquake effect) the major principal stresses at the toe and intensity of shear stress at the toe of the non-overflow section of the dam. **07**
- 1) Base width of dam = 56 meters
  - 2) Top width = 6 meters
  - 3) u/s slope = vertical
  - 4) d/s slope = 2 horizontal and 3 vertical
  - 5) starting of d/s slope from top of the dam = 9 meters
  - 6) location of drainage gallery from u/s heel = 8 meters
  - 7) height of dam = 84 meters
  - 8) height of water in dam = 80 meters
  - 9) Free board = 4 m.
  - 10) weight of concrete = 24 kN/cubic meter
  - 11) Weight density of water = 10 kN/cubic meter.

- Q.3** (a) What do you mean by the elementary profile of gravity dam? **07**
- (b) Briefly explain the function of drainage gallery. **07**

**OR**

- Q.3 (a)** An earthen dam made of a homogeneous material has the following data: **07**
- 1) Co-efficient of permeability of dam material =  $5 \times 10^{-4}$  cm/sec
  - 2) Level of top of dam = 200.0 meter
  - 3) Level of deepest river bed = 178.0 meter
  - 4) Highest flood level of reservoir = 197.5 meter
  - 5) Width of the top of dam = 4.5 meter
  - 6) Upstream slope = 3:1
  - 7) Downstream slope = 2:1
- Determine the phreatic line for this dam section and the discharge passing through the dam.
- (b)** A flow net is plotted for a homogeneous earthen dam of height 22 m and freeboard 2.0 m. The results obtained are, **07**
- 1) Number of potential drops = 10
  - 2) Number of flow channels = 4
- The dam has a horizontal filter of 30 m length at the downstream end and the co-efficient of permeability of the dam material is  $5 \times 10^{-4}$  cm/sec. Calculate the discharge per m run of the dam.
- Q.4 (a)** What are the 'earthen dams' and under what circumstances are they preferred? **07**
- (b)** Enumerate the different types of earthen dams, and draw neat sketches showing each type. **07**
- OR**
- Q.4 (a)** Enumerate the different methods which are adopted for constructing earthen dams. **07**
- (b)** What are the causes of failures of earth dam? **07**
- Q.5 (a)** Briefly describe an 'ogee spillway'. **07**
- (b)** Write a short note energy dissipation below spillways **07**
- OR**
- Q.5 (a)** What is meant by 'canal drops'? Why is the canal drops constructed in a canal system? **07**
- (b)** What are functions of canal head regulator? **07**

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**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER-VII • EXAMINATION – WINTER 2013**

**Subject Code: X70601****Date: 03-12-2013****Subject Name: Design of Hydraulic Structures****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) How dams are classified? Discuss in detail. **07**  
(b) Discuss the various investigations required to be carried out to determine the most suitable site for a dam **07**

- Q.2** (a) What is gravity dam? Enumerate the various forces acting on a gravity dam **07**  
(b) A concrete gravity dam has maximum water level 305.0 meter, bed level 225.0 meter, top RL of dam 309.0 meter, d/s face slope starts at RL of 300.0 meter, d/s slope 2 Horizontal: 3 Vertical, tail water is nil, upstream face of dam is vertical, center line of drainage gallery is 8 meter from u/s face of the dam, uplift pressure is 100% at heel, 50% at line of gallery and zero at toe, top width of dam is 14% of dam height, weight of the concrete is 24 KN/cubic meter. Considering only weight, water pressure and uplift, determine (i) Maximum vertical stresses at the toe and heel of the dam, (ii) Major principal stresses at the toe of dam, and (iii) Intensity of shear stress on a horizontal plane near the toe. **07**

**OR**

- (b) A triangular section gravity dam 40 meters high has water stored up to top and base width is 30 meter. Analyze the dam section to determine (i) Factor of safety against sliding, (ii) Factor of safety against overturning, (iii) there is no tension anywhere along the base of dam and (iv) maximum compressive stress in the dam body is within safe crushing strength of the material (10 kg/square centimeter). Assume coefficient of friction between the base and foundation as 0.7 and uplift pressure intensity coefficient as 0.45. **07**
- Q.3** (a) What are the different types of the earth dams? Support your answer with neat sketches. **07**  
(b) Discuss control of seepage in earthen dam. **07**

**OR**

- Q.3** (a) A flow net is plotted for a homogeneous earthen dam of height 25 meters and length 2000 meters with freeboard 2 meters. The results obtained indicate number of potential drops as 10 and number of flow channels as 4. The dam has a horizontal filter of 30 cm at the downstream end and the coefficient of permeability of the dam material is  $5 \times 10^{-4}$  cm/second. Calculate the discharge through the dam. **07**  
(b) Determine the length and thickness of the upstream impervious blanket for an earthen dam of the dimensions; top width 5 m, base width 100 m, free board 3 m, minimum water head 16 m, depth up to impervious foundation 25 m, permeability coefficient of pervious foundation is 3 cm/minute, and desirable reduction in seepage 80%. Neglect seepage through the blanket. **07**

- Q.4** (a) What are the spillways, why provided and enlist various types of spillways. **07**  
(b) Describe ogee spillway and sketch an ogee profile. How it is designed? **07**

