SYLLABUS

(With effect from 2013-2014)
Out Come Based Education

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2013–14)
ಫಲಿತಾಂಶ ಆಧಾರಿತ ಶಿಕ್ಷಣ

V and VI Semester

Bachelor Degree
in

CIVIL ENGINEERING

P.E.S. College of Engineering

Mandya - 571 401, Karnataka
(An Autonomous Institution Affiliated to VTU, Belagavi)
Grant -in- Aid Institution
(Government of Karnataka)
Accredited by NBA, New Delhi
Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ
(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running eight undergraduate and eight Postgraduate programs. It consists of six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome Based Education (OBE), has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of 2013-14.Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project is included in all undergraduate programs.

(Dr.H.V.RAVINDRA)
Dean (Academic)
Professor,
Dept. of Mechanical Engg.

(B.DINESH PRABHU)
Deputy Dean (Academic)
Associate Professor,
Dept. of Automobile Engg

Vision

"An institution of high repute, imparting quality education to develop innovative and Humane engineers"

Mission

"Committed to develop students potential through high quality teaching- learning processes and state of the art infrastructure"

DEPARTMENT OF CIVIL ENGINEERING

About the Department

The Civil Engineering Department was started in the year 1962 as one of the first branches inP.E.S College of Engineering, Mandya with an intake of 40. The department has carved a niche for itself by offering the most competent instructional programmes to the students. The department is running an undergraduate programme with an intake of 120 and it has started PG inn CAD structures with an intake of 18 in the year 2004. The department has been recognized as research center under VTU, Belgaum. The department is accredited by NBA, New Delhi for five years (2004-2009). The department is well equipped with laboratories, computing facilities, independent library and other facilities. The department has well qualified and experienced teaching faculties. The department also takes up consultancy work pertaining to civil engineering. Planning, structural design of buildings, testing of materials, testing of materials, soil investigation is part of the department activities.

VISION AND MISSION

- **VISION :**

  Department of Excellence developing engineers to address construction challenges.

- **MISSION:**

  Committed to
  - Develop faculty, staff and students
  - Create and nurture ambience for learning, innovation and research
  - Develop new construction materials and technology
  - Partner in developing skilled labour through vocational programmes

DEPARTMENT OF CIVILENGINEERING

(A) Programme Educational Objectives (PEOs)

The Bachelor of Engineering Programme in Electronics and Communication Engineering [B.E. (Civil)] during four years term aims to

I. Provide the students with strong fundamental and advanced knowledge in mathematics, science and engineering with respect to Civil Engineering discipline with an emphasis to solve engineering problems

II. Prepare the students through well - designed curriculum to excel in bachelor degree programme in Civil Engg. in order to engage in teaching or industrial or any technical profession and to pursue higher studies

III. Train students with intensive and extensive engineering knowledge and skill so as to understand, analyze, design and create novel products and solutions in the field of Civil engineering.

IV. Inculcate in students the professional and ethical attitude, effective communication skills, team spirit, multidisciplinary approach and ability to relate engineering issues to broader social context.

V. Provide students with an excellent academic environment to promote leadership qualities, character moulding and lifelong learning as required for a successful professional career.

(B) Programme Outcomes (POs):

The BACHELOR OF ENGINEERING Programme in Civil Engineering [B.E. (Civil)] must demonstrate that its graduates have

a) An ability to apply knowledge of mathematics, science and engineering to develop art of planning and executing constructional activities.

b) An ability to design and construct Civil Engineering structures

c) An ability to function effectively as an individual and as a member of engineering teams of other disciplines.

d) An understanding of professional and ethical responsibility at local, national and international levels.

g) An ability to effectively communicate orally and in writing on social and technical occasions in local and global scenarios.

h) The broad education to understand the impact of engineering solutions in a global and societal context.

i) An ability to engage in independent and lifelong learning in the broad context of technological change.

j) A knowledge of contemporary issues at local, national and international levels.

k) An ability to use the techniques, skills and modern engineering software tools which are necessary for engineering practice.

These programme outcomes (POs) are achieved through an array of courses. To ensure the achievement of POs, the course learning outcomes (CLOs) are so formulated that they address the POs.

Department ofCivil Engineering.

V Semester B.E. SCHEME OF TEACHING AND EXAMINATION 2013- 14

Sl. No.	Course Code	Course Title	Teaching Dept.	Hours Pattern L:T:P:H	Credits	Examination Marks			Exam Duration in hours
						CIE	EE	Total Marks	
1.	P13CV51	Water Supply Engineering	CV	2:2:0:4	3	50	50	100	3
2.	P13CV52	Highway Engineering	CV	4:0:0:4	4	50	50	100	3
3.	P13CV53	Analysis of Structures-II	CV	4:0:0:4	4	50	50	100	3
4.	P13CV54	Geotechnical Engineering-I	CV	4:0:0:4	4	50	50	100	3
5.	P13CV55	Design of RCC Structures	CV	4:0:0:4	4	50	50	100	3
6.	P13CV56	Hydrology and Water Resources	CV	4:0:0:4	4	50	50	100	3
7.	P13CVL57	Concrete Material testing Laboratory	CV	0:0:3:3	1.5	50	50	100	3
8.	P13CVL58	Computer Aided Civil Engineering Laboratory	CV	0:0:3:3	1.5	50	50	100	3
9	P13HU59	Professional and Efficient Avocation-I (PEA-I)	HS&M	2:0:0:2	0	(50)	---	---	---
10	P13CVL510	Industry Interaction-II	CV	0:0:1:1	0	(50)	--	--	---
Total					26	400	400	800	

VI Semester B.E. . (CIVIL) SCHEME OF TEACHING AND EXAMINATION 2013-14

Sl. No	Course Code	Course Title	Teaching Dept.	Hours Pattern L:T:P:H	Credits	Examination Marks			Exam Duration in hours
						CIE	SEE	Total Marks	
1.	P13CV61	Waste Water Treatment	CV	4:0:0:4	4	50	50	100	3
2.	P13CV62	Transportation Engineering	CV	4:0:0:4	4	50	50	100	3
3.	P13CV63	Geotechnical Engineering-II	CV	4:0:0:4	4	50	50	100	3
4.	P13CV64	Irrigation Engineering and Hydraulic Structures	CV	4:0:0:4	4	50	50	100	3
5.	P13CV65	Design and Drawing of RCC Structures	CV	2:0:3:5	4	50	50	100	3
6.	P13CV66	Elective-I Group-A	CV	2:2:0:4	3	50	50	100	3
7.	P13CVL67	Geotechnical Engineering Laboratory	CV	0:0:3:3	1.5	50	50	100	3
8.	P13CVL68	Extensive Survey Viva voce	CV	0:0:3:3	1.5	50	50	100	3
9	P13HU69	Professional and Efficient Avocation-I (PEA-II)	HS&M	2:0:0:2	0	(50)	---	---	
10	P13CVL610	Mini Project-II	CV	0:0:1	0	(50)	--	--	
Total					26	400	400	800	

* PEA-I, , Industry visit and interaction-II, PEA-II, Mini Project: All students shall have to pass this mandatory learning courses before completion of VIII-Semester

L: Lecture, T: Tutorial, P: Practical, H:Hrs/Week, CIE: Continuous Internal Evaluation, SEE: Semester End Examination, C: Credits

Courses – 1 Course One Hour Lecture= Two Hours Tutorial / Practical = 1 Credit

HC: Hard Core (4Credits) -4 Courses OS: Other subject (3 Credits) – 1 Course PS: Professional subject (4Credirs)- 1Course

* List of Electives-I (Group-A)

Sl.No.	Course Code	Elective Course Title
1.	P13CV661	Matrix Method of Structural Analysis
3.	P13CV663	Ground Water Hydrology
4.	P13CV664	Municipal and Rural Sanitation
5.	P13CV665	Photogrammetric and Remote Sensing

EVALUATION SCHEME							
Scheme	**Weightage**	**Marks**	**Event Break Up**				
CIE	50%	50	**Test I**	**Test II**	**Quiz I**	**Quiz II**	**Assignment**
			35	35	5	5	10
SEE	50%	100	**Questions to Set: 10**		**Questions to Answer: 5**		
Scheme of SEE Question Paper (100 Marks)							
Duration: 3Hrs			**Marks: 100**		**Weightage: 50%**		

- Each of the two questions set shall be so comprehensive as to cover the entire contents of the unit.
- There will be direct choice between the two questions within each Unit
- Total questions to be set are 10. All carry equal marks of 20
- The number of subdivisions in each main question shall be limited to three only
- Number of questions to be answered by students is 5

Course Title : WATER SUPPLY ENGINEERING			
Course Code: P13CV51	**Semester : V**	**L-T-P-H: 2 – 2 – 0 - 4**	**Credits:3**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to:

1. Understand the importance of safe drinking water, different water demands and population forecasting methods to arrive at per capita consumption for city/town, different water sources along with intake structures and pumps to apply the knowledge to solve engineering problems
2. Summarize drinking water quality parameters and analysis (Examination) procedure for compliance with standards.
3. Explain types of aeration and to understand sedimentation, coagulation and flocculation and to apply design concepts to sedimentation units.
4. Understand different types of filtration units and disinfection types, to apply design concepts to filtration units.
5. Explain different water softening methods and to illustrate different water distribution systems

Course Content

UNIT – I

INTRODUCTION: Role of water, need for protected water supply. Types of water demands, Fire demand – estimation by different empirical formulae, Per capita consumption, population forecasting- different methods with merits & demerits, variations in demand of water, peak factors, design periods.
SOURCES: Surface and subsurface sources – suitability with regard to quality and quantity.
INTAKE STRUCTURES – Different types, factor of selection and location of intakes.
PUMPS- Necessity, types, power of pumps, Design of the economical diameter for the rising main.

12 Hrs

UNIT – II

QUALITY OF WATER: Concept of safe water, wholesomeness & palatability, water borne diseases. Examination of Water - Objectives – Physical, chemical and Microbiological Examinations, (IS: 3025 and IS: 1622). Drinking water standards- BIS &WHO guidelines. Health significance of Fluoride, Nitrates and heavy metals like Mercury, Cadmium, Arsenic etc.
WATER TREATMENT: Introduction, objectives, treatment flow-chart showing units & impurities removed. **10 Hrs**

UNIT – III

AERATION- Principles,Objectives, types of aerators.
SEDIMENTATION: Introduction, objectives, types of settling & discrete particle, factors affecting settling, Theory of settling, settling tanks-types, design of circular, rectangular tanks only.
COAGULATION AND FLOCCULATION: Coagulant aided sedimentation: objectives, common coagulants, factors affecting, jar test, chemical feeding, flash mixing, Flocculation and clari- flocculation.

10 Hrs

UNIT – IV

FILTRATION: Theory of filtration, types of filters- slow sand, rapid sand and pressure filters including construction, operation, cleaning and their design – excluding under drainage system, back washing of filters, Operational problems in filters.
DISINFECTION: Theory of disinfection, types of disinfection, Chlorination, chlorine demand, residual chlorine, use of bleaching powder. **10 Hrs**

UNIT – V

WATER SOFTENING – Definition, methods of removal of hardness by lime soda process and zeolite process.

MISCELLANEOUS TREATMENT: Removal of colour, odour, taste, adsorption technique, fluoridation and de fluoridation.

DISTRIBUTION SYSTEMS: System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems.

MISCELLANEOUS: Pipe appurtenances, various valves, type of fire hydrants, pipe fitting, Layout of water supply pipes in buildings. **10 Hrs**

TEXT BOOKS:

1. Environmental Engineering-I – B.C. Punmia & Ashok Jain. Lakshmi Publications (P) Ltd.
2. Water supply Engineering – S.K.Garg, Khanna Publishers

REFERENCE BOOKS:

1. Manual on Water supply and treatment –CPHEEO, Ministry of Urban Development, New Delhi
2. Environmental Engineering- Howard S. Peavey, Donald R. Rowe, George
3. Water & Wastewater Engineering Vol-I-- Fair, Geyer and Okun : John Willey Publishers, New York

Course Outcome (CO)

After learning all the units of the course, the student is able to

01 Outline Importance of role of water, need for protected water supply. – L1 (Unit – I)
02 Explain the Concept of safe water, wholesomeness & palatability, water borne diseases. –L2 (Unit – II)
03 Describe Principles, Objectives and types of aerators. – L1 (Unit – III)
04 Explain Theory of filtration, types of filters.– L2 (Unit – IV)
05 Explain Pipe appurtenances, various valves, type of fire hydrants, pipe fitting.– L2 (Unit – V)
06 Describe methods of removal of hardness by lime soda process and zeolite process. – L1 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

01 Explain Role of water, need for protected water supply – L2
02 Discuss per capita consumption.– L2
03 Illustrate design periods – L3
04 Examine Different types, factor of selection and location of intakes.– L4
05 Discuss the necessity of pumps. – L2
06 Explain the types and power of pumps – L2
07 Discuss the population forecasting-
08 Different methods of population forecasting-L2
09 Discuss the merits and demerits of population forecasting– L2
10 Discuss fire demand. – L2
11 Explain the Design of the economical diameter for the rising main. – L2
12 Outline the intake structures and pumps. – L1

After learning all the topics of UNIT– II, the student is able to

13 Analyze the Drinking water standards- BIS & WHO guidelines. – L4
14 Explain the Concept of safe water.– L5
15 Identify the Physical, chemical and Microbiological Examinations, (IS: 3025 and IS: 1622).– L2
16 Explain the wholesomeness & palatability, water borne diseases.– L2
17 Discuss the Health significance of Fluoride. – L2
18 Illustrate the quality of water. – L4
19 Sketch the treatment flow-chart showing units & impurities removed. – L3
20 Explain the Health significance of nitrates.– L3

21 Describe the objectives of water treatment.– L2
22 Explain the Health significance of heavy metals like Mercury, Cadmium, Arsenic etc.– L2

After learning all the topics of UNIT– III, the student is able to

23 Define Principles of Aeration.– L1
24 Explain the Objectives of Aeration.– L2
25 Describe the Theory of settling.– L2
26 Explain the types of Aerators.– L2
27 Explain objectives of sedimentation. – L3
28 Describe factors affecting settling.– L1
29 Illustrate the design of circular, rectangular tanks. – L3
30 Describe Coagulant aided sedimentation. – L3
31 Summarize common coagulants used. – L2
32 Explain the factors affecting, jar test, chemical feeding, flash mixing, Flocculation and clari-flocculator. – L2

After learning all the topics of UNIT– IV, the student is able to

33 List the types of filters and explain them. – L1
34 Describe the Theory of filtration – L2
35 Analyze the Operational problems in filters – L4
36 Discuss the slow sand, rapid sand filters. – L2
37 Discuss the pressure filters including construction, operation, cleaning and their design. – L2
38 Describe the Operational problems in filters. – L2
39 List the barriers to delegation for engineers. – L1
40 Explain the types of disinfection. – L2
41 Explain the Chlorination, chlorine demand, residual chlorine. – L2
42 Differentiate between slow sand and rapid sand filters. – L4

After learning all the topics of UNIT– V, the student is able to

43 Discuss the methods of removal of hardness by lime soda process and zeolite process. – L2
44 Summarize the fluoridation and de fluoridation.– L2
45 Analyze the service reservoir capacity determination. – L4
46 Define the Water softening. – L1
47 List the type of fire hydrants – L1
48 List the Pipe appurtenances, various valves – L1
49 Explain the Removal of colour, odorand taste. – L2
50 Discuss the Layout of water supply pipes in buildings. – L2
51 Discuss the adsorption technique. – L2
52 Explain the methods of layout of distribution systems. – L2

Review Questions

1.Define per capita demand? Discuss the factors affecting per capita demand.

2.List the different methods of population forecasting.

3.Estimate the population of a town after 3 decades from the last known decade, with the available census data using incremental increase method.

Year	1970	1980	1990	2000	2010
Population	55000	60000	72000	86000	100000

4 Compare surface and subsurface sources with respect to quality and quantity.

5. From a clear water reservoir 6m deep and maximum water level 50 m, water is to be pumped to an

elevated reservoir at 102 m at a constant rate of 0.09 million liters per day. The distance of pumping is 2.2 km. Give the economical diameter of the rising main and BHP of the pump. Neglect minor losses and take f = 0.01.

6. Give the allowable limits of following parameters for drinking water as per IS 10500.
   i) Fluoride ii) Hardness iii) Iron iv) Nitrates and v) Turbidity.
7. Define BOD and COD and mention the limitations of BOD test.
8. Explain water borne diseases with consitive organisms.
9. Explain the methods of Aeration of water with appropriate sketches.
10. With a line diagram explain the treatment of water with conventional flow chart. Mention the impurities removed in each unit.
11. Prove theoretically that the surface loading and not the depth is the measure of effective removal of particles in an ideal sedimentation tank. Mention the assumptions made in the theory.
12. Design a rectangular plain sedimentation tank for treating raw water for a town 1.5 lakh populations with average water supply of 150 LPCD. Assume suitable design details. Sketch the dimensions of the tank.
13. Explain with neat sketch, the working of a rapid sand filter.
14. Design a set of rapid sand filters to treat 50 MLD of water making 2 percent it allowance for wash water and assuming 60 minutes per day to be last in backwashing.
15. Discuss various methods of disinfection of water.
16. A town requires 5 x 10^6 liters of water. Bleaching powder with 33% available chlorine is to be used as disinfectant. Calculate the annual requirement of bleaching powder with a suggested chlorine dosage of 1.5 mg/l.
17. Write short notes on the following:
    i) Deflnoridation of water
    ii) Zeolite process of softening
18. Discuss the necessity of protected water supply.
19. Explain the factors affecting per capita consumption/demand.
20. Estimate the population of a town after three decades from the last known census data available, using incremental increase method.

Year	1965	1975	1985	1995	2005
Population	55000	60000	72000	86000	100000

21. Discuss various surface and subsurface water sources with quality and quantity.
22. Explain a reservoir intake with neat sketch.
23. From a clear water reservoir 6 m deep and maximum water level 50 m, water is to be pumped to an elevated reservoir at 102 m at a constant rate of 0.09 million liters per day. The distance is 2.2 km. Give the economical diameter of the rising main
24. Discuss briefly, different water borne diseases with causative organisms.
25. The pH of incoming and outgoing water is 6.5 and 7.8 respectively. Assuming linear variation of pH, calculate the average pH of water.
26. Explain membrane filter technique.
27. Draw a neat flow diagram indicating various stages of treatment of water with significance of each unit operation.
28. Discuss various methods of aeration.
29. Explain coagulation process and discuss various coagulates used with merits and demerits.
30. Design a rectangular sedimentation tank for treating raw water for a town of 1.5 lakh population with

average water supply of 150 LPCD. Assume suitable design details. Sketch the dimensions of the tank.
31. Explain with a neat sketch, the working of a rapid sand filter.
32. Design a set of rapid sand filter to treat 50 MLD of water making 2 percent allowance for wash water and assuming 60 minutes per day to be last for back washing.
33. Discuss various methods of disinfection of water.
34. Write a note on defluoridation.
35. Explain Zeolite softening process.
36. Explain with neat sketch, layout of distribution of water.
37. Explain five hydrants.
38. Discuss two systems of water supply.
39. Write short notes on the following: i) Methods of layout of distribution systems. ii) Fire hydrant.
39. Write short notes on the following: i) Typical layout of water supply pipes in buildings. ii) Air relief valve.
40. Differentiate between lime soda and zeolite process.

Lesson Plan

UNIT – I

01 Role of water, need for protected water supply
02 Discuss per capita consumption
03 Design periods
04 Different types, factor of selection and location of intakes
05 Necessity of pumps
06 Types and power of pumps
07 Population forecasting
08 Different methods of population forecasting
09 Merits and demerits of population forecasting
10 Fire demand
11 Design of the economical diameter for the rising main
12 Intake structures and pumps

UNIT – II

13 Drinking water standards- BIS & WHO guidelines.
14 Concept of safe water.
15 Physical, chemical and Microbiological Examinations, (IS: 3025 and IS: 1622)
16 Wholesomeness & palatability, water borne diseases
17 Health significance of Fluoride
18 Quality of water
19 Treatment flow-chart showing units & impurities removed
20 Health significance of nitrates
21 Objectives of water treatment
22 Health significance of heavy metals like Mercury, Cadmium, Arsenic etc.,

UNIT – III

23 Principles of Aeration
24 Objectives of Aeration
25 Theory of settling
26 Types of Aerators
27 Objectives of sedimentation
28 Factors affecting settling

29 Design of circular, rectangular tanks
30 Coagulant aided sedimentation
31 Common coagulants used
32 Factors affecting, jar test, chemical feeding, flash mixing, Flocculation and clari- flocculator

UNIT – IV

33 Types of filters and explain them
34 Theory of filtration
35 Operational problems in filters
36 Slow sand, rapid sand filters
37 Pressure filters including construction, operation, cleaning and their design
38 Operational problems in filters
39 Barriers to delegation for engineers
40 Types of disinfection
41 Chlorination, chlorine demand, residual chlorine
42 Slow sand and rapid sand filters

UNIT – V

43 Methods of removal of hardness by lime soda process and zeolite process
44 Fluoridation and de fluoridation
45 Service reservoir capacity determination
46 Water softening
47 Type of fire hydrants
48 Pipe appurtenances, various valves
49 Removal of colour, odor and taste
50 Layout of water supply pipes in buildings
51 Adsorption technique
52 Methods of layout of distribution systems

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Outline Importance of role of water, need for protected water supply. – (Unit – I)	L1	M	M	L								
02	Explain the Concept of safe water, wholesomeness & palatability, water borne diseases.–(Unit – II)	L2	M	H									
03	Describe Principles, Objectives, and types of aerators. –(Unit – III)	L1	M	M	L								
04	Explain Theory of filtration, types of filters. – (Unit – IV)	L2	M	H									
05	Explain Pipe appurtenances, various valves, type of fire hydrants, pipe fitting .–(Unit – V)	L2	M	M	L								
06	Describe methods of removal of hardness by lime soda process and zeolite process. –(Unit – V)	L1	M	L									
L-Low, M-Moderate, H-High													

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**B**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Outline Importance of role of water, need for protected water supply. – (Unit – I)	L1	1	2	1								
02	Explain the Concept of safe water, wholesomeness & palatability, water borne	L2	2	3									
03	Describe Principles, Objectives, and types of aerators. –(Unit – III)	L1	2	2	1								
04	Explain Theory of filtration, types of filters. – (Unit – IV)	L2	2	1									
05	Explain Pipe appurtenances, various valves, type of fire hydrants, pipe fitting .–(Unit – V)	L2	2	2	3								
06	Describe methods of removal of hardness by lime soda process and zeolite process. –(Unit – V)	L1	2	3									
1-Low, 2-Moderate, 3-High													

Course Title : HIGHWAY ENGINEERING			
Course Code: P13CV52	**Semester : V**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Importance of Transportation and Different modes of transportation.
2. Importance of Roads in India and Current Road development programmes in India.
3. Importance of Geometric Design, Design control and criteria.
4. Highway cross section elements - Cross slope or Camber, Medians, Carriageway, Kerbs, Road Margins, Cross section details.
5. Steps for construction of a New Highway, Design and Construction of highway embankment.
6. Construction of sub-grade, Construction of WBM base course.
7. Object of Highway Pavements, Requirements of Highway Pavements.
8. Types of Pavement Structures and comparisons & their limitations.
9. Importance of Highway maintenance works.
10. Failures in different flexible pavement layers.

Course Content

UNIT – I

PRINCIPLES OF TRANSPORTATION ENGINEERING, HIGHWAY DEVELOPMENT & PLANNING: Importance of Transportation. Different modes of transportation, characteristics and comparison of different modes. Importance of Roads in India, Scope of Highway Engineering, Road development in India during 20^{th} and 21^{st} century, Highway Planning, Classification of Roads, Planning surveys and Interpretations, Determination of optimum road length by Saturation system, Third twenty years road development plan (Problems), Highway alignment, Engineering surveys for Highway alignment, Highway Projects, Detail Project Report (DPR). **10 Hrs**

UNIT – II

GEOMETRIC DESTIGN OF HIGHWAYS: Importance of Geometric Design, Design control and criteria, Highway cross section elements - Cross slope or Camber, Medians, Carriageway, Kerbs, Road Margins, Cross section details, Right of way, Sight Distance, Stopping Sight Distance (SSD), Overtaking Sight Distance (OSD), Design of HorizontalAlignment - Design Speed, Horizontal curves, Super elevation, Widening of Pavement on Horizontal Curves, Transition Curves, Design of Vertical alignment – Gradient, Vertical Curves, Summit Curves, Valley Curves. Problems on above. **10 Hrs**

UNIT – III

HIGHWAY MATERIALS AND HIGHWAY CONSTRUCTION: Materials used in Highway Construction, Soil Compaction, CBR test, Stone Aggregates, Properties and tests, Bituminous Binders-Types, Functions and tests, Bitumen Emulsion, Portland cement and Cement concrete. Bituminous Paving Mixes, Bituminous Mix Design by Marshall Method. Highway constructions – Typical components of Highway Pavement, Steps for construction of a New Highway, Design and Construction of Highway Embankment and Sub-grade, Methods of Soil compaction, Construction of Flexible Pavements, Component of flexible pavements, Construction of Wet Mix Macadam base, Construction of WBM base course, Prime coat, Tack Coat, CC Pavements – General features of plain and reinforced CC Pavements, Component of CC Pavement and their functions, Construction method using slip-form pavers, construction using fixed form and mechanized technique. **12 Hrs**

UNIT – IV

DESIGNOF HIGHWAY PAVEMENTS: Object of Highway Pavements, Requirements of Highway Pavements, Types of Pavement Structures and comparisons & their limitations, Flexible/Rigid Pavements – Components and their functions, Factor affecting design and performance of Flexible/Rigid pavements, Design Methods: Flexible pavements design methods – CBR method of Pavement design, Pavement design as per IRC guidelines, Types of joints in CC pavements and their functions, Rigid Pavement Design methods – using stress equations, as per IRC guidelines, Design Problems. **10 Hrs**

UNIT – V

HIGHWAY MAINTENANCE AND HIGHWAY DRAINAGE: Importance and Objectives of Highway maintenance works, Pavement Deterioration and Damages in Road Infrastructures, Classification of Highway maintenance works, Distress in Flexible and Rigid pavements and Maintenance Measures, Highway Drainage- Objects of Highway drainage, requirements and importance, Surface drainage system and design, Cross Drainage Structures, Sub-surface drainage system, Design of Filter Material, Drainage of Slopes and Erosion Controls, Road construction in water-logged areas. Design problems. **10 Hrs**

TEXT BOOK:

1. Highway Engineering – S.K. Khanna, C.E.G Justo, and A.Veeraragavan, Nem Chand and Bros, Roorkee, Revised 10th Edition.
2. Highway Engineering- Kadiyali, L.R., Khanna Publishers, New Delhi.
3. Traffic Engineering and Transport Planning – L.R. Kadiyali, Khanna Publishers, New Delhi.
4. Transportation Engineering – Subramanyam, K.P., Scitech Publications, Chennai

REFERENCE BOOKS:

1. Relevant IRC codes
2. Principles of Transportation Engineering- Partha Chakra Borthy, Prentice- Hall.
3. Specifications for Roads and Bridges- MoRT&H, IRC, New Delhi

Course Outcomes

After learning all the units of the course, the student is able to

01 Explain the principles of transportation engineering, highway development & planning. – L2 (Unit – I)
02 Describe the geometric design of highways. – L1 (Unit – II)
03 Explain the highway materials and highway construction. – L2 (Unit – III)
04 Design of highway pavements– L2 (Unit – IV)
05 Discuss about highway maintenance and highway drainage. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Describe the importance of transportation and different modes of transportation-L1
2. Explain the characteristics and comparison of different modes-L2
3. Importance of Roads in India and Current Road development programmes in India-L2
4. Explain the scope of Highway Engineering-L1
5. Describe the road development in India during 20th and 21st century-L1
6. Define highway planning-L2
7. Explain the Classification of Roads-L2
8. Describe the planning surveys and Interpretations-L1
9. Determination of optimum road length by Saturation system-L3
10. Define third twenty years road development plan, Road development plan vision 2021-L2
11. Explain Highway alignment, engineering surveys for Highway alignment-L2

12. Describe Detail Project Report (DPR)-L1

After learning all the topics of UNIT– II, the student is able to

13. Importance of Geometric Design, Design control and criteria.-L2
14. Explain the highway cross section elements.-L1
15. Define Sight Distance, Stopping Sight Distance (SSD).-L2
16. Describe Overtaking Sight Distance (OSD).-L1
17. Design of Horizontal Alignment.-L2
18. Design of Vertical alignment.-L2
19. Problems on above.-L4
20. Scope of Traffic Engineering and traffic characteristics.-L2
21. Explain Highway Drainage, objects of Highway drainage, requirements and importance.-L2
22. Define Surface drainage system and design, Sub-surface drainage system.-L2

After learning all the topics of UNIT– III, the student is able to

23. Describe the significance of soil as Highway material.-L1
24. Define soil compaction, Method of Compaction, CBR test.-L2
25. Define stone Aggregates its functions and desirable properties.-L2
26. Describe bituminous binders, types and characteristics of bituminous binder.-L1
27. Explain the properties of Portland cement and cement concrete.-L1
28. Describe highway constructions – typical components of Highway Pavement.-L1
29. Define the Steps for construction of a New Highway.-L2
30. Design and construction of highway embankment.-L2
31. Describe the Component of CC Pavement and their functions.-L1
32. Define the materials for construction of CC Pavements.-L2

After learning all the topics of UNIT– IV, the student is able to

33. Explain the requirements of highway pavements.-L1
34. Explain the different types of pavement structures and comparisons.L1
35. Define flexible Pavements, components and their functions.-L2
36. Explain the factor affecting design and performance of flexible pavements.-L1
37. Describe Pavement design as per IRC guidelines. L1
38. Define Rigid Pavements, components and their functions. L2
39. Explain the different types of joints in CC pavements and their functions. L1
40. Explain the factor affecting design. L1
41. Describe the performance of CC pavements.L1
42. Describe the rigid pavement design methods. L1

After learning all the topics of UNIT– V, the student is able to

43. Describe the importance of highway maintenance works. L2
44. Define the objectives of Highway maintenance. L2
45. Describe the classification of Highway maintenance works. L2
46. Explain thecauses of distress in Flexible and Rigid pavements .L2
47. Define the Maintenance requirement in different road components. L2
48. Explain the Failures in different flexible pavement layers. L2
49. Define the Patching of pot-hole. L2
50. Define Failure of CC pavement due to mud pumping. L2
51. Explain the objects and requirements of Highway drainage. L2
52. Define the Surface and sub-surface drainage system. L2

Review Questions

1.	What are the different modes of transportation? Explain the specific functions of each of them.
2.	What are the significant recommendations of Jayakar Committee report?
3.	What are the various surveys to be carried out before planning a highway system for a given area? Explain briefly.
4.	What are the major policies and objectives of Third 20-year road development plan?
5.	Explain with sketches the various factors controlling the alignment of roads.
6.	Write a note on 'Road Development Plan Vision 2021'.
7.	What are the design factors which controls the geometric elements? Explain briefly
8.	Explain camber. What are the objects and different shapes of camber?
9.	State the factors affecting friction or skid resistance.
10.	With sketches indicate where the sight distances get restricted on highways.
11.	The speeds of overtaking and overtaken vehicles are 70 km-ph and 40 km-ph respectively. If the acceleration of overtaking vehicle is 3.6 km-ph, calculate the safe overtaking sight distance. Draw a neat sketch of overtaking zone indicating with necessary details.
12.	Calculate the extra width of pavement required on a horizontal curve of radius 250 m on a two lane highway, the design speed being 70 km-ph. Assume wheel base = 7m
13.	Explain CBR and the test procedure for laboratory and field tests.
14.	What are the various tests carried out on the bitumen and their uses of each test?
15.	Write down the construction steps for Water Bound Macadam road.
16.	Discuss the importance and requirements of a good highway drainage system?
17.	Explain with neat sketches how the subsurface drainage system is provided to lower the water table, control of seepage flow and capillary rise.
18.	Write a note on: i) Maintenance of Highways ii) Pavement Evaluation
19.	What are the various types of failures in flexible and rigid pavement? Explain the causes.
20.	What are the factors to be considered while selecting the site for a proposed bridge?
21.	What are the substructures of bridge? Mention its functions with neat diagram
22.	Define culvert and draw a neat diagram of different types of culverts.
23.	Outline and discuss the scope of the highway Engineering study.
24.	Explain the Nagpur Road Plan classification of roads in India based on location and function.
25.	Describe the highway planning Surveys.
26.	What are the factors which control the highway alignment? Explain.
27.	Explain the necessity of Re-alignment Project.
28.	Write a note on Road Development Plan Vision 2012
29.	Write a note onPMGSY
30.	What are the factors affecting Skid resistance.
31.	Explain Pavement unevenness and how it is caused.
32.	Explain the following width of pavement or Carriageway
33.	Explain the following cross slope or Camber
34.	Calculate the super-elevation to be provided for a horizontal curve with a radius of 400 m for a design speed of 100 km-ph in Plain terrain. What is the coefficient of lateral friction mobilized if super-elevation is restricted to 0.07?
35.	Find the total width of Pavement of a horizontal Curve for a new N.H. to be aligned along a terrain with a ruling minimum radius. Assume v = 80 km-ph, w = 7.0, n = 2, l = 6 m, f = 0.15, e = 0.07.
36.	How do you determine length of Summit Curve and length of Valley Curve?
37.	Explain CBR and test Procedure for evaluating CBR in the laboratory.
38.	What are the properties and requirements of Road aggregates?
39.	Write down the construction steps for Water Bound Macadam Road.

40.	Explain the steps involved in the design of surface drainage system.
41.	Explain the method of controlling seepage flow.
42.	What are the methods to be adopted for Road Construction in water-logged area?
43.	What are the factors to be considered for evaluating vehicle operation cost?
44.	What are the common types of failures in flexible pavements?
45.	Write a note on Pavement Evaluation.
46.	What are the general causes of pavement failures?
47.	What are the factors to be considered while selecting site for a Bridge?
48.	What are the various types of Bridges? Indicate their suitability.
50.	Define the objectives of Highway maintenance?
51.	Define flexible Pavements, components and their functions?
52.	Define Rigid Pavements, components and their functions?

