Geotechnical Engineering		Semester	5
Course Code	**BCV502**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- Appreciate basic concepts of soil mechanics as an integral part in civil engineering.
- Comprehend basic engineering and mechanical properties of different types of soil.
- Become broadly familiar with geotechnical engineering requirements, such as, flow of water through soil medium and compaction characteristics.
- Model and measure strength & settlement characteristics and bearing capacity of soils.

Teaching-Learning Process (General Instructions)

1. **Use of Black Board, PPT and modern learning tools for teaching**
2. **Performing laboratory experiments to assess the desired properties of soil**

MODULE-1

INDEX PROPERTIES AND IS CLASSIFICATION

Index Properties: Phase Diagram, definitions, and their interrelationships. Determination of Index properties, Types of soil structures and Clay Minerals, IS soil classification of Soil.

MODULE-2

SOIL WATER-EFFECTIVE STRESS ANALYSIS

Soil Water: Permeability, Darcy's law-assumption and validity, coefficient of permeability and its determination (only laboratory method), permeability of stratified soils. Capillary phenomenon, Flow net characteristics and applications

Effective Stress Analysis: Effective stress concept-total stress, effective stress and Neutral stress.

MODULE-3

COMPACTION AND CONSOLIDATION

Compaction: Principle of compaction, Standard and Modified proctor's compaction tests, factors affecting compaction, effect of compaction on soil properties, Field compaction control

Mass-spring analogy, Terzaghi's one dimensional consolidation theory (No derivation). Consolidation characteristics of soil (Cc, av, mv and Cv). Laboratory one dimensional consolidation test, Pre-consolidation pressure and its determination by Casagrande's method.

MODULE-4

SHEAR STRENGTH

Concept of shear strength, Mohr–Coulomb Failure Criterion, Modified Mohr–Coulomb Criterion Total and effective shear strength parameters, Measurement of shear strength parameters - Direct shear test, unconfined compression test, triaxial compression test and field Vane shear test, Factors affecting shear strength of soils.

MODULE-5

BEARING CAPACITY AND SETTLEMENT

Bearing Capacity: Types of foundations, Determination of bearing capacity by Terzaghi's and BIS methods (IS: 6403), Modes of shear failure, Factors affecting Bearing capacity of soil. Effect of water table and load eccentricity on bearing capacity of soil, Field methods of determining bearing capacity of soil (SPT and plate load test).

Settlement: Types of settlements and importance, Computation of immediate and consolidation settlement, permissible differential and total settlements (IS 8009 Part 1).

PRACTICAL COMPONENT OF IPCC

Sl. No	Experiments
1	Water content determination by oven drying, Rapid moisture meter method
2	Grain size analysis (Sieve analysis of soil)
3	In-situ density tests i) Core-cutter method ii) Sand replacement method
4	Consistency limits i) Liquid limit test (by Casagrande's and cone penetration method) & ii) Plastic limit test
5	Co-efficient of permeability test i) Constant head test ii). Variable head test
6	Standard compaction test (light compaction only)
7	Direct shear test
8	Unconfined compression test & Laboratory vane shear test
9	Triaxial test (unconsolidated undrained test only)
10	Demonstration of Standard penetration test & Boring equipment
11	Demonstration of Proctors Needle
12	Demonstration of Vane shear test

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

- Comprehend the fundamentals of Soil mechanics and identify and classify the soil
- Apply the knowledge to determine MDD and OMC and compute consolidation properties and shear parameters of soil and compute the settlement and bearing capacity of soil
- Apply the knowledge to determine shear parameters of soil and compute the settlement and bearing capacity of soil
- Carry out experiments to assess the index properties of soil and determine Compaction, Permeability and Shear Strength characteristics of soil.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and

for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will

have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Text Books

1. Gopal Ranjan and Rao A.S.R., Basic and Applied Soil Mechanics, New Age International (P) Ltd., New Delhi. 2016
2. Murthy V.N.S., Principles of Soil Mechanics and Foundation Engineering, UBS Publishers and Distributors, New Delhi. 2018
3. Braja, M. Das, Geotechnical Engineering; Thomson Business Information India (P) Ltd., India. 2015
4. Punmia B C, Soil Mechanics and Foundation Engineering, Laxmi Publications co., New Delhi. 2017
5. Soil Testing for Engineers by S. Mittal and J.P. Shukla 2020

