BMS COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF TEACHING AND EXAMINATION 2016-2017

VI SEMESTER B.E

Code	Course Title	Teaching Department	Credits				Credits	Contact Hours/ Week	**CIE marks**	**SEE marks**	**TOTAL MARKS**
			L	T	P	S					
16CV6DCDSS	Design Of Steel Structures	CIVIL	3	1			**4**	5	50	50	100
16CV6DCDRC	Design of RC Structures	CIVIL	3	1		-	**4**	5	50	50	100
16CV6DCWWT	Waste water Treatment	CIVIL	2	-	1	2	**5**	4	50	50	100
16CV6DCESP	Extensive survey project	CIVIL	1	-	1	2	**4**	3	50	50	100
16CV6DCSWL	Software Applications lab	CIVIL	1	-	1	-	**2**	3	50	50	100
16CV6DE---	DEC-2	CIVIL	3	-	-	-	**3**	3	50	50	100
16CV6DE---	DEC-3	CIVIL	3	-	-	-	**3**	3	50	50	100
						Total	**25**	**26**			**700**

L- Lecture Hours/Week, T- Tutorial -2Hours/week, P- Practical- 2 Hours/week. S-Self Study

BMS COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF TEACHING AND EXAMINATION 2016-2017

	Course Code	Course Title	Teaching Department	CREDITS				Contact Hours/ week	CIE marks	SEE marks	Total marks
				L	T	P	Total				
DEC-2	**16CV6DETOE**	Theory of elasticity	CIVIL	3	-	-	**3**	3	50	50	100
	16CV6DEGIT	Ground Improvement Technique	CIVIL	3	-	-	**3**	3	50	50	100
	16CV6DESWM	Solid Waste Management	CIVIL	3	-	-	**3**	3	50	50	100
	16CV6DEPMC	Pavement Materials & Construction	CIVIL	3	-	-	**3**	3	50	50	100
DEC-3	**16CV6DEIHS**	Irrigation and hydraulic structures	CIVIL	3	-	-		3	50	50	100
	16CV6DEERS	Earth Retaining Structures	CIVIL	3	-	-	**3**	3	50	50	100
	16CV6DESMA	Structural Masonry	CIVIL	3	-	-	**3**	3	50	50	100
	16CV6DEPAD	Pavement Design	CIVIL	3	-	-	3	3	50	50	100

VI SEMESTER CIVIL ENGINEERING

Design of Steel Structures

Course Name	Design of steel structures	Course Code	16CV6DCDSS	SEE Duration	SEE+CIE
Credits	04	L-T-P-S Credits	3:1:0:0	03 Hours	50+50

Course Objective:

To teach the students, the method of design of various steel structural members and their connections.

Course Outcome:

CO1.: Knowledge of limit state design and its techniques.
CO2: An ability to analyse and design structural steel joints.
CO3 : An ability to analyse and design structural steel members subjected to flexure, tension and compression.
CO4: An ability to understand the concepts of plastic analysis and use for the design of structural elements.

Introduction: Advantages and disadvantages of steel structures, Loads and load combinations, Design considerations, Limit state method (LSM) of design, Failure criterion of steel, codes, Specifications and section classification. **04Hours**

Design of Tension Members: Introduction, Types of tension members, Slenderness ratio, Behavior of axially loaded tension members, Modes of failure, Factors affecting the strength of tension members, Design of axially loaded tension members with bolted and welded connection, Lug angles. **06Hours**

Design of Compression Members: Introduction, Behavior of compression members, Sections used for compression members, built up sections, Effective length of compression members, Design of compression members with lacing, Design of simple slab base and gusseted base. **12Hours**

Design of beams: Introduction, Beam sections, factors affecting lateral stability, Behavior of simple rolled steel beams in bending, Design of laterally supported and laterally unsupported rolled steel beams.
Design of Plate Girders: Basic design of plate girders using tension field method (Economical depth, Stiffeners only) **10hours**

Bolted Connections: Introduction, Behavior of bolted joints, Design of Simple joints with ordinary black bolts and High strength Friction Grip Bolts(HSFG), Moment resistant connections(moment parallel and perpendicular to the plane of joint),beam to beam and beam to column connection (framed connection only) **08Hours**

Welded Connections: Introduction, Welding process, Advantages of welding, Types and properties of welds, Types of joints, weld symbols, Weld specifications, Effective areas of welds, Design of welds, Design of Simple joints, Moment resistant connections(moment parallel and perpendicular to the plane of joint),beam to beam and beam to column connection (framed connection only) **06 Hours**

Plastic Behavior Structural Steel: Introduction, plastic theory, Plastic hinge concept, plastic collapse load, conditions of plastic analysis, Theorems of plastic collapse, Plastic analysis of Continuous Beams (No design) **06 Hours**