Lesson Plan

UNIT – I

1. Importance of Transportation. Different modes of transportation.
2. Characteristics and comparison of different modes.
3. Importance of Roads in India, Current Road development programmes in India
4. Scope of Highway Engineering.
5. Road development in India during 20^{th} and 21^{st} century.
6. Highway planning, Classification of Roads,
7. Planning surveys and Interpretations.
8. Determination of optimum road length by Saturation system,
9. Third twenty years road development plan,
10. Road development plan vision 2021, Highway alignment.

UNIT – II

11. Importance of Geometric Design, Design control and criteria,
12. Highway cross section elements - Cross slope or Camber, Medians
13. Sight Distance,
14. Stopping Sight Distance (SSD).
15. Overtaking Sight Distance (OSD),
16. Design of Horizontal Alignment – Design Speed
17. Horizontal curves,
18. Superelevation,
19. Widening of Pavement on Horizontal Curves,
20. Transition Curves.

UNIT – III

22. Soil-Significance of soil as Highway material, properties, Soil compaction, Method of Compaction,
23. Stone Aggregates – Functions, desirable properties,.
24. Bituminous Binders- Types and Characteristics of Bituminous binder, Functions, desirable properties.
25. Portland cement and Cement concrete.
26. Highway constructions – typical components of Highway Pavement.
27. Steps for construction of a New Highway, Design and Construction of highway embankment.
28. Construction of sub-grade, Construction of WBM base course.
29. Bituminous Macadam base course, Bitumen mastic wearing course.
30. CC Pavements – General features of plain and reinforced CC Pavements.
31. Component of CC Pavement and their functions.
32. Materials for construction of CC Pavements, construction method using slip-form paver.
33. Construction using fixed form and mechanized technique

UNIT – IV

34. Object of Highway Pavements, Requirements of Highway Pavements.
35. Types of Pavement Structures and comparisons & their limitations.
36. Flexible Pavements – Components and their functions.
37. Factor affecting design and performance of flexible pavements, Flexible pavements design methods
38. Pavement design as per IRC guidelines.
39. Rigid Pavements – Components and their functions.
40. Types of joints in CC pavements and their functions.
41. Factor affecting design and performance of CC pavements.
42. Rigid Pavement Design methods – using stress equations, as per IRC guidelines.
43. Design Problems.

UNIT – V

44. Importance of Highway maintenance works,
45. Objectives of Highway maintenance,
46. Classification of Highway maintenance works,
47. Causes of distress in Flexible and Rigid pavements,
48. Maintenance requirement in different road components,
49. Failures in different flexible pavement layers,
50. Patching of the pot-hole,
51. Failure of CC pavement due to mud pumping,
52. Objects and requirements of Highway drainage
53. Surface and sub-surface drainage system, Design of Filter Material

Course Articulation Matrix(CAM)

Sl. No	Course Outcome – CO	Program outcome(ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the principles of transportation engineering, highway development & planning. – (Unit – I)	L2	**L**	**M**	**H**								
02	Describe the geometric design of highways. – (Unit – II)	L1	**L**	**M**	**H**								
03	Explain the highway materials and highway construction.– (Unit – III)	L2	**L**	**M**	**H**								
04	Design of highway pavements. – (Unit – IV)	L2	**L**	**M**									
05	Discuss about highway maintenance and highway drainage – (Unit – V)	L2	**L**	**M**	**H**								

L-Low, M-Moderate, H-High

Course Assessment Matrix(CAM)

Sl. No	Course Outcome – CO	Program outcome(ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the principles of transportation engineering, highway development & planning. – (Unit – I)	L2	**1**	**2**	**3**								
02	Describe the geometric design of highways. – (Unit – II)	L1	**1**	**2**	**3**								
03	Explain the highway materials and highway construction.– (Unit – III)	L2	**1**	**2**	**3**								
04	Design of highway pavements. – (Unit – IV)	L2	**1**	**2**									
05	Discuss about highway maintenance and highway drainage – (Unit – V)	L2	**1**	**2**	**3**								

1-Low, 2-Moderate, 3-High

Course Title : ANALYSIS OF STRUCTURES -II			
Course Code: P13CV53	**Semester : V**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Categorise the structures on the basis of Static and Kinematic Indeterminacies.
2. Energy concept in dealing the indeterminate Pin jointed plane frames,Castigliono's Theorems.
3. Understanding the importance of Force and Deformation methods in analysing the Indeterminate Structures.
4. Analysing Beams and Rigid jointed Plane frames, orthogonal, manually, unknowns<=3, using Slope-Deflection ,Moment Distribution and Kani's Methods.
5. Introducing the analysis of Indeterminate Structures using Matrix methods,system approach only.
6. Analysing plane truss,continuous beams and plane frames, manually, unknowns<=3, using flexibility and stiffness matrix methods.

Course Content

UNIT – I

INDETERMINATE TRUSS ANALYSIS: Analysis of indeterminate trusses by Strain Energy Method, using Castiglione's theorem with static indeterminacy ≤3. **08Hrs**

UNIT – II

SLOPE DEFLECTION METHOD : Introduction, sign convention, Development of Slope-deflection equations and Analysis of Beams and Orthogonal Rigid jointed plane frames (non-sway and sway) with kinematic redundancy less than or equal to three. (Members to be axially rigid)

10 Hrs

UNIT – III

MOMENT DISTRIBUTION METHOD: Introduction, Definition of terms – Distribution factor, Development of method and Analysis of beams and orthogonal rigid jointed plane frames (non-sway and sway) with kinematic redundancy less than/equal to three (Members to be axially rigid).

10 Hrs

UNIT – IV

KANI'S METHOD: Introduction, Basic Concept, Analysis of Continuous beams and Analysis of orthogonal rigid jointed non-sway plane frames.Analysis of rigid jointed plane frame with symmetry considerations, non-sway frames. Analysis of rigid jointed plane frames sway due to vertical and horizontal loadings. **10 Hrs**

UNIT – V

FLEXIBILITY MATRIX METHOD OF ANALYSIS: System Approach-Introduction, Development of flexibility matrix for plane truss element and continuous beams and Analysis of plane truss and continuous beams by flexibility method with static indeterminacy ≤.3.

STIFFNESS MATRIX METHOD OF ANALYSIS: System Approach-Introduction, Development of stiffness matrix for plane truss and continuous beams elements. Analysis of plane truss and continuous beams by stiffness method with kinematic indeterminacy less than or equal to three. **14 Hrs**

TEXT BOOK:

1. Basic Structural Analysis – Reddy C.S. – Second Edition, Tata McGraw Hill Publication Company Ltd.
2. Theory of Structures Vol. 2 – S.P. Gupta, G.S. Pandit and R. Gupta, Tata McGraw Hill Publication Company Ltd.
3. Structural Analysis-II – S.S. Bhavikatti – Vikas Publishers, New Delhi.

REFERENCE BOOKS:

1. Indeterminate Structural Analysis – J. Sterling Kinney, Oxford and IBH Publishing Co.
2. Elementary Structural Analysis- Noris C.H., Wilbur J. B., McGraw Hill International Book Edition.
3. Advanced Structural Analysis- Ashok K. Jain., Nem Chand & Bros., Roorkee. India.
4. Structural Analysis- D.S. Prakash Rao., A Unified Approach, University Press.
5. Intermediate Structural Analysis- C.K. Wang., McGraw Hill Publications.

Course Outcome

After learning all the units of the course, the student is able to

1. Derive Strain energy method & Castiglione's theorems. – L2 (Unit – I)
2. Explain concept and deriving the slope-deflection equation. – L2 (Unit – II)
3. Explain the steps for analysis of structure by moment distribution method. – L2 (Unit – II)
4. Analyse the continuous beam by Kani's method. – L2 (Unit – III)
5. Define Relative stiffness factor, distribution factor and rotation factor. – L2 (Unit – IV)
6. Compute of flexibility influence coefficients and flexibility matrix.– L3 (Unit –V)

Topic Learning Outcome

After learning all the topics of UNIT– I, the student is able to

1. Derivation of Strain energy method & Castiglione's theorems.-L3
2. Analysis of indeterminate trusses using Castiglione's 2nd theorem with static indeterminacy (<3)-L4

After learning all the topics of UNIT– II, the student is able to

3. Explains the concept and deriving the slope-deflection equation.-L2
4. States the sign convention used in slope deflection method.-L1
5. Analyse the beam with kinematic indeterminacy less than three. –L3
6. Analyse the beam with kinematic indeterminacy equal to three. –L3
7. Analyse the orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three.-L3
8. Analyse the orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three.-L3
9. Analyse the orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy equal to three.-L3
10. Analyse the orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy less than three.-L3
11. Analyse the orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy equal to three.-L3

After learning all the topics of UNIT– III, the student is able to

12. Explains the steps for analysis of structure by moment distribution method.-L1
13. Define Relative stiffness factor.-L1
14. Define distribution factor.-L1
15. Analyse the beam with kinematic indeterminacy less than three by moment distribution method.-L3
16. Analyse the beam with kinematic indeterminacy equal to three by moment distribution method.-L3

17. Analyse the orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three by moment distribution method.-L3
18. Analyse the orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy equal to three by moment distribution method.-L3
19. Analyse the orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy less than three by moment distribution method.-L3
20. Analyse the orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy equal to three by moment distribution method.-L3

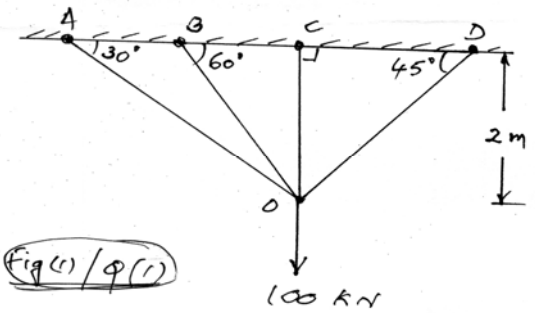
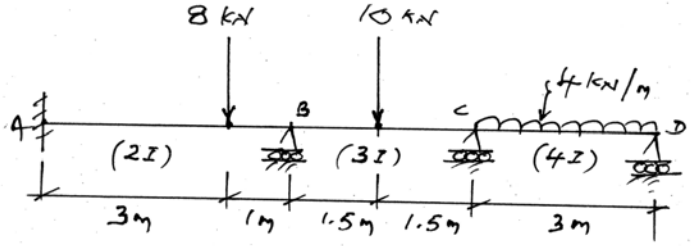
After learning all the topics of UNIT– IV, the student is able to

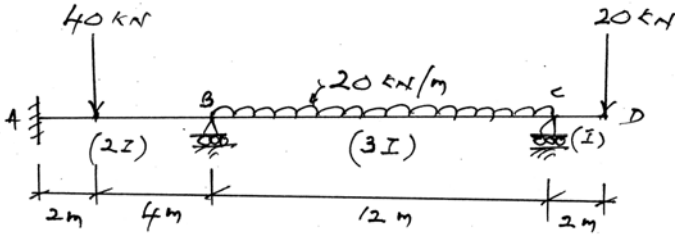
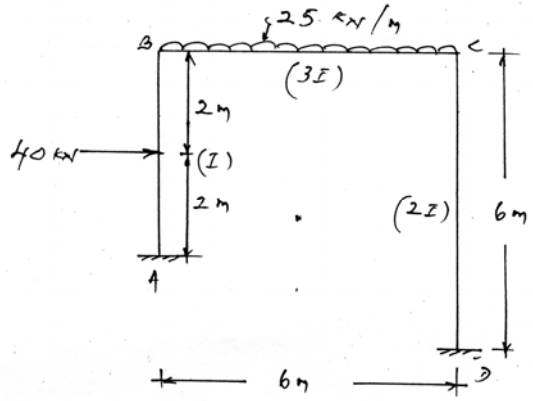
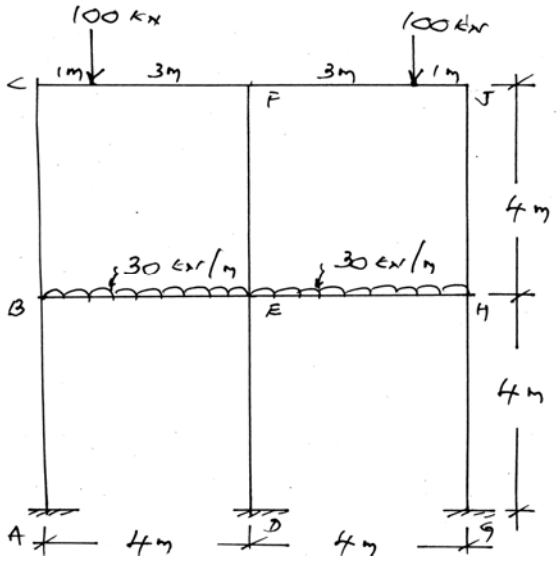
21. Explain the basic concept of analysis of structures by Kani's method.-L1
22. Define Relative stiffness factor.-L1
23. Define distribution factor.-L1
24. Define rotation factor.-L1
25. Analyse the continuous beam by Kani's method.-L3
26. Analyse the rigid jointed plane frames (non-sway) by Kani's method.-L3
27. Analyse the rigid jointed plane frames (sway) by Kani's method.-L3

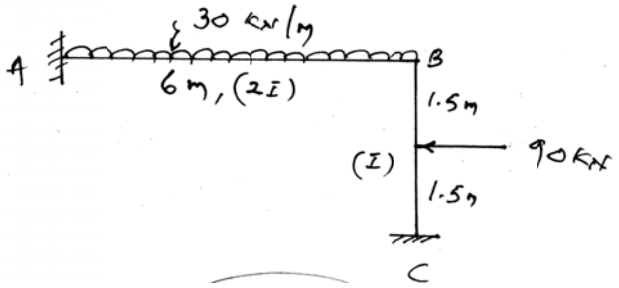
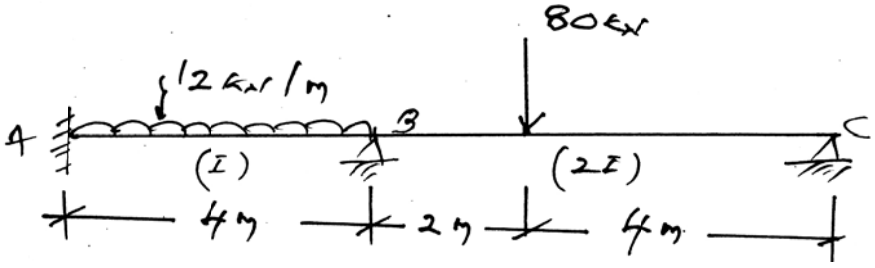
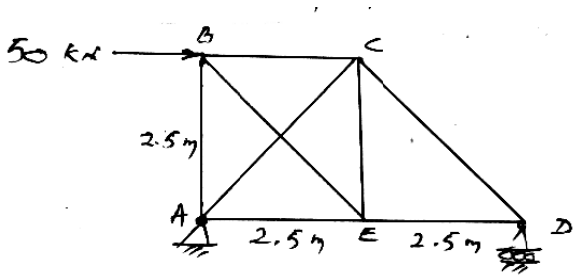
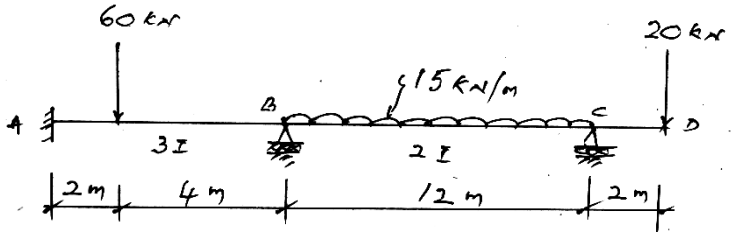
After learning all the topics of UNIT– V, the student is able to

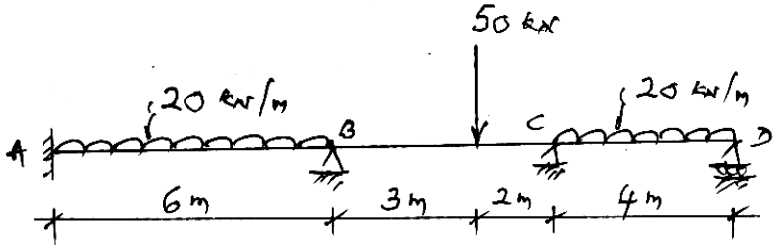
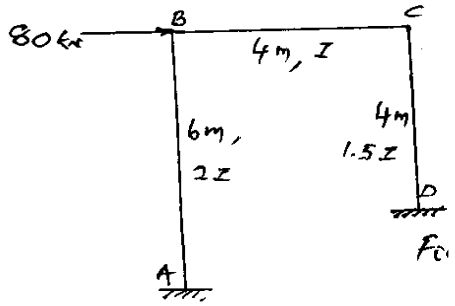
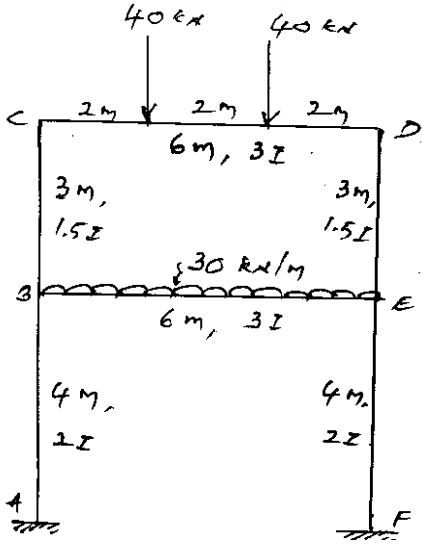
28. Define Flexibility matrix method of analysis.-L1
29. Development of flexibility matrix for plane truss element and continuous beams.-L2
30. Analysis of plane truss and continuous beams by flexibility method with static indeterminacy ≤.3.-L2
31. Define Stiffness matrix method of analysis.-L1
32. Development of stiffness matrix for plane truss and continuous beams elements.-L2
33. Analysis of plane truss by stiffness method with kinematic indeterminacy less than three.-L3
34. Analysis of plane truss by stiffness method with kinematic indeterminacy equal to three.-L3
35. Explain Continuous beams by stiffness method with kinematic indeterminacy less than three.-L1
36. Explain Continuous beams by stiffness method with kinematic indeterminacy equal to three.-L1

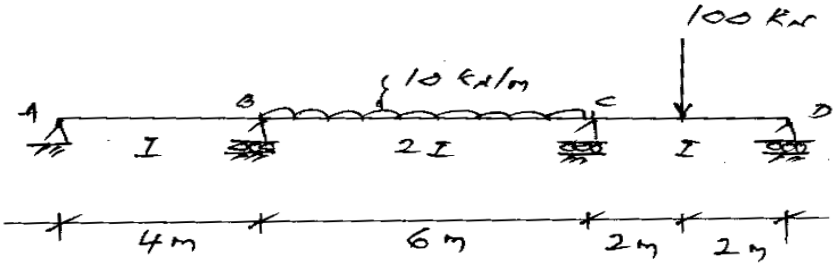
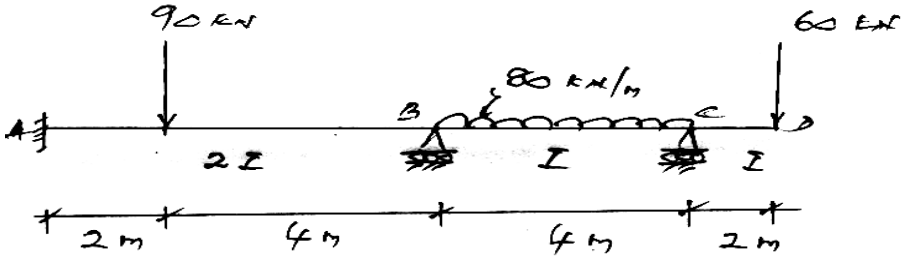
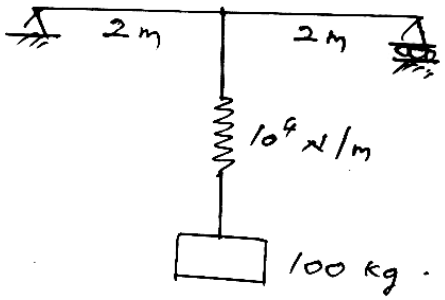
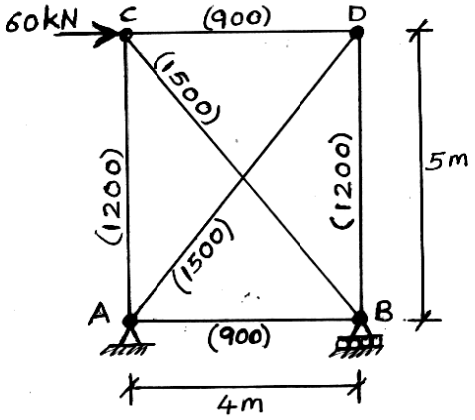
Review Questions

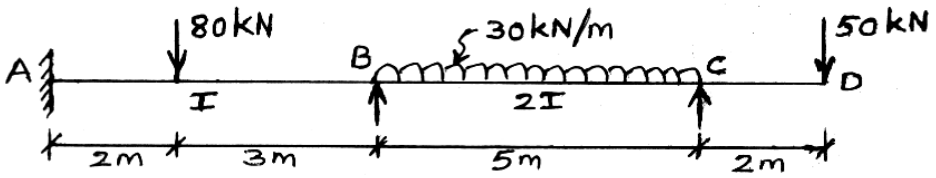
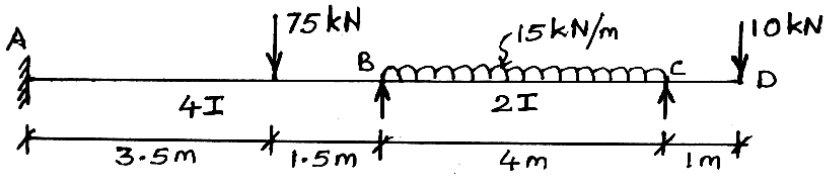
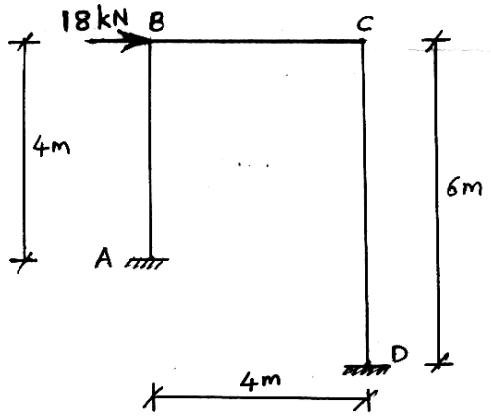
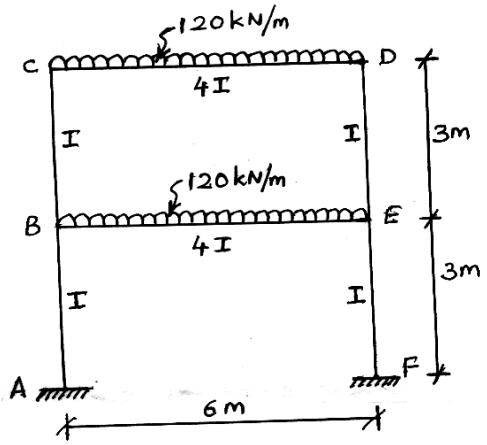
1	Analyze the pin-jointed plane frame shown in figure. Take AE is same for all the members.  Fig (1) / Q (1)
2	Analyze the continuous beam shown in figure by slope deflection method. Draw BMD and SFD. 

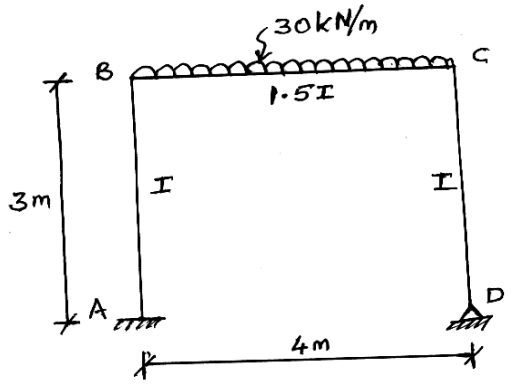
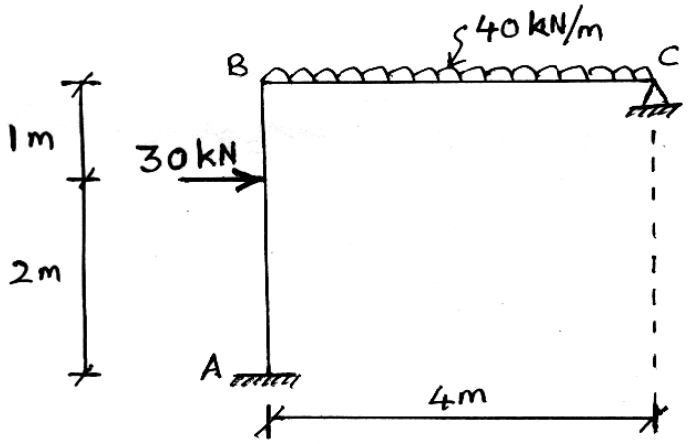
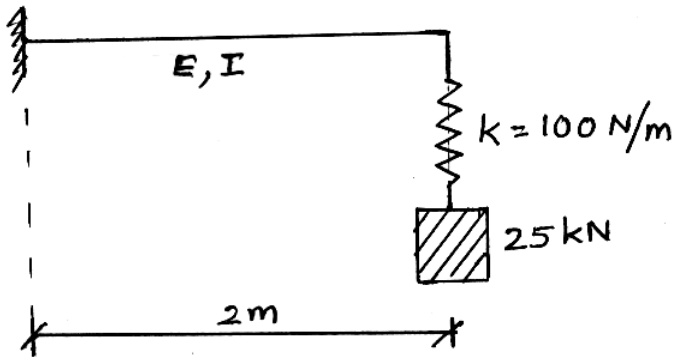
3	Analyze the continuous beam shown in figure if support B sinks by 5 mm downwards, using moment distribution method. Draw BMD and elastic curve. Take E = 200 GP_a, I = $2.4*10^8$ mm^4 
4	Analyze the frame shown in figure by moment distribution method. Draw BMD and elastic curve. 
5	Analyze the frame shown in figure by Kani's method. Use advantage of Symmetry. Draw the BMD. Assume EI constant. 

6	Analyze the frame shown in figure byflexibility matrix method. Draw BMD and SFD. 
7	Analanalyze the continuous beam shown in figure by stiffness matrix method. Draw BMD and SFD. 
8	Explain Natural Frequency.
9.	A simply supported beam of span *l* with flexural rigidity EI is carrying a weight W at the center of the span. Compute the natural period and natural frequency.
10.	Explain Period of Vibration
11.	Find the forces in the members of the Pin jointed plane frame shown in figure AE = Constant. 
12.	Analyse the continuous beam shown in figure, using slope–deflection method. Drawn SFD, BMD, and elastic curve. 

13.	Analyse the continuous beam shown in figure using moment distribution method. The support B sinks by 10 mm. Draw BMD and elastic curve. Take E = $2x10^5$ N/mm^2 and I = $1.20x10^{-4}m^4$. 
14.	Analyse the frame shown in figure by moment distribution method. Draw BMD and elastic curve. 
15.	Analyse the frame shown in figure using Kani's method. Take the advantage of symmetry. Draw BMD. 
16.	Define D'Alembert's Principle.
17.	Define Degrees of freedom.
18.	Define Damping.
19.	Define Free vibration.

20.	Analyse the continuous beam shown in figure using Flexibility matrix method. Draw SFD and BMD. 
21.	Analyse the continuous beam shown in figure using stiffness matrix method. Draw BMD and Elastic curve. 
22.	Determine the natural frequency of the system shown in figure Take EI = 10^4 Nm^2 
23.	Find the forces in the members of the pin – jointed plane truss shown in figure. The sectional areas of members in mm^2 are given in parenthesis. 

24.	Analyze the continuous beam shown in figure by slope deflection method. Sketch BMD, SFD and elastic curve 
25.	Analyze the continuous beam shown in figure by moment distribution method. Sketch BMD, SFD and elastic curve. 
26.	Analyze the portal frame shown in figure by slope deflection method. All members have same flexural rigidity. Sketch BMD and elastic curve. 
27.	Analyze the portal frame shown in figure by Kani's method. Take advantage of symmetry. Sketch the BMD. 

28.	Analyze the frame shown in figure by flexibility method. Sketch BMD and elastic curve. 
29.	Analyse the frame shown in figure by stiffness method. Sketch BMD and elastic curve. 
30.	Explain Free vibration
31.	Explain Periodic motion
32.	Explain harmonic motion
33.	Explain natural period
34.	Obtain the natural frequency of the system shown in figure, Assume; E = 200 GPa and I = $86x10^6$ mm^4 

Lesson Plan

UNIT – I

1. Derivation of Strain energy method
2. Derivation of Castiglione's theorems
3. Analysis of indeterminate trusses using Castiglione's 2nd theorem with static indeterminacy (<3)

UNIT – II

4. Concept and deriving the slope-deflection equation.
5. Sign convention used in slope deflection method.
6. Beam with kinematic indeterminacy less than three.
7. Beam with kinematic indeterminacy equal to three.
8. Orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three.
9. Orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three.
10. Orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy equal to three.
11. Orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy less than three.
12. Orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy equal to three.

UNIT – III

13. Steps for analysis of structure by moment distribution method.
14. Relative stiffness factor.
15. Distribution factor.
16. Beam with kinematic indeterminacy less than three by moment distribution method.
17. Beam with kinematic indeterminacy equal to three by moment distribution method.
18. Orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy less than three by moment distribution method.
19. Orthogonal rigid jointed plane frames (non-sway) with kinematic indeterminacy equal to three by moment distribution method.
20. Orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy less than three by moment distribution method.
21. Orthogonal rigid jointed plane frames (sway) with kinematic indeterminacy equal to three by moment distribution method.

UNIT – IV

22. Basic concept of analysis of structures by Kani's method.
23. Relative stiffness factor.
24. Distribution factor.
25. Rotation factor.
26. Continuous beam by Kani's method.
27. Rigid jointed plane frames (non-sway) by Kani's method.
28. Rigid jointed plane frames (sway) by Kani's method.

UNIT – V

29. Flexibility matrix method of analysis.
30. Flexibility matrix for plane truss element and continuous beams.
31. Plane truss and continuous beams by flexibility method with static indeterminacy ≤.3.
32. Stiffness matrix method of analysis.
33. Stiffness matrix for plane truss and continuous beams elements.
34. Plane truss by stiffness method with kinematic indeterminacy less than three.
35. Plane truss by stiffness method with kinematic indeterminacy equal to three.
36. Continuous beams by stiffness method with kinematic indeterminacy less than three.
37. Continuous beams by stiffness method with kinematic indeterminacy equal to three.

Course Articulation Matrix(CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Derive Strain energy method & Castiglione's theorems. (Unit – I)	L2	L	M	H								
02	Explain concept and deriving the slope-deflection equation. (Unit – II)	L2	L	M	H								
03	Explain the steps for analysis of structure by moment distribution method. (Unit – II)	L2	L	M	H								
04	Analyse the continuous beam by Kani's method.(Unit – III)	L2	L	M									
05	Define Relative stiffness factor, distribution factor and rotation factor. (Unit – IV)	L2	L	M	H								
06	Compute of flexibility influence coefficients and flexibility matrix. (Unit – V)	L3	L	M									

L-Low, M-Moderate, H-High

Course Assessment Matrix(CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Derive Strain energy method & Castiglione's theorems. (Unit – I)	L2	1	2	3								
02	Explain concept and deriving the slope-deflection equation. (Unit – II)	L2	1	2	3								
03	Explain the steps for analysis of structure by moment distribution method. (Unit – II)	L2	1	2	3								
04	Analyse the continuous beam by Kani's method. (Unit – III)	L2	1	2									
05	Define Relative stiffness factor, distribution factor and rotation factor. (Unit – IV)	L2	1	2	3								
06	Compute of flexibility influence coefficients and flexibility matrix. (Unit – V)	L3	1	2									

1-Low, 2-Moderate, 3-High

Course Title : GEOTECHNICAL ENGINEERING-I			
Course Code: P13CV54	**Semester : V**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Prerequisite course for

The student should have the knowledge of Engineering Mechanics,Strength of Materials ans Analysis of Structures I.

Course Learning Objectives (CLOs)

This course aims to know

1. History of soil mechanics, origin and formation of soil.
2. Clay mineralogy and soil structure, soil as three phase systemand inter relationship
3. Index properties and their determination, classification of soil.
4. Flow of water through soils, compaction of soils.
5. Effective stress concept and consolidation of soil.

Course Contents

UNIT– I

INTRODUCTION: History of soil mechanics, origin and formation of soil.

CLAY MINERALOGY AND SOIL STRUCTURE- Primary and Secondary valence forces, clay mineral structure, common clay minerals in soils – Kaolinite-Illite and Montmorillonite Isomorphous substitution, Specific surface, cation exchange capacity of soil water interaction – diffuse double layer and double layer repulsion; structure of coarse grained soils – single grained structure, structure of clay soils – flocculent and dispersed structure.

SOIL AS A THREE – PHASE SYSTEM - Phase Diagram, Basic definitions and interrelationship. Water content and specific gravity of soils and their determination **12Hrs**

UNIT– II

INDEX PROPERTIES OF SOILS AND THEIR DETERMINATION:

Particle size distribution, (Sieve analysis and Hydrometer analysis) Consistency limits- liquid limit- Casagrande's and fall cone methods, plastic limit, Shrinkage limit and indices, insitu density- Core cutter and Sand replacement methods, activity of clay.

CLASSIFICATION OF SOILS: Purpose of soil classification, Particle size classification – MIT classification and IS classification, Textural classification, unified soil classification and IS classification Plasticity chart and its importance, Field identification of soils. Water content and specific gravity of soils and their determination **10Hrs**

UNIT– III

FLOW OF WATER THROUGH SOILS: Darcy's law- assumption and validity, coefficient of permeability and its determination (laboratory and field), factors affecting permeability, permeability of stratified soils, Seepage velocity, Superficial velocity and coefficient of percolation.