Reference Books

1. T.W. Lambe and R.V. Whitman, Soil Mechanics-, John Wiley & Sons. 1991
2. Donald P Coduto, Geotechnical Engineering- Phi Learning Private Limited, New Delhi. 2010
3. Shashi K. Gulathi & Manoj Datta, Geotechnical Engineering-Tata McGraw Hill Publications. 2010
4. Bowles J E, Foundation analysis and design, McGraw- Hill Publications 5th edition 2001
5. Malcolm D Bolton, “A Guide to soil mechanics”, Universities Press., 2003
6. Manual of Soil Laboratory Testing- Head K.H., (1986)- Vol. I, II, III, Princeton Press, London 2006

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Students may be teamed in to teams of four and given the task of determining the SBC of soil at any site shown. They will be required to conduct all relevant tests and use the knowledge gained to assess SBC of soil. This will address PO6, PO9, PO10 and PO12. If EXCEL is used for calculation of bearing capacity, PO5 also will be addressed.

Concrete Technology		Semester	5
Course Code	BCV503	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3hrs
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

Course objectives:

- To recognize material characterization of ingredients of concrete and its influence on properties of concrete
- To study the properties of fresh concrete and hardened concrete
- Proportion ingredients of Concrete to arrive at most desirable mechanical properties of Concrete.
- Ascertain various types of special concrete with their properties.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos, NPTEL materials
4. Quiz/Assignments/Open book test to develop skills.
5. Adopt problem-based learning (PBL) to develop analytical and thinking skills.
6. Encourage collaborative learning, site visits related to subject and impart practical knowledge.

MODULE-1

Concrete Ingredients

Cement manufacturing process, chemical composition and their importance, hydration of cement, types of cement. Testing of cement, steps to reduce carbon footprint.

Fine aggregate: Functions, requirement, Alternatives to River sand, M-sand introduction, and manufacturing. Coarse aggregate: Importance of size, shape and texture. Grading and blending of aggregate. Testing on aggregate, requirement. Recycled aggregates Water – qualities of water.

Chemical admixtures – plasticizers, accelerators, retarders, and air entraining agents. Mineral admixtures – Pozzolanic and cementitious materials, Fly ash, GGBS, silica fumes, Metakaolin and rice husk ash.

MODULE-2

Fresh Concrete

Factors affecting workability. Measurement of workability–slump, Compaction factor and Vee-Bee Consistometer tests, flow tests. Segregation and bleeding. Process of manufacturing of concrete- Batching, Mixing, Transporting, Placing and Compaction. Curing – Methods of curing – Water curing, membrane curing, steam curing, accelerated curing, self- curing. Good and Bad practices of making and using fresh concrete and Effect of heat of hydration during mass concreting at project sites.

MODULE-3

Hardened Concrete

Factors influencing strength, W/C ratio, gel/space ratio, Maturity concept, testing of hardened concrete, Creep – factors affecting creep. Shrinkage of concrete – plastic shrinking and drying shrinkage, Factors affecting shrinkage. Definition and significance of durability. Internal and external factors influencing durability, Mechanisms- Sulphate attack – chloride attack, carbonation, freezing and thawing. Corrosion, Durability requirements as per IS-456, In situ testing of concrete- Penetration and pull-out test, rebound hammer test, ultrasonic pulse velocity, core extraction – Principal, applications and limitations.

MODULE-4

Concrete Mix Design

Principles of concrete mix design, Parameters and factors influencing mix design, Concept of Mix Design with and without admixtures, variables in proportioning and Exposure conditions, Selection criteria of ingredients used for mix design, Procedure of mix proportioning. Numerical Examples of Mix Proportioning using IS-10262:2019.

MODULE-5

Special Concretes

RMC-manufacture and requirement as per QCI-RMCPCS, properties, advantages, and disadvantages. Self-Compacting concrete- concept, materials, tests, properties, application and typical mix Fiber reinforced concrete - types of fibres, properties, application of FRC. Light weight concrete-material properties and types. Typical light weight concrete mix proportion and applications, materials, requirements, mix proportion and properties of Geo polymer Concrete, High Strength Concrete and High-Performance Concrete.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Testing of cement: Consistency, fineness, setting time,
2	Specific Gravity, Soundness and strength of cement
3	Testing of fine aggregate: Specific Gravity, sieve analysis and zoning, bulking of fine
4	aggregate, bulk density, silt content.
5	Testing of coarse aggregate: Specific Gravity, sieve analysis, bulk density, flakiness index,
6	elongation index, water absorption & moisture content, soundness of aggregate.
7	Concrete Mix design by IS code method as per 10262- 2019 & 456-2000, DOE method.
8	Demonstration of Testing of concrete cube of specified strength
9	Demonstration of Testing of concrete beam for pure bending

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

Relate material characteristics and their influence on microstructure of concrete.