Note: Study of this course shall be based on IS 800-2007

Text Books:

1. Design of steel structures-N Subramanian,Oxford publishers, Published: 2011
2. Limit state design of steel structures-Duggal,Tata- Mcgraw Hill Publishers, 2nd Edition

Reference Books:

1. Limit state design of steel structures (Based on IS-800-2007 in SI Units)-Dr.Ramchandra and Virendra Gehlot,Scientific Publishers
2. Design of steel structures by Limit state method-S.S.Bhavikatti,I.K.International publishers.
3. Steel structures-Design and practice by N. Subramanian, oxford university press

VI SEMESTER CIVIL ENGINEERING

Design of RC Structures

Course Name	Design of RC structures	Course Code	16CV6DCDRC	SEE Duration	SEE+CIE
Credits	04	L-T-P-S Credits	3:1:0:0	03 Hours	50+50

COURSE OBJECTIVE:

To provide fundamental knowledge of concrete and steel reinforcement used for reinforced concrete design, and knowledge of design methodologies for different load conditions.

COURSE OUTCOME:

CO1: Explain the fundamental principles and procedures in the component design of reinforced structures.

CO2: Apply the principles of analysis of the Indian code design specification, the concepts of strain compatibility and equilibrium concepts to determine the strength of RC members.

CO3: Design of simple RC components as per IS Codes.

Objectives and Methods of Analysis and Design, and Properties of Concrete and Steel: Introduction, Objectives of the Design of Reinforced Concrete Structures, Method of Design, Analysis of Structures, Design Loads, Loads and Forces, Properties of Concrete. Workability and Durability of Concrete, Properties of Steel.

Philosophies of Design by Limit State Method: Introduction, Basic principles of working stress method, Principles of limit state method, Partial safety factors, Characteristic and design loads, Characteristic and design strength, Stress block parameters for limit state of collapse by flexure Ultimate flexural strength of singly reinforced rectangular sections, Doubly reinforced rectangular sections, flanged sections, Ultimate shear strength of RC sections, Ultimate torsional strength of RC sections, Concepts of development length and anchorage. Analysis examples of singly reinforced, Doubly reinforced, flanged sections, Shear strength and development length

Serviceability limit states: General aspects of serviceability, Deflection limit as in IS: code, Calculation of deflection (Theoretical method) Cracking in structural concrete members, Calculation of deflections and crack width.

Design of Beams: General Specification for flexural design of beams- Practical requirements, Size of beam, Cover to reinforcement, Spacing of bars, Design procedures for critical sections for bending moment and shear, Anchorages of bars, Check for development length, Reinforcement requirements, Slenderness limits for beams to ensure lateral stability, Design examples for simply supported and Cantilever beams for rectangular and Flanged sections.

Design of Slabs: General consideration of design of slabs, Rectangular slabs spanning one direction Rectangular slabs spanning in two directions for various boundary conditions. Design of simply supported, cantilever and continuous slabs.

Design of Columns: General aspects, Classifications Effective length of column, Loads on columns, Slenderness ratio for columns, Minimum eccentricity, Design of short axially loaded columns, Design of column subject to combined axial load and uni-axial moment Biaxial moment using SP – 16 charts.

Design of Footings: Introduction, load for footings. Design basis for limit state method, Design of isolated rectangular footing for axial load and uniaxial moment.

Design of Stair cases: General feature, Types of stair case, loads on stair cases, effective span as per IS code provisions, Distribution of loading on stairs, Design of Open Well & Dog Legged Stair case.

TEXT BOOKS

1. Limit State design of reinforced concrete by PC Verghese, PHI-Learning Pvt. Ltd, New Delhi, 2nd edition (2012)

2. Reinforced Concrete Design – S. Unnikrishnan Pillai and Devadas Menon, tata McGraw-Hill Publishing Company Limited, New Delhi., 3rd edition 2009

REFERENCE BOOKS

1.Limit State design of reinforced concrete – BC Punmia, Ashok Kumar Jain and Arun Kumar Jain- Laxmi Publications, New Delhi

2 Reinforced concrete structures - Park and Paulay- John Wiley and sons, Singapore

3. Limit state design of reinforced concrete structures – P Dayaratnam, Oxford and IBH

Publishing company Pvt ltd., New Delhi

4. Design of Reinforced concrete structures – N. Krishna Raju, CBS Publishers, New Delhi

VI SEM CIVIL ENGINEERING

WASTE WATER TREATMENT

Subject	Waste Water Treatment	Sub. Code	16CV6DCWWT	SEE Duration	SEE+CIE
Credits	05	L-T-P-S Credits	2:0:1:2	3 Hrs	50 + 50

COURSE OBJECTIVE:

To provide knowledge about waste water characteristics, their disposal, treatment methods and to design sewers

COURSE OUTCOME:

CO1: Describe strength of waste water and select appropriate treatment and disposal methods
CO2: Explain the concepts of sewage systems and design sewers
CO3: Describe and design various components of waste water treatment facilities

Introduction: Necessity for sanitation, methods of domestic waste water disposal, types of sewage systems and their suitability.