**OR**

- Q.4** (a) An ogee spillway with vertical upstream face has design discharge of 3000 cubic meter per second, crest length of 150 m, normal reservoir level is 700.0, average river bed level is 650.0 m, coefficient of pier is 0.01, coefficient of abutments is 0.1, number of span is 10 and coefficient of discharge is 2.2. Determine the crest level and profile of the overflow spillway section. **07**
- (b) Calculate discharge over a spillway, crest length 100 m, wherein water flow depth changes from 1 m to 4 m in hydraulic jump formation in stilling basin. **07**
- Q.5** (a) Define energy dissipation. Discuss various methods used for energy dissipation. **07**
- (b) Describe with neat sketches the various types of bucket type energy dissipation. **07**
- OR**
- Q.5** (a) What is a fall in a canal? Why is it necessary to provide a fall in a canal? **07**
- (b) What is cross-regulator? What are the functions of a cross regulator? **07**

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**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**PDDC - SEMESTER – VII • EXAMINATION – WINTER 2012**

**Subject code: X 70601****Date: 03/01/2013****Subject Name: Design of Hydraulic Structures****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Discuss the various factors which govern the selection of type of dam **07**  
(b) What factors affect the selection of site for a dam discuss them briefly **07**

- Q.2** (a) Prove that the base width  $b$  for an elementary ( or theoretical ) profile of a low gravity dam is given by **07**

$$b = h/\sqrt{s-1} \text{ in which}$$

$h$  = height of the dam, and

$s$  = specific gravity of the dam material

assume that the uplift pressure acts on the full area of the base

Also calculate the maximum compressive stress developed in the dam.

- (b) Following data were obtained from the stability analysis of a concrete gravity dam. **07**

( I ) total overturning moment about toe =  $1 \times 10^6$  kN-m

( II ) total resisting moment about toe =  $2 \times 10^6$  kN-m

( iii ) total vertical force above the base = 50000 kN

( iv ) base width of the dam = 50 m

( v ) slope of the down stream face = 0.8 horizontal : 1 vertical

Calculate the maximum and minimum vertical stress to which the foundations will be subjected to. What is the maximum principal stress at the toe ? assume there is no tail water.

**OR**

- (b) A 100 meter high concrete dam has base width 70 meter and top width 7 meter. Upstream slope is vertical and downstream slope starts from 10 meter below top of the dam and downstream slope is 0.7 horizontal : 1 vertical and free board is 4 meter is located in Seismic Zone V. Specific weight of concrete is 24.525 kN/cubic meter and its modulus of elasticity is  $20.601 \times 10^6$  kN/m<sup>2</sup>. Calculate the earth quake forces by seismic coefficient method per unit of the dam. **07**  
Assume soil – foundation system factor = 1.0 , importance factor = 2.0 and basic seismic coefficient = 0.08

- Q.3** (a) How earth dams are designed **07**  
(b) Discuss the various causes of failure of the earth dam **07**

**OR**

- Q.3** (a) A homogeneous earth dam 20 meter high has crest width 6 meter, upstream slope 4: 1 and downstream slope 3:1. The properties of the soil mass in the dam are : saturated unit weight = 21.19 kN/m<sup>3</sup> ; submerged unit weight = 11.38 kN/m<sup>3</sup>; angle of internal friction = 26 degree ; and cohesion = 39.24 kN/m<sup>2</sup>. Check the stability of the upstream portion of the dam against horizontal shear at the base of the **07**

dam. At the top of shoulder of the upstream slope of the dam the seepage line may be assumed to be 5 meter below the crest of the dam.

- (b) Design an upstream blanket for a dam of height 15 meter, base width 66 meter, crest width 6 meter, upstream slope and downstream slope 2 horizontal : 1 vertical. Height of reservoir water surface 12 meter and height of pervious strata 10 meter below the base width of dam. Width of the rock toe on downstream side of the dam is 15 meter. The thickness of the blanket may be taken as 1.5 meter. The coefficient of permeability of the blanket soil is 0.08 meter/day and that of the foundation soil is 67 m/day. **07**

**Q.4 (a)** How spillways are classified? Describe briefly the types of the spillways. **07**

- (b) An ogee type of spillway has 20 crest gates each having 10 meter clear span. Find the maximum flood that can be safely passed by lifting all the gates when the maximum reservoir elevation is 110 meter and the crest level is 106.00 meter. **07**

Take coefficient C as  $2.16 \sqrt{(\text{meter})/\text{sec}}$

Coefficients of end contractions are 0.05 and 0.10 for the piers and the abutments respectively. Neglect velocity of approach.

**OR**

**Q.4 (a)** What are the functions of ( i ) chute blocks and ( ii ) baffle blocks in stilling basins ? **07**

- (b) An ogee spillway has 2.5 m head above the crest. Depth of flow at the toe of the spillways is 0.6 meter. **07**

Assume coefficient C as  $2.16 \sqrt{(\text{meter})/\text{sec}}$

Compute:

- ( i ) the discharge per meter length of the spillway
- ( ii ) Pre jump velocity at the toe
- ( iii ) Prejump Froude number of the flow
- ( iv ) conjugate depth required for hydraulic jump.

If the actual tailwater depth is 4.5 meter , what type of energy dissipator would you provide ?

**Q.5 (a)** Describe with neat sketches the various types of bucket energy dissipators. **07**

- (b) Discuss the various types of energy dissipation devices used below spillways in relation to the positions of the tailwater rating curves ( TWRC ) and jump height curve ( JHC). **07**

**OR**

**Q.5 (a)** Discuss the procedure for designing a sarda type fall **07**

- (b) What is canal head works? Describe briefly the functions of the canal headworks. **07**

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