Distinguish concrete behaviour based on its fresh and hardened properties.

Illustrate proportioning of different types of concrete mixes for required fresh and hardened properties using professional codes.

Select a suitable type of concrete based on specific application.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25**

marks.

- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

Neville A.M. "Properties of Concrete"-4th Ed., Longman.

M.S. Shetty, Concrete Technology - Theory and Practice Published by S. Chand and Company, New Delhi.

Kumar Mehta. P and Paulo J.M. Monteiro "Concrete-Microstructure, Property and Materials", 4th Edition, McGraw Hill Education, 2014

A.R. Santha Kumar, "Concrete Technology", Oxford Un iversity Press, New Delhi (NewEdition).

Web links and Video Lectures (e-Resources):

Cement https://nptel.ac.in/courses/105102012/1
Aggregates https://nptel.ac.in/courses/105102012/6
Mineral admixtureshttps://nptel.ac.in/courses/105102012/11
Chemical admixtures https://nptel.ac.in/courses/105102012/9
https://nptel.ac.in/courses/105102012/10
Concrete mix design https://nptel.ac.in/courses/105102012/14

Concrete production & fresh concrete https://nptel.ac.in/courses/105102012/19 Engineering properties of concretehttps://nptel.ac.in/courses/105102012/23 Dimensional stability & durability https://nptel.ac.in/courses/105102012/27 Durability of concrete https://nptel.ac.in/courses/105102012/31 Special concretes https://nptel.ac.in/courses/105102012/36
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning ● Seminars/Quizz(To assist in GATE Preparations ● Demonstrations in Lab ● Self Study on simple topics ● Simple problems solving using Excel ● Virtual Lab Experiments

Environmental Engineering Lab		Semester	5
Course Code	BCV504	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	2
Examination type (SEE)	Practical		

Course objectives:

- To learn different methods of water & waste water quality
- To conduct experiments to determine the concentrations of water and waste water
- To determine the degree and type of treatment
- To understand the environmental significance and application in environmental engineering practice.

Sl.NO	Experiments
1	Preparation chemical solutions required for analysis and sampling methodologies
2	Determination of pH, Conductivity, TDS and Turbidity.
3	Determination of Acidity and Alkalinity
4	Determination of Calcium, Magnesium and Total Hardness.
5	Determination of Dissolved Oxygen
6	Determination of BOD.
7	Determination of Chlorides
8	Determination of percentage of % of available chlorine in bleaching powder sample, Determination of Residual Chlorine and chlorine demand.
9	Determination of Solids in Sewage: i) Total Solids, ii) Suspended Solids, iii) Dissolved Solids, iv) Volatile Solids, Fixed Solids v) Settleable Solids.
10	Determination of optimum coagulant dosage using Jar test apparatus.
11	Determination Nitrates and Iron by spectrophotometer
	Demonstration Experiments (For CIE)
12	Determination of COD (Demonstration)
13	Air Quality Monitoring (Demonstration)
14	Determination of Sound by Sound level meter at different locations (Demonstration)

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

- Acquire capability to conduct experiments and estimate the concentration of different parameters.
- Compare the result with standards and discuss based on the purpose of analysis.
- Determine type of treatment, degree of treatment for water and waste water.
- Identify the parameter to be analysed for the student project work in environmental stream.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before

the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- IS codes-3025 series
- Standard method for examination of water and waste water, APHA, 20th edition
- Clair Sawyer and Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Series in Civil and Environmental Engineering.

Numerical methods in civil engineering		Semester	5
Course Code	**BCV515A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3;0;0;0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- To learn various numerical techniques.
- To solve Numerical differentiation and integration problems.
- Apply numerical techniques to solve civil engineering problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos, NPTEL materials
4. Quiz/Assignments/Open book test to develop skills.
5. Adopt problem-based learning (PBL) to develop analytical and thinking skills.