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) **07 Hours**

Materials of Sewers: Sewer materials, shapes of sewers, laying of sewers, joints & testing of sewers, ventilation & cleaning of sewers. **04 Hours**

Sewer Appurtenances: Catch basins, manholes, flushing tanks, oil and grease traps, drainage traps. Basic principles of house drainage. Typical layout plan showing house drainage connections, maintenance of house drainage. **05 Hours**

Waste Water Characteristics: Sampling, significance, techniques and frequency. Physical, chemical and biological characteristics, Aerobic and anaerobic activity, CNS cycles. BOD and COD. Their significance problems. 0**5 Hours**

Disposal of Effluents: Disposal of effluents by dilution, self-purification phenomenon. Oxygen sag curve, Zones of purification, sewage farming sewage sickness, effluent disposal standards for land, surface water & ocean. Numerical problems on disposal of effluents. Streeter Phelps equation. **04 Hours**

Treatment of Waste Water: Flow diagram of municipal waste water treatment plant. Preliminary & primary treatment: Screening, grit chambers, skimming tanks, and primary sedimentation tanks – design criteria & design examples.

05 Hours

Secondary Treatment Suspended growth and fixed film bioprocess.
Tricking filter–theory and operation, types and designs. Activated sludge process – principle and flow diagram, modifications of ASP, F/M ratio. Design of ASP.

05 Hours

Low cost treatment methods: Septic tank, oxidation pond and oxidation ditches–design. Reuse and recycle of waste water**.** **04 Hours**

Site visit to sewage Treatment plant

Text Books:

1. Sewage disposal and air pollution engineering. S.K.Garg,Khanna publishers, 2015
2. Sewage disposal and engineering. B.C.Punmia.Arihant publications, 2016

Reference Books:

1. Water and waste water engineering vol-II: Fair, Geyer and Okun: John Willey Publishers, New York.
2. Waste water treatment, disposal and reuse: Metcalf and Eddy Inc: Tata McGraw Hill Publications.
3. Manual on waste water treatment: CPHEEO, ministry of urban development, Delhi.

VI SEM CIVIL ENGINEERING

EXTENSIVE SURVEY PROJECT

Sub Code	**16CV6DCESP**	**Total Hrs**	**Field Hours+ 39 Hours**	**L:T:P: S = 1:0:1:2 Credits**
Credits	**4**	**Exam Marks**	**CIE+SEE=50+50**	**Contact hours 3 hrs**

The extensive survey project shall be conducted at a suitable site for a period of one week, where possible arrangement shall be made for all the students and teacher to camp near the project site.

Field data shall be collected using modern surveying tools such as total station, auto levels etc. Students shall be encouraged to down load and process the data each day.

Project could be chosen from the following set.

Projects:

- Housing and town planning
- Hydraulics & Irrigation
- Roads and Bridges
- Water Supply and Sanitation
- Public health
- Infrastructure related projects.
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Proposed Evaluation: Students are expected to prepare a detailed report giving the introduction, projects details and design for a final viva-voce examination.

VI SEM CIVIL ENGINEERING

SOFTWARE APPLICATION IN CIVIL ENGINEERING

Sub Code	16CV6DCSWL	Total Hrs	26 Hours	SEE Duration	L:T:P credits
Credits	2	Exam Marks	CIE+SEE=50+50	2 hrs	1:0:1

Course outcome:

1. An ability to understand Computational techniques related to civil engineering structural elements.
2. An ability to analyse and design RCC and steel structures using the software tools
3. An ability to model Civil Engineering structural elements using the software tools to understand their behavior

1. Analysis of structural elements such as Beam, column, slab, footing for a given loading and boundary conditions

2. Design of structural members such as Beam, column, slab, footing for given loading and boundary conditions

3. Analysis and design of rolled steel roof trusses

4. To analyse and design a RCC/Steel frame completely

5. FEM modeling of simple structural elements (Beams, columns slabs, trusses, frames, masonry elements, soil behavior etc.,) for different loading and end conditions, to evaluate the load versus deflection diagrams etc.,

MS EXCEL

6. Calculation of areas and volumes for the given data
7. Plotting of different types of graphs for the given data

References:

Training manuals and User manuals

VI SEM CIVIL ENGINEERING
ELECTIVE: THEORY OF ELASTICITY

Course	Theory of Elasticity	Sub. Code	16CV6DETOE	SEE Duration	SEE+CIE
Credits	3	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

Course Objectives:

- Introduce continuum mechanics to students and prepare them to take Finite Element Analysis
-
- **Course outcome**:
  An ability to
  CO1: Explain the concepts of stress invariants and strains transformations,
  CO2: Discuss stress-strain relations and Torsion of Circular and non-circular sections

1. Concepts of stress at a point and stress tensors, Transformation of stresses, Stress Invariants - Principal stresses, Maximum Shear stresses and their planes (3D problems), Octahedral stress, Hydrostatic state of stress, Equilibrium equations.

