

Semester-II

Savitribai Phule Pune University Board of Studies in Civil Engineering B.E.

Civil 2015 Course (w. e. f. June 2018)

401007 Dams and Hydraulic Structures

Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

Examination Scheme:

In-sem: 30 marks (1 Hour)

End-sem :70 marks (2.5 Hours)

Oral : 50 marks

Unit I

(4 Hrs.)

a) Introduction to dams

Introduction, Historical development of dams, Different terms related to dams, Selection of site for dam, Factors governing selection of type of dam, Classification of dams, Classification based on purpose, Classification based on materials, Classification based on size of project, Classification based on hydraulic action, Classification based on structural action, Dams and earthquakes, Dams and social issues, Large dams verses small dams, Displacement and rehabilitation, Dams and climate change.

b) Dam Safety and Instrumentation

Introduction, Objectives of dam safety and instrumentation, Types of measurements, Instrumentation data system, Working principles and functions of instruments, Selection of Equipment's, Different Instruments, Piezometers, Porous tube piezometer, Pneumatic piezometer, Vibrating wire piezometer, Settlement measurement system Vibrating wire settlement cell, Magnetic settlement system, Inclinator, Joint meter, Pendulums, Inverted Pendulum, Hanging Pendulum, Automatic pendulum coordinator, Vibrating wire pressure cell, Extensometer, Embedment strain gauge, Temperature gauge, distributed fiber optics temperature tool, seismograph.

UNIT 2

(7 Hrs.)

a) Gravity Dams

Introduction, Components of gravity dam, Conditions favoring gravity dams, Forces acting on gravity dam, Combinations of loading for design, Seismic analysis of dam, Terms related to seismic analysis, Determination of Seismic forces (Zangar's method), Effect of horizontal earthquake acceleration, Effect of vertical earthquake acceleration, Stress analysis in gravity dam (Only concept, no derivations), Vertical or normal stress, Principal stresses, Shear

stress, Middle third rule, Modes of failure of gravity dam, Elementary profile of gravity dam, Concept of low and high gravity dams, **Various Design methods of gravity dam** (Introduction only)— Details of Gravity method or 2 D method, ,Construction of gravity dams, Colgrout masonry, Roller Compacted Concrete (R.C.C.),Temperature control in mass concreting, Crack formation in gravity dam, Control of crack formation in dams, Construction joints, Keys, Water seal, Retrofitting.

b) Arch Dam and Other Dams (Introduction only)

Introduction, Concept of Arch Dam, Conditions favoring an arch dam, Classification of an arch dam, Constant angle arch dam, Constant radius arch dam, Variable radius arch dam, Arch gravity dam, Double curvature arch dam, Buttress dams, Advantages of Buttress dams, Limitations of Buttress dams, Types of buttress dams.

Unit III

(7 Hrs.)

a) Spillway and Gates [6 Lectures]

Introduction, Location of Spillway, Different key levels and heads in spillway, Spillway Capacity, Components of spillway, Approach channel, Control structure, Discharge channel, Energy dissipation device, Tail channel, Classification of spillway, Classification based on operation, Main or service spillway, Auxiliary spillway, Emergency spillway, Classification based on gates, Gated spillway, Ungated spillway, Classification based on features, Straight drop spillway(Free overflow spillway),Saddle spillway, Side channel spillway, Overflow or ogee spillway, Chute or open channel or trough spillway, Shaft or morning glory spillway, Siphon spillway, Conduit or tunnel spillway, Stepped spillway,

Design of Ogee spillway or overflow spillway, Shape of crest, Equations for spillway profile on upstream and downstream, Energy dissipation below spillway, Classification of energy dissipation devices, Energy dissipation in stilling basin, Stilling basin, Components of stilling basin, Types of stilling basins, Indian standard stilling basins, Energy dissipation through buckets, Solid roller bucket, Slotted roller bucket, Ski jump bucket, Correlation between jump height and tail water depth.

b) Spillway Gates

Introduction of Spillway gates , Classification of spillway crest gates, Classification based on function, Classification based on movement of gates, Classification based on special features, Introduction to automatic gates, Maintenance of gates, Inspection of gates.

Unit IV

(7 Hrs.)

a) Earth Dam

Introduction, Conditions favoring an earth dam, Limitations of earth dam, Classification of earth dam, Classification based on---materials, method of construction, height; Selection of type of earth dam, Components of an earth dam, Requirements for safe design of earth dam, Hydraulic (Seepage) Analysis, Plotting of seepage line, Case 1: Homogeneous earth dam with horizontal drainage blanket, Determination of seepage discharge using phreatic line.

Case II: Composite earth dam with casing and hearting, Properties of phreatic line, Determination of seepage discharge through earth dam using flownet, Structural stability analysis of homogeneous and zoned earth dam, Forces acting on earth dam, Method of stability analysis of an earth dam, Procedure of analysis by Swedish slip circle method, Fellenius Method of Locating Centre of Critical Slip circle, Stability analysis for foundation, Failure of earth dam, Classification of failure of earth dams, Hydraulic Failure, Seepage failure, Structural failure, Seepage control in earth dams, causes of seepage, Seepage control measures, Construction of earth dam,

b) Diversion head works

Introduction, Function of diversion headworks, Selection of site for diversion headworks, Layout of diversion headworks, Components of diversion headworks, Design of weir on permeable foundation, Criteria for safe design of weir floor, Brief introduction to Bligh and Lane's theory, Khosla's theory based on potential theory approach, Khosla's theory of independent variables, Design criteria of weirs on permeable foundations, Checks for stability and safety of weirs.