COMPACTION OF SOILS: Definition, Principle of compaction, Standard and Modified proctor's compaction tests and their Indian standard versions, factors affecting compaction, effect of compaction on soil properties, Field compaction control, and Proctor needle. Compacting equipments. **10 Hrs**

UNIT– IV

EFFECTIVE STRESS CONCEPT – Total and effective stresses, Pore water pressure, Terzaghi's effective stress equation and its limitations, Capillary phenomena, Quick sand phenomena.

CONSOLIDATION OF SOILS : Definition, spring analogy normally consolidated, under consolidated and over consolidated soils, pre-consolidation pressure and its determination by- Casagrande's method and log-log method, Consolidation characteristics of soil (Cc, av, mv and Cv),
Terzaghi's one-Dimensional consolidation theory (Assumptions and limitations only) Laboratory 1-D consolidation test to determine the consolidation characteristics of soil, determination of coefficient of consolidation by square root of time fitting method, logarithmic time fitting method and rectangular hyperbola method. **10Hrs**

UNIT– V

SHEAR STRENGTH OF SOILS: Concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes, Total and effective shear strength parameters, Concept of pore pressure, factors affecting shear strength of soils, Laboratory determination of shear strength of soils – Direct shear test, Triaxial compression test, Unconfined compression test and vane shear test, Test under different drainage conditions, sensitivity and Thixotropic of clay **10Hrs**

Text Books:

1. Principles of Geotechnical Engineering; Braja, M. Das (2002),Fifth Edition, Thomson Business Information India (P) Ltd., India
2. Soil Engineering in Theory and Practice- Alam Singh and Chowdhary G.R. (1994), CBS Publishers and Distributors Ltd., New Delhi.
3. Soil Mechanics and Foundation Engg.- Punmia B.C. (2005), 16th Edition Laxmi Publications Co. , New Delhi.

Reference Books:

1. Foundation Analysis and Design- Bowles J.E. (1996), 5th Edition, McGraw Hill Pub. Co. New York.
2. Soil Mechanics and Foundation Engineering- Murthy V.N.S. (1996), 4th Edition, UBS Publishers and Distributors, New Delhi.
3. Basic and Applied Soil Mechanics- Gopal Ranjan and Rao A.S.R. (2000), New Age International (P) Ltd., New Delhi.
4. Geotechnical Engineering- Venkatrahmaiah C. (2006), 3rd Edition New Age International (P) Ltd., New Delhi.

Course Outcome (CO)

After learning all the units of the course, the student is able to

1. Explain the concept of specific gravity and water content determination of soil and its definition.– L1 (Unit – I)
2. Explains the concept of particle size distribution and consistency limit.– L1 (Unit – II)
3. Explains the co-efficient of permeability and how to determine in lab and field.– L1 (Unit – III)
4. Explain Total and effective stresses, Pore water pressure, Terzaghi's effective stress.– L1 (Unit – IV)
5. Explain the concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes.L1 (Unit – IV)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Explain Soil mechanics, origin and formation of soil.(L1)
2. Differentiate Flocculent and dispersed structure.(L2)
3. Determine Specific gravity and water content of soil.(L1)
4. Define Specific gravity and water content of soil.(L1)

After learning all the topics of UNIT– II, the student is able to

1. Explains the concept of particle size distribution and consistency limit. .(L1)
2. Describe the shrinkage limit and indices. .(L2)
3. Describe the purpose of soil classification. Describe the different method of soil classification. .(L2)
4. Explain the plasticity chart and its importance and how to identify the soil in field. .(L1)
5. Determination of specific gravity of soil and water determination. .(L1)

After learning all the topics of UNIT– III, the student is able to

1. Explains the co-efficient of permeability and how to determine in lab and field. .(L1)
2. Explain the factors affecting permeability, permeability of stratified soils. .(L1)
3. Define Seepage velocity, superficial velocity and coefficient of percolation. .(L1)
4. Explain factors affecting compaction, effect of compaction on soil properties, Field compaction control, and Proctor needle. .(L1)
5. State Darcy's law and explain the Principle of compaction, Modified proctor's compaction. .(L1)

After learning all the topics of UNIT– IV, the student is able to

1. Explain Total and effective stresses, Pore water pressure, Terzaghi's effective stress. .(L1)
2. Explain Capillary phenomena, Quick sand phenomena. .(L1)
3. Describe spring analogy normally consolidated, under consolidated and over consolidated soils. .(L2)
4. Explain Terzaghi's one-Dimensional consolidation theory, assumptions and limitations only laboratory 1-D consolidation tests to determine the consolidation characteristics of soil. .(L1)
5. Determine the coefficient of consolidation by square root of time fitting method, logarithmic time fitting method and rectangular hyperbola method. .(L1)

After learning all the topics of UNIT– V, the student is able to

1. Explain Concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes. .(L1)
2. Explain Total and effective shear strength parameters, Concept of pore pressure, factors affecting shear strength of soils. .(L1)
3. Determination of shear strength of soils – Direct shear test, Triaxial compression test, unconfined compression test and vane shear test. .(L1)
4. Explain test under different drainage conditions, sensitivity and Thixotropic of clay. .(L1)

Review Questions

1 Mention three different clay minerals commonly found in soils. Explain any one with their structure.
2 Explain the concept of electrical diffuse double layer.
3 Differentiate between
Hydrogen bond and Vander walls bond
4 Differentiate between
flocculated structures and dispersed structures
5 Define Porosity
6 Define Air content
7 Define Water content
8 Starting from 3-phase diagram, with usual notations prove that

$$\gamma_d = \frac{(1-n_a)G\gamma_\omega}{1+G\omega}$$

9 The maximum and minimum dry unit weights of sand, determined in the laboratory are 21 kN/m^3 and 16 kN/m^3 respectively. If the relative density of sand is 60%. Determine the insitu porosity of the sand deposit, Take G = 2.65.

10 With a neat sketch explain plasticity chart and its use in classification of fine-grained soils.

11 Explain how silts and clays are identified in the field.

12 The following data was obtained in a shrinkage limit test:
Initial weight of saturated soil = 0.956 N
Initial volume of saturated soil = 6.85×10^{-5} m^3
Final dry volume = 2.41×10^{-5} m^3
Final dry weight = 0.435 N
Determine shrinkage limit, specific gravity of soil solids.

13 Briefly explain the factors affecting the permeability of soils.

14 Explain the terms superficial velocity and seepage velocity. Derive the relation connecting the two.

15 The following data was recorded in a constant head permeability test.
Internal diameter of the permeameter = 7.5 cm
Head lost over a sample length of 15 cm = 25 cm
Quality of water collected in 60 sec = 625 ml
void ratio of the sample = 0.79. Calculate coefficient of permeability of the soil. Also determine discharge velocity during the test. If the test is carried out at a temperature of 25℃, estimate the permeability of soil for a void ratio of 0.65 at 20℃. Take viscosity of water as η_1 = 8.95 millipoise and η_2 = 10.09 millipoise at 25℃ and 20℃ respectively.

16 Briefly explain the use of proctor needle in field compaction control.

17 Discuss the effect of compaction on soil properties.

18 Calculate the comp active energies applied in modified proctor and standard proctor test.

19 Explain the quick sand phenomenon in soils.

20 What is meant by under, normally and over-consolidated soils.

21 The depth of water in a well is 3m. Below the bottom of the well, there is a layer of sand 5m thick. Below this sand layer, there is a clay deposit. The specific gravities of sand and clay are 2.64 and 2.7 respectively. Their water contents are 25% and 20% respectively. Calculate the total stress, pour water pressure and effective stress at (i) 3 m below the bottom of the well and (ii) 7 m below the bottom of well.

22 What is a per consolidation pressure? Explain the Casagrande's method of determining the per consolidation pressure from laboratory consolidation Test.

23 Explain the logarithm of time fitting method of determination of coefficient of consolidation.

24 An undisturbed sample of clay, 24 mm thick, consolidated 50% in 20 minutes, when tested in laboratory with drainage allowed at top and bottom. The clay layer from which the sample was obtained is 4.0 m thick in the field. How much time will it take to consolidate 50% with double drainage?

25 Explain Mohr-Coulomb's failure theory.

26 List the merits and demerits of direct shear test.

27 In a drained triaxial compression test a saturated sand sample failed at a deviator stress of 360 kN/m^2 under a cell pressure of 100 kN/m^2. Find the effective shear parameters of sand. If another identical sample is tested under a cell pressure of 200 kN/m^2 , What would be the deviator stress at which the specimen fails?

28 With neat sketches explain any two clay minerals.

29 Explain Flocculated and Dispersed structure.

30 The maximum and minimum dry unit weights of sand determined in the laboratory are 21 kN/m^3 and 16 kN/m^3 respectively. If the relative density of sand is 60%. Determine the insitu porosity of the sand deposit, Take G = 2.65.

31 Draw the plasticity chart and explain it with a neat sketch.

32 The values of liquid limit (w_l) plastic limit (w_p) and shrinkage limit (w_s) of a soil are 60%, 30% and 20% respectively. If a sample of this soil has a volume of 40 cm^3 at w_l and 23.5 cm^3 at w_s.
What is the value of specific gravity of soil solids?

33 Briefly explain the correction to be applied to a hydrometer reading.

34 Briefly explain the factors affecting the permeability of soils.

35 Derive an expression for co-efficient of permeability used in variable head permeability test.

36 The following data was recorded in a constant head permeability test. Area of permeameter = 50 $\times 10^2$ mm^2, Height of soil sample = 60 mm. If a quantity of 430 cc of water is passed down in 10 minute under an effective constant head of 400 mm. Calculate coefficient of permeability and seepage velocity during the test. On oven drying the specimen weighs 4.98 N. Take G = 2.65.

37 State and explain briefly the factors affecting compaction of soil.

38 The following are the results of a compaction test

Mass of mould + wet soil N	29.25	30.95	31.50	31.25	30.70
Water content %	10	12	14.3	16.1	18.2

Volume of the mould = 1000 ml. Mass of the mould = 10 N. Specific gravity G = 2.70 take $\gamma_w = 9.81 \times 10^{-6}$ N/mm^3. Find OMC, maximum dry density plot zero air voids line.

39 Explain with sketch total, neutral and effective pressure in soil.

40 What is meant by under, Normally and over-consolidated soil.

41 In a laboratory consolidation test on a 20 mm thick saturated clay sample with double drainage, it was observed that the time required for 50% consolidation was 10 minutes. Estimate the time required for the clay layer of 5 m thick at the site to undergo 50% consolidation, if there is drainage only towards top of the clay layer. What is the time required for the clay layer at the site to reach 90% consolidation? If the clay layer at the site has a provision for drainage both at its top and bottom. What is the time required to undergo 90% consolidation.

42 Explain Primary and Secondary Consolidation

43 Explain Time factor

44 Explain Compression Index

45 Explain rectangular hyperbola method for determining coefficient of consolidation.

46 Following data were obtained from a consolidation test on a clay sample with double drainage conditions
voids ratio at 100 kPa = 1.37
voids ratio at 200 kPa = 1.25
Thickness of the soil sample at 100 kPa = 20 mm
Coefficient of permeability = 5 × 10-7 mm/sec
Calculate ; (i) compression index (ii) coefficient of volume change (iii) coefficient of consolidation in mm2/year.

47 Explain Mohr-Coulomb's failure theory.

48 How the shear tests classified is based on drainage condition? Give one example for each type as applicable to a field problem.

50 A vane 112.5 mm long 75 mm in diameter was pressed into soft clay at the bottom of a borehole. Torque was applied to fail the soil. The shear strength of clay was found to be 37 kN/m^2. Determine the torque that was applied.

Lesson Plan

UNIT– I

1. Soil mechanics, origin and formation of soil.
2. Flocculent and dispersed structure.
3. Specific gravity and water content of soil.
4. Specific gravity and water content of soil.

UNIT– II

6. Concept of particle size distribution and consistency limit.
7. Shrinkage limit and indices.
8. Purpose of soil classification. Describe the different method of soil classification.
9. Plasticity chart and its importance and how to identify the soil in field.
10. Specific gravity of soil and water determination.

UNIT– III

11. Co-efficient of permeability and how to determine in lab and field.
12. Factors affecting permeability, permeability of stratified soils.
13. Seepage velocity, superficial velocity and coefficient of percolation.
14. Factors affecting compaction, effect of compaction on soil properties, Field compaction control, and Proctor needle.
15. Darcy's law and explain the Principle of compaction, Modified proctor's compaction.

UNIT– IV

16. Concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes.
17. Total and effective shear strength parameters, Concept of pore pressure, factors affecting shear strength of soils.
18. Shear strength of soils – Direct shear test, Triaxial compression test, unconfined compression test and vane shear test.
19. Test under different drainage conditions, sensitivity and Thixotropic of clay.

UNIT– V

20. Total and effective stresses, Pore water pressure, Terzaghi's effective stress.
21. Capillary phenomena, Quick sand phenomena.
22. Spring analogy normally consolidated, under consolidated and over consolidated soils.
23. Terzaghi's one-Dimensional consolidation theory, assumptions and limitations only laboratory 1-D consolidation tests to determine the consolidation characteristics of soil.
24. Coefficient of consolidation by square root of time fitting method, logarithmic time fitting method and rectangular hyperbola method.

Course Articulation MatrixCAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the concept of specific gravity and water content determination of soil and its definition. (Unit – I)	L1	**H**	M			L						
02	Explains the concept of particle size distribution and consistency limit. (Unit – II)	L1	**H**	**M**			L						
03	Explains the co-efficient of permeability and how to determine in lab and field. (Unit – III)	L1	**H**	**M**									
04	Explain Total and effective stresses, Pore water pressure, Terzaghi's effective stress.(Unit – IV)	L1	**H**	**M**									
05	Explain the concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes. (Unit – IV)	L1	**H**	**M**									

The course learning outcomes (CLOs) are achieved through topic learning outcomes (TLOs)

Course AssessmentMatrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the concept of specific gravity and water content determination of soil and its definition.– L1 (Unit – I)	L1	3	2			1						
02	Explains the concept of particle size distribution and consistency limit. (Unit – II)	L1	3	2			1						
03	Explains the co-efficient of permeability and how to determine in lab and field. (Unit – III)	L1	3	2									
04	Explain Total and effective stresses, Pore water pressure, Terzaghi's effective stress.(Unit – IV)	L1	3	2									
05	Explain the concept of shear strength, Mohr-coulomb theory, conventional and modified failure envelopes. (Unit – IV)	L1	3	2									

Course Title : DESIGN OF RCC STRUCTURES			
Course Code: P13CV55	**Semester : V**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

This Course forms a prerequisite course for

The student should have the knowledge of Engineering Mechanics,Strength of Materials ans Analysis of Structures I.

Course Learning Objectives (CLOs)

This Course aims to

1. To provide basic knowledge of mathematics, science and engineering in the areas of limit state of collapse and serviceability of R C elements.
2. Enable the students to identify, formulate and solve engineering problems of R C elements subjected to flexure, shear and torsion.
3. To give procedural knowledge to design a system, component or process as per needs and specifications of R C elements such as beams, slabs, columns and footings subjected to various load combinations with different boundary conditions.
4. To imbibe the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing of R C elements for strength and durability.
5. To show the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.
6. To provide factual knowledge on analysis and design of R C elements who can participate and succeed in competitive examinations.

Course Content

UNIT – I

INTRODUCTION TO LIMIT STATE DESIGN: Philosophy and principle of limit state design along with the assumptions, Partial safety factors Characteristic Load and Strength. Introduction to stress block parameters, Concept of balanced, under and over reinforced sections Limit state of collapse in flexure of rectangular and flanged sections with examples. Limit state of collapse in flexure of rectangular and flanged sections with examples. Limit state of collapse in shear and torsional strength of sections with examples. Problems on Limit state of collapse in shear and torsional strength of sections with examples. **10 Hrs**

UNIT – II

SERVICEABILITY LIMIT STATES: Introduction to working stress method, Elastic behaviour of rectangular section, Under, Balanced and Over reinforced sections. Simple Problems on Flexural strength, Deflection and cracking in beams using IS Code provisions. Deflection and cracking – codal provisions, Deflection control in design and problems, Problems on Calculations of deflections, Problems on Calculations of deflections, Calculations of crack width, Calculations of crack width. **10 Hrs**

UNIT – III

LIMIT STATE DESIGN OF BEAMS: Design of singly Reinforced Beams, Singly Reinforced Beams – problem solving, Design of Doubly Reinforced Beams and problem solving Design of Flanged Beams T and L beams including Problem solving, Types of shear failures – Design for shear strength, Types and design of shear reinforcement with problem solving, Analysis of Torsional moment – Torsional shear stress, Reinforcement for Torsion. **12 Hrs**

UNIT – IV

LIMIT STATE DESIGN OF SLABS AND STAIRS: Introduction to one way and two way slabs, Design of one way cantilever slab, simply supported slab, continuous slab Design of two way slabs. Design of two way slabs, Introduction to stair cases and design of dog legged stair, Design of dog legged stair, Design of open well stair cases, Importance of bond, anchorage, lap length etc. **10 Hrs**

UNIT – V

LIMIT STATE DESIGN OF COLUMNS AND FOOTINGS:

Design of short axially loaded RC columns with problems, RC Columns with uniaxial moment including Problems, RC Columns with biaxial moments and problems, Design concepts of footing (Limit state), Isolated footings with axial load – square type. Isolated footings with axial load – Rectangular, Isolated footings with axial load – and moment. **10 Hrs**

Text Book:

1. SINHA S N, Reinforced Concrete Design, Tata McGraw Hill Publications
2. KARVE S R AND SHAH V L, Limit State Theory And Design Of Reinforced Concrete – Vidyarthi Prakashan, Pune

Reference Books:

1. PARK AND PAULAY, Reinforced Concrete, John Wiley and Sons
2. PUNMIA B C, JAIN A K AND JAIN A K, Reinforced Concrete Design, Lakshmi Publications, New Delhi.
3. JAIN A K, Limit State Method of Design, Nem Chand and Brothers, Roorkee.

Course Outcome

After learning all the units of the course, the student is able to

1. Explain the principle of limit state design along with the assumptions.(L1)-UNIT-I
2. Explain working stress method, Elastic behaviour of rectangular section, Under, Balanced and over reinforced sections. (L1)-UNIT-II
3. Design of singly Reinforced Beams– problem solving. (L2)- UNIT III
4. Design of two way slabs.(L2) UNIT- IV
5. Design of short axially loaded RC columns with problems, RC Columns with uniaxial moment including Problems. (L2) UNIT- V

Topic Learning Outcome

After learning all the topics of UNIT– I, the student is able to

1. Explain the principle of limit state design along with the assumptions.(L1)
2. Define partial safety factors. (L1)
3. Discuss characteristic Load and Strength. Stress block parameters(L2)
4. Explain concept of balanced, under and over reinforced sections(L1)
5. Explain Limit state of collapse.(L1)
6. Solve problems on Limit state of collapse in shear and torsional strength of sections with examples.(L2)

After learning all the topics of UNIT– II, the student is able to

1. Explain working stress method, (L1)
2. Explain elastic behaviour of rectangular section, (L1)
3. Explain Under, Balanced and over reinforced sections.(L1)
4. Solve the simple Problems on Flexural strength, Deflection and cracking in beams using IS Code provisions. (L1)

5. Explain the Deflection and cracking – Codal provisions, Deflection control in design and problems. (L1)

After learning all the topics of UNIT– III, the student is able to

1. Design the singly Reinforced Beams– problem solving.(L2)
2. Design the Doubly Reinforced Beams and problem solving. (L2)
3. Design the Flanged Beams.(L2)
4. Design T beams,(L2)
5. Design L beams. (L2)
6. Explain Torsional moment – Torsional shears stress, Reinforcement for Torsion. (L1)

After learning all the topics of UNIT– IV, the student is able to

1. Analyse the one way and two way slabs.(L4)
2. Design the one way cantilever slab. (L2)
3. Design the simply supported slab, continuous slab. (L2)
4. Design the two way slabs. (L2)
5. Design the stair cases, Design of dog legged stair, Design of open well stair cases.(L2)

After learning all the topics of UNIT– V, the student is able to

1. Design of short axially loaded RC columns.(L2)
2. Design RC Columns with uniaxial moment. (L2)
3. Design RC Columns with biaxial moments. (L2)
4. Explain the design concepts of footing (Limit state).(L1)
5. Design the Isolated footings with axial load – square type. (L2)
6. Design the Isolated footings with axial load – Rectangular, Isolated footings with axial load – and moment. (L2)

Review question

1	Explain in brief Partial Safety factor for loads and Materials
2	Explain in brief Characteristic load
3	Explain in brief Limiting depth of Neutral axis
4	Write a short note on loads to be considered on RC Structures.
5	Explain different Modes of failure of RC Section with Sketches.
6	What is limit state? List the different limit sates used in RCC Design.
7	The following data is given for a T-Beam Width of Flange = 1100 mm; Depth of Flange = 125 mm; width of rib = 300 mm; Effective depth = 550 mm. Reinforcement = 8#20 mm on tension side; Concrete Mix = M_{20}; Steer grade = Fe415. Determine the moment of resistance of the section.
8	What is development length? Obtain an expression for development length.
9	Distinguish between short term and long term deflection in RC Members.
10	A simply supported beam 300 mm wide and 600 mm effective depth carries a UDL of 70 kN/m including its own weight over an effective span of 7 m. The reinforcement on the tension side consists of 6 bars of 20 mm diameter. Out of these, 3 bars are bent up near the supports. Design the shear reinforcement in the beam. Sketch the details.
11	A Cantilever beam of 4 m span carries a load of 40 kN/m. The width of the beam is 300 mm. Design the beam and sketch the reinforcement.
12	Design a slab for a room 6m×6m clear in size. Live load acting on the slab is 3 kN/m^2, load due to floor finish is 1 kN/m^2. Use M20 Concrete and Fe415 steel. Sketch the reinforcement details. The slab is simply supported on all the four edges on wall of thickness 300 mm.

13	What are the functions of longitudinal and transverse reinforcement in columns? What are IS456-2000 provisions for the same?
14	Design a Rectangular column of unsupported length 2.5 m to carry an axial load of 600 kN. Adopt M20 Mix and Fe415 steel
15	A square footing has to transfer a load of 800 kN from a square column 400 mm x 400 mm. Design the footing assuming M20 Concrete and Fe415 steel. Sketch the reinforcement details. Both ends of the column are fixed, SBC of soil is 200 kN/m^2
16	How do you calculate the effective span of stairs?
17	Design a doglegged staircase for a residential building considering a live load of 3 kN/m^2. Size of staircase room 2.2 m x 5.5 m. Vertical distance between the floor is 3 m. Landing slab spans in the same direction as flights and is supported at the end on wall of thickness 230 mm. Use M20 Concrete and Fe415 steel. Sketch the details of reinforcement. Design one flight.
18	Explain characteristic strength and characteristic load with the help of diagrams. Hence define the design strength and design load.
19	Explain tension failure and compression failure in case of rectangular beams subjected to flexure.
20	What is limiting depth of neutral axis? Obtain an expression for the same.
21	What is development length? Obtain an expression for the same.
22	A rectangular beam of size 280 mm × 520 mm overall is reinforced with 4 - #16 in tension side and 2 - #12 in compression as hanger bars. Determine the moment of resistance of the section. What is its limiting moment of resistance and limiting percentage of steel? Also determine the maximum UDL the beam can carry over an effective span of 6 m for the given steel. Use M20 Concrete and Fe415 steel.
23	Explain the cover requirements for steel in case of beams, slabs and footings from the serviceability point of view.
24	What are modification factors? How are they determined?
25	Write a note on estimation of crack width in case of beams subjected to flexure.
26	Explain the different modes of failure of beams subjected to shear with the help of neat sketches.
27	A reinforced concrete beam 300 mm × 550 mm overall consists of 6 - #20 of grade Fe415. The effective cover is 50 mm. Out of 6 bars, 3 bars have been bent up at 45^0. Design the shear reinforcement if the beam is subjected to a uniformly distributed factored load of 100 kN/m over a simply supported effective span of 7.3 m. Grade of concrete is M20. Sketch the details of reinforcement along and across the section.
28	Design a simply supported beam of a T-beam and slab system where beams are spaced 3.5 m c/c. 150 mm slab is cast monolithically with beams. The clear span of beam is 9.5 m. The slab supports a live load of 4.25 kN/m^2 at service condition. The bearing for beam is 450 mm. Use M20 Concrete and Fe415 steel. Sketch the details of steel.
29	Explain the behavior of column subjected to axial load and uniaxial moment with the help of interaction diagram.
30	Design a Rectangular column to carry an axial load of 1200 kN at working condition. The unsupported length of column is 4 m. The ends of column are held in position and restrained against rotation. Sketch the details of steel. Use M20 Concrete and Fe415 steel.
31	A square column 500 mm × 500 mm Carrie a load 1600 kN. Design a suitable footing. Take SBC of soil as 180 kN/m^2 . The density of soil is 18 kN/m^3. Use M20 Concrete and Fe415 steel. Sketch the details of steel.
32	Design a dog legged stairs for an office building consisting of 2.6 × 5.6 m clear room. Vertical distance between the floors is 3.6 m. Width of flight is 1.2 m. Imposed load is 3 kN/m^2. Finish load is 1 kN/m^2. Assume the stairs are supported on 230 mm wall. Such

	that both landing slab and flight spans longitudinally. Take the intermediate flight for design and sketch the details of steel. Use M20 Concrete and Fe415 steel.
33	Define limit state. Explain how the variation of loads and material strength have been accounted in it.
34	Obtain the expressions for $X_{u\cdot limit}$ using M_{20} concrete with Fe250, Fe415 and Fe500 Steels.
35	Explain; i) Anchorage length, ii) Development length
36	A R.C. beam of rectangular section 230 x 400 mm is reinforced with 4 bars of 12mm diameter in tension side with an effective cover of 30 mm. Determine the ultimate moment of resistance of the section. What maximum imposed UDL, the beam can carry if it is simply supported over a span of 3.50 m. Use M_{20} concrete and Fe 415Steel.
37	Distinguish between sort term and long term deflections. Explain IS code recommended deflection check based on span to depth ratio.
38	A rectangular simply supported beam of span 4 m is 350 mm x 650 mm in cross section. It carries a live load of 9 kN/m together with an imposed load of 4 kN/m excluding self weight. It is reinforced with 3 bars of 25 mm diameter on the tension side with an effective cover of 50mm. Calculate the short term deflection at the central span. Use M-20 concrete and Fe 415 steel.
39	A simply supported beam 300x650 mm carries a UDL of 74 kN/m including its own weight over an effective span of 6 m. The reinforcement consists of 5 bars of 25 mm diameter at tension side at an effective cover of 50 mm. Two bars can be bent up at 1 m distance from the support. Design the shear reinforcement for the beam. Use M-20 concrete and Fe-415 steel. Assume width of supports 400 mm.
40	Distinguish between one-way and two-way slabs.
41	Design a RC slab of size 6 m x 4 m, whose one short edge is discontinuous and corners are restrained at supports. The slab has to carry a live load of 3 kN/m^2 and floor finish 1 kN/m^2. Sketch the reinforcement details. Use M-20 concrete and Fe 415 steel.
42	Distinguish between short column and long column.
43	Why minimum eccentricity is introduced in column design by limit state method? How is it determined?
44	Design a rectangular column 5 m long restrained in position and direction at both ends to carry an axial load of 1200 kN. Use M-20 concrete and Fe 415 Steel.
45	A rectangular column 400 mm x 600 mm carries a load of 2000 kN. The SBC of soil is 200 kN/m^2 .Design an isolated footing and sketch the reinforcement. Use M-20 concrete and Fe 415 steel.
46	Explain IS code provisions for effective span of stairs without stringer beams, with the help of neat sketches for each case
47	Design a waist slab type, dog-legged stair case for residential building, given the following data: Clear dimensions of stair case hall is 2.6 m x 4.75 m Height between floors = 3.20 m Rise = 160 mm, Tread = 250 mm Width of flight = landing width = 1.25 m Assume the stairs to be supported on 230 mm thick masonry walls at the outer edges of the landings. Sketch the reinforcement details. Use M-20 concrete and Fe 415 steel.

Lesson plan

UNIT – I

1. Principle of limit state design along with the assumptions.
2. Partial safety factors.
3. Characteristic Load and Strength. Stress blocks parameters.
4. Concept of balanced, under and over reinforced sections.
5. Limit state of collapse.
6. Problems on Limit state of collapse in shear and torsional strength of sections with examples.

UNIT – II

7. Working stress method,
8. Elastic behaviour of rectangular section,
9. Under, Balanced and over reinforced sections.
10. Simple Problems on Flexural strength, Deflection and cracking in beams using IS Code provisions.
11. Deflection and cracking – Codal provisions, Deflection control in design and problems.

UNIT – III

12. Design of singly Reinforced Beams– problem solving.
13. Design of Doubly Reinforced Beams and problem solving.
14. Design of Flanged Beams.
15. Design T beams.
16. Design L beams.
17. Explain Torsional moment – Torsional shears stress, Reinforcement for Torsion.

UNIT – IV

18. Analysis the one way and two way slabs.
19. Design of one way cantilever slab.
20. Design of simply supported slab, continuous slab.
21. Design of two way slabs.
22. Design of stair cases, Design of dog legged stair, Design of open well stair cases.

UNIT – V

23. Design of short axially loaded RC columns.
24. Design of RC Columns with uniaxial moment.
25. Design of RC Columns with biaxial moments.
26. Design concepts of footing (Limit state).
27. Design of Isolated footings with axial load – square type.
28. Design of Isolated footings with axial load – Rectangular, Isolated footings with axial load – and moment.

Course Articulation Matrix(CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the principle of limit state design along with the assumptions.UNIT-I	L1	**M**	**M**	**L**								
02	Explain working stress method, Elastic behaviour of rectangular section, Under, Balanced and over reinforced sections. UNIT-II	L1	**M**										
03	Design of singly Reinforced Beams– problem solving. UNIT-III	L2	**M**		**L**								
04	Design of two way slabs. UNIT-IV	L2	**M**										
05	Design of short axially loaded RC columns with problems, RC Columns with uniaxial moment including Problems. UNIT-V	L2	**M**	**L**	**L**								

L-Low, M-Moderate, H-High

Course Assessment Matrix(CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the principle of limit state design along with the assumptions.UNIT-I	L1	**2**	**2**	**1**								
02	Explain working stress method, Elastic behaviour of rectangular section, Under, Balanced and over reinforced sections.UNIT-II	L1	**2**										
03	Design of singly Reinforced Beams– problem solving. UNIT-III	L2	**2**		**1**								
04	Design of two way slabs. UNIT-IV	L2	**2**										
05	Design of short axially loaded RC columns with problems, RC Columns with uniaxial moment including Problems. UNIT-V	L2	**2**	**1**	**1**								
06	Explain the principle of limit state design along with the assumptions.UNIT-I	L1	**2**	**1**									

1-Low, 2-Moderate, 3-High

Course Title : HYDROLOGY AND WATER RESOURCES ENGINEERING			
Course Code: P13CV56	**Semester : V**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Know about precipitation and catchment, Hydrologic cycle. World water budget Indian's meter Budget, Types (standard gauge & Siphon type rain gauge only), Measurement of precipitation Rainfallness curve, Hyetograph, Rain gauge network, Mean precipitation over an area, Estimation of missing rainfall data, Double mass curve technique, Return period, Plotting positions, I.D.F. curves, PMP. Catchment – definition, stream pattern, description of the basin.
2. Understand abstractions and runoff, abstractions – Evaporation, Factors affecting evaporation, Measurement of evaporation using evaporation pans, Methods of reduction of reservoir evaporation, Transpiration, Evapotranspiration, Estimation of evapotranspiration.
3. Learn about infiltration, infiltration capacity, infiltration rate, Measurement of infiltration, Infiltration indices. Runoff – Introduction, Types of runoff, Factors affecting runoff, Basin yield, Rainfall-runoff correlation, Estimation of runoff with empirical equations – Dicken's formula, Ryve's formula and Inglis formula.
4. Obtain the knowledge about hydrograph, Factors affecting flood hydrograph, Components of a hydrograph, Base flow separation, Effective rainfall, Unit Hydrograph, Unit hydrograph from complex storms, Unit hydrograph of different duration , S – Curve method.
5. Know about groundwater hydrology, Occurrence and movement of ground water - Vertical distribution of groundwater, Aquifers, Specific retention, Specific yield, Darcy's Law, Hydraulic conductivity, Transmissivity.
6. Understandaboutwell Hydraulics, Steady-radial flow into a confined aquifer, Thiem's equation, Steady-radial flow into an unconfined aquifer.
7. Learn about Water resources engineering, Flood estimation, rational method, PMF, Leaves and flood walls. Reservoir Planning- Types of reservoir, Investigations for reservoir planning, Selection of site for a reservoir, Zones of storage in a reservoir, Reservoir yield,
8. Obtain the knowledge about Mass curve and Demand curve, determination of reservoir capacity using mass curve, Flood routing – reservoir routing by ISD method, Reservoir losses, Useful life of a reservoir

Course Content

UNIT – I

PERICIPITATION AND CATCHMENT: Introduction. Hydrologic cycle. World water budget Indian's meter Budget, Types (standard gauge & Siphon type rain gauge only), Measurement of precipitation Rainfallness curve, Hyetograph, Rain gauge network, Mean precipitation over an area, Estimation of missing rainfall data, Double mass curve technique, Return period, Plotting positions, I.D.F. curves, PMP. Catchment – definition, stream pattern, description of the basin.