2. Concepts of strain at a point and strain tensor, Engineering strain, Transformation of strains, Principal strains, Maximum strains and their planes, Compatibility equations.

3. Constitutive Laws, Generalized Hooke's Law, Stress – Strain relations, Strain – Displacement relations, equilibrium and compatibility conditions in Cartesian and polar co-ordinates in two dimensions, Airy's stress function.

4. Torsion of circular sections, St.Venant's theory, membrane analogy**.**

5. Stress concentration due to circular holes in plates, effect of concentrated load in straight boundaries.

Text book:

1. Advanced Mechanics of Solids, 3rd edition, L S Srinath, McGraw Hill pub., 2009

Reference Books:

Theory of Elasticity - Timoshenko & Goodier - McGraw Hill
Elasticity tensor, Dyadic and Engineering applications- Chow P.C. & Pagano N.J - D.Von Nastrand
Theory of Elasticity- Sadhu Singh- Khanna Publishers
Theory of Elasticity - Verma P.D.S - Vikas Publishing Pvt. Ltd
Plasticity for Structural Engineers- Chenn W.P and Hendry D.J- Springer Verlag
Continuum Mechanics Fundamentals- Valliappan C.- Oxford IBH Publishing Co. Ltd.,
Applied Stress Analysis- Sadhu Singh- Khanna Publishers

Engineering Solid Mechanics - Abdel Rahman Ragab, Salah E A Bayoumi- CRC press, London
Applied Elasticity- Sitharam T G and Govindaraju- Interline publishing
Advanced Mechanics of Materials- Seely and Smith- John Wiley

VI SEM CIVIL ENGINEERING
DEPARTMENT ELECTIVE
GROUND IMPROVEMENT TECHNIQUES

Course	Ground improvement techniques	Sub. Code	16CV6DEGIT	SEE Duration	SEE+CIE
Credits	3	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

COURSE OUTCOME:

An ability to:

CO1: Explain different ground improvement techniques and suggest remedies

CO2: Describe different methods of compaction and select proper compaction control tests

CO3 : Suggest techniques of dewatering and recommend suitable admixtures for soil modification.

CO4: Discuss grouting techniques and materials used .

Introduction: Definition, Objectives of soil improvement, Classification of ground improvement techniques, , Factors to be considered in the selection of the best soil improvement technique.

Shallow Compaction techniques: Introduction, methods of compaction –static, dynamic, kneading, vibratory, principles of soil compaction, properties of compacted soil, equipments for shallow surface compaction **09 Hours**

Deep compaction techniques : Types of deep compaction techniques- explosion, heavy tamping, vibro compaction, stone columns, sand compaction piles, case studies **06 Hours**

Hydraulic modification: Necessity, methods- preloading & dewatering, preloading using vertical drains –sand drain & geosynthetic drain, properties**,** , methods of Dewatering by well points system- different types, types of drains, **09 Hours**

Chemical Modification: Definition, aim, special effects, and methods. Admixtures - cement, lime, fly ash, bitumen, stabilization. Suitability of each, chemical reactions, other chemicals – lignin, natural and synthetic polymers, miscellaneous chemical stabilizers , case studies **09 Hours**

Grouting: Introduction, aspects, grouting materials, grouting plant, injection methods, jet grouting, applications,

Miscellaneous methods: concept of crib walls, gabions, Mattresses, case studies. **06 Hours**

Text Books:

1. Ground Improvement Techniques- Purushothama Raj P. Laxmi Publications, New Delhi, Edition :Second, 2016
2. Ground improvement techniques – Nihar ranjan Patra , UBS publishers, New delhi, 1012

Reference Books:

1. Engineering principles of ground modification- Manfred Haussmann (1990) - Mc Graw Hill Pub. Co., New York.
2. Methods of treatment of unstable ground- Bell, F.G. (1975) Butterworths, London.
3. Expansive soils- Nelson J.D. and Miller D.J. (1992) -, John Wiley and Sons.
4. Soil Stabilization; Principles and Practice- Ingles. C.G. and Metcalf J.B. (1972) - Butterworths, London.
5. Construction and Geotechnical Method in Foundation Engineering- Koerner R.M. (1985) - Mc Graw Hill Pub. Co., New York.