Unit V

(6 Hrs.)

a) Canals

Introduction, Classification of canals, Classification based on alignment, Classification based on soil, Classification based on source of supply, Classification based on discharge, Classification based on lining, Classification based on excavation, Components of canal, Data required for canal design, Selection of canal alignment, Design of stable canal in alluvial beds, Kennedy's theory, Design of canal by Kennedy's theory, Limitations of Kennedy's theory, Lacey's regime theory, Design of canal by Lacey's theory, Canal lining, Need of canal lining, Requirements of lining material, Classification of canal lining, Hard surface lining including Ferrocement lining, Soft surface lining, Buried lining, Advantages of canal lining, Design of lined canal, Benefit – cost analysis for canal lining.

b) Canal Structures

Canal falls Introduction, Necessity of canal fall, Selection of site for canal fall, Classification of canal fall, Types of falls, Free fall or open fall, Notch fall, Ogee Fall, Rapid Stepped fall, Straight glacis fall, Sarda fall, Semi pressure fall, Baffle or Englis Fall, Montague fall Siphon well or cylinder fall, Pressure or closed conduit fall, Shaft or Pipe fall, Selection of type of fall, **Canal outlets**- Introduction of Canal outlet or module, **Canal escapes**- Introduction of Escapes, Significance of canal escape, **Canal regulators**--Canal regulators.

Unit VI

(5 Hrs.)

a) C. D. Works

Introduction, Necessity of cross drainage works, Selection of site for Cross Drainage work, Data required for design of Cross Drainage work, Classification of Cross Drainage works, Drain over canal-Siphon, Super passage, Canal over drain—Aqueduct, Siphon aqueduct, Canal and drain water mixed in each other--Level crossing, Inlet and Outlet, Selection of suitable type of C. D. works, Design considerations for cross drainage works.

b) River Training Structures

Introduction, Classification of rivers, Classification based on topography, regime, alignment, source, Behaviour of rivers, River training, Objectives of river training, Classification of river training, purpose, orientation, River training structures, Embankment or Levee, Guide banks, Groynes or spurs, Artificial cut off, Pitched island, Submerged sill or dykes, Closing dykes.

Term Work (A+B+C)

A) Analysis /Design Assignments. (Compulsory)

- 1) Stability analysis of gravity dam
- 2) Design of profile of spillway and energy dissipation device below the spillway
- 3) Stability analysis of zoned earthen dam
- 4) Analysis of weirs on permeable foundations.
- 5) Design of unlined and lined canal.

B) Site visits and reports with photographs (compulsory)

1. Gravity dam.
2. Earth dam.
3. D. work/ Canal structure(s)/Weirs/Barrage.

C) Review of any one case study of failure of hydraulic structure from the published literature or patent related to Hydraulic structures (in a group of five students).

Note:-

Visit report should consist of Name of project, date of visit , need and practical significance of project, salient features of project, technical details of project, detailed description and figures of different components of project, special features of project, the technical, social, financial and environmental impact of project on downstream and upstream, photographs of technical details of visit, if allowed . If not allowed for technical details, the photograph near board of project or site as a proof of visit.

Reference Books :-

1. Design of Small Dams- United States Department of the Interior, Bureau of Reclamation revised reprint 1974, Oxford and IBH Publishing Co.
2. Irrigation and Water Resources Engineering- Asawa G.L- New Age International (P) Ltd. Publishers, first ed, 2005.
3. Irrigation Engineering and Hydraulic Structures- Garg S.K- Khanna Publishers N.D. 13th ed, 1998.
4. Design Textbook in Civil Engineering: Volume Six: Dams- Leliavsky, Serge – Oxford and IBH Publishing Co. Pvt. Ltd., 1981.
5. Roller Compacted Concrete Dams- Mehrotra V.K- Standard Publishers Distributors, Delhi, 1st ed, 2004.
6. Irrigation, Water Resources and Water Power Engineering- Modi, P.N. - Standard Book House, New Delhi, 2nd ed, 1990.
7. Irrigation and Water Power Engineering - Punmia B.C. - Laxmi Publication.

I.S. Codes:

1. I.S. 8605 – 1977 (Reaffirmed 1998), Code of practice for construction of masonry in dams, third reprint, July 1999, B.I.S. New Delhi.
2. I.S. 6512-1984 (Reaffirmed 1998), Criteria for design of solid gravity dams, first revision, first reprint, September, 1998, B.I.S. New Delhi.
3. I.S. 457 – 1957 (Reaffirmed, 2005), Code of practice for general construction of plain and reinforced concrete for dam and other massive structures, sixth reprint, January 1987, B.I.S. New Delhi.

4. I.S. 10135 – 1985, Code of practice for drainage system for gravity dams, their foundations and abutments, first revision, B.I.S. New Delhi.
5. I.S. 14591 – 1999, Temperature control mass concrete for dams – guidelines, B.I.S.
6. I.S. 11223 – 1985 (Reaffirmed 2004), Guidelines for fixing spillway capacity, edition 1.2 (1991-09), B.I.S. New Delhi.
7. I.S. 6934 – 1998 (Reaffirmed 2003), Hydraulic design of high ogee overflow spillways – recommendations, first revision, B.I.S. New Delhi.
8. I.S. 11155- 1994, Construction of spillways and similar overflow structures – Code of practice, B.I.S. New Delhi.
9. I.S. 5186 – 1994, Design of chute and side channel spillway – criteria, first revision, B.I.S. New Delhi.
10. I.S. 10137- 1982 (Reaffirmed 2004), Guidelines for selection of spillways and energy dissipaters, B.I.S. New Delhi.
11. I.S. 4997 – 1968 (Reaffirmed 1995) Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron, sixth reprint, January, 1998, B.I.S. New Delhi.
12. I.S. 7365-1985, Criteria for hydraulic design of bucket type energy dissipaters, first revision, B.I.S. New Delhi.