10 Hrs

UNIT – II

ABSTRACTIONS AND RUNOFF: Introduction. Abstractions – Evaporation, Factors affecting evaporation, Measurement of evaporation using evaporation pans, Methods of reduction of reservoir evaporation, Transpiration, Evapotranspiration, Estimation of evapotranspiration. Infiltration – Infiltration capacity, infiltration rate, Measurement of infiltration, Infiltration indices. Runoff – Introduction, Types of runoff, Factors affecting runoff, Basin yield, Rainfall-runoff correlation, Estimation of runoff with empirical equations – Dicken's formula, Ryve's formula and Inglis formula **10Hrs**

UNIT – III

STREAM FLOW AND HYDROGRAPH: Stream – classification of stream, stream gauging, and measurement of discharge, stage-discharge relations, and introduction. Hydrograph – Definition, Factors affecting flood hydrograph, Components of a hydrograph, Base flow separation, Effective rainfall, Unit Hydrograph, Unit hydrograph from complex storms, Unit hydrograph of different duration , S – Curve method **12Hrs**

UNIT – IV

GROUND WATER HYDROLOGY: Introduction. Occurrence and movement of ground water - Vertical distribution of groundwater, Aquifers, Specific retention, Specific yield, Darcy's Law, Hydraulic conductivity, Transmissivity. Well Hydraulics – Steady-radial flow into a confined aquifer, Thiem's equation, Steady-radial flow into an unconfined aquifer. **10Hrs**

UNIT – V

WATER RESOURCES ENGINEERING: Introduction. Flood estimation, Rational method, PMF, Leaves and flood walls. Reservoir Planning- Types of reservoir, Investigations for reservoir planning, Selection of site for a reservoir, Zones of storage in a reservoir, Reservoir yield, Mass curve and Demand curve, determination of reservoir capacity using mass curve, Flood routing – reservoir routing by ISD method, Reservoir losses, Useful life of a reservoir. **10Hrs**

Text Books:

1. Engineering Hydrology – Subramanya K, Tata McGraw Hill, New Delhi.
2. A Text Book of Hydrology – Jayarami Reddy, Lakshmi Publications, New Delhi.
3. Hydrology – H.M. Raghunath, Wiley Eastern Publication, New Delhi.

Reference Books:

1. Hand Book of Hydrology – Ven Te Chow
2. Hydrology and Water Resources Engineering – R.K. Sharma and Sharma, Oxford and IBH, New Delhi.
3. Hydrology and water resources Engineering – Garg S.K., Khanna Publishers, New Delhi.
4. Applied Hydrology – Linsely, Kohler and Paulhus, Wiley Eastern Publication, New Delhi9.
5. Ground Water Hydrology – Todd, Wiley eastern Publication, New Delhi.

Course Outcome

After learning all the units of the course, the student is able to

1. Explain how to measure of precipitation using standard gauge & Siphon type rain gauge–L2. (UNIT-I)
2. List the methods of reduction of reservoir evaporation, transpiration and evapotranspiration–L1. (UNIT-II)
3. Define Base flow separation, effective rainfall and unit Hydrograph–L2. (UNIT-III)
4. Describe steady-radial flow into an unconfined aquifer–L2. (UNIT-IV)
5. Define zones of storage in a reservoir, Reservoir yield, Mass curve and Demand curve–L2 (UNIT-V).

Topic Learning Outcome

After learning all the topics of UNIT– I, the student is able to

1. Explain precipitation and catchment, Hydrology–L1.
2. Describe the practical applications of Hydrology–L1.
3. Explain Hydrologic cycle (Descriptive and Horton's qualitative representation) –L1.
4. Explain Precipitation and its forms–L1.
5. List the types of Precipitation–L1.
6. Define the Measurement of precipitation (standard gauge& Siphon type rain gauge only) –L1.
7. Describe Rainfall mass curve, Hyetograph–L1.
8. Explain Rain gauge network, Mean precipitation over an area–L1.
9. Estimate of missing rainfall data, Double mass curve technique–L1.

10. Define Return period, Plotting positions, I.D.F. curves and PMP–L1.

After learning all the topics of UNIT– II, the student is able to

11. Explain Abstractions, evaporation and Factors affecting evaporation–L1.
12. Describe the measurement of evaporation using evaporation pans–L2.
13. Explain the methods of reduction of reservoir evaporation, Transpiration, Evapotranspiration–L1.
14. Estimate the evapotranspiration–L2.
15. Explain infiltration, infiltration capacity and infiltration rate–L1.
16. Describe the measurement of infiltration, Infiltration indices–L2.
17. Define Runoff, types of runoff, factors affecting runoff and basin yield–L2.
18. Describe Rainfall and runoff correlation–L2.
19. Estimate runoff with empirical equations – Dicken's formula, Ryve's formula–L2.
20. Estimate runoff with empirical equations Inglis formula–L2.

After learning all the topics of UNIT– III, the student is able to

21. Define Stream, classification of stream and stream gauging–L2.
22. Explain the measurement of discharge–L2.
23. Describe stage-discharge relations–L2.
24. Define Hydrograph–L2.
25. Explain Factors affecting flood hydrograph–L2.
26. Describe the components of a hydrograph–L2.
27. Define base flow separation–L2.
28. Explain Effective rainfall–L2.
29. Define Unit Hydrograph–L2.
30. Describe Unit hydrograph from complex storms–L2.
31. Describe Unit hydrograph of different duration–L2.
32. Explain S – Curve method–L2.

After learning all the topics of UNIT– IV, the student is able to

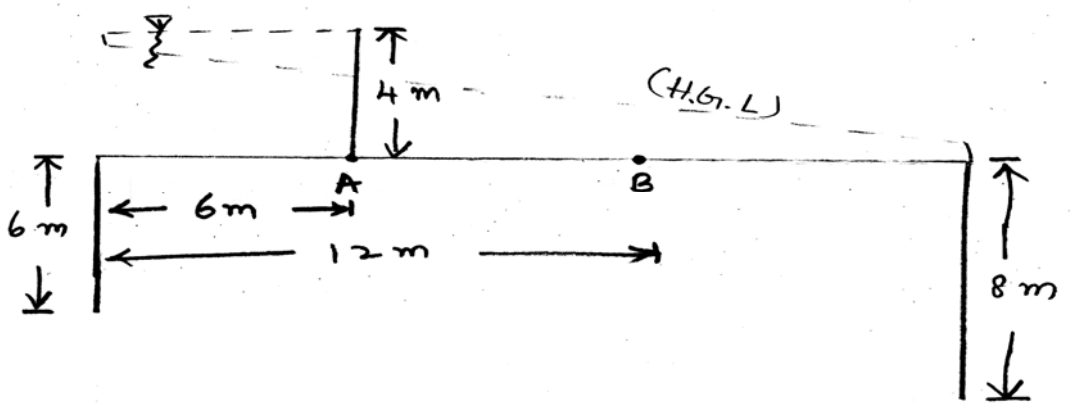
33. Describe the occurrence of ground water–L2.
34. Describe the movement of ground water–L2.
35. Explain Vertical distribution of groundwater–L2.
36. Define Aquifers–L2.
37. Explain Specific retention –L2.
38. Define Specific yield–L2.
39. State Darcy's Law–L2.
40. Define Hydraulic conductivity and Transmissivity–L2.
41. Define Well Hydraulics and Steady-radial flow into a confined aquifer–L2.
42. Explain Thiem's equation and steady-radial flow into an unconfined aquifer–L2.

After learning all the topics of UNIT– V, the student is able to

43. Define flood estimation and rational method–L2.
44. Describe PMF, Leaves and flood walls–L2.
45. Define Reservoir Planning and types of reservoir–L2.
46. Explain the investigations for reservoir planning–L2.
47. Describe the selection of site for a reservoir–L2.
48. Define zones of storage in a reservoir and reservoir yield–L2.
49. Explain Mass curve and Demand curve–L2.
50. Determine the reservoir capacity using mass curve–L2.
51. Explain flood routing and reservoir routing by ISD method–L2.
52. Define reservoir losses and useful life of a reservoir–L2.

Review Questions

1.	Defined Irrigation. List out the benefits and Ill-effects of irrigation
2.	Distinguish between direct irrigation and Indirect irrigation
3.	Explain sprinkler irrigation. Mention its advantages & disadvantages
4.	Make a note on frequency of irrigation
5.	Determine the storage capacity of a soil from the following data. Field capacity =20%, permanent wilting point = 12%, depth of root zone = 1m and dry density of soil = 1.8 gm/cc. Also, determine the depth of water required if the irrigation water is supplied when the moisture content falls to 20% and the field application efficiency is 80%. If the conveyance losses in the channel network are 12% of outlet discharge, calculate the depth of water required at canal outlet.
6.	What is duty and delta? Derive the relation between them. Mention any two methods of improving duty
7.	What is a canal? Explain, with neat sketch, the classification of canals based on their alignment.
8.	What are the factors to be considered while aligning a canal?
9.	Design an irrigation canal using Lacy's silt theory with the following data i)Full supply discharge = 10 cumecs (ii)Lacy's silt factor = 0.9 (iii) Side slope = 0.5 H = 1V
10.	Distinguish between a dam and a Reservoir. With a neat sketch explain the storage zones of a reservoir
11.	Make a note on economical height of a reservoir.
12.	Explain the method of determining the capacity of a reservoir for a known demand
13.	With a neat sketch, Explain the components of a typical diversion head work.
14.	Make a note on safety criterion suggested by Bligh for the design of impervious floor of a weir.
15.	Distinguish between exit gradient and critical gradient
16.	List out the causes of failure of weirs founded on permeable soils.
17.	What is a gravity dam? List out the stabilizing forces and destabilizing forces acting on gravity dam
18.	Make a note on practical profile of a gravity dam.
19.	Draw uplift pressure diagram for a dam holding 50 m of water with upstream face vertical, top and bottom width are 10 m and 30 m respectively. Uplift may be considered to be acting on 60% of the area of section. Tail water depth is 5 m. Also, draw the uplift pressure diagram, if there is a drainage gallery at 6 m from upstream face.
20.	How the earthen dams are classified? With a neat sketch explain zoned embankment type of earthen dam
21.	Briefly discuss the causes of failure of earthen dam.
22.	With a neat sketch, explain the procedure of determining the seepage line in a homogeneous earthen dam with horizontal drainage blanket.
23.	What is a spillway? Mention the essential requirements of a spillway.
24.	With a neat sketch explain a Ogee spillway. Give all design details along with crest profile equation.
25.	Make a note on energy dissipaters
26.	Discuss in brief the benefits and ill effects of irrigation
27.	Find the time required to cover an area of 0.1 hectares when a tube well is discharging at the rate of 0.03 Cumecs for irrigating rabi crops. Average depth of flow is expected to be 7.5 cm. Average infiltration rate for the soil may be taken in 5 cm/hour.
28.	Explain the terms 'duty' and 'delta'. Also derive relationship between them.
29.	After how many days will you supply water to soil (clay loam) in order to ensure efficient irrigation of the given crop, if i) Field Capacity of soil = 27% ii) Permanent wilting point = 14% iii) Density of soil = 1.5 g/cm^3

	iv) Effective depth of root zone = 75 cm v) Daily consumptive use of water for the given crop = 11 mm.
30.	List out various types of cross drainage works. Describe any one type with neat sketch
31.	Design a channel section for the following data using Lacey's theory. Discharge, Q = 30 Cumecs, Slit factor, f = 1.0 Side slope = ½ : 1 Also find the longitudinal slope.
32.	Define the following i) Surcharge storage (ii) Valley storage
33.	Define the following (i) Safe yield (ii) Secondary yield
34.	Explain how you determine safe yield from a reservoir of a given capacity using graphical method.
35.	Differentiate between the following: i) A barrage and a weir ii) Gravity weirs and non-gravity weirs
36.	Figure below shows the section of a hydraulic structure founded on sand. Calculate the average hydraulic gradient. Also, find the uplift pressures at points 6 and 12 m from the upstream end of the floor and find the thickness of the floor at those points. 
37.	What do you understand by the elementary profile of a gravity dam? Derive an expression for determining base width of such a dam based on stress criterion.
38.	Given the following data, determine limiting height of the dam. R.L of base of dam = 1450 m R.L of H.F.L = 1480.5 m Specific gravity of the masonry = 2.4 Safe Compressive Stress for masonry = 120 tonnes/m^2 Height of waves = 1 m.
39.	With the help of a sketch, explain zoned embankment type earthen dam.
40.	Write a note on selecting a suitable preliminary section for an Earth dam
41.	What is a spillway? Discuss any one type of spillway with a neat sketch
42.	What do you mean by energy dissipation below spillways? What are the methods available to dissipate the energy?
43.	Define irrigations? Explain the necessity of irrigations in India
44.	With a neat sketch, explain border flooding method of irrigation
45.	Find the time required to cover an area of 0.1 ha, where a tube well is discharging at the rate of 0.03 cumecs for irrigating rabi crops. Average depth of flow is expected to be 75 mm. average infiltration rate for the soil may be taken as 50 mm/hr. Also find the maximum area that can be irrigated by the available discharge of 0.03 cumecs.

46.	Define the following: i. Crop ratio ii. Kor watering iii. Kor period iv. Crop period v. Base period
47.	The yield of water in Mm^3 from a catchment area during each successive month is 1.4,2.1,2.8,8.4,11.9,11.9,7.7,2.8,2.52,2.24,1.96,1.68. Determine the minimum capacity of a reservoir required to allow the above volume of water, to be drawn off at a uniform rate. Assuming there is no loss of water over the spillway.
48.	Briefly explain irrigations efficiencies
49.	After how many days, will you supply water to soil in order to ensure efficient irrigation of the given crop, if i) Field capacity of soil = 27% ii) Permanents wilting point = 14% iii) Dry density of soil =15 kN/m^3 iv) Effective depth of root zone = 750 mm. v) Daily consumptive use =11 mm
50.	Define canal. Explain the classifications based on discharge condition
51.	Design an irrigation channel on Kennedy's theory, to carry a discharge of 45 Cumecs. Take N = 0.0225 and m = 1.05. The channel has a bed shape of 1 in 5000
52.	Mentions the different types of crops. With a neat sketch explain trapezoidal notch fall

Lesson Plan:

UNIT – I

1. Hydrologic cycle, precipitation-forms and types.
2. standard gauge & Siphon type rain gauge,
3. Measurement of precipitation Rainfall mass curve,
4. Hyetograph, Rain gauge network,
5. Mean precipitation over an area,
6. Estimation of missing rainfall data,
7. Double mass curve technique,
8. Return period, Plotting positions,
9. I.D.F. curves, PMP,
10. Catchment – definition, stream pattern, description of the basin.

UNIT – II

11. Abstractions – Evaporation, Factors affecting evaporation,
12. Measurement of evaporation using evaporation pans,
13. Methods of reduction of reservoir evaporation, Transpiration, Evapotranspiration,
14. Estimation of evapotranspiration.
15. Infiltration – Infiltration capacity, infiltration rate,
16. Measurement of infiltration, Infiltration indices,
17. Runoff – Introduction, Types of runoff, Factors affecting runoff, Basin yield,
18. Rainfall-runoff correlation,
19. Estimation of runoff with empirical equations – Dicken's formula, Ryve's formula
20. Estimation of runoff with empirical equations– Inglis formula.

UNIT – III

21. Stream – classification of stream,

22. stream gauging,
23. measurement of discharge,
24. stage-discharge relations
25. Hydrograph – Definition, Factors affecting flood hydrograph,
26. Components of a hydrograph
27. Base flow separation,
28. Effective rainfall,
29. Unit Hydrograph,
30. Unit hydrograph from complex storms,
31. Unit hydrograph of different duration,
32. S – Curve method.

UNIT – IV

33. Introduction, occurrence and
34. movement of ground water,
35. Vertical distribution of groundwater,
36. Aquifers, Specific retention,
37. Specific yield,
38. Darcy's Law,
39. Hydraulic conductivity, Transmissivity,
40. Well Hydraulics – Steady-radial flow into a confined aquifer,
41. Thiem's equation,
42. Steady-radial flow into an unconfined aquifer.

UNIT – V

43. Introduction. Flood estimation, Rational method,
44. PMF, Leaves and flood walls,
45. Reservoir Planning- Types of reservoir,
46. Investigations for reservoir planning,
47. Selection of site for a reservoir,
48. Zones of storage in a reservoir, Reservoir yield,
49. Mass curve and Demand curve,
50. Determination of reservoir capacity using mass curve,
51. Flood routing – reservoir routing by ISD method,
52. Reservoir losses, Useful life of a reservoir

Course Articulation Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Program outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain how to measure of precipitation using standard gauge & Siphon type rain gauge.	**L1**	**H**	**H**	**H**								
02	List the methods of reduction of reservoir evaporation, transpiration and evapotranspiration.	**L1**	**M**	**M**									
03	Define Base flow separation, effective rainfall and unit Hydrograph.	**L2**	**L**	**M**									
04	Describe steady-radial flow into an unconfined aquifer	**L2**	**M**	**L**									
05	Define zones of storage in a reservoir, Reservoir yield, Mass curve and Demand curve	**L2**	**M**	**L**									

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Program outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain how to measure of precipitation using standard gauge & Siphon type rain gauge.	**L1**	**3**	**3**	**3**								
02	List the methods of reduction of reservoir evaporation, transpiration and evapotranspiration.	**L1**	**2**	**2**									
03	Define Base flow separation, effective rainfall and unit Hydrograph.	**L2**	**1**	**2**									
04	Describe steady-radial flow into an unconfined aquifer	**L2**	**2**	**1**									
05	Define zones of storage in a reservoir, Reservoir yield, Mass curve and Demand curve	**L2**	**2**	**1**									

1-Low, 2-Moderate, 3-High

Course Title : CONCRETE MATERIAL TESTINGLABORATORY			
Course Code: P13CVL57	**Semester : V**	**L-T-P-H:0 – 0 –3-3**	**Credits:1.5**
Contact Period : Lecture :39 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course learning objectives

This course aims to

1) Identify the consistency, specific gravity and setting time of cement.
2) Describe soundness and fineness of cement.
3) Find the compressive strength of cement.
4) Design the concrete mix.
5) Find the slump, compaction factor and Vee-Bee test value.
6) Describe the compressive strength, spilt tensile and flexure strength of concrete.
7) Learn about NDT (Non-Destructive Test).

LIST OF EXPERIMENTS TO BE CONDUCTED:

Tests on Cement: **12 Hrs**

1. Standrad consistency
2. Specific gravity
3. Setting time
4. Soundness test
   i) By using Lechatelier's
   ii) By autoclave method
5. Finess test
   i) Using 90 micron sieve
   ii) air-permiability test by Blaine's appartus
6. Compression strength test

Concrete Mix design: **9 Hrs**

7. Design of concrete mix by IS method

Tests on Fresh concrete: 9 Hrs

8. Slump test
9. Compaction factor test
10. Vee Bee Consistometer test

Tests on Hardend concrete **6 Hrs**

11. Compression stretngth test
12. Spilt tensile test
13. Flexural strength of concrete

Tests on Hardend concrete using NDT **3 Hrs**

14. Rebound Hammer test
15. Ultrasonic test

TEST BOOKS:

1. Properties of concrete-Neville,A.M -ELBS Edition, Longman Ltd London
2. Concrete Technology- M.S. Shetty
3. IS 10262-2004
4. Concrete Manual- Dhanpat Rai & Sons, New Delhi

REFERENCE BOOKS

1. Non destructive Test and Evaluation of materials – J. Prasad, C G K Nair, - Mc Graw Hill.
2. Properties of fresh concrete – Power T . C. – E and F N, London
3. Concrete Technology – A.R .Santhakuma, - Oxford University

Course Outcome

After learning all the units of the course, the student is able to

1) Determine the consistency, specific gravity, setting time and soundness of cement.
2) Explain fineness and compressive strength of cement.
3) Design a concrete mix.
4) Describe slump, compaction factor and Vee-Bee Consistometer test.
5) Illustrate compressive strength, spilt-tensile and flexural strength of concrete.
6) Define NDT (Non-Destructi

Course Title : COMPUTER AIDED CIVIL ENGINEERING LABORATORY			
Course Code:P13CVL58	**Semester : V**	**L-T-P-H: 0 – 0 – 3 - 3**	**Credits:1.5**
Contact Period : Lecture :39 Hr, Exam: 3Hr		**Weightage :CIE: 50% SEE:50%**	

This course aims to

1. Learn excel software.
2. Draw SFD and BMD for Simply supported beam for different conditions using Excel.
3. Solve earth work problems using excel.
4. Plot compaction curve for soil using excel.
5. Design structural components of building using excel.
6. Learn commercially available software like STAAD Pro.
7. Analyse and design of beams with different support conditions.
8. Analyse and design of columns.
9. 3D analysis and design of multi storied building.

10. USE OF EXCEL IN CIVIL ENGINEERING PROBLEMS **18 Hrs**

Use of spread sheet for the following civil engineering problems:

i) SFD and BMD for Cantilever and simply supported beam subjected to uniformly distributed and unfromly varying load acting throughout the span.
ii) Computation of earthwork
iii) Design of horizontal curve by offset method.
iv) Design of superelevation
v) Ploting of compaction curve for soil.
vi) Regression analysis for rainfall and runoff relation
vii) Design of one way slabs
viii) Design of singly reinforced and doubly reinforced rectangular beams
ix) Design of columns and footings.

2. STRUCTURAL ANALYISIS SOFTWARE **21 Hrs**

Use of commercially available software for

i) Introduction to STAAD Pro
ii) Analysis of Propped cantilever beams
iii) Analysis of Fixed beams
iv) Analysis of Continuos beams
v) Analysis of 2D portal frames (single storied and multi storied)
vi) Analysis of truss
vii) Analysis of cables and arches
viii) Design of RCC beams and columns
ix) Analysis and design of multi-storied building (3D)

Course Outcome

After learning all the units of the course, the student is able to

1) Draw SFD and BMD for various kind of beam using Excel.
2) Plot graph for various problems using excel.
3) Prepare design spared sheet.
4) Analyse and design 2D and 3D structures.

Course Title : WASTE WATER TREATMENT			
Course Code: P13CV61	**Semester : VI**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Understand importance of safe drinking water, different water demands and population forecasting methods to arrive at per capita consumption for city/town, different water sources along with intake structures and pumps to apply the knowledge to solve engineering problems.
2. Summarize drinking water quality parameters and analysis (Examination) procedure for compliance with standards.
3. Explain types of aeration and to understand sedimentation, coagulation and flocculation and to apply design concepts to sedimentation units.
4. Understand different filtration units and disinfection types and to apply design concepts to filtration units.
5. Explain different water softening methods and to illustrate different water distribution systems

Course Content

UNIT – I

INTRODUCTION: Necessity of sanitation, Systems of sanitation and disposal, types of sewerage systems and their suitability. Dry weather flow (DWF) - factors affecting dry weather flow, flow variations and their effects on design of sewerage system; computation of design flow. Wet weather flow (WWF) - estimation of storm flow by rational method and empirical formulae, Time of concentration. Problems on DWF & WWF.

DESIGN OF SEWERS: Hydraulic formulae for velocity, effects of flow variations on velocity, self-cleansing and non-scouring velocities, Design of hydraulic elements for circular sewers flowing full and flowing partially full (No derivations). Problem **12 Hrs**

UNIT – II

MATERIALS OF SEWERS: Sewer materials, Selection criteria, shape of sewers, laying of sewers, joints and testing of sewers, ventilation and cleaning of sewers.

SEWER APPURTENANCES: Catch basins, manholes, flushing tanks, oil and grease traps, Drainage traps.

PUMPING OF SEWAGE- Need, types of pump, problems on power of pumps and rising mains.

HOUSE DRAINAGE-Typical layout plan showing house drainage connections, maintenance of house drainage **10 Hrs**

UNIT – III

WASTE WATER CHARACTERIZATION: Physical, Chemical and Biological characteristics, typical wastewater characteristics, Biological treatment process-Aerobic and Anaerobic activity, CNS cycles. BOD and COD. their significance & problems on BOD

DISPOSAL OF SEWAGE: Disposal by dilution-self-purification phenomenon. Oxygen sag curve, Zones of purification, Sewage farming, sewage sickness, Effluent standards for Disposal on to land & in to surface waters **10 Hrs**

UNIT – IV

TREATMENT OF SEWAGE: Importance of treatment, methods of treatment, Flow diagram of conventional municipal sewage treatment plant.

PRIMARY TREATMENT: Screening, grit chambers, skimming tanks and primary sedimentation tanks – Design criteria & Design examples of PST.

SECONDARY TREATMENT: Advantages of biological treatment system, Suspended growth and attached growth system. Trickling filter – theory, operation, types, operational problems & design problems. **10 Hrs**

UNIT – V

ACTIVATED SLUDGE PROCESS- Principle, flow diagram, Modifications of ASP, F/M ratio, Design Anaerobic Sludge digestion, Sludge digestion tanks, Design of Sludge drying beds, Low cost waste treatment method, Septic tank, Oxidation Pond and Oxidation ditches, Reuse and recycle of waste water **10 Hrs**

TEXT BOOKS:

1. Environmental Engineering II – B.C. Punmia & Asok Jain Lakshmi Publications (P) Ltd.
2. Wastewater treatment – S.K. Garg, Khanna publications.

REFERENCE BOOKS:

1. Manual on Waste Water Treatment: CPHEEO, Ministry of Urban Development, New Delhi.
2. Water & Wastewater Engineering Vol-II-- Fair, Geyer and Okun: John Willey Publishers, New York.
3. Waste Water Treatment, Disposal and Reuse: Metcalf and Eddy Inc: Tata McGraw Hill

Course Outcome (CO)

After learning all the units of the course, the student is able to

1. Outline Importance of necessity of sanitation, Systems of sanitation and disposal, types of sewerage systems and their suitability. – L1 (Unit – I)
2. Explain the Sewer materials, Selection criteria, shape of sewers, laying of sewers, joints and testing of sewers, ventilation and cleaning of sewers. – L2 (Unit – II)
3. Explain the Biological treatment process-Aerobic and Anaerobic activity, CNS cycles. – L2 (Unit – III)
4. Design the under drainage system, back washing of filters, Operational problems in filters. – L2 (Unit – IV)
5. Describe the System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems – L1(Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

23 Explain Importance of necessity of sanitation – L2
24 Discuss Systems of sanitation and disposal,.– L2
25 Illustrate Dry weather flow (DWF) – L3
26 Examine flow variations and factors affecting dry weather flow,.– L4
27 Discuss the estimation of storm flow by rational method. – L2
28 Explain the estimation of storm flow by empirical formulae– L2
29 Discuss Hydraulic formulae for velocity – L2
30 Different effects of flow variations on velocity -L2
31 Discuss self-cleansing and non-scouring velocities.– L2
32 Discuss the Design of hydraulic elements for circular sewers flowing full. – L2
33 Explain the Design of hydraulic elements for circular sewers flowing partially. – L2
34 Outline the types of sewerage systems. – L1

After learning all the topics of UNIT– II, the student is able to

35 Analyze the Sewer materials, Selection criteria. – L4
36 Explain shape of sewers, laying of sewers,.– L5
37 Identify joints and testing of sewers, ventilation and cleaning of sewers.– L2

38 Explain Importance of Catch basins, manholes .– L2
39 Discuss flushing tanks, oil and grease traps. – L2
40 Illustrate Importance of need, types of pump. – L4
41 Problems on power of pumps and rising mains. – L3
42 Explain Typical layout plan showing house drainage connections.– L3
43 Describe maintenance of house drainage.– L2
44 Explain Drainage traps.– L2

After learning all the topics of UNIT– III, the student is able to

33 Define Physical, Chemical and Biological characteristics, typical wastewater characteristics.– L1
34 Explain the Biological treatment process-Aerobic and Anaerobic activity.– L2
35 Describe CNS cycles. BOD and COD.– L2
36 Explain the significance & problems on BOD.– L2
37 Explain the Disposal by dilution-self-purification phenomenon. – L3
38 Describe Oxygen sag curve.– L1
39 Illustrate the Zones of purification. – L3
40 Describe the Sewage farming. – L3
41 Summarize about sewage sickness – L2
42 Explain the Effluent standards for Disposal on to land & in to surface waters.. – L2

After learning all the topics of UNIT– IV, the student is able to

43 Explain the importance of treatment, methods of treatment. – L1
44 Describe Flow diagram of conventional municipal sewage treatment plant. – L2
45 Analyze Operational problems in filters. – L4
46 Discuss under drainage system, back washing of filters. – L2
47 Discuss theory of disinfection. – L2
48 Describe Chlorination. – L2
49 List types of disinfection – L1
50 Explain chlorine demand. – L2
51 Explain residual chlorine. – L2
52 Explain the use of bleaching powder. – L2

After learning all the topics of UNIT– V, the student is able to

53 Discuss the methods of removal of hardness by lime soda process and zeolite process. – L2
54 Summarize the fluoridation and de fluoridation.– L2
55 Analyze the service reservoir capacity determination. – L4
56 Define the Water softening. – L1
57 List the type of fire hydrants – L1
58 List the Pipe appurtenances, various valves – L1
59 Explain the Removal of colour, odor and taste. – L2
60 Discuss the Layout of water supply pipes in buildings. – L2
61 Discuss the adsorption technique. – L2
62 Explain the methods of layout of distribution systems. – L2

Review Questions

1.	Explain the different types of water carriage system with their merits and demerits
2.	Explain self-cleansing and non-scouring velocities
3.	Explain how the sewers are classified
4.	Define runoff. Explain the various factors in which the quantity of runoff depends
5.	A town with a population of 30,000 on an area of 60 hectares is supplied with water of 120

	lp-cd. If the co-efficient of runoff for the area is 0.6 and time of concentration is 30 minutes. Calculate the discharge for which the sewers of a proposed combined system will be designed
6.	What are the points to be considered while selecting the sewer material? Briefly explain them
7.	A 40 cm diameter sewer is to flow at 0.4 depth on a grade ensuring a degree of self cleansing equivalent to that obtained at full depth at a velocity of 80cm/sec. Find : i) the required grade ii)associated velocity iii) the rate of discharge at this depth Given: i) Mannings rugosity co-efficient = 0.014 ii)Proportionate area = 0.252. iii) Proportionate HMD (r/R) = 0.684
8.	With a neat sketch, explain the components, working and operation troubles of a manhole
9.	A town with a population of 60000 is supplied with 180 lpcd of water. A separate sewer from, this town enters a pumping station through a low level sewer at R.L. 120.00 m. This sewage is to be pumped to a high level sewer at R.L. 129.00 m. Assuming that 80% of water reaches sewer. Determine, i) size of pump well ii) B.H.P. of pump motor required and iii) size of the rising main, if the length is 120 m. Assume suitable data wherever required.
10.	Explain the self-Purification Phenomenon stream with the help of sketch.
11.	Differentiate between BOD and COD
12.	Differentiate between Aerobic and anaerobic decomposition
13.	Differentiate between Hydraulic loading and organic loading
14.	5ml of raw sewage was diluted by specially prepared water in 300 ml capacity BOD bottle. The DO concentration of diluted sample at the beginning of test was 9mg/L and 6mg/L after 5-day incubation at 20^0C. Find the BOD of raw sewage
15.	Differentiate between attached growth processes and suspended growth processes. List various treatment techniques falling under each category
16.	Write a schematic diagram of attached growth process in a trickling filter, mark the salient features.
17.	Explain the various trickling filter troubles and remedial measures for the same.
18.	With a flow diagram, explain the primary and secondary treatment practiced in a waste water treatment plant. Briefly explain various unit operations and unit processes and their functions
19.	Design a primary classifier of rectangular shape for a population of 50,000, with a water supply of 180 lp-cd
20.	With a neat sketch, explain the working of a anaerobic sludge digester
21.	Design a standard rate trickling filter for the following data. i) Waste water flow from primary clarifier = 5 MLD ii) BOD_5 of raw waste water = 150 mg/L iii) Surface loading rate = 2500 lit/m^2/day iv) Organic loading = 165 g/m^3/day Determine, i) depth ii) volume of filter iii) Efficiency of filter unit using NRC formula.
22.	Explain the system of sewerage with its advantage and disadvantages
23.	Work out the ratio of DWF to WWF having the following data. Area = 30,000 hectares, water supply rate = 200 lpd population = 15 x 10^5. Intensity of rain fall 15 mm/hr Average permeability factor = 0.5. Assume 60% of water supply reaches the sewer. Comments on your results.
24.	Define time of entry and time of flow.
25.	Define self-cleansing and non-scouring velocities.
26.	Calculate the velocity and discharge of the sewer running full. The dia of sewer is 200 mm and laid at a gradient of 1 in 200 apply crimp Burge's formula.
27.	What are the factors to be considered while selection of the materials of sewer?

28.	What are the factors to be considered while selection of the materials of sewer?
29.	A town has a population of 50,000. The average per capita water supply demands 270 lpd. The separate system of sewerage has been provided. Assume that 70% of water reaches the sewerage pumping station. Determine the size of the raising main. Take velocity as 1m /sec and maximum demand as 2.5 times the average demand.
30.	Explain the function of a drop manhole with a neat sketch.
31.	Explain carbon cycle.
32.	Define B.O.D. and list the limitation of B.O.D. test
33.	Explain the self-purification process of a polluted stream.
34.	Write a note on Sewage farming and sewage sickness and preventing measures of it.
35.	Explain unit operations and process flow diagram of municipal waste water treatment.
36.	Design a grit chamber for an average flow of 200 lit/sec make suitable assumptions.
37.	What are the classification of sedimentation tanks and locations of them?
38.	Explain the working of Tickling filters with a neat sketch.
39.	Explain with a flow diagram three basic operations involved in the activated sludge process.
40.	Explain the three stages in sludge digestion.
41.	Explain Importance of Catch basins, manholes
42.	Illustrate Importance of need, types of pump
43.	Explain Typical layout plan showing house drainage connections
44.	Describe maintenance of house drainage
45.	Examine flow variations and factors affecting dry weather flow
46.	Discuss Hydraulic formulae for velocity
47.	Explain the Design of hydraulic elements for circular sewers flowing partially
48.	Discuss the Design of hydraulic elements for circular sewers flowing full.
49.	Explain the Biological treatment process-Aerobic and Anaerobic activity.
50.	Illustrate the Zones of purification
51.	Explain the significance & problems on BOD
52.	Explain the Disposal by dilution-self-purification phenomenon

Lesson Plan

UNIT – I

1. Importance of necessity of sanitation.
2. Systems of sanitation and disposal.
3. Types of sewerage systems and their suitability.
4. Dry weather flow (DWF), factors affecting dry weather flow.
5. Flow variations.
6. Effects on design of sewerage system.
7. Explanation of estimation of storm flow by rational method.
8. Explanation of estimation of storm flow by empirical formulae.
9. Hydraulic formulae for velocity.
10. Effects of flow variations on velocity.
11. Self-cleansing and non-scouring velocities.
12. Design of hydraulic elements for circular sewers flowing full and flowing partially full.