E learning:
Nptel web and video course.

VI SEM CIVIL ENGINEERING
DEPARTMENT ELECTIVE
SOLID WASTE MANAGEMENT

Course	Solid waste management	Sub. Code	16CV6DESWM	SEE Duration	SEE+CIE
Credits	3	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

Course Outcomes :
An ability to

CO1: Describe the fundamentals of characterization and quantification

CO2: Explain the mechanisms of providing engineering remedies to disposal issues

CO3: Illustrate the process of safety, legal and societal needs

INTRODUCTION: Definition, land pollution-scope and importance of solid waste management, functional elements of solid waste management. Sources, Classification and characteristics- Municipal, Commercial & Industrial. Methods of quantification. **4 hours**

COLLECTION AND TRANSPORTATION: System of collection, Collection equipment, garbage chutes, transfer stations-bailing and compacting, route optimization techniques and problems. **6 hours**

TREATMENT/PROCESSING TECHNIQUES: Components of separation, volume reduction, size reduction, chemical reduction and biological processing problems.

INCINERATION: process-3T's, factors affecting incineration process, incinerators –types, prevention of air pollution, pyrolysis, design criteria for incineration **8 hours**

COMPOSTING: Aerobic and Anaerobic composting, factors affecting composting, Indore and Bangalore processes, mechanical and semi mechanical composting processes, vermin composting

SANITARY LAND FILLING: Different types, Trench method area method, Ramp and pit method, site selection, basic steps involved, cell design, prevention of site pollution, leachate & gas control methods, geosynthetic fabrics in sanitary landfills **8 hours**

DISPOSAL METHODS: Open dumping-selection of site, ocean disposal, feeding to hogs, incineration, pyrolysis, composting, sanitary land filling, merits and demerits, biomedical wastes and disposal **8 hours**

RECYCLING AND REUSE: Material and energy recovery operations refuse in other industries, plastic wastes, environmental significance and reuse. **5 hours**

TEXT BOOKS:

1 Integrated solid waste management: Tchobanoglous:M/c Graw Hill, 1993
2. Solid waste management in developing countries Bhide and sundearashan, 1983

REFERENCE BOOKS:

1. Hand Book on solid waste disposal: pavoni j.L
2. Environmental engineering; peavey and Techobanoglou.3. Biomedical waste handling rules -2000

VI SEM CIVIL ENGINEERING
DEPARTMENT ELECTIVE
PAVEMENT MATERIALS & CONSTRUCTION

Subject	Pavement Materials and construction	Sub. Code	16CV6D	SEE Duration	SEE+CIE
Credits	3	L-T-P-S Credits	3:0:0:0	3 Hrs	50 + 50

Course outcome:

An ability to:

CO1 Explain types and characteristics of various pavement materials

CO2 Design bituminous mixes as per Specifications

CO3 Describe equipments used for the construction of different pavement layers with their advantages

CO4 Understand the specifications and methods of Flexible and Rigid pavement construction

PAVEMENT MATERIALS

Aggregates: Origin, classification, requirements, properties and tests on road aggregates, concepts of size and gradation-design gradation, maximum aggregate size, aggregate blending-Methods **04 Hours**

Binders and Modified Binders: Types-Origin, preparation, properties and composition of bituminous road binders (Plain and Modified Binders), requirements-tests-uses **03 Hours**

Bituminous Emulsions and Cutbacks: Types, properties, tests and uses. **02 Hours**

Adhesion of Bituminous Binders to Road Aggregates: Adhesion failure, mechanism of stripping, tests and methods of improving adhesion **02 Hours**

Bituminous Mixes: Introduction- - Mechanical properties, dense and open textured mixes, bituminous mix, design methods using Rothfuch's Method only and specification using different criteria - Marshall Mix Design, properties-Voids in Mineral Aggregates, Voids in total mix, Density, Flow, Stability, Percentage Voids filled with Bitumen, Problems on above. (No Hveem Stabilometer & Hubbard-Field Tests) Superpave Mix – necessity-Applications, Introduction to Cold Mix Technology. **08 Hours**

PAVEMENT CONSTRUCTION

Equipments in Highway Construction: Various types of equipment for Excavation, Grading and Compaction, working principle, advantages and limitations. **05 Hours**

Subgrade: Earthwork grading and construction of embankments and cuts for roads. Preparation of subgrade, quality control tests. **03 Hours**

Flexible Pavements: Specifications of materials, construction and field control checks for various types of flexible pavement layer, maintenance and repairs in flexible pavement layer. **05 Hours**

Cement Concrete Pavements: Specifications and method of cement concrete pavement construction; Quality control tests; Construction of various types of joints. **04 Hours**

REFERENCES

Text Books:

1. S. K. Khanna, C. E. G. Justo and A. Veeraragavan, "Highway Engineering", Revised 10th Edition, Nem Chand and Bros, Roorkee, 2014.
2. Sharma, S.C., `Construction Equipment and its Management', Khanna Publishers 6th edition

Reference Books:

1. R. Srinivasa Kumar, "Textbook of Highway Engineering", Universities Press (India) Private Ltd., 2012.
2. S. P. Bindra, "A Course in Highway Engineering", Dhanpat Rai Publications, 5th Revised Edition, 2013.
3. Ministry of Road Transport and Highways, 5th Edition, Published by Indian Roads Crongress, New Delhi.

MOOCs:

1. https://www.nptel.ac.in/

VI SEMESTER CIVIL ENGINEERING

Elective : IRRIGATION AND HYDRAULIC STRUCTURES

Course name	Irrigation and Hydraulic Structures	Sub Code	16CV6DCIHS	SEE duration	SEE +CEE
Credits	3	L-T-P-S	3: 0: 0: 0	3 hours	50+50

Course Objective:
This course is designed to provide basic skills required in estimation of crop water requirement, analysis and design of storage, conveyance and distribution works. It also provides the fundamental knowledge of best management practices in irrigation and water logging issues.

Course Outcomes:
At the end of the course, students will acquire ability to;
CO1: Identify various systems and methods of irrigation, estimate water requirements of the crops and canal capacity required, use modern tools for the estimation of irrigation requirement
CO2: Design weirs on impermeable floors, unlined canals, and select appropriate cross drainage works
CO3: Estimate the storage capacity of a reservoir
CO4: Analyse the stability of gravity dams
CO5: Explain water logging issues and remedial measures, efficient ways of irrigation management

INTRODUCTION
Crops of India (Karnataka in particular), cropping seasons in India.
Irrigation: Definition, necessity of irrigation, benefits and ill effects
Sources and types - Surface and groundwater, types of irrigation and methods of water application.
Irrigation potential and practices in India (Karnataka in particular), major, medium and minor irrigation projects.
Irrigation water quality **02 hours**

WATER REQUIREMENT OF CROPS
Definition of consumptive use, duty, delta, base period, crop period, KOR depth, gross command area, culturable command area, intensity of irrigation, time factor, crop factor
Irrigation efficiencies, irrigation requirement, frequency of irrigation Tools and database available for the estimation of irrigation requirement (such as CropWAT etc.)
Canal capacity determination from field water requirement **06 hours**

FLOW IRRIGATION

Types of irrigation canals, alignments of canals, standard sections of unlined canal in cutting and filling

Design of irrigation canals using Lacey's regime channel theory and Kennedy's method **06 hours**

Cross drainage works: Functions and necessity of aqueduct, siphon, superpassage, level crossing, inlet-outlet. Storage, conveyance and distribution works 0**5 hours**

Diversion head works and Canal regulatory works: General layout and different parts, difference between weirs and barrages, canal escapes.

Design of weirs / barrages on impermeable floors: Components- Glacis, rigid and flexible apron, Design of impermeable floors -Bligh's method 05hours

RESERVOIRS

Types of reservoirs, investigations for reservoir site, storage zones

Determination of storage capacity and yield of reservoirs using analytical and graphical methods **04 hours**

DAMS

Types of dams: Earthen dams, Rockfill dams and gravity dams

Gravity dams: Spillways and non-overflow sections, forces acting on a gravity dam, elementary and practical profile, stability analysis

Drainage galleries: functions and types

Spillways and Gates: Types of spillways, types of gates: radial and vertical

Energy dissipaters: Types of energy dissipaters 0**5 hours**

WATER LOGGING

Definition, detection, prevention, remedial measures: Surface and sub-surface drains, field drainage, salinity controlling measures, groundwater recharging 0**4 hours**

IRRIGATION MANAGEMENT

Canal law and its applications, penalties for unauthorized use of irrigation water, institutions and their participation in irrigation management, command area development

Smart irrigation, water harvesting and micro irrigation methods 0**3 hours**

Text Books

Irrigation Engineering and Hydraulic Structures – S.K. Garg, Khanna Publications, New Delhi, 2006

Irrigation, Water Resources and Water Power Engineering – P.N. Modi, Standard book house, New Delhi, 2014

Reference Books/Codes:

Irrigation and Water Power Engineering- B.C. Punmia, Pande Brij Basi Lal, Arun Kumar Jain, Ashok Kumar Jain, Laxmi Publications, New Delhi

Irrigation and Water Resources Engineering- G.L Asawa, New Age International Publishers, New Delhi

Irrigation Engineering: R. K. Sharma and T. K. Sharma, S. Chand and Company

Management of Drip / Trickle or Micro irrigation- Megh R. Goyal, Apple Academic Press, Canada

Micro Irrigation Systems in India: Emergence, Status and Impacts- Viswanathan, P. K., Kumar, M. Dinesh, Narayanamoorthy, A. (Eds.). Springer Pub.