UNIT – II

13. Sewer materials, Selection criteria.
14. Shape of sewers, lying of sewers.
15. Joints and testing of sewers.
16. Ventilation and cleaning of sewers.
17. Importance of Catch basins, manholes.

18. Flushing tanks, oil and grease traps, Drainage traps.
19. Importance of need, types of pump.
20. Problems on power of pumps and rising mains.
21. Typical layout plan showing house drainage connections.
22. Maintenance of house drainage.

UNIT – III

23. Physical, Chemical and Biological characteristics.
24. Typical wastewater characteristics.
25. Explain the Biological treatment process-Aerobic and Anaerobic activity.
26. CNS cycles.
27. BOD and COD.
28. Significance & problems on BOD.
29. Disposal by dilution-self-purification phenomenon.
30. Oxygen sag curve, Zones of purification, Sewage farming,
31. Explain sewage sickness.
32. Effluent standards for Disposal on to land & in to surface waters.

UNIT – IV

33. Importance of treatment, methods of treatment.
34. Flow diagram of conventional municipal sewage treatment plant.
35. Design the under drainage system.
36. Back washing of filters.
37. Operational problems in filters.
38. Theory of disinfection.
39. Types of disinfection.
40. Chlorination, chlorine demand.
41. Residual chlorine.
42. Use of bleaching powder.

UNIT – V

43. Methods of removal of hardness by lime soda process and zeolite process.
44. Removal of colour and odour.
45. Taste, adsorption technique.
46. Fluoridation and de fluoridation.
47. System of supply, service reservoirs.
48. Capacity determination.
49. Methods of layout of distribution systems.
50. Pipe appurtenances and various valves.
51. Type of fire hydrants and pipe fitting.
52. Layout of water supply pipes in buildings.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Outline Importance of necessity of sanitation, Systems of sanitation and disposal, types of sewerage systems and their suitability. – (Unit – I)	L1	M	M	L								
02	Explain the Sewer materials, Selection criteria, shape of sewers, laying of sewers, joints and testing of sewers, ventilation and cleaning of sewers.–(Unit – II)	L2	M	H									
03	Design the under drainage system, back washing of filters, Operational problems in filters. –(Unit – III)	L1	M	M	L								
04	Explain the Biological treatment process-Aerobic and Anaerobic activity, CNS cycles. – (Unit – IV)	L2	M	H									
05	Describe the System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems .– (Unit – V)	L2	M	M	L								

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Outline Importance of necessity of sanitation, Systems of sanitation and disposal, types of sewerage systems and their suitability. – (Unit – I)	L1	1	2	1								
02	Explain the Sewer materials, Selection criteria, shape of sewers, laying of sewers,	L2	2	3									
03	Design the under drainage system, back washing of filters, Operational problems in	L1	2	2	1								
04	Explain the Biological treatment process-Aerobic and Anaerobic activity, CNS cycles. – (Unit – IV)	L2	2	1									
05	Describe the System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems .– (Unit – V)	L2	2	2	3								
06	Outline Importance of necessity of sanitation, Systems of sanitation and disposal, types of sewerage systems and their suitability. – (Unit – I)	L1	2	3									

1-Low, 2-Moderate, 3-High

Course Title : TRANSPORTATION ENGINEERING			
Course Code: P13CV62	**Semester : VI**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Role of railways in transportation, Advantages of Railways, Permanent Way, Requirements of an ideal permanent way, Capacity of Railway Track, Gauges in Railway Track, Selection of Gauges, Uniformity of Gauges, Railway Track Cross-sections, Coning of Wheels,
2. Stress in Railway Tracks; Stresses in Track, Rails, Sleepers and Ballast, Traction and Tractive Resistances, Hauling Capacity of Locomotive,
3. Introduction to airport engineering, Regional planning and Airport site selection Runway Design - Orientation of runway by using wind rose diagram - Basic runway length, Corrections for Elevation, Temperature and Gradient to runway length by ICAO and FAA specification - runway cross sections
4. Taxiway Design: Factors affecting the layout of the taxiway geometrics of taxiway- design of Exit taxiways- ICAO Specifications, Fillets, Separation Clearance, Problems on above. Visual aids: Airport marking, lightings.
5. Geometric Design of the Track-Necessity, Gradient and Grade Compensation, Speed of Train, Radius of Curve, Cant, Cant-Deficiency, Negative Cant, Curves-Effect of curvature, Types of Curves, Necessity of providing Transition Curve, Length of TC, Widening of Gauge on Curves,
6. Points and Crossings- Necessity, Turnouts, Switches, Fixed Heel type, Crossings, Problems on above. Stations and Yards-Site selection for RS, Requirements of RS, Types of Yards, Level Crossings.
7. Introduction to airport engineering, Regional planning and Airport site selection Runway Design - Orientation of runway by using wind rose diagram - Basic runway length, Corrections for Elevation, Temperature and Gradient to runway length by ICAO and FAA specification - runway cross sections.
8. Taxiway Design: Factors affecting the layout of the taxiway geometrics of taxiway- design of Exit taxiways- ICAO Specifications, Fillets, Separation Clearance, Problems on above. Visual aids: Airport marking, lightings.
9. Introduction – types of tunnels, advantages and disadvantages, economics of tunneling, tunnel surveying, transferring of centerline and gradient from the earth surface to inside the tunnel working face. Design of shape and size of tunnel. Methods of tunneling in soft soil Liner Plate Method of tunneling. Tunneling in rock - vertical shafts, pilot tunneling, methods of tunneling in hard rock. Tunnel lining and tunnel ventilation,
10. Harbors-Introductions, classifications, natural phenomenon affecting the design of harbor viz. wind, wave, tide and currents. Harbor layout with component parts, breakwaters, wharfs and Quays, Jetties and Piers, Dry Dock and Wet Dock, Navigational aids.

Course Content

UNIT – I

RAILWAY TRANSPORTATION: Role of railways in transportation, Advantages of Railways, Permanent Way, Requirements of an ideal permanent way, Capacity of Railway Track, Gauges in Railway Track, Selection of Gauges, Uniformity of Gauges, Railway Track Cross-sections, Coning of Wheels, Stress in Railway Tracks**;** Stresses in Track, Rails, Sleepers and Ballast, Traction and Tractive Resistances, Hauling Capacity of Locomotive, Problems on above. **10 Hrs**

UNIT – II

RAILS, SLEEPERS AND BALLAST: Functions of Rails, Requirements, Types of Rail Sections, Comparison of Rail Types, Length of Rails, Rail Failures, Wear on Rails, Methods to reduce wear, Rail Joints, Requirements, types of joints, Welding of Rails and advantages, Creep of Rails, Effects of Creep, Measurement of Creep and remedies, Sleepers-function and requirements, Classification of Sleepers, Comparison of Different types of sleepers, Spacing of Sleepers and Sleeper Density Ballast- Functions and requirements, Types of Ballast, Size and Section of Ballast, Quantity of Ballast and Renewal of Ballast, Materials required for one km length of track, Problems on above **10 Hrs**

UNIT – III

GEOMETRIC DESIGN OF THE TRACK-Necessity, Gradient and Grade Compensation, Speed of Train, Radius of Curve, Cant, Cant-Deficiency, Negative Cant, Curves-Effect of curvature, Types of Curves, Necessity of providing Transition Curve, Length of TC, Widening of Gauge on Curves, Problems on above, Points and Crossings- Necessity, Turnouts, Switches, Fixed Heel type, Crossings, Problems on above. Stations, Yards-Site selection for RS, Requirements of RS, Types of Yards, Level Crossings. **10 Hrs**

UNIT – IV

AIRPORT PLANNING AND RUNWAY DESIGN

Introduction to airport engineering, Regional planning and Airport site selection Runway Design - Orientation of runway by using wind rose diagram - Basic runway length, Corrections for Elevation, Temperature and Gradient to runway length by ICAO and FAA specification - runway cross sections problems on above. Taxiway Design: Factors affecting the layout of the taxiway geometrics of taxiway- design of Exit taxiways- ICAO Specifications, Fillets, Separation Clearance, Problems on above. Visual aids: Airport marking, lightings **10 Hrs**

UNIT – V

TUNNELSAND HARBORS:

Introduction – types of tunnels, advantages and disadvantages, economics of tunneling, tunnel surveying, transferring of centerline and gradient from the earth surface to inside the tunnel working face. Design of shape and size of tunnel. Methods of tunneling in soft soil Liner Plate Method of tunneling. Tunneling in rock - vertical shafts, pilot tunneling, methods of tunneling in hard rock. Tunnel lining and tunnel ventilation, Harbors-Introductions, classifications, natural phenomenon affecting the design of harbor viz. wind, wave, tide and currents. Harbor layout with component parts, breakwaters, wharfs and Quays, Jetties and Piers, Dry Dock and Wet Dock, Navigational aids **12 Hrs**

TEXT BOOK:

1. Railway Engineering- Saxena and Arora, Dhanpat Rai and Sons, New Delhi.
2. Railway Engineering- Satish Chandra and Agarwal, M.M., Oxford University Press, New Delhi
3. Indian railway Track, Agarwal M.M, Jaico Publications, Bombay.

REFERENCE BOOKS:

1. Airport Planning and Design – Khanna, Arora and Jain – Nemchand Roorkee.
2. Dock & Tunnel Engineering- Srinivasan R Harbour, Charotar Publishing House.
3. Docks and Harbour Engineering- Oza H.P. and Oza G.H., Charotar Publishing House.
4. Railway Track Engineering- Antia.

Course Outcomes

After learning all the units of the course, the student is able to

06 Briefly explain the role of railways in the development of our country. – L2 (Unit – I)

07 Discuss different types of rail sections used on BG track with sketches. – L2 (Unit – II)

08 Draw a neat diagram of Left Hand Turnout and show its various components – L3 (Unit – III)
09 Explain briefly the various factors which affect the layout of taxiway– L1 (Unit – IV)
10 Explain Linear Plate Method of tunneling. – L1 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Describe Role of railways in transportation,-L2
2. Explain Advantages of Railways, Permanent Way,-L1
3. Explain Requirements of an ideal permanent way, ,-L1
4. Describe Capacity of Railway Track, ,-L1
5. Define Gauges in Railway Track, ,-L1
6. Explain Selection of Gauges, Uniformity of Gauges, ,-L1
7. Describe Railway Track Cross-sections, ,-L1
8. Define Coning of Wheels, ,-L1
9. Determination Stresses in Track, ,-L1
10. Explain Rails, Sleepers and Ballast, ,-L1
11. Describe Traction and Tractive Resistances,-L1,
12. Problems on above-L1

After learning all the topics of UNIT– II, the student is able to

13. Importance of Functions of Rails, Requirements.-L1
14. List the different types of Rail Sections, Comparison of Rail Types.-L2
15. Define the Length of Rails, Rail Failures.-L1
16. Describe Wear on Rails, Methods to reduce wear-L2
17. Explain Rail Joints, Requirements, types of joints-L1
18. Define Welding of Rails and advantages-L1
19. Explain Creep of Rails, Effects of Creep-L2
20. Explain the function and requirements of Sleepers-L1
21. Classification of Sleepers and Comparison of Different types of sleepers-L2
22. Spacing of Sleepers, Types of Ballast, Size and Section of Ballast-L1

After learning all the topics of UNIT– III, the student is able to

23. Describe Geometric Design of the Track-Necessity,-L1
24. Define Gradient and Grade Compensation,-L2
25. Define Speed of Train, Radius of Curve, Cant, Cant-Deficiency,-L2
26. Describe Negative Cant, Curves-Effect of curvature,-L1
27. Explain Types of Curves, Necessity of providing Transition Curve,-L1
28. Describe Length of TC, Widening of Gauge on Curves,-L1
29. Define Points and Crossings- Necessity,-L2
30. Explain Turnouts, Switches, Fixed Heel type,-L2
31. Describe Crossings, Problems on above.-L1
32. Problems on above.-L2

After learning all the topics of UNIT– IV, the student is able to

33. Describe airport engineering and Regional planning-L2
34. Explain Airport site selection Runway Design – L1
35. Describe the Orientation of runway by using wind rose diagram – L2
36. Define Basic runway length-L2
37. Describe the Corrections for Elevation-L1
38. Explain about Temperature and Gradient to runway length by ICAO and FAA specification – L2
39. Describe Runway cross sections problems on above.-L2
40. Explain the Taxiway Design and factors affecting the layout of the Taxiway geometrics-L1
41. Design of Exit taxiways according to ICAO Specifications-L2
42. Describe the Fillets, Separation Clearance, and Problems on above-L3

After learning all the topics of UNIT– V, the student is able to

43. With neat sketch explain the working sequence involved in needle beam method of tunneling.-L1
44. With neat sketch explain different types of tunnel cross sections, under what situations is a particular cross section is preferred.-L2
45. Explain with neat sketch Forepoling and Needle Beam Method of tunneling in soft soil.-L2
46. Briefly explain the method of tunneling in hard rock.-L2
47. Write short notes on Tunnel Lining and Tunnel ventilation.-L2
48. Distinguish between natural and artificial harbours.-L2
49. How are harbours classified on the basis of location?-L1
50. Define Breakwater and mention its classification.-L2
51. Distinguish between wharfs and quays, jetties and Piers.-L2
52. Distinguish between Dry Dock and Wet Dock.L2

Review Questions

1.	What are disturbed, undisturbed and representative samples? Explain briefly.
2.	Explain any one of the Geophysical methods of sub-surface soil investigation
3.	Explain with respect to sampling tube, with a neat sketch the following : i) Inside clearance ii)Outside clearance
4.	Explain with respect to sampling tube, with a neat sketch the following : i)Area ratio ii) Recovery ratio
5.	List the different methods of control ground water during excavation, explain any two methods
6.	Estimate the position of ground water table from the following data obtained from the field. Depth up to which water is bailed out in 30 m. Raise in water levels; on 1st day 2.2 m, 2nd day 1.8 m and 3rd day 1.5 m
7.	Explain the terms 'pressure bulb' and 'isobar'
8.	A point load of 1000 kN acts at the ground surface. Compute the vertical stress at 6 m depth i) on the axis of load ii) 1.5 m away from the axis. Use Westgaurd analysis Take $\mu = 0.3$
9.	A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160 kN/m^2. Computer the vertical stress induced at a depth of 4m below the centre of ring foundation
10.	Mention the properties and uses of flownets.
11.	Explain the method of locating phreatic line in an earth dam on impermeable boundary with downstream horizontal filter.
12.	Explain the method of locating phreatic line in an earth dam on impermeable boundary with downstream horizontal filter
13.	Explain the method of locating phreatic line in an earth dam on impermeable boundary with downstream horizontal filter.
14.	State the assumptions made in Rankine's theory for active earth pressure
15.	Describe Culmann's graphical method of finding the active earth pressure on a retaining wall with a grannular backfill.
16.	A retaining wall 4m high, has a smooth, vertical back.. The backfill has a horizontal surface in level with the top of the wall. There is uniformly distributed surcharge load of 36 kN/m^2 intensity over the backfill. The unit weight of the backfill is 18 kN/m^3. Its angle of shearing resistance is 30º and cohesion is zero. Determine the magnitude and point of application of active pressure per meter length of the wall.
17.	Mention the types of slope failure and various causes of slope failure.
18.	Explain the friction circle method of stability analysis for slopes.
19.	An embankment is to be constructed with C = 20 kN/m^2, ϕ = 20º and γ = 20 kN/m^3,

	F.S = 1.25, Height = 10 m. Estimate required side slope. Taylor's stability numbers are as follows.

.Slope Angle	90	75	60	45	30	20	0
Taylor stability number in	0.182	0.134	0.097	0.062	0.025	0.005	0

	Also find the factor of safety if the slope if 1V:2H for $\phi = 20^{\circ}$.
20.	Define ultimate, net, safe and allowable bearing capacity
21.	Explain with a neat sketch, the effect of ground water table on bearing capacity
22.	A square footing is to be constructed on a deep deposit of sand at a depth of 0.9 m to carry a design load of 3000 kN, with a factor of safety 2.5. Ground water table may rise to ground level during rainy season. Design the plan dimensions of the footing, given : $\gamma_{sat} = 20$ kN/m^3, $N_C = 25$, $N_q = 34$, $N_r = 32$
23.	Explain the terms: Immediate settlement, consolidation settlement and second consolidation settlement.
24.	Determine the elastic settlement of a footing 3m x 3m resting on a sandy 80%. Given E_S = 45000 kN/m^2, $\mu = 0.3$, footing carries a load of 2000 kN, $I_W = 0.82$ (rigid)
25.	The time to reach 40% consolidation is 32.5 sec for a sample of 1 cm thick tested in the laboratory under conditions of double drainage. How long will the corresponding layer in the field to reach the same degree of consolidation if it is 10m thick and drained on one side only.
26.	What is permanent way? What are the ideals requirements of permanent way?
27.	With a neat sketch and dimensions draw a typical cross-section of a broad gauge straight track in cutting for a double line.
28.	Mention the relative merits and demerits of flat footed rails and Bull headed rails.
29.	What is meant by wear of rails? Discuss the various causes of wear and suggest suitable measures to reduce the effect of wear on rails.
30.	Calculate the Quantity of materials required for the construction of B.G. track of length 5 km using the following data: Rail section: 52 kg of standard length 13 m. Sleeper density: (m+4).
31.	Calculate the maximum permissible train load that can be pulled by a locomotive having four pairs of driving wheels carrying an axle load of 24 tons each. The train has to run at a speed of 80 kmph on a straight level track (B.G). Also calculate the reduction in speed, if train has to climb a Gradient of 1 in 200.
32.	Explain: i) Ruling Gradient
33.	Explain ii) Momentum Gradient
34.	Explain iii) Gradients in station yards.
35.	Define superelevation.
36.	A 5º curve diverges from a 3º main curve in reverse direction in the layout of a B.G. yard. If the speed on the branch line is restricted to 35 kmph, determine the restricted speed on the main line.
37.	Draw a neat sketch of left hand turnout and show the various parts on it.
38.	If a cross-over occurs between two M.G. parallel tracks of same crossing number 1 in 12 with straight intermediate position between the reverse curves and the distance between the centres of tracks is 3.5 m. Find the intermediate straight distance and overall length of cross over.
39.	With the aid of neat sketch explain the types of marshalling yard.
40.	What are the important factors to be considered while selecting a site for an airport? Explain
41.	The length of runway under standard conditions is 1620 m. The airport site has an elevation of 270 m. Its reference temperature is 32º.90C. If the runway is to be constructed with an effective Gradient of 0.2%. Determine the corrected runway length
42.	Explain briefly the various factors which affect the layout of taxiway.
43.	Design an exit taxiway joining a runway of 45 m width and a parallel main taxiway of 22.5 m

	width. The total angle of turn is 30º and the turn off speed is 80 kmph. Check the stopping distance if the separation clearance is 198.7 m.
44.	Write short notes on Airport marking
45.	What is a tunnel? What are the advantages and disadvantages of a tunnel?
46.	Explain the fore poling method of tunneling.
47.	Write a note on tunnel ventilation.
48.	Draw a neat sketch of Harbour layout with component parts..
50.	What are tides and how it affects the harbor structures?
51.	What is break water? How it is constructed?
52.	Design of Exit taxiways according to ICAO Specifications

Lesson Plan

UNIT – I

1. Role of railways in transportation, Advantages of Railways,
2. Permanent Way, Requirements of an ideal permanent way,
3. Capacity of Railway Track, Gauges in Railway Track,
4. Selection of Gauges, Uniformity of Gauges,
5. Railway Track Cross-sections,
6. Coning of Wheels,
7. Stresses in Track,
8. Rails, Sleepers and Ballast,
9. Traction and Tractive Resistances,
10. Hauling Capacity of Locomotive, Problems on above.

UNIT – II

11. Functions of Rails, Requirements, Types of Rail Sections,
12. Comparison of Rail Types, Length of Rails, Rail Failures,
13. Wear on Rails, Methods to reduce wear,
14. Rail Joints, Requirements, types of joints, Welding of Rails and advantages,
15. Creep of Rails, Effects of Creep, Measurement of Creep and remedies,
16. Sleepers-function and requirements,
17. Classification of Sleepers, Comparison of Different types of sleepers,
18. Spacing of Sleepers and Sleeper Density
19. Ballast- Functions and requirements, Types of Ballast, Size and Section of Ballast,
20. Problems on above.

UNIT – III

21. Geometric Design of the Track-Necessity,
22. Gradient and Grade Compensation, Speed of Train,
23. Radius of Curve, Cant, Cant-Deficiency,
24. Negative Cant, Curves-Effect of curvature,
25. Types of Curves, Necessity of providing Transition Curve, Length of TC,
26. Widening of Gauge on Curves, Problems on above,
27. Points and Crossings- Necessity, Turnouts,
28. Switches, Fixed Heel type, Crossings, Problems on above.
29. Types of Yards, Level Crossings.
30. Problems on above

UNIT – IV

31. Introduction to airport Engineering, Regional planning and
32. Airport site selection
33. Runway Design - Orientation of runway by using wind rose diagram –

34. Basic runway length, Corrections for Elevation, Temperature and Gradient to runway length Runway cross sections problems on above.
35. Taxiway Design: Factors affecting the layout of the taxiway geometrics of taxiway-
36. Design of Exit taxiways- ICAO Specifications,
37. Fillets, Separation Clearance,
38. Problems on above.
39. Visual aids: Airport marking, lightings

UNIT – V

40. Introduction, types of tunnels, advantages and disadvantages,
41. Economics of tunneling, tunnel surveying,
42. Transferring of centerline and gradient from the earth surface to inside the tunnel working face.
43. Design of shape and size of tunnel.
44. Methods of tunneling in soft soil Liner Plate Method of tunneling.
45. Tunneling in rock - vertical shafts,
46. Pilot tunnelling, methods of tunneling in hard rock.
47. Tunnel lining and tunnel ventilation,
48. Harbors-Introductions, classifications,
49. Natural phenomenon affecting the design of harbor viz. wind, wave, tide and currents.
50. Harbor layout with component parts, breakwaters,
51. Wharfs and Quays, Jetties and Piers,
52. Dry Dock and Wet Dock, Navigational aids.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	b	c	d	e	f	g	h	i	j	k
01	Briefly explain the role of railways in the development of our country. – (Unit – I)	**L2**	**L**	**M**	**H**								
02	Discuss different types of rail sections used on BG track with sketches – (Unit – II)	**L1**	**L**	**M**	**H**								
03	Draw a neat diagram of Left Hand Turnout and show its various components.– (Unit – III)	**L2**	**L**	**M**	**H**								
04	Explain briefly the various factors which affect the layout of taxiway. – (Unit – IV)	**L2**	**L**	**M**									
05	Explain Linear Plate Method of tunnelling – (Unit – V)	**L2**	**L**	**M**	**H**								

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	b	c	d	e	f	g	h	i	j	k
01	Briefly explain the role of railways in the development of our country. – (Unit – I)	**L2**	**1**	**2**	**3**								
02	Discuss different types of rail sections used on BG track with sketches – (Unit – II)	**L1**	**1**	**2**	**3**								
03	Draw a neat diagram of Left Hand Turnout and show its various components.– (Unit – III)	**L2**	**1**	**2**	**3**								
04	Explain briefly the various factors which affect the layout of taxiway. – (Unit – IV)	**L2**	**1**	**2**									
05	Explain Linear Plate Method of tunnelling – (Unit – V)	**L2**	**1**	**2**	**3**								

1-Low, 2-Moderate, 3-High

Course Title : GEOTECHNICALENGINEERING-II			
Course Code: P13CV63	**Semester : VI**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Know the importance of exploration program and methods of soil exploration; study the types of soil samples & Samplers and to understand the Stabilization of boreholes. To locate the ground water table in fine and coarse grained soils and to know the control of ground water during excavation.
2. Understand Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads. Draw Pressure distribution diagrams of Boussinesq's and Westergaard's theories. To know characteristics and uses of flownets, Methods of drawing flownets for Dams and sheet piles. To determine the phreatic line in earth dams with and without filter.
3. Understand Active and passive earth pressures, Earth pressure at rest & Earth pressure coefficient. To Understand Earth pressure theories- Rankine's and Coulomb's –assumptions and limitations. To Know Graphical solutions for active earth pressure. To Determine Lateral earth pressure in cohesive and cohesion less soils.
4. Know types of slopes and causes and type of failure of slopes. To Understand Stability of finite and infinite slopes.
5. Definition of ultimate, net and safe bearing capacities & Allowable bearing pressure. Terzaghi's and Brinch Hansen's bearing capacity equations-assumptions and limitations. Bearing capacity of footing subjected to eccentric loading. Effect of ground water table on bearing capacity. Plate load test, Standard penetration test, cone penetration test. Settlement Analysis, Data for settlement analysis, computation of settlement, Consolidation and secondary settlements Tolerance. BIS specifications for total and differential settlements of footings and rafts.

Course Content

UNIT – I

SUBSURFACE EXPLORATION: Importance of exploration program, Methods of exploration: Boring, sounding tests, geophysical methods- Electrical resistivity and Seismic refraction methods. Types of samples, undisturbed, disturbed and representative samples Samplers, sample disturbance, area ratio, Recovery ratio, clearance ratios, Stabilization of boreholes - Typical bore log. Number and depth of borings for various civil engineering structures, soil exploration report.

DRAINAGE AND DEWATERING: Location of ground water table in fine and coarse grained soils. Determination of ground water level by Hvorselev's method. Control of ground water during excavation: Dewatering- Ditches and sumps, well point system, Shallow well system, Deep well system, Vacuum Method, Electro- Osmosis method. **12 Hrs**

UNIT – II

STRESSES IN SOILS: Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads. Comparison of Boussinesq's and Westergaard's analysis. Pressure distribution diagrams, contact pressure, Newark's chart

FLOWNETS: Laplace equation (no derivation) assumptions and limitations only, characteristics and uses of flownets, Methods of drawing flownets for Dams and sheet piles. Estimating quantity of seepage and Exitgradient. Determination of phreatic line in earth dams with and without filter. Piping and protective filter, graded filter **10 Hrs**

UNIT – III

LATERAL EARTH PRESSURE: Active and passive earth pressures, Earth pressure at rest, Earth pressure coefficient. Earth pressure theories- Rankine's and Coulomb's –assumptions and limitations, Graphical solutions for active earth pressure (cohesion less soil only) –Culmann's and Rebhann's methods Lateral earth pressure in cohesive and cohesion less soils, Earth pressure distribution.

10 Hrs

UNIT – IV

STABILITY OF EARTH SLOPES: Types of slopes, causes and type of failure of slopes. Definition of factor of safety, Stability of finite and infinite slopes- Method of slices, Friction Circle method, Fellineous method, Taylor's stability number **10 Hrs**

UNIT – V

BEARING CAPACITY: Definitions of ultimate, net and safe bearing capacities, Allowable bearing pressure. Terzaghi's and Brinch Hansen's bearing capacity equations-assumptions and limitations Bearing capacity of footing subjected to eccentric loading. Effect of ground water table on bearing capacity. Plate load test, Standard penetration test, cone penetration test

FOUNDATION SETTLEMENT: Settlement Analysis, Data for settlement analysis, computation of settlement, Concept, immediate, consolidation and secondary settlements (no derivations), Tolerance. BIS specifications for total and differential settlements of footings and rafts. **10 Hrs**

TEXT BOOK:

1. Soil Engineering in Theory and Practice- Alam Singh and Chowdhary G.R. (1994), CBS Publishers and Distributors Ltd., New Delhi.
2. Soil Mechanics and Foundation Engg.- Punmia B.C. (2005), 16thEdition Laxmi Publications Co. , New Delhi.
3. Soil Mechanics and Foundation Engineering- Murthy V.N.S.(1996), 4th Edition, UBS Publishers and Distributors, New Delhi.

REFERENCE BOOKS:

1. Foundation Analysis and Design- Bowles J.E. (1996), 5th ediition, McGraw Hill Pub. Co. New York.
2. Basic and Applied Soil Mechanics- Gopal Ranjan and Rao A.S.R.(2000), New Age International (P) Ltd., New Delhi.
3. Geotechnical Engineering- Venkatrahmaiah C. (2006), 3rd Edition New Age International (P) Ltd., New Delhi

Course Learning Outcome

After learning all the units of the course, the student is able to

01 Explain the importance of exploration program and methods of soil exploration. – L2 (Unit – I)
02 Explain Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads.. – L2 (Unit – II)
03 Explain Active and passive earth pressures, Earth pressure at rest & Earth pressure coefficient.. – L2(Unit – III)
04 List types of slopes. – L1 (Unit – IV)
05 Define of ultimate, net and safe bearing capacities & Allowable bearing pressure.– L2(Unit – V)

Topic Learning Outcome

After learning all the topics of UNIT – I, the student is able to

1. Explain the importance of exploration program and methods of soil exploration.
2. List the types of soil samples & Samplers.
3. Describe the Stabilization of boreholes.
4. Locate the ground water table in fine and coarse grained soils.
5. Explain the control of ground water during excavation.

After learning all the topics of UNIT – II, the student is able to

6. Explain Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads.
7. Draw Pressure distribution diagrams of Boussinesq's and Westergaard's theories.
8. List characteristics and uses of flownets, Methods of drawing flownets for Dams and sheet piles.
9. Determine the phreatic line in earth dams with and without filter.

After learning all the topics of UNIT – III, the student is able to

10. Explain Active and passive earth pressures, Earth pressure at rest & Earth pressure coefficient.
11. Describe Earth pressure theories- Rankine's and Coulomb's –assumptions and limitations.
12. explain Graphical solutions for active earth pressure
13. Determine Lateral earth pressure in cohesive and cohesion less soils

After learning all the topics of UNIT – IV, the student is able to

14. List types of slopes.
15. Describe Causes and type of failure of slopes.
16. Explain Stability of finite and infinite slopes.

After learning all the topics of UNIT – V, the student is able to

17. Define ultimate, net and safe bearing capacities & Allowable bearing pressure.(L1)
18. Explain Terzaghi's and Brinch Hansen's bearing capacity equations-assumptions and limitations
19. Describe Bearing capacity of footing subjected to eccentric loading
20. Explain the Effect of ground water table on bearing capacity.
21. Explain Plate load test, Standard penetration test, cone penetration test.
22. Describe Settlement Analysis,
23. Explain settlement analysis, computation of settlement,
24. Explain Consolidation and secondary settlements Tolerance.
25. Explain BIS specifications for total and differential settlements of footings and rafts.

Review questions

1	What are disturbed, undisturbed and representative samples? Explain briefly.
2	Explain any one of the Geophysical methods of sub-surface soil investigation.
3	Explain with respect to sampling tube, with a neat sketch the following : i) Inside clearance ii)Outside clearance iii) area ratio iv) Recovery ratio
4	List the different methods of control ground water during excavation, explain any two methods.
5	Estimate the position of ground water table from the following data obtained from the field. Depth up to which water is bailed out in 30 m. Raise in water levels; on 1st day 2.2 m, 2nd day 1.8 m and 3rd day 1.5 m.
6	Explain the terms 'pressure bulb' and 'isobar'
7	A point load of 1000 kN acts at the ground surface. Compute the vertical stress at 6 m depth i) on the axis of load ii) 1.5 m away from the axis. Use Westgaurd analysis Take $\mu = 0.3$
8	A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160 kN/m^2. Computer the vertical stress induced at a depth of 4m below the centre of ring foundation
9	Mention the properties and uses of flownets.
10	Explain the method of locating phreatic line in an earth dam on impermeable boundary with downstream horizontal filter.
11	What is exist gradient? How do you estimate quantity of seepage?
12	State the assumptions made in Rankine's theory for active earth pressure.
13	Describe Culmann's graphical method of finding the active earth pressure on a retaining wall with a grannular backfill.