Water and the Laws in India- Ramaswamy R Iyer (ed.) SAGE Publications India Ltd. New Delhi

E Learning resources:

Irrigation and Drainage Engineering- Delft University of Technology Open Course Ware

http://ocw.tudelft.nl/courses/watermanagement/irrigation-and-drainage/course-home/

Water Resources Engineering- NPTEL Lectures

http://nptel.ac.in/courses/105105110/

IWRM-education E-learning resources

http://www.iwrm-education.de/#!category:Water_governance

VI SEM CIVIL ENGINEERING

DEPARTMENT ELECTIVE
EARTH RETAINING STRUCTURES

Subject	Earth retaining structures	Sub. Code	16CV6DEERS	SEE Duration	SEE+CIE
Credits	03	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

Course objective:
The overall objective of this course is to provide students the fundamentals needed for the design and stability analysis of earth structures (Dams) and earth retaining structures (Conventional Retaining walls, MSE walls, Cantilever and Anchored sheet pile walls, Braced cuts and Coffer dams).

Course Outcomes:

Upon completion of the course, the student should be able to:

CO1: Identify different causes of failure and seepage control measures for embankment dams.
CO2: Analyze earthen dams for their stability.
CO3: Identify and select different earth retaining structures (e.g. Conventional Retaining walls, MSE walls, Cantilever and Anchored sheet pile walls, Braced cuts and Coffer dams) for given project constraints.
CO4: Design and analyze different earth retaining structures.

EARTH STRUCTURES: Introduction about earthen dams - different types of earthen dams with sketches and their suitability. Hydraulic fill and rolled fill methods of construction – causes of failure of earth dam – Design criteria of earth dams – Selection of suitable preliminary section of dams- Stability analysis of earthen dams – Seepage control in earthen dams - Role of Filters in Earth Dam Design - ROCK FILL DAMS - Origin and usage of rock fill dams, Different parts of rock fill dams. **7 hours**

RETAINING WALLS: Introduction, types, failure of retaining walls by sliding, overturning and bearing - Stability analysis and Principles of the design of retaining walls – Gravity retaining walls, cantilever retaining walls, counterfort retaining walls (no structural design) – Other modes of failure of retaining walls – Drainage from the backfill. **5 hours**

MECHANICALLY STABILISED EARTH RETAINING WALLS:Introduction – Types –Backfill and Reinforcing Materials – Construction of walls – Design considerations – Design methods of walls – External Stability of walls – Problems. **6 hours**

Cantilever sheet pile walls: Introduction - Types of sheet pile walls – Free cantilever sheet pile - cantilever sheet pile in cohesion-less soils – cantilever sheet pile penetrating in clay. **5 hours**

Anchored Sheet Pile Walls: Anchored sheet pile with free earth support in cohesion-less and cohesive soil- Bulkheads with fixed earth support method – Analysis using equivalent beam method, Problems**.** **5 hours**

BRACED CUTS: Introduction, Lateral earth pressure on sheeting's - Different types of sheeting and bracing systems – design principles of various components of bracings. **4 hours**

COFFER DAMS & CELLULAR COFFER DAMS: Introduction – types of coffer dams - Design method of cellular coffer dams on rock by Tennessee Valley Authority (TVA) method – safety against sliding, slipping, overturning, vertical shear and stability against bursting, problems on design of coffer dam on rock . **4 hours**

Text Books:

1. Soil Mechanics and Foundation Engineering: Dr. K.R. Arora, Pub: Standard Publishers & Distributors, 5th edition, 2005
2. Irrigation Engineering and Hydraulic Structures: S.K. Garg, Pub: Khanna Publishers.2006

Reference Books:

Soil Mechanics and Foundation Engineering: Dr. V.N.S. Murthy, Pub: CBS Publishers & Distributors.

Soil Mechanics and Foundations: Dr. B.C. Punmia, Pub: Laxmi Publications (P) Ltd.
Designing with Geosynthetics: Robert M. Koerner, Pub: Xlibris.

Numerical Examples, Problems and Objective Questions in Geotechnical Engineering: A.V. Narasimha Rao & C. Venkataramaiah, Pub: Universities Press.

Irrigation and Water Power Engineering: Dr. B. C. Punmia, Dr. Pande B B Lal, Ashok Kumar Jain and Arun Kumar Jain, Pub: Laxmi Publications (P) Ltd.