<table>
<tr><td>14</td><td>A retaining wall 4m high, has a smooth, vertical back.. The backfill has a horizontal surface in level with the top of the wall. There is uniformly distributed surcharge load of 36 kN/m^2 intensity over the backfill. The unit weight of the backfill is 18 kN/m^3. Its angle of shearing resistance is 30º and cohesion is zero. Determine the magnitude and point of application of active pressure per metre length of the wall.</td></tr>
<tr><td>15</td><td>Mention the types of slope failure and various causes of slope failure.</td></tr>
<tr><td>16</td><td>Explain the friction circle method of stability analysis for slopes.</td></tr>
<tr><td>17</td><td>An embankment is to be constructed with C = 20 kN/m^2, ϕ = 20º and γ = 20 kN/m^3, F.S = 1.25, Height = 10 m. Estimate required side slope. Taylor's stability numbers are as follows.
<table>
<tr><td>.Slope Angle</td><td>90</td><td>75</td><td>60</td><td>45</td><td>30</td><td>20</td><td>0</td></tr>
<tr><td>Taylor stability number in</td><td>0.182</td><td>0.134</td><td>0.097</td><td>0.062</td><td>0.025</td><td>0.005</td><td>0</td></tr>
</table>
Also find the factor of safety if the slope if IV:2H for ϕ = 20º</td></tr>
<tr><td>18</td><td>Define ultimate, net, safe and allowable bearing capacity</td></tr>
<tr><td>19</td><td>Explain with a neat sketch, the effect of ground water table on bearing capacity</td></tr>
<tr><td>20</td><td>A square footing is to be constructed on a deep deposit of sand at a depth of 0.9 m to carry a design load of 3000 kN, with a factor of safety 2.5. Ground water table may rise to ground level during rainy season. Design the plan dimensions of the footing, given : γ_{sat} = 20 kN/m^3, N_C =25, N_q = 34, N_r = 32.</td></tr>
<tr><td>21</td><td>Explain the terms : Immediate settlement, consolidation settlement and second consolidation settlement.</td></tr>
<tr><td>22</td><td>Determine the elastic settlement of a footing 3m x 3m resting on a sandy 80%. Given E_S = 45000 kN/m^2, μ = 0.3, footing carries a load of 2000 kN, I_W = 0.82 (rigid).</td></tr>
<tr><td>23</td><td>The time to reach 40% consolidation is 32.5 sec for a sample of 1 cm thick tested in the laboratory under conditions of double drainage. How long will the corresponding layer in the field to reach the same degree of consolidation if it is 10m thick and drained on one side only.</td></tr>
<tr><td>24</td><td>What are the Obligations of soil exploration?</td></tr>
<tr><td>25</td><td>Explain in detail how a geotechnical report is prepared for a major project.</td></tr>
<tr><td>26</td><td>Describe the method of conducting SPT as per BIS code.</td></tr>
<tr><td>27</td><td>Explain the following methods of controlling ground water during examination.
(i) Shallow well system (ii) Electro osmosis method</td></tr>
<tr><td>28</td><td>Explain briefly how you locate ground water label in fine and coarse grained soils.</td></tr>
<tr><td>29</td><td>Explain the determination of ground water level by HVORSELEV's Method</td></tr>
<tr><td>30</td><td>Bring out clearly the difference between Bousinesq's and Westergaurd's analysis for the determination of stress in soil mass due to point load. Give respective equation.</td></tr>
<tr><td>31</td><td>Explain in detail the construction of Newmark's influence chart with an influence value of 0.005.</td></tr>
<tr><td>32</td><td>A concentrated load of 10 kN acts on the surface of a soil mass. Using Boussinesq's analysis find the vertical stress at points (i) 3M below the surface on the axis of loading and (ii) at radial distance of 2M from axis of loading but at same depth of 3M.</td></tr>
<tr><td>33</td><td>Mention the properties and uses of flow nets.</td></tr>
<tr><td>34</td><td>Explain the method of locating phreatic line in an earthen dam on impermeable boundary with down steam horizontal filter.</td></tr>
<tr><td>35</td><td>What is Oxit gradient? How do you estimate the quantity of seepage?</td></tr>
<tr><td>36</td><td>State the assumptions made in Rankine's theory for active earth pressure.</td></tr>
<tr><td>37</td><td>Describe Culmann's graphical method of finding the active earth pressure on a retaining wall with a granular backfill.</td></tr>
<tr><td>38</td><td>Compute the intensities of active and passive earth pressure at a depth of 8M in dry cohesion less sand with an angle of internal friction of 30°and unit weight of 18 kN/m^3. What will be the intensities of active & passive earth pressure if the water level rises to the ground level? Take</td></tr>
</table>

	saturated unit weight of sand as 22 kN/m^3.
39	Mention the types of slope failure and various causes for slope failure.
40	Explain the friction circle method of stability analysis for slopes.
41	A 5M deep canal has side slopes of 1:1 The properties of soil are C_u = 20 kN/m^2, $\phi u = 10°$, e = 0.8 and G =2.8 If the Taylor's stability number is 0.108, determine the factor of safely with respect of cohesion, when the canal runs full, Also find the same in case of sudden draw down. If the Taylor's stability number for this condition is 0.137.
42	What are the assumptions made in Terzaghi's bearing capacity theory?
43	Explain method of conducting field plate load test. Discuss the validity of the test results in the design of foundation.
44	A square footing 2.5 M by 2.5 m is built in a homogeneous bed of sand of unit weight 20 kN/m^3 and having an angle of shearing resistance of 36°. The depth of the base of the footing is 1.5 m below the ground surface. Calculate the safe load that can be carried by a footing with a factor with a factor of safety of 3 against complete shear failure. Use Terzaghi's analysis. Take N_c = 65.4, N_q = 49.4, and N_r = 54.
45	Explain the terms: Immediate settlement, consolidation settlement and secondary consolidation settlement.
46	In a consolidation test void ratio decreased from 0.7 to 0.65 when the load was changed from 50 kN/m^2 to 10 kN/m^2. Compute compression index and co-efficient of volume change.
47	A serial sample 20 mm thick takes 20 minutes to reach 20% consolidation. Find the time taken for a clay layer 6 mm thick to reach 40% consolidation. Assume double drainage in both the cases.

Lesson plan

UNIT – I

1. Know the importance of exploration program
2. methods of soil exploration.
3. Study the types of soil samples & Samplers.
4. Understand the Stabilization of boreholes.
5. Locate the ground water table in fine and coarse grained soils.
6. Know the control of ground water during excavation.
7. Number and depth of borings for various civil engineering structures,
8. soil exploration report.
9. Determination of ground water level by Hvorselev's method
10. Control of ground water during excavation.
11. Dewatering- Ditches and sumps, well point system, Shallow well system, Deep well system,
12. Vacuum Method, Electro- Osmosis method.

UNIT – II

13. Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads
14. Comparison of Boussinesq's and Westergaard's analysis
15. Pressure distribution diagrams
16. contact pressure
17. Newark's chart
18. Laplace equation (no derivation) assumptions and limitations only
19. characteristics and uses of flownets
20. Methods of drawing flownets for Dams and sheet piles.
21. Estimating quantity of seepage and Exit gradient
22. Determination of phreatic line in earth dams with and without filter

UNIT – III

23. Active earth pressure
24. Passive earth pressure
25. Earth pressure at rest
26. Earth pressure coefficient
27. Earth pressure theories- Rankine's and Coulomb's –assumptions and limitations
28. Graphical solutions for active earth pressure (cohesion less soil only)
29. Culmann's and Rebhann's methods
30. Lateral earth pressure in cohesive and cohesion less soils
31. Earth pressure distribution.
32. Numerical problems.

UNIT – IV

33. Types of slopes
34. causes of failure of slopes
35. type of failure of slopes.
36. Definition of factor of safety
37. Stability of finite and infinite slopes
38. Method of slices
39. Friction Circle method
40. Fellineous method
41. Taylor's stability number
42. Numerical problems

UNIT – V

43. Definitions of ultimate, net and safe bearing capacities, Allowable bearing pressure
44. Terzaghi's and Brinch Hansen's bearing capacity equations-assumptions and limitations
45. Bearing capacity of footing subjected to eccentric loading.
46. Effect of ground water table on bearing capacity
47. Plate load test, Standard penetration test, cone penetration test.
48. Settlement Analysis
49. Data for settlement analysis
50. computation of settlement
51. Concept of immediate, consolidation and secondary settlements
52. BIS specifications for total and differential settlements of footings and rafts.

Course Articulation Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the importance of exploration program and methods of soil exploration.(Unit – I)	L2	**L**										
02	Explain Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads.(Unit – II)	L2	**H**	**M**	**L**								
03	Explain Active and passive earth pressures, Earth pressure at rest & Earth pressure coefficient.(Unit – III)	L2	**H**	**L**									
04	List types of slopes.(Unit – IV)	L1	**H**	**M**	L								
05	Define of ultimate, net and safe bearing capacities & Allowable bearing pressure.(Unit – V)	L2	**H**	**L**	M								

The course learning outcomes (CLOs) are achieved through topic learning outcomes (TLOs)

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the importance of exploration program and methods of soil exploration. (Unit – I)	L2	**2**										
02	Explain Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads.(Unit – II)	L2	**2**	**2**	1								
03	Explain Active and passive earth pressures, Earth pressure at rest & Earth pressure coefficient.(Unit – III)	L2	**2**	**2**	**1**								
04	List types of slopes. (Unit – IV)	L1	**1**	**1**									
05	Define of ultimate, net and safe bearing capacities & Allowable bearing pressure.(Unit – V)	L2	**2**	**2**	1								

1-Low, 2-Moderate, 3-High

Course Title : IRRIGATION ENGINEERING AND HYDRAULIC STRUCTURES			
Course Code: P13CV64	**Semester : VI**	**L-T-P-H: 4 – 0 – 0 - 4**	**Credits:4**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Understand the significance of Irrigation, types of irrigation, quality of irrigation water,potential and development of irrigation in India. Also gaining knowledge about crops- water requirement, crop period, Duty and Delta of crop, Relationship between Duty and Delta, factors affecting Duty,utilization of irrigation water, irrigation efficiency, frequency of irrigation.
2. Gain the knowledge about Canal- Definition, types , alignment, sediment transport, Design of stable channels, cross section of canal, maintenance of canal, lining of irrigation canal,. Also knows about cross drainage works- Definition, types, culverts and small bridges, canal regulation and escapes, afflux,causeways and Box culverts, derivation of Discharge passing through Broad crested formula and Orifice formula.
3. Having proficiency about Gravity dam- Definition, typical cross section, factors governing the selection of a dam, various forces acting on a Gravity dam,modes of failures, Principal stresses and shear stresses, elementary profile of a Gravity dam, High and Low Gravity dam, two dimensional stability analysis , inspection galleries. Also knows about spillways- Definition, types, Ogee spillway- Design of crest, dischargecalculation, Energy dissipaters, standard stilling basins, USBR stilling basins II & IV, crest gates and its types.
4. Learn about concepts of earthen dam- Introduction, types, causes of failure, seepage control and its types. Also learn about tank irrigation- Definition, Isolated tanks and series of tanks, surplus escape weirs, typical cross section, Design principles, tank sluices- introduction, typical cross section.
5. Understand Ground water irrigation through open wells- Geological factors controlling occurrence of ground water, types, yield of an open well, tube well – types, boring of tube well, spacing of tube well, failure and life of a tube well, pumping arrangements, advantages and disadvantages of tube well irrigation over canal irrigation.

Course Content

UNIT – I

IRRIGATION AND WATER REQUIREMENT OF CROPS.

Introduction , Definition, necessity of Irrigation, Advantages and Disadvantages of irrigation, Types of Irrigation – surface and sub-surface, Methods of Irrigation, Problems, Quality of Irrigation water, Potential and Development. Water Requirement of crops- crop period, Duty and Delta of a crop, Relationship between Duty and Delta, Factors affecting Duty, Optimum utilization of Irrigation water, Irrigation efficiency, soil moisture irrigation relationship, Frequency of Irrigation, Problems.

12 Hrs

UNIT – II

CANALS AND CROSS DRAINAGE WORKS.

Canals –Definition, Types, Alignment of Canals, Canal system, sediment transport, Mechanics of sediment transport, Design of stable channels- Kenndy's theory and Lacey's theory, Problems.

Cross section of an Irrigation channel, Maintenance of Irrigation canal, Lining of Irrigation canal, canal regulation, canal regulator. Cross Drainage works- Definition, Types, construction of Culverts and small Bridges, Afflux, Derivation of Discharge passing through Broad crested formula and Orifice formula, causeways and Box culverts, canal escapes , metering flumes **12 Hrs**

UNIT – III

GRAVITY DAM AND SPILLWAYS.

Introduction , Definition, factors governing the selection of a dam, Typical cross section, Forces acting on

Gravity dam, modes of failures, Principal shear and stresses, Problems, Two dimensional stability analysis by Analytical method, Elementary profile of a gravity dam, High and low gravity dam, galleries. Spillway – Definition, Types, Ogee spillway- Design of crest, Discharge calculation, Energy dissipaters, standard stilling basin, U S B R stilling basins II & IV, spillway crest gates and its types. **12 Hrs**

UNIT – IV

EARTHEN DAM AND TANK IRRIGATION.

Introduction , Types of Earthen dams, Causes of failure of Earthen dams, seepage control and its types. Tank irrigation- Definition, Isolated tanks and tanks in series, surplus escape weirs, Typical cross section, Design principles, Problems. Tank sluices , typical cross sections. **8 Hrs**

UNIT – V

GROUND WATER FOR IRRIGATION THROUGH WELLS AND BORE WELLS.

Definition, Geological factors controlling occurrence of Ground water, Wells- Types, yield of an open well, Problems. Tube well- Types, Boring of tube well, spacing of tube wells, failure and life of a tube well, Pumping arrangements, Advantages and Disadvantages of Tube well irrigation over canal irrigation. **8 Hrs**

TEXT BOOK:

1. Irrigation engineering and hydraulic structure – S.K. GERG
2. Irrigation engineering and hydraulic structure– B.C. Punmia
3. Irrigation engineering and hydraulic structure–Ramamrutham

REFERENCE BOOKS:

1. Irrigation engineering and hydraulic structure – P.M Modi and S.M. Seth
2. Irrigation and water power engineering –B.C.Punmia

Course Learning Outcome

After learning all the units of the course, the student is able to

1. Explain the significance of Irrigation, types of irrigation, quality of irrigation water,potential and development of irrigation in India. L2 (Unit – I)
2. Explaintypes of canal, canal Alignment, sediment transport, Design of stable channels, cross section of canal, maintenance of canal, lining of irrigation canal.– L2 (Unit – II)
3. List the factors governing the selection of a dam, various forces acting on a Gravity dam,modes of failures.– L1(Unit – III)
4. List the types of earthen dams, Causes of failure of earthen dams. – L1 (Unit – IV)
5. List and explain the Geological factors controlling occurrence of Ground water.– L2(Unit – V)

Topic Learning Outcome

After learning all the topics of UNIT – I, the student is able to

1. Explain types of Irrigation – (L2)
2. List the methods of Irrigation. – (L2)
3. Explain quality of Irrigation water. – (L2)
4. Explain water Requirement of crops-– (L2)
5. Define crop period, – (L2)
6. Define duty and – (L2)
7. Define delta of a crop, – (L2)
8. Derive relationship between Duty and Delta, – (L2)
9. List factors affecting Duty – (L2)
10. Explain optimum utilization of Irrigation water – (L2)

After learning all the topics of UNIT – II, the student is able to

11. Explain Types and Alignment of Canals, Canal system.(L1)
12. Explain Kenndy's theory.(L1)
13. Explain Lacey's theory, Problems. (L1)

14. List the Types of Culverts and small Bridges(L1)
15. Explain the procedure of construction of Culverts and small Bridges (L1)
16. Derive the formula for Discharge passing through Broad crested wire (L2)

After learning all the topics of UNIT – III, the student is able to

17. Define the factors governing selection of a dam. (L2)
18. Explain the Typical cross section of dam.(L1)
19. Describe the Forces acting on Gravity dam.(L2)
20. Explain the modes of failures.(L1)
21. State the Principal shear and stresses and problems.(L1)
22. Explain two dimensional stability analysis by Analytical method.(L1)
23. Define the elementary profile of a gravity dam.(L2)
24. Explain High and low gravity dam, galleries. (L1)
25. Define Spillway. Explain the different Types of spillway.(L2)
26. Define Ogee spillway and design of crest.(L2)
27. Explain Discharge calculation, Energy dissipaters.(L1)
28. Define standard stilling basin and U S B R stilling basins II & IV.(L2)

After learning all the topics of UNIT – IV, the student is able to

29. List the different types of earthen dams, Causes of failure of earthen dams. (L1)
30. Explain seepage control and its types.(L1)
31. Define Tank irrigation. (L2)
32. Discuss in detail about isolated tanks and tanks in series. (L2)
33. Explain surplus escape weirs and its typical cross section. (L1)
34. Explain the design principles of surplus escape weirs. (L1)
35. Solve the problems on surplus escape weirs. (L1)
36. Define Tank sluices and sketch its typical cross sections.(L2)

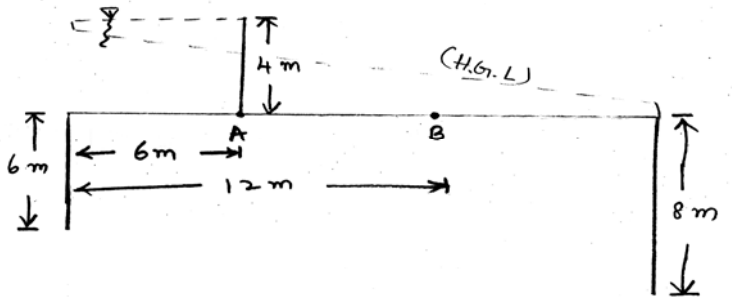
After learning all the topics of UNIT – V, the student is able to

37. Define the geological factors controlling occurrence of Ground water. (L2)
38. Define Wells and different types of well. (L2)
39. Explain the yield of an open well.(L1)
40. Solve Problems on above.(L2)
41. Define Tube well and different typesof tube well. (L2)
42. Define boring of tube well and spacing of tube wells. (L2)
43. Define the failure and life of a tube well, Pumping arrangement.(L2)
44. Explain the Advantages and Disadvantages of Tube well irrigation over canal irrigation.(L1)

Review questions

1.	Define Irrigation. List out the benefits and Ill-effects of irrigation.
2.	Distinguish between direct irrigation and Indirect irrigation.
3.	Explain sprinkler irrigation. Mention its advantages & disadvantages.
4.	Make a note on frequency of irrigation
5.	Determine the storage capacity of a soil from the following data. Field capacity =20%, permanent wilting point = 12%, depth of root zone = 1m and dry density of soil = 1.8 gm/cc. Also, determine the depth of water required if the irrigation water is supplied when the moisture content falls to 20% and the field application efficiency is 80%. If the conveyance losses in the channel network are 12% of outlet discharge, calculate the depth of water required at canal outlet.

6.	What is duty and delta? Derive the relation between them. Mention any two methods of improving duty.
7.	What is a canal? Explain, with neat sketch, the classification of canals based on their alignment.
8.	What are the factors to be considered while aligning a canal?
9.	Design an irrigation canal using Lacy's silt theory with the following data : (i)Full supply discharge = 10 cumecs (ii) Lacy's silt factor = 0.9 (iii) Side slope = 0.5 H = 1V
10.	Distinguish between a dam and a Reservoir. With a neat sketch explain the storage zones of a reservoir.
11.	Make a note on economical height of a reservoir.
12.	Explain the method of determining the capacity of a reservoir for a known demand.
13.	With a neat sketch, Explain the components of a typical diversion head work.
14.	Make a note on safety criterion suggested by Bligh for the design of impervious floor of a weir.
15.	Distinguish between exit gradient and critical gradient.
16.	List out the causes of failure of weirs founded on permeable soils.
17.	What is a gravity dam? List out the stabilizing forces and destabilizing forces acting on gravity dam.
18.	Make a note on practical profile of a gravity dam.
19.	Draw uplift pressure diagram for a dam holding 50 m of water with upstream face vertical, top and bottom width are 10 m and 30 m respectively. Uplift may be considered to be acting on 60% of the area of section. Tail water depth is 5 m. Also, draw the uplift pressure diagram, if there is a drainage gallery at 6 m from upstream face.
20.	How the earthen dams are classified? With a neat sketch explain zoned embankment type of earthen dam.
21.	Briefly discuss the causes of failure of earthen dam
22.	With a neat sketch, explain the procedure of determining the seepage line in a homogeneous earthen dam with horizontal drainage blanket.
23.	What is a spillway? Mention the essential requirements of a spillway.
24.	With a neat sketch explain a Ogee spillway.
25.	Give all design details along with crest profile equation.
26.	Make a note on energy dissipaters.
27.	Discuss in brief the benefits and ill effects of irrigation.
28.	Find the time required to cover an area of 0.1 hectares when a tube well is discharging at the rate of 0.03 Cumecs for irrigating rabi crops. Average depth of flow is expected to be 7.5 cm. Average infiltration rate for the soil may be taken in 5 cm/hour.
29.	Explain the terms 'duty' and 'delta'. Also derive relationship between them
30.	After how many days will you supply water to soil (clay loam) in order to ensure efficient irrigation of the given crop, if i) Field Capacity of soil = 27% ii) Permanent wilting point = 14% iii) Density of soil = 1.5 g/cm^3 iv) Effective depth of root zone = 75 cm v) Daily consumptive use of water for the given crop = 11 mm.
31.	List out various types of cross drainage works. Describe any one type with neat sketch
32.	Design a channel section for the following data using Lacey's theory. Discharge, Q = 30 Cumecs, Slit factor, f = 1.0, Side slope = ½ : 1 Also find the longitudinal slope.
33.	Define the following i) Surcharge storage (ii) Valley storage

34.	Define the following (iii) Safe yield (iv) Secondary yield
35.	Explain how would you determine safe yield from a reservoir of a given capacity using graphical method
36.	Differentiate between barrage and weir
37.	Differentiate between the Gravity weirs and non-gravity weirs
38.	Figure below shows the section of a hydraulic structure founded on sand. Calculate the average hydraulic gradient. Also, find the uplift pressures at points 6 and 12 m from the upstream end of the floor and find the thickness of the floor at those points. 
39.	What do you understand by the elementary profile of a gravity dam? Derive an expression for determining base width of such a dam based on stress criterion
40.	Given the following data, determine limiting height of the dam. R.L of base of dam = 1450 m R.L of H.F.L = 1480.5 m Specific gravity of the masonry = 2.4 Safe Compressive Stress for masonry = 120 tonnes/m^2 Height of waves = 1 m.
41.	With the help of a sketch, explain zoned embankment type earthen dam.
42.	Write a note on selecting a suitable preliminary section for an Earth dam.
43.	What is a spillway? Discuss any one type of spillway with a neat sketch.
44.	What do you mean by energy dissipation below spillways?
45.	What are the methods available to dissipate the energy?

Lesson plan

UNIT – I

1. Types of Irrigation
2. Methods of Irrigation
3. Quality of Irrigation water
4. Water Requirement of crops
5. crop period
6. duty
7. delta of a crop
8. Derive relationship between Duty and Delta
9. factors affecting Duty
10. Optimum utilization of Irrigation water

UNIT – II

11. factors governing selection of a dam
12. Typical cross section of dam
13. Forces acting on Gravity dam
14. Modes of failures.

15. Principal shear and stresses and problems
16. Two dimensional stability analyses by Analytical method.
17. Elementary profile of a gravity dam.
18. High and low gravity dam,
19. Galleries, Spillway.
20. Explain the different Types of spillway.
21. Ogee spillway and design of crest.
22. Discharge calculation,
23. Energy dissipaters. Standard stilling basin and U S B R stilling basins II & IV.

UNIT – III

24. factors governing selection of a dam.
25. Typical cross section of dam.
26. Forces acting on Gravity dam.
27. modes of failures.
28. Principal shear and stresses and problems.
29. two dimensional stability analyses by Analytical method.
30. the elementary profile of a gravity dam.
31. High and low gravity dam, galleries.
32. Spillway Types of spillway.
33. Ogee spillway and design of crest.
34. Discharge calculation,Energy dissipaters.
35. standard stilling basin U S B R stilling basins II & IV.

UNIT – IV

36. different types of earthen dams, Causes of failure of earthen dams.
37. seepage control and its types
38. Tank irrigation.
39. isolated tanks and tanks in series.
40. surplus escape weirs and its typical cross section.
41. design principles of surplus escape weirs.
42. Solve the problems on surplus escape weirs.
43. Tank sluices and
44. sketch its typical cross sections.

UNIT – V

45. Geological factors controlling occurrence of Ground water.
46. Wells and different types of well.
47. Yield of an open well.
48. Solve Problems on above.
49. Tube well and different types of tube well.
50. Boring of tube well and spacing of tube wells.
51. Failure and life of a tube well, Pumping arrangement.
52. Advantages and Disadvantages of Tube well irrigation over canal irrigation.

Course Articulation Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the significance of Irrigation, types of irrigation, quality of irrigation water, potential and development of irrigation in India	L2	**L**										
02	Explain types of canal, canal Alignment, sediment transport, Design of stable channels, cross section of canal, maintenance of canal, lining of irrigation canal.	L2	**H**	**M**	**L**								
03	List the factors governing the selection of a dam, various forces acting on a Gravity dam, modes of failures.	L2	**H**	**L**									
04	List the types of earthen dams, Causes of failure of earthen dams.	L1	**H**	**M**	L								
05	List and explain the Geological factors controlling occurrence of Ground water.	L2	**H**	**L**	M								

The course learning outcomes (CLOs) are achieved through topic learning outcomes (TLOs)

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the significance of Irrigation, types of irrigation, quality of irrigation water, potential and development of irrigation in India	L2	**2**										
02	Explain types of canal, canal Alignment, sediment transport, Design of stable channels, cross section of canal, maintenance of canal, lining of irrigation canal.	L2	**2**	**2**	1								
03	List the factors governing the selection of a dam, various forces acting on a Gravity dam, modes of failures.	L2	**2**	**2**	**1**								
04	List the types of earthen dams, Causes of failure of earthen dams.	L1	**1**	**1**									
05	List and explain the Geological factors controlling occurrence of Ground water.	L2	**2**	**2**	1								

1-Low, 2-Moderate, 3-High

Course Title : DESIGN AND DRAWING OF RCC STRUCTURES			
Course Code: P13CV65	**Semester : VI**	**L-T-P-H: 2-0-3-5**	**Credit : 4**
Contact Period : Lecture :65 Hr, Exam: 4Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. To draw layout plans.
2. To draw structural components.
3. To draw staircase.
4. To design and drawing of combined footing.
5. To design and drawing of retaining wall.
6. To design and drawing of water tanks.
7. To design and drawing of portal frames.
8. To design and draw the Circular and rectangular water tanks resting on ground.

Course Content

UNIT – I

Layout Drawing: General layout of building showing, position of columns, footing, beam, slab with notations and abbreviations

UNIT – II

Beam and slab floor system, continuous beams.

UNIT – III

Staircase: Dog-legged and open well.

UNIT – IV

Column footing: column and footing (square and rectangular)

UNIT – V

Rectangular combined footing (Slab and beam type)

UNIT – VI

Simple portal frames (single bay and single storey)

UNIT – VII

Retaining walls (Cantilever and counter fort type)

UNIT – VIII

Circular and rectangular water tanks resting on ground (flexible base and rigid base),using IS: 3370(Part IV) only

TEXT BOOK:

1. Structural Design and Drawing- Krishnamurthy- (Concrete Structures), CBS publishers, New Delhi, Tata Mc-Graw publishers

REFERENCE BOOKS:

1. Design of RC Structures- N. Krishnaraju, CBS publishers, New Delhi
2. Reinforced Concrete Structures – B.C.Punmia – Laxmi Publishing Co.

Course Outcome

After learning all the units of the course, the student is able to

1. Draw layout plans – L2 (Unit – I)
2. Draw structural components – L2 (Unit – II)
3. Draw staircase – L2 (Unit – III)
4. Design and draw the combined footing – L2 (Unit – IV)
5. Design and draw the retaining wall – L2 (Unit – V)
6. Design and draw the water tanks –L3 (Unit – VI)
7. Design and draw the portal frames – L3(Unit – VII)
8. Design and draw the Circular and rectangular water tanks resting on ground – L3(Unit–VIII)

Topic Learning Outcome

After learning all the topics of UNIT– I, the student is able to
Draw layout plans

After learning all the topics of UNIT– II, the student is able to
Draw structural components

After learning all the topics of UNIT– III, the student is able to
Draw staircase

After learning all the topics of UNIT– IV, the student is able to
Design and draw the combined footing

After learning all the topics of UNIT– V, the student is able to
Design and draw the retaining wall

After learning all the topics of UNIT– VI, the student is able to
Design and draw the water tanks

After learning all the topics of UNIT– VII, the student is able to
Design and draw the portal frames

After learning all the topics of UNIT– VIII, the student is able to
Design and draw the Circular and rectangular water tanks resting on ground

Review Questions

1.	A RCC dog legged stair case has the following details: Stair case hall : 2.5m x 5m Floor to floor height: 3.6 m Rise: 150 mm = 0.15 m Tread: 250 mm Waist stab: 180 mm (over all) Width of stair: 1.2 m Bearing: 160 mm (landing slab) No. Of steps : 11 (12 R and IIT) Main steel: # 10@ 109 Distribution steel : # @ 230 Materials: M20 concrete, Fe 415 steel. Draw to a suitable scale, the following: a) Plan

<table>
<tr><td></td><td>b) Sectional elevation along the first flight which starts from foundation
c) Sectional elevation along the second flight.</td></tr>
<tr><td>2.</td><td>An interior panel of a two way continuous slab for a hall has an effective size 4m x 6m. The details are as follows:
<table>
<tr><td>Thickness of slab</td><td>150 mm</td></tr>
<tr><td>Wall thickness</td><td>250 mm</td></tr>
<tr><td>Span steel</td><td>#10@ 150 for short span
10 @ 200 for long span</td></tr>
<tr><td>Support steel</td><td># 12 @ 150 for short span
12 @ 180 for long span</td></tr>
<tr><td>Distribution steel</td><td># 8@ 200</td></tr>
</table>
Provide suitable effective cover based on severe exposure condition. Use M20 concrete and Fe 415 steel. Draw to a suitable scale.
a) Cross section of slab at mid span along short span
b) Cross section of slab at mid span along long span
c) Plan showing the details of all reinforcement</td></tr>
<tr><td>3.</td><td>An isolated rectangular RCC column and footing has the following details:
Dimension of column 250 mm x 500 mm
Size of footing 2m x 3m
Depth of footing at the junction = 550 mm
Depth of footing at the edge = 250 mm
Depth of foundation = 1.2 m
Details of steel :
Column : 8 # 20 as mains with # 6 @ 150 stirrups
Footing # 20 @ 200 –shorter direction, # 20 @ 250 – longer direction.
Using M 20 concrete and Fe 415 steel, draw to suitable scale, the following:
a) Sectional plan of column and footing
b) Sectional elevation of column and footing
c) Prepare bar bending schedule for footing steel and column steel up to 1m above ground level</td></tr>
<tr><td>4.</td><td>Design a cantilever retaining wall to retain earth embankment 3m high above ground level. The unit weight of earth is 18 kN/m^3 and its angle of repost is 30º. The embankment is horizontal at its top. The safe bearing capacity of soil may be taken as 100 N/m^2 and the coefficient of friction between soil and concrete as 0.5. Use M20 concrete and Fe 415 bars. Draw the following to suitable scale:
a) Cross section of retaining wall
b) Longitudinal section of stem and base slab showing all steel for about 3m lengths
c) Sectional plan showing the details of steel in toe and heel slab</td></tr>
<tr><td>5.</td><td>Design a circular water tank with flexible base for capacity of 40,000 liters. The depth of water is to be 4m, including a free board of 200 mm. Use M 20 concrete and Fe 415 steel.
Draw the following to suitable Scale;
a) Cross section of the water tank showing the reinforcement details in wall.
b) Cross section of the water tank showing the reinforcement details in base slab.</td></tr>
<tr><td>6.</td><td>Following is the data of a staircase located in an office building:
Grade of Concrete : M_{25}
Type of Steel : F_C415
Type of Stair : Dog legged
Vertical distance between ground and floor = 3.52 m. Rise = 160 mm, Tread = 250 mm,
No. of flights = 2
No. of Risers in Each height = 11,</td></tr>
</table>

	Width of Stair =1.2 m Waist slab thickness = 200 mm Main steel 10mmϕ @ 150 mm c/c Distribution steel 8mmϕ @ e 200 mm c/c Both landing slab and waist slab span in the same direction. Prepare the necessary structural drawings along with bar bending schedule.
7.	A column and footing is to be provided with the following details. i) Column size 300 x 300 mm ii) Longitudinal steel : 8 bars of 12 mmϕ distributed equally iii) lateral ties : 8 mmϕ @300 mm c/c iv) Height of column : 4 m v) Footing size : 1.9 m x 1.9 m, Steel: 10 mmϕ @ 100 mm c/c both ways depth of footing slab at the face of the column is 450 mm and 250 mm at the edge. Depth of excavation = 1.2 m. Grade of concrete = M_{20}, Grade of steel = F_C415 Draw to a suitable scale a) Sectional elevation b) Plan c) Prepare bar bending schedule for mat only.
8.	A Rectangular beam of cross section 300x450 mm is supported on 5 columns which are equally spaced @ a c/c distance of 3.3 m .The columns are of 300 mm x 300 mm in section. The Reinforcement consists of 4-bars of 16 mm dia (+ve reinforcement) at mid span 4-bars of 16 mm dia at all supports (+ ve Reinforcements). 2 bar of +ve Reinforcement has been curtailed near each support. Anchor bars consist of 2# 16 mmϕ . Stirrups are of 8 mm dia. 2 legged vertical @ 200 mm c/c throughout. Draw the longitudinal section and important cross section. Grade of concrete M20, Grade of steel Fe 415.
9.	Design a cantilever retaining wall to retain earth embankment 4 m high above ground level. The density of earth is 18 kN/m^3 and its angle of repose is 30°. The embankment is horizontal at its top. The safe bearing capacity of the soil may be taken as 200 kN/m^2 and co-efficient of friction between soils and concrete is 0.5. Adopt M_{20} grade concrete and F_C 415 steel. Draw the following to suitable scale; i) Cross section of retaining wall ii) Longitudinal section of stem and base slab
10.	Design a circular water tank with flexible base for capacity of 35,000/liters, the depth of water is to be 3.5 m, including free board of 200 mm. Use M_{20} concrete and F_c 415 steel. Draw the following to suitable scale. Cross section of water tank. Showing the reinforcement details in wall and base slab.

Lesson Plan

UNIT – I

1. Draw layout plans

UNIT – II

2. Draw structural components

UNIT – III

3. Draw staircase

UNIT – IV

4. Design and draw the combined footing

UNIT – IV

5. Design and draw the retaining wall

UNIT – IV

6. Design and draw the water tanks –L3 (Unit – VI)

UNIT – IV

7. Design and draw the portal frames – L3 (Unit – VII)

UNIT – IV

8. Design and draw the Circular and rectangular water tanks resting on ground – L3(Unit–VIII)

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Draw layout plans (Unit – I)	L2	L	M	H								
02	Draw structural components (Unit – II)	L1	L	M	H								
03	Draw staircase (Unit – III)	L2	L	M	H								
04	Design and draw the combined footing (Unit – IV)	L2	L	M									
05	Design and draw the retaining wall (Unit – V)	L2	L	M	H								
06	Design and draw the water tanks (Unit – VI)	L2	L	M									
07	Design and draw the portal frames (Unit – VII)												
08	Design and draw the Circular and rectangular water tanks resting on ground (Unit–VIII)												

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	b	c	d	e	f	g	h	i	j	k
01	Draw layout plans (Unit – I)	L2	1	2	3								
02	Draw structural components (Unit – II)	L1	1	2	3								
03	Draw staircase (Unit – III)	L2	1	2	3								
04	Design and draw the combined footing (Unit – IV)	L2	1	2									
05	Design and draw the retaining wall (Unit – V)	L2	1	2	3								
06	Design and draw the water tanks (Unit – VI)	L2	1	2									
07	Design and draw the portal frames (Unit – VII)												
08	Design and draw the Circular and rectangular water tanks resting on ground (Unit–VIII)												

1-Low, 2-Moderate, 3-High

Course Title : MATRIX METHODS OF STRUCTURAL ANALYSIS			
Course Code: P13CV661	**Semester : VI**	**L-T-P-H: 2 – 2 – 0 - 4**	**Credits:3**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Categorise the structures on the basis of force and deformations.
2. Energy concept in dealing the indeterminate structures.
3. Understanding matrix influence, transformation procedures from system to element and hence flexibility and stiffness matrix methods.
4. Analysing plane truss, continuous beams and plane frames, manually, unknowns<=3, using flexibility and stiffness methods.
5. Direct stiffness approach and analysing plane truss and continuous beam problems.

Course Content

UNIT – I

ENERGY CONCEPTS : Brief history of structural mechanics, structural systems, degrees of static and kinematic indeterminacies, geometrical and material non-linearity, concepts of stiffness and flexibility, energy concepts in structural analysis, strain energies – axial, flexural and shear, real work and complementary work. Principle of virtual displacement for a rigid body and deformable body, principle of potential energy, stationary complementary energy, minimum complementary energy, Maxwell Betti's theorem of reciprocal displacement. Development of flexibility and stiffness matrices with reference to the given coordinates. **10 Hrs**

UNIT – II

TRANSFORMATION MATRIX: Relationship between element and system, transformation of information from system forces to element forces using equilibrium equations, transformation of information from system displacement to element displacement, contra gradient laws, element stiffness and flexibility matrices (bar, beam). Generation of system stiffness/ flexibility matrix using uncoupled element stiffness/ flexibility matrices. Analysis of statically indeterminate structures - trusses and continuous beams by flexibility matrix method (element approach). **10 Hrs**

UNIT – III

FLEXIBILITY MATRIX METHOD: Analysis of statically indeterminate rigid jointed plane frames by flexibility matrix method (element approach)

STIFFENESS MATRIX METHOD: Analysis of statically indeterminate structures truss by stiffness matrix method (element approach) **10 Hrs**

UNIT – IV

STIFFENESS MATRIX METHOD: Analysis of statically indeterminate structures continuous beams and simple frames by stiffness matrix method (element approach) **10 Hrs**

UNIT – V

DIRECT STIFFENESS METHOD: Local and global coordinate systems, rotation transformation matrix, direct assembly of element stiffness matrices. Analysis of indeterminate structures (i) Plane truss and (ii) continuous beam. **12 Hrs**

TEXT BOOK:

1. C.S.Reddy, Basic Structural Analysis, TMH, New Delhi 2001

2. G.S.Pandit & S.P.Gupta, Structural Analysis-A Matrix Approach, 2nd Edition, TATA McGraw Hill.
3. S. Rajasekaran, Computational Structural Mechanics, PHI, New Delhi 2001

REFERENCE BOOKS:

1. W.Weaver and J.H.Gere., Matrix Analysis of Framed Structures, Van Nastran, 1980.
2. A.K.Jain, Advanced Structural Analysis with computer Application Nemchand and Brothers, Roorkee, India
3. Fundamentals of Structural Mechanics, M.L. Gambhir., PHI, New Delhi.

Course Outcome

After learning all the units of the course, the student is able to

01 Explain the brief history of structural mechanics and structural systems. – L2 (Unit – I)
02 State and prove Contra gradient laws– L1 (Unit – II)
03 Analysis of rigid jointed plane frame by flexibility matrix method(element approach)– L3 (Unit – III)
04 Analysis of Continuous beams by Stiffness Matrix Method.. – L3 (Unit – IV)
05 Define and determine the local and global coordinate systems and rotation transformation matrix- L2 (Unit – V)

Topic Learning Outcome

After learning all the topics of UNIT– I, the student is able to

1. Explain the brief history of structural mechanics and structural systems
2. Define and determine the degree of static and kinematic indeterminacies
3. Explain the concept of stiffness and flexibility
4. Explain the energy concepts in structural analysis
5. State the real work and complementary work
6. Describe the Principle of virtual displacement for a rigid and deformable body, Principle of potential energy, Stationary complementary energy and minimum complementary energy
7. Derive the Maxwell's Betti's theorem of reciprocal displacement

After learning all the topics of UNIT– II, the student is able to

8. Describes the relationship between element and system, transformation of information from system forces to element forces using equilibrium equations, transformation of information from system displacement to element displacement
9. State and prove Contra gradient laws
10. Derive the element stiffness and flexibility matrices for bar and beam elements
11. Analyse the statically indeterminate structure by flexibility matrix method (element approach)
12. Truss
13. Continuous beam

After learning all the topics of UNIT– III, the student is able to

14. Analysis of rigid jointed plane frame by flexibility matrix method(element approach)
15. Analyse the statically indeterminate structure by stiffness matrix method (element approach)
    a. Truss
    b. Continuous beam
    c. Plane frames

After learning all the topics of UNIT– IV, the student is able to

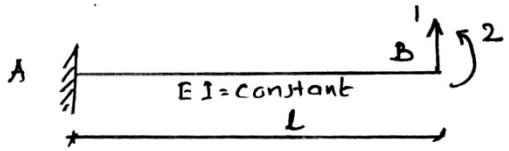
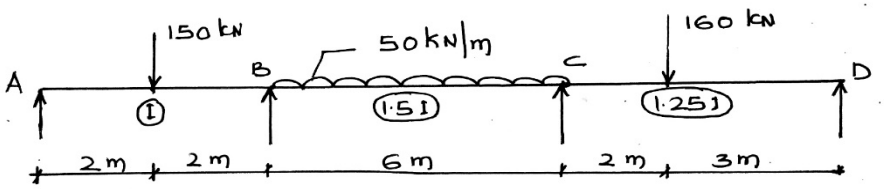
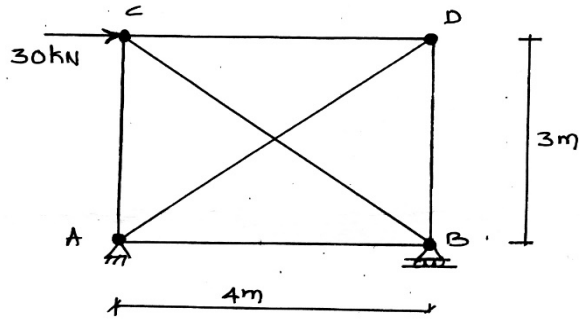
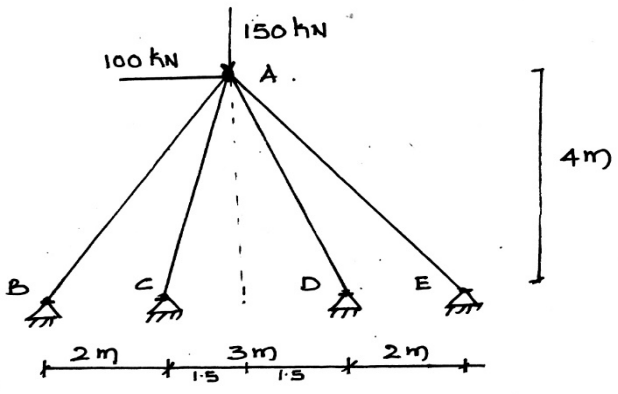
16. Analysis of Continuous beams by Stiffness Matrix Method.
17. Analysis of rigid jointed plane frame by stiffness Matrix Method (element approach)

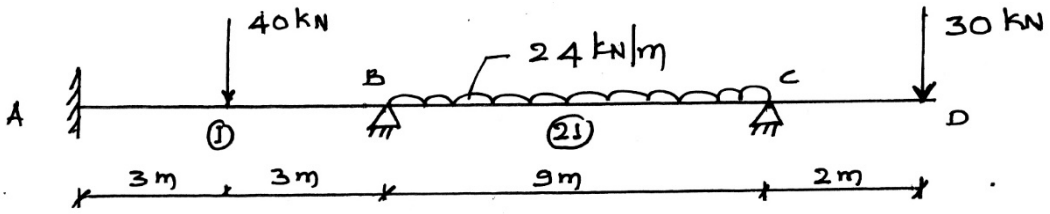
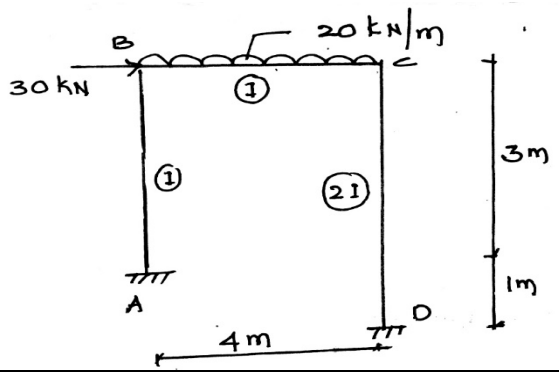
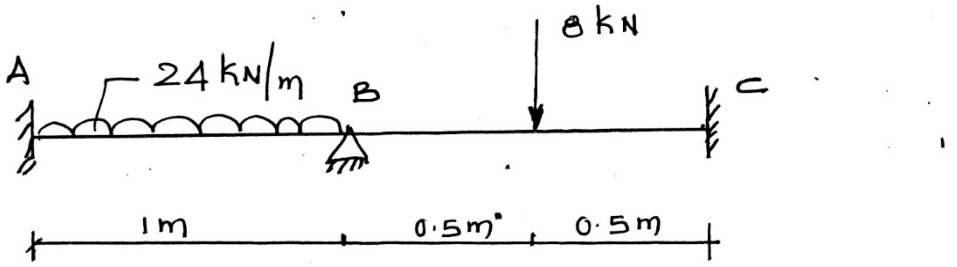
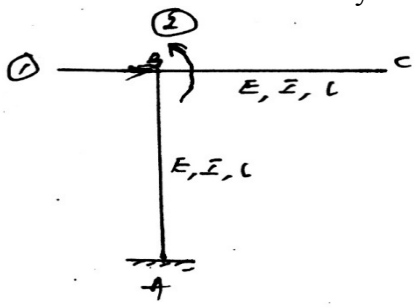
After learning all the topics of UNIT– V, the student is able to

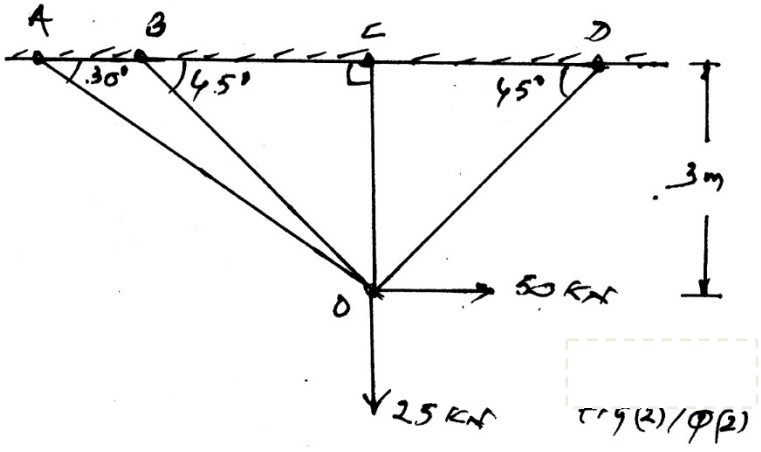
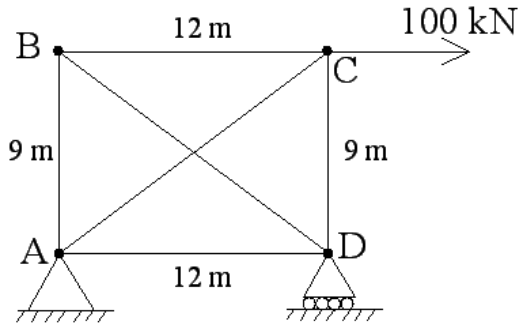
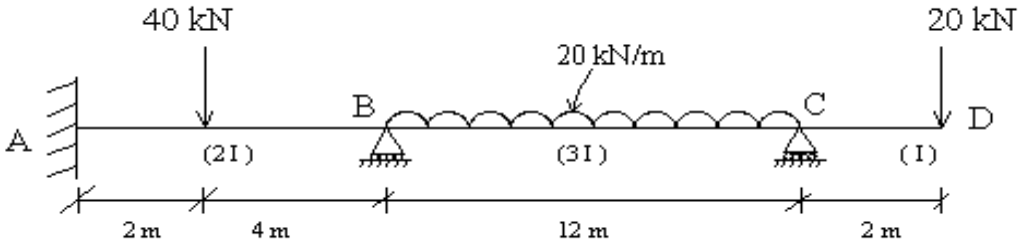
18. Define and determine the local and global coordinate systems and rotation transformation matrix

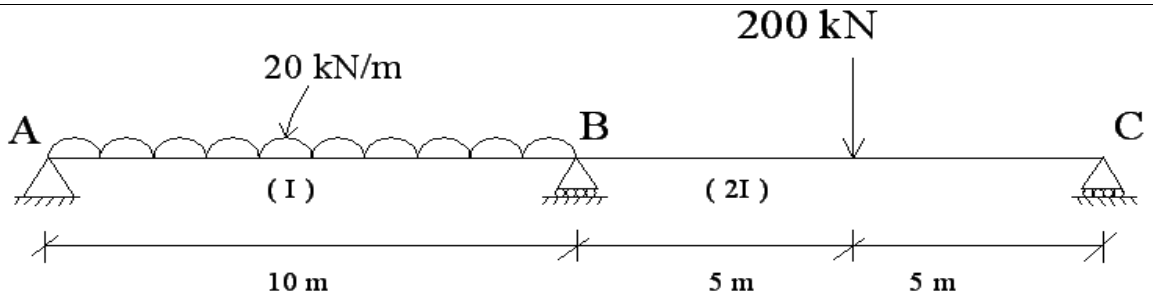
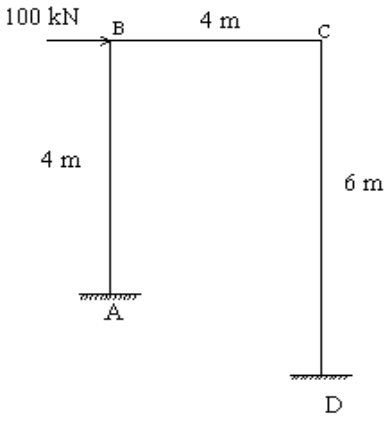
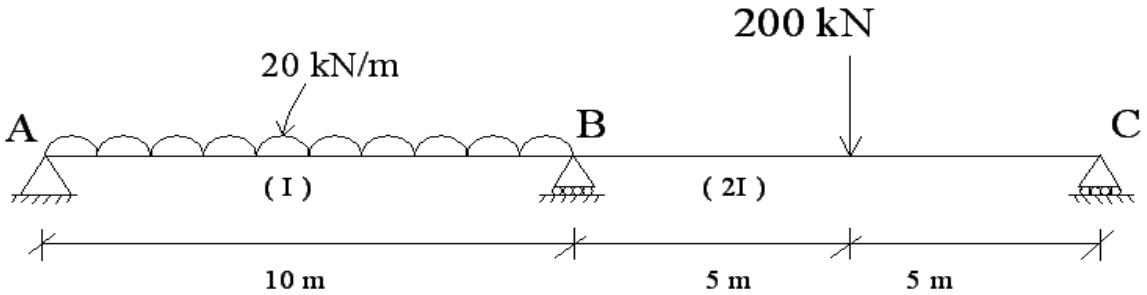
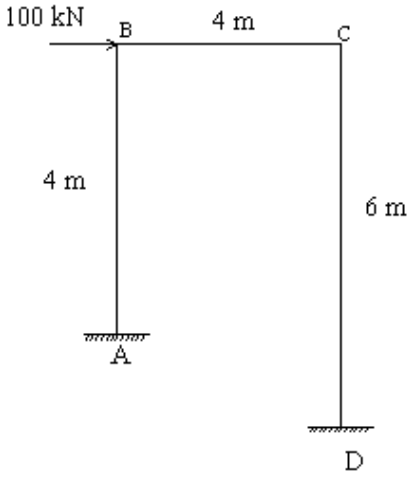
19. Explain the steps for direct assembly of element stiffness matrices.
20. Analyse the statically indeterminate structure by direct stiffness method
    a. Truss
    b. Continuous beam

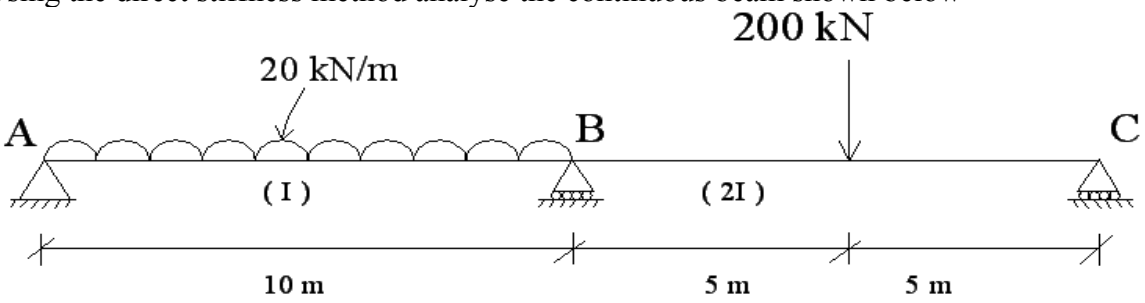
Review questions

1	Explain following terms:Static indeterminacy
2	Explain following terms: Kinematic indeterminacy
3	Explain following terms: Local and Global axis
4	Explain following terms: Force transportation matrix and displacement transformation matrix
5	Generate the flexibility and stiffness matrix for the beam shown in fig and prove that [F] [K] =1 
6	Analyse the continuous beam shown in Fig by flexibility method using force transformation matrix. Also sketch the BMD and elastic curve 
7	Find the forces in the members of the pin jointed plane truss shown in Fig by force transformation method. Assume AE same for all members 
8	Find the forces in the members of the pin jointed plane truss shown in fig by stiffness method using displacement transformation matrix. Assume AE to be same for all the members. 

9	Analyse the continuous beam shown in Fig using stiffness method. Adopt displacement transformation approach. Draw BMD and S.F.D. 
10	Analyse the portal frame shown in Fig by Stiffness method using displacement transformation method and draw the BMD & Elastic curve.. 
11	Obtain the member stiffness matrix in local coordinates for the following cases i) Truss Element ii) Beam element with axial deformation
12	Obtain the transformation matrix 'T' for converting from local to global axes
13	Using Direct stiffness approach, analyse the continuous beam shown in Fig. Draw BMD and SFD 
14	Define state and estimate indeterminacy of structures.
15	Prove that the stiffness and flexibility matrices are symmetrical.
16	Find the flexibility and stiffness matrices for the system with reference to the co-ordinates shown in fig 

17	Analyse the plane truss shown in FigUsing flexibility matrix element approach, Take AE is constant. 
18	Explain: Local and system coordinates
19	Explain: Boundary conditions
20	Explain: Rotation transformation matrix
21	Write the procedure to form overall structure stiffness method for plane truss in direct stiffness matrix method.
	Analyse the pin jointed truss shown in Fig.1 using matrix flexibility method, element approach. Take L / AE = 1 for all members. 
22	Analyse the continuous beam shown in Fig.2 by flexibility method. Adopt element approach Draw B.M.D. 
23	Analyse the continuous beam shown in Fig.1 by element approach of stiffness method. Sketch B.M.D.

	
24	Analyse the frame shown in Fig.2 by flexibility method, element approach. Consider only bending deformations. Sketch B.M.D. Take EI = constant. 
25	Analyse the continuous beam shown in Fig.1 by element approach of stiffness method. Sketch B.M.D. 
26	Analyse the frame shown in Fig.2 by stiffness method, element approach. Consider only bending deformations. Sketch B.M.D. Take EI = constant 

27	Prove that $[K] = [R]^T[K][R]$ with usual notations, as applied to direct stiffness method.
28	Obtain the global element stiffness matrix of a truss element, with usual notations.
29	Using the direct stiffness method analyse the continuous beam shown below 

Lesson Plan

UNIT I

01 Brief history of structural mechanics and structural systems
02 Determination the degree of static and kinematic indeterminacies
03 Concept of stiffness and flexibility
04 Energy concepts in structural analysis
05 Real work and complementary work
06 Principle of virtual displacement for a rigid and deformable body,
07 Principle of potential energy, Stationary complementary energy and minimum complementary energy
08 Maxwell's Betti's theorem of reciprocal displacement

UNIT II

09 Relationship between element and system, transformation of information from system forces to element forces using equilibrium equations, transformation of information from system displacement to element displacement
10 Contra gradient laws
11 Element stiffness and flexibility matrices for bar and beam elements
12 Statically indeterminate structure by flexibility matrix method (element approach)
a) Truss
b) Continuous beam

UNIT III

13 Rigid jointed plane frame by flexibility matrix method(element approach)
14 Statically indeterminate structure by stiffness matrix method (element approach)
a) Truss
b) Continuous beam
c) Plane frames

UNIT IV

15 Continuous beams by Stiffness Matrix Method.
16 Rigid jointed plane frame by stiffness Matrix Method (element approach)

UNIT V

06 Determine the local and global coordinate systems and rotation transformation matrix
07 Steps for direct assembly of element stiffness matrices.
08 Statically indeterminate structure by direct stiffness method
a) Truss
b) Continuous beam

Course Articulation Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the brief history of structural mechanics and structural systems. (Unit – I)	L2	**L**	**M**									
02	State and prove Contra gradient laws (Unit – II)	L1	**M**	**H**									
03	Analysis of rigid jointed plane frame by flexibility matrix method(element approach) (Unit – III)	L3	**M**		**H**								
04	Analysis of Continuous beams by Stiffness Matrix Method. (Unit – IV)	L3	**L**	**H**									
05	Define and determine the local and global coordinate systems and rotation transformation matrix (Unit – V)	L2	**M**	**H**									

L-Low, M-Moderate, H-High

The course learning outcomes (CLOs) are achieved through topic learning outcomes (TLOs)

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Explain the brief history of structural mechanics and structural systems. (Unit – I)	L2	**1**	**2**									
02	State and prove Contra gradient laws (Unit – II)	L1	**2**	**3**									
03	Analysis of rigid jointed plane frame by flexibility matrix method(element approach) (Unit – III)	L3	**2**		**3**								
04	Analysis of Continuous beams by Stiffness Matrix Method.(Unit – IV)	L3	**1**	**3**									
05	Define and determine the local and global coordinate systems and rotation transformation matrix (Unit – V)	L2	**2**	**3**									

1-Low, 2-Moderate, 3-High

Course Title : GROUND WATER HYDROLOGY			
Course Code: P13CV662	**Semester : VI**	**L-T-P-H: 2 – 2 – 0 - 4**	**Credits:3**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Differentiate surface water hydrology and ground water hydrology, characterize the subsurface water, and assess the availability of ground water in different hydrologic formations.
2. Use different methods to investigate type of soil formation and hence to assess the availability of ground water.
3. Classify the geologic formations and assess the effect excessive ground water withdrawals.
4. Use different methods of estimating the hydraulic conductivity in sub soil.
5. Estimate the yield of sub surface water resources using different methods.
6. Evaluate the safe amount of ground water that can be withdrawn from different hydrological formations.
7. Classify different types of wells, their design, construction and maintenance.
8. To develop, complete and maintain a well.
9. Select the type and capacity of pump for particular well.
10. Understand and adopt the ground water recharge
11. Manage the basins with conjunctive use.

Course Contents

UNIT– I

INTRODUCTION: Importance. Vertical distribution of sub-surface water. Occurrence of ground water in different types of rocks and soils. Ground water exploration – Seismic method, Electrical resistivity method, Bore hole geo-physical techniques; Electrical logging, Radio active logging, Induction logging, Sonic logging and Fluid logging. Definition of aquifer, Aquifuge, Aquitard and Aquiclude. Confined and unconfined aquifers. Problems. Aquifer parameters – Specific yield, Specific retention, Porosity, Storage coefficient, derivation of the expression. Determination of specific yield. Land subsidence due to ground water withdrawals. Estimation of yield of underground sources – on the basis of velocity of flow of ground water and pumping tests. Problems. **10Hrs**

UNIT– II

DARCY'S LAW AND GROUND WATER FLOW: Introduction. Darcy's law. Coefficient of permeability and Intrinsic permeability, Transmissibility, Hydraulic conductivity. Determination of hydraulic conductivity- formulae, laboratory methods, tracer tests, augar hole tests and pumping tests of wells. Hydraulic conductivity in Anisotropic aquifers. Problems. Ground water flow problems- Steady one dimensional flow in a homogeneous aquifer, flow in a aquifer with recharge, flow in a confined aquifer of constant thickness and flow in a confined aquifer of variable thickness. Barometric efficiency, tidal efficiency and relation between them. Problems.

10Hrs

UNIT– III

WELL HYDRAULICS – STEADY FLOW: Introduction. Steady radial flow in confined and unconfined aquifers. Pumping tests. Well efficiency. Problems.

UNSTEADY FLOW: Unsteady confined flow – Theis equation. Theis solution (recovery test), and Jacob's solution for theis non equilibrium equation. Image wells, law of times- barrier and recharge boundaries. Problems. **12 Hrs**

UNIT– IV

DESIGN AND CONSTRUCTION OF WATER WELLS: Well diameter, well depth and design of well screen. Open wells versus tube well – advantages and disadvantages. Water well drilling – Boring, driving, cavity wells, jetting, core drilling, rotary drilling. Well revitalization. Water well construction – pull back method, open hole method, bail down method, wash down method. Problems **10Hrs**

UNIT– V

WATER WELLS & GROUND WATER RECHARGE: Well completion. Well development. Well maintenance. Yield test and selection of pumps of an open well. Tube wells – types and design. Pumps for lifting water - Working principles, Power requirements. Problems.

Artificial recharge – concept and recharge methods. Ground water management –concepts, equation of hydrologic equilibrium and management by conjunctive use. **10Hrs**

TEXTBOOKS:

1. **Ground Water**- H.M. Raghunath, - New Age International (P) Limited, publishers, Bangalore.
2. **Ground Water Hydrology** - D K. Todd, - Wiley and Sons, Singapore.
3. **Numerical Ground Water Hydrology**- A.K. Rastogi, - Penram, International Publishing (India), Pvt. Ltd., Mumbai.

REFERENCEBOOKS:

1. **Ground Water Hydrology**- Bower H.- McGraw Hill, New Delhi.
2. **Ground Water and Tube Wells**- Garg Satya Prakash, - Oxford and IBH, New Delhi.
3. **Ground Water Resource Evaluation**- W.C. Walton, - McGraw Hill - Kogakusha Ltd., New Delhi.
4. **Irrigation Engg. and Hydraulic structures** – S K Garg, Khanna publishers, New Delhi

Course Outcome (CO)

After learning all the units of the course, the student is able to

1. Define aquifer parameters and ground water hydrology. – L1 (Unit – I)
2. Define Coefficient of permeability, intrinsic permeability and transmissibility. – L2 (Unit – II)
3. Determine the discharge from a pumping well when the storage coefficient and Transmissivity of confined aquifer are known and vice-versa in case of unconfined (water table) aquifer when the flow steady. (Use of Thiem's equilibrium equation).-L5 (Unit – III)
4. Distinguish an open well from a tube well and to evaluate the merits and demerits of open wells and tube wells. – L2 (Unit – IV)
5. Choose a proper pumping set, know their working principle and calculate the power required to drive the pumps to ensure satisfactory yield from wells. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Define Ground water hydrology, importance and vertical distribution of sub-surface water.-L1
2. Describe the occurrence of ground water in different types of rocks and soils. Ground water exploration – Seismic method.-L1
3. Explain Electrical resistivity method, Bore hole geo-physical techniques and Electrical logging.-L2
4. Define Radioactive logging, Induction logging, sonic logging and Fluid logging.-L1
5. Definition of aquifer, Aquifuge, Aquitard and Aquiclude.-L1
6. Explain Confined and unconfined aquifers. Problems.-L2
7. Define Aquifer parameters – Specific yield, Specific retention, Porosity, Storage coefficient, derivation of the expression.-L1

8. Determination of specific yield. Problems.-L1
9. Explain Land subsidence due to ground water withdrawals. Estimation of yield of underground sources – on the basis of velocity of flow of ground water.-L2
10. Describe Pumping tests and solve problems.-L1

After learning all the topics of UNIT– II, the student is able to

11. Define ground water flow and state Darcy's law and the equation.-L2
12. Define of Coefficient of permeability, Intrinsic permeability.-L1
13. Define Transmissibility, and Hydraulic conductivity. Problems.-L1
14. Determination of hydraulic conductivity- formulae, laboratory methods. Problems.-L1
15. Determination of hydraulic conductivity- tracer tests, augar hole tests.-L1
16. Explain Pumping tests of wells/-L2
17. Define hydraulic conductivity in Anisotropic aquifers and Problems on above.-L1
18. Solve Ground water flow problems- L2
19. Solve problems on Steady one dimensional flow in a homogeneous aquifer, flow in an aquifer with recharge.-L1
20. Solve problems on Flow in a confined aquifer of constant thickness, flow in a confined aquifer of variable thickness.-L1
21. Define Barometric efficiency, tidal efficiency and relation between them. Problemson the these.-L1

After learning all the topics of UNIT– III, the student is able to

22. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer.(Use of Thiem's equilibrium equation)-L1
23. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer. (Use of Thiem's equilibrium equation). –L1
24. Explain the Assumptions of Thiem's equation.-L2
25. Solve the Numerical Problems on steady radial flow into a well in confined and unconfined aquifer.-L1
26. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of unsteady radial flow in confined aquifer.((Use of Theis non-equilibrium equation)-L1
27. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer. (Use of Theis non-equilibrium equation with Jacob's correction).-L1
28. Statement and use of law of times to interpret (locate) the recharge and barrier boundaries near a well.-L1
29. Solve Numericals on above.-L2
30. Define the Confirmation of the boundary from recovery test.-L1
31. Describe about Well flow near aquifer boundaries- application of method of images to find the solution to problems in which there is a deviation from radial flow system due the presence of barrier / recharge boundaries.-L2
32. Solve Numericals on above. –L1

After learning all the topics of UNIT– IV, the student is able to

33. Define the Design parameters for a well- Well diameter, well depth and well screen.-L1
34. Explain Open wells and tube wells – differences, advantages and disadvantages.-L2
35. Describe the Different methods of drilling deep wells– Boring, driving.-L2
36. Define Cavity wells and jetting.-L1
37. Define Core drilling and rotary drilling.-L1

38. Explain the advantages and disadvantages of different methods of drilling deep wells –L2
39. Describe the Suitability of different methods of drilling deep wells.-L2
40. Define Well revitalization.-L1
41. Define Water well construction – pull back method, open hole method.-L1
42. Explain Bail down method and wash down method.-L2

After learning all the topics of UNIT– V, the student is able to

43. Define Well completion- Grouting, sealing and disinfection of the well.-L1
44. Explain Well development- pumping, surging, surging with air and back washing with air.-L2
45. Describe Well development- Hydraulic jetting, using chemicals and hydraulic fracturing.-L2
46. Explain Well maintenance.-L2
47. Define Yield test and selection of pumps – types and design and working principles.-L1
48. Describe Power requirements and Problems.-L2
49. Explain artificial recharge – concept and recharge methods- basin method and stream-channel method.-L2
50. Explain flooding method, irrigation method, pit method and recharge well method.-L2
51. Define Ground water management –concepts, equation of hydrologic equilibrium.-L1
52. Describe conjunctive, variation in ground water levels under conjunctive use and systematic approach for studying conjunctive use problems.-L2

Review Questions

1.	With the help of a diagram explain the vertical distribution of subsurface water.
2.	Distinguish between unconfined and confined aquifers.
3.	At a certain point in an unconfined aquifer of 3 km^2 area, the water table was at an elevation of 102.00m. Due to natural recharge in a wet season, its level rose to 103.20 m. A volume of 1.5 $M.m^3$ of water was then pumped out of the aquifer causing the water table to reach a level of 101.20 m. Assuming the water table in the entire aquifer to response in a similar way, estimate i) the specific yield of the aquifer and ii) the volume of recharge during the wet season.
4.	Describe in detail the exploration of ground water by electrical resistivity method.
5.	Briefly explain any two methods of logging.
6.	Explain the terms: i) specific yield
7.	Explain the terms: i) permeability ii) transmissibility
8.	Explain the terms: i) storage coefficient ii) intrinsic permeability.
9.	During hydrogeological investigation two potential aquifers 32 km apart, were located, one being 5000 years old and other 25000 years old. They were found to be connected by a water bearing stratum of 30 m thickness running inclined at 20 m/km. From a few observation wells, the hydraulic gradient was found to be 0.2 m/km. Determine the transmissibility of the water bearing stratum.
10.	State Darey's law governing ground water movements. Explain its significance and validity.
11.	What is permeability? Explain the determination of permeability by constant head Permeameter.
12.	The water table wells in two observation wells 350mapart are +210.5and +206.25m respectively. If the hydraulic conductivity and porosity of the aquifer are 12.5m/day and 15%, what is the actual velocity of flow in the aquifer?
13.	Derive an equation for discharge for the case of study radial flow into an unconfined aquifer using Dupuit's theory. List the assumptions and limitations.
14.	A well with a radius *of* 0.5m, completely penetrates an unconfined aquifer of thickness 50m and K = 30m/day. The well is pumped so that the water level in the well remains at 40m above the bottom. Assuming that pumping has essentially no effect on water table at r = 500m, what is the steady state discharge?
15.	What are the assumptions made in the Dupit's theory? Derive the expression for discharge from a

	well fully penetrating a confined aquifer.
16.	Compute the number of image wells and mark them neatly in a sketch of an aquifer bounded by two impermeable barriers intersecting at right angles.
17.	Compute the number of image wells and mark them neatly in a sketch of an aquifer bounded by two impermeable barriers intersecting at an angle of 45°.
18.	Enumerate the advantages and disadvantages of open wells and tube wells.
19.	Explain with neat sketch the rotary drilling method.
20.	Explain the importance of well development and list out the methods used for well development.
21.	What is well revitalization? Explain, how a dried out open well is revitalized?
22.	Enumerate the operations involved in well completion.
23.	What is conjunctive use? Explain the benefits of conjunctive use.
24.	What are the factors to be considered while selecting proper pumping unit for the well?
25.	Explain a submersible pump with a neat sketch.
26.	Explain the importance of ground water recharge.
27.	Explain any two methods of ground water recharge.