Geotechnical Engineering: Dr. C. Venkataramaiah, Pub: New age publications.
Soil Mechanics & Foundation Engineering: P. Purushotam Raj, Pub: Dorling Kindersley (India) Pvt. Ltd

VI SEM CIVIL ENGINEERING

ELECTIVE: STRUCTURAL MASONRY

Subject	Structural Masonry	Sub. Code	16CV6DESMA	SEE Duration	SEE+CIE
Credits	03	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

Course Objectives:

- Students are expected to understand the strength and elastic properties of masonry and its constituent materials and failure modes and shall be introduced to design of load bearing masonry buildings

Course outcome:
An ability to
CO1: Recognise the strength and elastic properties of masonry and its constituent materials
CO2: Comprehend the interaction between the masonry constituents
CO3: Analyse and design load bearing masonry components & systems as per BIS codes

Introduction, Masonry Units, Materials and Types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection of mortars.

Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, failure theories of masonry under compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength

Flexural and shear bond, flexural strength and shear strength: Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength.

Design of load bearing masonry buildings: Permissible stresses, stress reduction and shape reduction factors, increase in permissible stresses for eccentric

vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels. Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall. Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions.

Introduction to reinforced masonry: Concepts for vertical and horizontal reinforcement schemes for masonry, construction process, BIS codal provisions
Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure.

Text Books:

Brick and Reinforced Brick Structures, Dayaratnam P., Oxford & IBH, 1987

Structural masonry by K.S. Jagadish

Reference Books:

Structural masonry: Hendry A.W. -Macmillan Education Ltd.,
Design of Masonry structures - Sinha B.P & Davis -S.R. E & FN Spon
Design of Reinforced and Prestressed Masonry- Curtin- Thomas Telford
Structural Masonry- Sven Sahlin- Prentice Hall
Alternative Building Materials & Technologies- Jagadish.K.S, Venkatarama Reddy B V & Nanjunda Rao K S- New Age International, New Delhi & Bangalore
IS 1905 (1993 and revised ed.) BIS, New Delhi.
SP 20 (S & T)- BIS, New Delhi

VI SEM CIVIL ENGINEERING

ELECTIVE: PAVEMENT DESIGN

Course	Pavement design	Sub. Code	16CV6DEPAD	SEE Duration	SEE+CIE
Credits	03	L-T-P-S Credits	3:0::0:0	3 Hrs	50 + 50

COURSE OUTCOMES:

An ability to :

CO 1 Describe fundamental theory of design of flexible and rigid pavements

CO 2 Design flexible pavement and rigid pavement as per IRC specifications

CO 3 Analyse the stresses in rigid pavements

INTRODUCTION:
Types of Pavement, Comparison of Flexible and Rigid Pavements, Components and Functions of flexible pavements, Difference between Highway pavement and Air field pavement,

04 Hours

DESIGN FACTORS:
Pavement design factors, loads – axle load distribution, ESWL, EWL, VDF due to varying loads and CSA, Problems.

06 Hours

FUNDAMENTALS OF DESIGN OF PAVEMENTS:
Design life, Traffic factors, climatic factors, Evaluation of Subgrade soil strength, Plate load Test, CBR Test, Stresses and deflections, Boussinesq's Elastic Theory – principle, Assumptions – Limitations, Problems using vertical stress charts and deflection charts

07 Hours

FLEXIBLE PAVEMENT DESIGN:
Assumptions, Empirical, Semi-empirical and Analytical Methods – CBR method, CSA Method using IRC 37-2012, Group index Method, AASHTO Method, McLeod Method, Busmister theory – Assumptions, Problems.

07 Hours

STRESSES IN RIGID PAVEMENT:

Components and their functions, Design factors, General properties of concrete affecting design, Analysis of stresses – Assumptions – Westergaard's Analysis –– Critical stress Locations – Wheel load stresses, Warping stress – Frictional stress – combined stresses (using chart / equations) - Problems.

08 Hours

DESIGN OF RIGID PAVEMENT:

Design of C.C. Pavement by IRC: 58 – 2002 for dual and Tandem axle load, Requirements of joints, Types of joints – Expansion joint – contraction joint – warping joint – construction joint – longitudinal joint, Design features of CRCP, SFRC and ICBP, Problems.

08 Hours

REFERENCES

Text Books:

4. S. K. Khanna, C. E. G. Justo and A. Veeraragavan, "Highway Engineering", Revised 10th Edition, Nem Chand and Bros, Roorkee, 2014.
5. R. Srinivasa Kumar, "Textbook of Highway Engineering", Universities Press (India) Private Ltd., 2012.

Reference Books:

1. E. J. Yoder and M. W. Witczak, "Principles of Pavement Design", Second Edition, John Wiley and Sons, Inc, 1975.
2. Relavent IRC codes