Lesson Plan

UNIT– I

1. Introduction to ground water hydrology – definition, importance and vertical distribution of sub-surface water.
2. Occurrence of ground water in different types of rocks and soils. Ground water exploration – Seismic method.
3. Electrical resistivity method, Bore hole geo-physical techniques; Electrical logging.
4. Radioactive logging, Induction logging, Sonic logging and Fluid logging.
5. Definition of aquifer, Aquifuge, Aquitard and Aquiclude. Confined and unconfined aquifers. Problems.
6. Aquifer parameters – Specific yield, Specific retention, Porosity, Storage coefficient, derivation of the expression.
7. Determination of specific yield. Problems.(2)
8. Land subsidence due to ground water withdrawals.
9. Estimation of yield of underground sources – on the basis of velocity of flow of ground water.
10. Pumping tests and problems.

UNIT– II

11. Darcy's law for subsurface flow and use it for flow problems.
12. Coefficient of permeability, Intrinsic permeability,
13. Transmissibility, and Hydraulic conductivity
14. Determine hydraulic conductivity in the laboratory.
15. Determine hydraulic conductivity in the field using tracer tests, and augar hole tests.
16. Estimate hydraulic conductivity by pumping tests of wells and to estimate equivalent hydraulic conductivity in anisotropic aquifers.
17. Obtain discharge and drawdown in case of Steady one dimensional flow in a homogeneous aquifer.
18. Obtain discharge and drawdown in case of Flow in a aquifer with recharge
19. Obtain discharge and drawdown in case of Flow in a confined aquifer of constant thickness
20. Obtain discharge and drawdown in case of Flow in a confined aquifer of variable thickness. Problems
21. Define and Establish relationship between Storage coefficient, Barometric efficiency and tidal efficiency

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UNIT– III

22. Introduction, Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer.(Use of Thiem's equilibrium equation)
23. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer. (Use of Thiem's equilibrium equation).
24. Assumptions of Thiem's equation.
25. Numerical Problems on steady radial flow into a well in confined and unconfined aquifer.
26. Numerical Problems on steady radial flow into a well in an unconfined aquifer
27. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of unsteady radial flow in confined aquifer.((Use of Theis non-equilibrium equation)
28. Determination of discharge from a pumping well when the storage coefficient and Transmissivity are known and vice-versa in case of steady radial flow in confined aquifer. (Use of Theis non-equilibrium equation with Jacob's correction). Assumptions of Theis equation.
29. Numerical Problems on unsteady radial flow into a well in confined and unconfined aquifer.
30. Numerical Problems on unsteady radial flow into a well in an unconfined aquifer
31. Statement and use of law of times to interpret (locate) the recharge and barrier boundaries near a well and numerical. Confirmation of the boundary from recovery test.
32. Well flow near aquifer boundaries- application of method of images to find the solution to problems in which there is a deviation from radial flow system due the presence of barrier / recharge boundaries. Numericals.

UNIT– IV

33. Design parameters for a well- Well diameter, well depth and well screen.
34. Open well – differences, advantages and disadvantages.
35. Tube wells – differences, advantages and disadvantages.
36. Different methods of drilling deep wells– Boring, driving.
37. Cavity wells, jetting.
38. Core drilling, rotary drilling.
39. Advantages. disadvantages and suitability of different methods of drilling deep wells
40. Well revitalization.
41. Water well construction – pull back method, open hole method.
42. Bail down method, wash down method.

UNIT– V

43. Well completion- Grouting, sealing and disinfection of the well.
44. Well development- pumping, surging, surging with air and back washing with air.
45. Well development- Hydraulic jetting, using chemicals and hydraulic fracturing.
46. Well maintenance.
47. Yield test and selection of pumps – types and design and working principles.
48. Power requirements and Problems.
49. Artificial recharge – concept and recharge methods- basin method and stream-channel method.
50. Flooding method, irrigation method, pit method and recharge well method.
51. Ground water management –concepts, equation of hydrologic equilibrium.
52. Introduction to conjunctive, variation in ground water levels under conjunctive use and systematic approach for studying conjunctive use problems.

Course Articulation Matrix CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define aquifer parameters and ground water hydrology. (Unit – I)	L1	**H**	**M**			**L**						
02	Define Coefficient of permeability, intrinsic permeability and transmissibility. (Unit – II)	L2	**H**	**M**			**L**						
03	Determine the discharge from a pumping well when the storage coefficient and Transmissivity of confined aquifer are known and vice-versa in case of unconfined (water table) aquifer when the flow steady. (Use of Thiem's equilibrium equation).(Unit – III)	L5	**H**	**M**									
04	Distinguish an open well from a tube well and to evaluate the merits and demerits of open wells and tube wells. (Unit – IV)	L2	**H**	**M**									
05	Choose a proper pumping set, know their working principle and calculate the power required to drive the pumps to ensure satisfactory yield from wells. (Unit – V)	L2	**H**	**M**									

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define aquifer parameters and ground water hydrology. (Unit – I)	L2	3	2			1						
02	Define Coefficient of permeability, intrinsic permeability and transmissibility. (Unit – II)	L1	3	2			1						
03	Determine the discharge from a pumping well when the storage coefficient and Transmissivity of confined aquifer are known and vice-versa in case of unconfined (water table) aquifer when the flow steady. (Use of Thiem's equilibrium equation).(Unit – III)	L1	3	2									
04	Distinguish an open well from a tube well and to evaluate the merits and demerits of open wells and tube wells. (Unit – IV)	L1	3	2									
05	Choose a proper pumping set, know their working principle and calculate the power required to drive the pumps to ensure satisfactory yield from wells. (Unit – V)	L1	3	2									

1-Low, 2-Moderate, 3-High

Course Title : MUNICIPAL AND RURAL SANITATION			
Course Code: P13CV664	**Semester : VI**	**L-T-P-H: 2 – 2 – 0 - 4**	**Credits:3**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Understand the Communicable diseases, modes of communication,
2. Understand the General methods of control, Water borne, Air borne,
3. Understand the Vector borne and Rodent borne diseases,
4. Explain Zoonosis occurrence and their control.
5. Investigate water supply scheme, Protection of well waters,
6. Understand the drinking water quality standards.
7. Describe Types of pumps and their salient features.
8. Explain the Concept of Eco sanitation,
9. Explain the components of sanitation.
10. Explain the concept of refuse collection disposal.
11. Explain the concept of milk sanitation, Food sanitation,
12. Explain the Swimming pool sanitation,
13. Explain the Fairs and festival sanitation.

Course Contents

UNIT– I

COMMUNICABLE DISEASES: Terminology, modes of communication, general methods of control. Water borne, Air borne, vector borne and Rodent borne diseases, Zoonosis Occurrence and their control **10Hrs**

UNIT– II

INTRODUCTION: Need for protected water supply, Investigation for water supply scheme, Protection of well waters, Drinking water quality standards. Types of pumps and their salient features **10Hrs**

UNIT– III

ECOLOGICAL SANITATION: Concept of Eco sanitation components of sanitation:- Criteria for sanitation, Trenching composting toilets, Two pit latrines, Aqua privy, Septic tank, soak pit, Rain water harvesting its needs and uses, Five methods of recharging ground water using water from roof tops of buildings. **12 Hrs**

UNIT– IV

REFUSE COLLECTION DISPOSAL: Definition, Elements of management, collection, Transport and disposal-open dumping, composting, land filling-Advantages and Disadvantages **10Hrs**

UNIT– V

MILK SANITATION: Essential, test for milk quality pasteurization.
FOOD SANITATION: food Contamination, food borne infection and food adulteration control.
SWIMMING POOL SANITATION: Diseases, Control of algae.
FAIRS AND FESTIVAL SANITATION: **10Hrs**

TEXTBOOKS:

1. "Environmental sanitation – Joseph A solvato – John willey.
2. Municipal rural sanitation – Ehler, VMl Steel EW, T.M.M.

REFERENCEBOOKS:

1. Ecological sanitation – Unowinblad & Stokholm Environmental Institute.
2. Preventive and social medicine – Park & Park.

Course Outcome (CO)

After learning all the units of the course, the student is able to

Define Communicable diseases, Terminology, modes of communication. – L1 (Unit – I)
Explain Investigate water supply scheme, Protect well waters. – L2 (Unit – II)
Explain the methods of recharging ground water using water from roof tops of buildings. – L5 (Unit – III)
Explain the transport and disposal, open dumping, composting, land filling. – L2 (Unit – IV)
Explain Food sanitation, Food Contamination, Food borne infection and Food adulteration control. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Define communicable diseases.-L1
2. Describe the terminology of communicable diseases. – L1
3. Explain the modes of communication. – L2
4. Define General methods of control. – L1
5. Define Water borne.–L1
6. Define Air borne.–L1
7. Define vector borne.–L1
8. Define Rodent borne diseases. – L1
9. Define Zoonosis Occurrence.–L1
10. Define the control of Zoonosis occurrence.–L1

After learning all the topics of UNIT– II, the student is able to

11 Explain the Need for protected water supply. – L2
12 Explain the investigation for water supply scheme. – L4
13 Describe the drinking water quality standards. – L4
14 Explain the types of pumps. – L2
15 Describe salient features of pumps. – L2

After learning all the topics of UNIT– III, the student is able to

16 Illustrate the concept of Eco-sanitation components of sanitation. – L3
17 Explain the Criteria for sanitation. – L3
18 Explain the Trenching composting toilets. – L5
19 Explain two pit latrines. – L2
20 Discuss the Aqua privy. – L2
21 Define the Septic tank. – L1
22 Define the soak pit.-L2
23 Define the Rain water harvesting–L2.
24 Define the Rain water harvesting needs.–L2
25 Define the Rain water harvesting uses.–L2
26 Explain the Five methods of recharging ground water using water from roof tops of buildings.–L2

After learning all the topics of UNIT– IV, the student is able to

27 Explain the Elements of management. – L1
28 Compare the collection – L4
29 Explain the Transport- open dumping. – L2

30 Explain the Land filling.–L2
31 Explain disposal-open dumping.–L1

After learning all the topics of UNIT– V, the student is able to

32 Explain the Essential of Milk sanitation. – L1
33 Describe the Tests for milk quality Pasteurization.–L2
34 Describe the Food sanitation. – L2
35 Define and describe Food Contamination. – L1
36 Explain Food borne infection. – L1
37 Define Food adulteration control. – L1
38 Explain Swimming pool sanitation. – L1
39 Explain different cattle borneDiseases. – L1
40 Explain about Control of algae. – L1
41 Describe in detail about Fairs and festival sanitation. – L1

Review Questions

1.	Explain in detail the modes of transmission and general methods of control of communicable diseases
2.	Define Garbage
3.	Define Rubbish
4.	Discuss in detail the importance and need for protected water supply
5.	Discuss on the selecting of sources for rural water supply.
6.	Explain in detail different types of privies that may be adopted for rural sanitation schemes
7.	Explain in brief Bangalore method and Indore method of composting
8.	Explain conservancy system with merits and demerits.
9.	What is rain water harvesting?
10.	Discuss different methods of harvesting
11.	Discuss general methods of collection of solid wastes.
12.	Discuss disposal methods
13.	Explain functioning of biogas plant with neat sketch.
14.	What is pasteurization?
15.	Discuss in detail the process of milk pasteurization
16.	Discuss different cattle borne diseases.

Lesson Plan

UNIT– I

1. Communicable diseases and its terminology,
2. Modes of communication,
3. General methods of control.
4. Water borne,
5. Air borne,
6. Vector borne and
7. Rodent borne diseases,
8. Zoonosis Occurrence and their control

UNIT– II

9. Introduction.
10. Need for protected water supply.
11. Investigation for water supply scheme.
12. Protection of well waters.

13. Drinking water quality standards.
14. Types of pumps and their salient features.

UNIT– III

15. Concept of Eco sanitation components of sanitation.
16. Criteria for sanitation.
17. Trenching composting toilets.
18. Two pit latrines.
19. Aqua privy.
20. Septic tank.
21. Soak pit.
22. Rain water harvesting its needs.
23. Rain water harvesting uses.
24. Methods of recharging ground water using water from roof tops of buildings.

UNIT– IV

25. Refuse collection disposal Definition.
26. Elements of management.
27. Refuse collection disposal collection.
28. Transport-open dumping.
29. Disposal-open dumping.
30. Composting.
31. Land filling.
32. Advantages and disadvantages.

UNIT– V

33. Milk sanitation, Essential.
34. Test for milk quality Pasteurization.
35. Food sanitation.
36. Food Contamination.
37. Food borne infection.
38. Food adulteration control.
39. Swimming pool sanitation.
40. Cattle borne Diseases.
41. Control of algae.
42. Fairs and festival sanitation.

Course Articulation Matrix CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define Communicable diseases, Terminology, modes of communication. (Unit – I)	L2	**H**	**M**			**L**						
02	Explain Investigate water supply scheme, Protect well waters. (Unit – II)	L1	**H**	**M**			**L**						
03	Explain the methods of recharging ground water using water from roof tops of buildings. (Unit – III)	L1	**H**	**M**									
04	Explain the transport and disposal, open dumping, composting, land filling. (Unit – IV)	L1	**H**	**M**									
05	Explain Food sanitation, Food Contamination, Food borne infection and Food adulteration control. (Unit – V)	L1	**H**	**M**									

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define Communicable diseases, Terminology, modes of communication. (Unit – I)	L2	3	2			1						
02	Explain Investigate water supply scheme, Protect well waters. (Unit – II)	L1	3	2			1						
03	Explain the methods of recharging ground water using water from roof tops of buildings. (Unit – III)	L1	3	2									
04	Explain the transport and disposal, open dumping, composting, land filling. (Unit – IV)	L1	3	2									
05	Explain Food sanitation, Food Contamination, Food borne infection and Food adulteration control. (Unit – V)	L1	3	2									

1-Low, 2-Moderate, 3-High

Course Title : PHOTOGRAMMETRY AND REMOTE SENSING			
Course Code: P13CV665	**Semester : VI**	**L-T-P-H: 2 – 2 – 0 - 4**	**Credits:3**
Contact Period : Lecture :52 Hr, Exam: 3Hr		**Weightage : CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims to

1. Terrestrial photogrammetry, photo theodolite, Horizontal and vertical angles from terrestrial photographs, horizontal position from photographic measurements, elevation of points by photographic measurements, determination of focal length.
2. Advantages vertical tilted and oblique photographs, geometry of vertical photographs, scale of vertical photograph over flat and variable terrain, ground coordinates, computation of length of align, computation of flying height, relief displacement, overlaps, flight planning, computation of required number of photographs for a given area, ground control in photogrammetry, Basics of stereoscopy, stereoscopes, uses parallax, basic elements in photographic interpretation introduction to digital photogrammetric..
3. Ideal remote sensing system, basic of electromagnetic remote sensing, electromagnetic energy, electromagnetic spectrum, interaction with earth's atmosphere, interaction with earth surface materials, spectral reflectance of earth surface materials, Introduction platforms-IRS, Landsat, SPOT, cartosat, ikonos, envisat etc., sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS, microwave sensors, sensor resolutions(spatial, spectral, radiometric and temporal).
4. Basics of digital image processing- radiometric and geometric corrections, image enhancements, image transforms based on arithmetic operation, image filtering, thematic classification (supervised and unsupervised), maximum lively hood classification, introduction to accuracy assessment of classification, applications remote sensing, applications in land use cover analysis, change detection, water resource, urban planning, environmental and geological applications

Course Contents

UNIT– I

PHOTOGRAMMETRY: Introduction, basic definitions, terrestrial photogrammetry, photo theodolite, Horizontal and vertical angles from terrestrial photographs, horizontal position from photographic measurements, elevation of points by photographic measurements, determination of focal length. **10Hrs**

UNIT– II

AREIAL PHOTOGRAMMETRY: Advantages vertical tilted and oblique photographs, geometry of vertical photographs, scale of vertical photograph over flat and variable terrain, ground coordinates, computation of length of align, computation of flying height, relief displacement, overlaps, flight planning, computation of required number of photographs for a given area, ground control in photogrammetry, Basics of stereoscopy, stereoscopes, uses parallax, basic elements in photographic interpretation introduction to digital photogrammetric. **12Hrs**

UNIT– III

REMOTE SENSING PLATFORMS AND SENSORS: Introduction, ideal remote sensing system, basic of electromagnetic remote sensing, electromagnetic energy, electromagnetic spectrum, interaction with earth's atmosphere, interaction with earth surface materials, spectral reflectance of earth surface materials, Introduction platforms-IRS, Landsat, SPOT, cartosat, ikonos, envisat etc., sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS, microwave sensors, sensor resolutions(spatial, spectral, radiometric and temporal) **10Hrs**

UNIT– IV

PROPERTIES OF DIGITAL IMAGE DATE FORMATS: Basics of digital image processing-radiometric and geometric corrections, image enhancements, image transforms based on arithmetic operation, image filtering. **10Hrs**

UNIT– V

REMOTE SENSING IMAGE INTERPRETATION: Thematic classification (supervised and unsupervised), maximum lively hood classification, introduction to accuracy assessment of classification, applications remote sensing, applications in land use cover analysis, change detection, water resource, urban planning, environmental and geological applications. **10Hrs**

TEXTBOOKS:

1. Mikhail E J Bethe and J.C. M cGlone, Introduction to modern photogrammetric Wiley, 2001.
2. Wolf P.R and B.A. Dewitt, Elements of photogrammetric with application in GIS, 3rd ed, McGraw-hill 2000
3. Lille sand T.M and R.W. Kiefer, Remote sensing and image interpretation. 4th ed, john Wiley & sons,2000

REFERENCEBOOKS:

1. Jensen J.R., Introduction digital image processing: a remote sensing perspective. 2nd ed prentice Hal, 1996.
2. Richards J.A. and X. Jia, Remote sensing digital image analysis: an introduction. 3rd ed, Springer, 1999
3. Mather P.M., Computer processing of remotely-sensed image: an introduction. Wiley, 1988.

Course Outcome (CO)

After learning all the units of the course, the student is able to

1. Define Horizontal position from photographic measurements. – L1 (Unit – I)
2. Explain Ground coordinates, computation of length of align, computation of flying height. – L2 (Unit – II)
3. Explain Sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS. – L5 (Unit – III)
4. Explain Image enhancements, image transforms based on arithmetic operation, image filtering. – L2 (Unit – IV)
5. Explain Change detection, water resource, urban planning, environmental and geological applications. – L2 (Unit – V)

Topic Learning Outcomes

After learning all the topics of UNIT– I, the student is able to

1. Define photogrammetry.-L1
2. Describe terrestrial photogrammetry. – L1
3. Explain Horizontal angles from terrestrial photographs. – L2
4. Define vertical angles from terrestrial photographs. – L1
5. Define horizontal position from photographic measurements.–L1
6. Define elevation of points by photographic measurements.–L1
7. Determination of focal length.–L1

After learning all the topics of UNIT– II, the student is able to

08 Explainaerial photogrammetry. – L2
09 Explaingeometry of vertical photographs. – L4
10 Describe the advantages of vertical tilted. – L4
11 Explainthe advantages of variable terrain. – L2

12 Describe the scale of vertical photograph over flat. – L2
13 Define ground coordinates.-L1
14 Describe the computation of required number of photographs for a given area.-L2
15 Explain the basics of stereoscopy.-L4
16 Define the basic elements in photographic interpretation.-L1
17 Explain oblique photographs, computation of length of align and computation of flying height.-L2
18 Define relief displacement.-L1
19 Define ground control in photogrammetry.-L1
20 Define overlaps and flight planning .-L1

After learning all the topics of UNIT– III, the student is able to

21 Illustrate an ideal remote sensing system. – L3
22 Explain the basic of electromagnetic remote sensing. – L3
23 Explain the electromagnetic energy. – L5
24 Explain the electromagnetic spectrum
25 Explain the interaction with earth's atmosphere. – L2
26 Discuss about interaction with earth surface materials. – L2
27 Definespectral reflectance of earth surface materials. – L1
28 Define platforms.-L2
29 DefineIRS, Landsat, SPOT.–L2
30 Define cartosat, ikonos, and envisat. –L2
31 Definesensors-active and passive.–L2
32 DefineMSS, AVHRR.–L2
33 Define LISS, TM, PAN, WIFS.– L2
34 Explainmicrowave sensors and sensor resolutions.–L2

After learning all the topics of UNIT– IV, the student is able to

35 Explain the Properties of digital image date formats. – L2
36 Illustrate the basics of digital image processing. – L4
37 Explain radiometric corrections.-L2
38 Explain geometric corrections. – L2
39 Explain image enhancements .–L2
40 Explain image transforms based on arithmetic operation .–L2
41 Explain image transforms based on image filtering.-L2

After learning all the topics of UNIT– V, the student is able to

42 Explainremote sensing image interpretation. – L1
43 Compare supervised and unsupervised thematic classification.–L4
44 Describe maximum lively hood classification. – L2
45 Defineaccuracy assessment of classification. – L1
46 List the applications of remote sensing. – L1
47 List the applications in land use cover analysis. – L1
48 Explain change detection. – L1
49 Explainwater resource. – L1
50 Explainurban planning. – L1
51 Describeenvironmentalapplications. – L1
52 Describegeologicalapplications. – L1

Review Questions

1	Define photogrammetry.
2	Describe terrestrial photogrammetry.
3	Explain Horizontal angles from terrestrial photographs.
4	Define vertical angles from terrestrial photographs.
5	Define horizontal position from photographic measurements
6	Define elevation of points by photographic measurements.
7	Determination of focal length.
8	Explainaerial photogrammetry.
9	Explaingeometry of vertical photographs.
10	Describe the advantages of vertical tilted.
11	Explainthe advantages of variable terrain.
12	Describe the scale of vertical photograph over flat.
13	Define ground coordinates.
14	Describe the computation of required number of photographs for a given area.
15	Explain the basics of stereoscopy.
16	Define the basic elements in photographic interpretation.
17	Explain oblique photographs, computation of length of align and computation of flying height.
18	Define relief displacement.
19	Define overlaps and flight planning
20	Define ground control in photogrammetry.
21	Illustrate an ideal remote sensing system.
22	Explain the basic of electromagnetic remote sensing.
23	Explain the electromagnetic energy.
24	Explain the electromagnetic spectrum.
25	Explain the interaction with earth's atmosphere.
26	Discuss about interaction with earth surface materials.
27	Definespectral reflectance of earth surface materials.
28	Define platforms.
29	DefineIRS, Landsat, and SPOT.
30	Define cartosat, ikonos, and envisat.
31	Definesensors-active and passive.
32	DefineMSS, AVHRR.
33	Define LISS, TM, PAN, and WIFS.
34	Explainmicrowave sensors and sensor resolutions
35	Explain the Properties of digital image date formats.
36	Illustrate the basics of digital image processing.
37	Explain radiometric corrections.
38	Explain geometric corrections.
39	Explain image enhancements.
40	Explain image transforms based on arithmetic operation.
41	Explain image transforms based on image filtering.
42	Explainremote sensing image interpretation.
43	Compare supervised and unsupervised thematic classification.
44	Describe maximum lively hood classification.
45	Defineaccuracy assessment of classification.
46	List the applications of remote sensing.
47	List the applications in land use cover analysis.
48	Explain change detection.

49	Explainwater resource.
50	Explainurban planning.
51	Describeenvironmentalapplications.
52	Describegeologicalapplications.

Lesson Plan

UNIT– I

01 Introduction to photogrammetry.
02 Terrestrial photogrammetry.
03 Horizontal angles from terrestrial photographs.
04 Vertical angles from terrestrial photographs.
05 Horizontal position from photographic measurements.
06 Elevation of points by photographic measurements.
07 Determination of focal length

UNIT– II

08 Introduction to aerial photogrammetry.
09 Geometry of vertical photographs.
10 Advantages of vertical tilted.
11 Advantages of variable terrain.
12 Scale of vertical photograph over flat.
13 Ground coordinates.
14 Computation of required number of photographs for a given area.
15 Basics of stereoscopy.
16 Basic elements in photographic interpretation.
17 Oblique photographs, computation of length of align and computation of flying height.
18 Relief displacement.
19 Ground control in photogrammetry.
20 Overlaps and flight planning.

UNIT– III

21 Ideal remote sensing system.
22 Basic of electromagnetic remote sensing.
23 Electromagnetic energy.
24 Electromagnetic spectrum
25 Interaction with earth's atmosphere.
26 Interaction with earth surface materials.
27 Spectral reflectance of earth surface materials. platforms
28 IRS, Landsat, SPOT
29 Cartosat, ikonos, and envisat.
30 sensors-active and passiveMSS, AVHRR
31 LISS, TM, PAN, WIFSmicrowave sensors and sensor resolutions

UNIT– IV

32 Properties of digital image date formats.
33 Basics of digital image processing.
34 Radiometric corrections.
35 Geometric corrections.
36 Image enhancements.
37 Image transforms based on arithmetic operation.
38 Image transforms based on image filtering

UNIT– V

42 Remote sensing image interpretation.
43 Supervised and unsupervised thematic classification.
44 Maximum lively hood classification.
45 Accuracy assessment of classification.
46 Applications of remote sensing.
47 Applications in land use cover analysis.
48 Change detection.
49 Water resource.
50 Urban planning.
51 Environmentalapplications.
52 Geologicalapplications.

Course Articulation Matrix CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define Horizontal position from photographic measurements. (Unit – I)	L2	**H**	**M**			**L**						
02	Explain Ground coordinates, computation of length of align, computation of flying height.(Unit – II)	L1	**H**	**M**			**L**						
03	Explain Sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS. (Unit – III)	L1	**H**	**M**									
04	Explain Image enhancements, image transforms based on arithmetic operation, image filtering.(Unit – IV)	L1	**H**	**M**									
05	Explain Change detection, water resource, urban planning, environmental and geological applications. (Unit – V)	L1	**H**	**M**									

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Learning Outcome – CLO After learning all the units of the course, the student is able to		Programme Outcome										
			a	b	c	d	e	f	g	h	i	j	k
01	Define Horizontal position from photographic measurements. (Unit – I)	L2	3	2			1						
02	Explain Ground coordinates, computation of length of align, computation of flying height.(Unit – II)	L1	3	2			1						
03	Explain Sensors-active and passive, MSS, AVHRR, LISS, TM, PAN, WIFS. (Unit – III)	L1	3	2									
04	Explain Image enhancements, image transforms based on arithmetic operation, image filtering.(Unit – IV)	L1	3	2									
05	Explain Change detection, water resource, urban planning, environmental and geological applications. (Unit – V)	L1	3	2									

1-Low, 2-Moderate, 3-High

Course Title : GEOTECHNICAL ENGINEERING LABORATORY			
Course Code: P13CVL67	**Semester : VI**	**L-T-P-H: 0- 0 – 3 - 3**	**Credits:1.5**
Contact Period : Lecture :39 Hr, Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

This course aims to

1) Know the properties of soil.
2) Determine the specific gravity of different types of soil using density bottle and pycnometer method.
3) Determine moisture content present in the soil by different methods.
4) Classify the soil as per IS classification by sieve analysis.
5) Determine the density of soil in the field by core cutter and sand replacement method.
6) Determine maximum dry density and optimum moisture content of soil by light and heavy compaction test.
7) Define the consistency of soil.
8) Calculate the co-efficient of permeability of soil by constant and variable head method.
9) Calculate the shear parameters, major and minor principal stress of soil by direct shear test.
10) Calculate the unconfined compressive strength and cohesion of the soil by unconfined compression test.
11) Calculate the California bearing ratio of soil by CBR test.

LIST OF EXPERIMENTS TO BE CONDUCTED:

1. Tests for determination of specific gravity and moisture content 3 Hrs
2. Grain size analysis of soil sample (sieve analysis) 3 Hrs
3. In situ density by core cutter and sand replacement methods. 3 Hrs
4. Consistency Limits – Liquid Limit (Casagrande and Cone Penetration Methods), plastic limit and shrinkage limit 3 Hrs
5. IS Light Compaction Test and IS Heavy Compaction Test 3 Hrs
6. Coefficient of permeability by constant head and variable head methods 3 Hrs
7. Strength Tests
   a. Unconfined Compression Test 3Hrs
   b. Direct Shear Test 3 Hrs
   c. Triaxial Compression Test (Unconsolidated & Undrained) 3Hrs
8. Consolidation Test – Determination of compression index and coefficient of consolidation 3 Hrs
9. Laboratory vane shear test 2 Hrs
10. Determination of CBR value 3 Hrs
11. Determination of free Swell index of soils 2 Hrs
12. a) Demonstration of miscellaneous equipments such as Augers, Samplers, Rapid Moisture meter, Proctor's needle
    b) Demonstration of Hydrometer Test
    c) Demonstration of Swelling Pressure Test
    d) Demonstration of determination of relative density of sands 2 Hrs

REFERENCE BOOKS:

1. Soil Testing for Engineers – Lambe T.W., - Wiley Eastern Ltd., NewDelhi.
2. Manual of Soil Laboratory Testing – Head K.H., (1986) – Vol I, II, III, Princeton Press, London.
3. Engineering Properties of Soil and Their Measurements – Bowles J.E (1988), - Mc Graw Hill Book Co. New york.

4. BIS CODES of Practice: IS 2720 (Part-3/sec.1) – 1987; IS 2720 (Part-2)-1973; IS 2720 (Part – 4)-1985; IS 2720 (Part – 5)-1985; IS 2720 (Part-6) – 1972; IS 2720 (Part – 7) -1980; IS 2720 (Part -8)-1983; IS 2720(Part -17) – 1986; IS 2720 (Part -10)- 1973; IS 2720 (Part-13)-1986; IS 2720 (Part-11)-1971; IS 2720 (Part -15)-1986; IS 2720 (Part30)- 1987; IS 2720 (Part 14)-1977; JS 2720 (Part -14) -1983; IS 2720 (Part – 28) -1974; IS 2720 (Part -29) – 1966, IS 2720 (Part – 60) 1965.

Course outcomes

After learning all the units of the course, the student is able to

1) Explain the properties of soil.
2) Classify the different type of soil.
3) Calculate safe bearing capacity of soil.
4) Calculate the shear parameters i.e., cohesion and angle of internal friction of the soil.
5) Determine the liquid limit, plastic limit, liquidity index, flow index and plastic index of the soil.

Course Title : EXTENSIVE SURVEY			
Course Code: P13CVL68	**Semester : VI**	**L-T-P-H: 0 – 0 – 3–3**	**Credits:1.5**
Contact Period : Lecture :39 Hr ,Exam: 3Hr		**Weightage :CIE:50% SEE:50%**	

This course aims to

1. Identify surveying instruments
2. Construct rectangle, hexagon using tape/chain and other accessories.
3. Construct rectangles, pentagon, hexagon, using tape /chain and compass.
4. Determine the distance between two inaccessible points using chain/tape and compass.
5. determine points using radiation and intersection method of plane tabling.
6. Solve 3-point problem in plane tabling using Bessel's graphical solution.
7. Use fly leveling technique and Rise and Fall methods.
8. Determine difference in elevation between two points using reciprocal leveling.
9. To conduct profile leveling and to draw the longitudinal section
10. Demonstrate Minor instruments - Clinometer, Ceylon ghat tracer, Hand level, Box sextant, Planimeter and Pantagraph..

LIST OF EXPERIMENTS TO BE CONDUCTED:

(To be conducted between 5th& 6th Semester for a period of 2 weeks, Viva voce conducted along with 6th Semester exams). An extensive survey training involving investigation and design of the following project report consisting of design and drawings.

1. **GENERAL INSTRUCTIONS, RECONNAISSANCE OF SITES AND FLY LEVELING TO ESTABLISH BENCH MARKS.**

2. **NEW TANK PROJECTS**: The work shall consist of
   i) Alignment of center line of the proposed bund, Longitudinal and cross sections of the center line.
   ii) Capacity surveys.
   iii) Details at Waste weir and sluice points.
   iv) Canal alignment.

(At least one of the above new tank projects should be done by using TOTAL STATION)

3. **OLD TANK PROJECTS**: The work shall consist of
   I. Alignment of center line of the proposed bund, Longitudinal and cross sections of the center line.
   ii) Capacity surveys.
   iii) Details at Waste weir and sluice points.
   iv)Canal alignment.

(At least one of the above old tank projects should be done by using TOTAL STATION)

4. **WATER SUPPLY AND SANITARY PROJECT**: Examination of sources of water supply, Calculation of quantity of water based on existing and projected population. Preparation of village map by any suitable methods of surveying (like plane tabling). Location of sites for ground level and overhead tanks underground drainage system surveys for laying the sewers.

5. **HIGHWAY PROJECT**: Preliminary and detailed investigations to align a new road (min. 1 to 1.5 km stretch) between two obligatory points. The investigations shall consist of topographic surveying of strip of land for considering alternate routes and for final alignment. Report should justify the selected alignment with details of all geometric designs for traffic and design speed assumed. Drawing shall include key plan initial alignment, final alignment, longitudinal section along final alignment, typical cross sections of road. (Drawing should be preferably done using AutoCAD)

REFERENCE BOOK:

1. Surveying, Vol-1, B.C.Punmia, Laxmi Publications, New Delhi.
2. Plane Surveying, Vol-1, A.M. Chandra, New-age International Ltd.

Course Outcomes

After learning all the units of the course, the student is able to

1. Handle various surveying instruments - chain, tape, compass, auto level, Plane table and minor instruments.
2. Construct polygons- triangle, rectangle, pentagon etc by using chain, tape compass.
3. Calculate the difference in elevation by reciprocal leveling, profile leveling for roads, water supply and sewer lines by using auto level.
4. Measure angles and bearings and traversing by using compass.
5. Locate the points by radiation, intersection and solution of 2 and 3 point problems using plane table.