Module-1

Historical development of Numerical techniques, role in investigations, research and design in the field of civil engineering development of algorithm/ flow charts for following methods for the solution of linear simultaneous equation- Gaussian elimination method, Gauss-Jordan matrix inversion method, Gauss-Siedel method and Factorization method.

Module-2

Development of algorithm for Bisection method.

Newton-Raphson method and its applications for solution of nonlinear algebraic and transcendental equations from problems in hydraulics, irrigation engineering, structural engineering and environmental engineering.

Module-3

Numerical differentiation and integration

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method – Two-point and three-point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules. Trapezoidal rule, Simpson's one-third and their application for computation of area of BMD drawn for statically determinate beams.

Module-4

New Marks method for computation of slopes and deflections in statically determinate beams.

Development of algorithm and application of solution of ordinary differential equation to civil engineering problems by Euler's method, Runge Kutta 4^{th} order method

Module-5

Introduction, expression of derivatives by finite difference: backward differences, forward differences, and central differences. Application of finite difference method for analysis of statically determinate beams, statically indeterminate beams, Buckling of columns, Beams on elastic foundation.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. To learn various numerical techniques.
2. To solve Numerical differentiation and integration problems.
3. Apply numerical techniques to solve civil engineering problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Grewal. B.S. and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi
2. Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi.
3. Chapra. S.C. and Canale. R. P., "Numerical Methods for Engineers, Tata McGraw Hill, New Delhi.
4. Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi.
5. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private, New Delhi.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/111107105
- https://www.coursera.org/learn/numerical-methods-engineers
- https://cosmolearning.org/courses/numerical-methods-and-programing/video-lectures/.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- solving civil engineering problems

OCCUPATIONAL SAFETY AND HEALTH MONITORING		Semester	5
Course Code	**BC515B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3;0:0:0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To Identify hazards in the workplace that pose a danger or threat to their safety or health.
- To Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
- To analysis a potential safety or health hazard
- To Discuss role of health and safety in the workplace pertaining to the responsibilities of workers, managers, supervisors.
- To Identify decisions required to maintain protection of the environment, workplace as well as personal health and safety.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. various types of innovative teaching techniques through videos, animation films may be adopted so that the delivered lesson can progress the students in theoretical, applied and practical skills.
2. Encourage collaborative (Group Learning) Learning in the class.
3. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
4. Seminars and Quizzes may be arranged for students in respective subjects to develop skills.

Module-1

Occupational Hazard and Control Principles:

Safety, History and development, National Safety Policy. Occupational safety and Health Act (OSHA), Occupational Health and Safety administration - Laws governing OSHA and right to know. Accident – causation, investigation, investigation plan, Methods of acquiring accident facts, Supervisory role in accident investigation.

Module-2

Ergonomics at Work Place:

Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, Ergonomic Programs. Hazard cognition and Analysis, Human Error Analysis – Fault Tree Analysis – Emergency Response - Decision for action – purpose and considerations.

Module-3

Fire Prevention and Protection:

Fire Triangle, Fire Development and its severity, Effect of Enclosures, early detection of Fire, Classification of fire and Fire Extinguishers.

Electrical Safety, Product Safety: Technical Requirements of Product safety.

Module-4

Health Considerations at Work Place:

Types of diseases and their spread, Health Emergency. Personal Protective Equipment (PPE) – types and advantages, effects of exposure and treatment for engineering industries, municipal solid waste. Environment management plans (EMP) for safety and sustainability.

Module-5

Occupational Health and Safety Considerations:

Water and wastewater treatment plants, Handling of chemical and safety measures in water and wastewater treatment plants and labs, Construction material manufacturing industries like cement plants, RMC Plants, precast plants, and construction sites. Policies, roles and responsibilities of workers, managers and supervisors.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Identify hazards in the workplace that pose a danger or threat to their safety or health.
2. Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. Present a coherent analysis of a potential safety or health hazard
4. Discuss the role of health and safety in the workplace pertaining to the responsibilities of workers, managers, supervisors.
5. Identify the decisions required to maintain protection of the environment, workplace as well as personal health and safety.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Goetsch D. L.,(1999), "Occupational Safety and Health for Technologists, Engineers and Managers", Prentice Hall.
2. Heinrich H.W.,(2007),"Industrial Accident Prevention-A Scientific Approach",McGraw-Hill Book Company National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991),
3. "Industrial Safety and Pollution Control Handbook.
4. Colling D.A.,(1990),"Industrial Safety Management and Technology", Prentice Hall,New Delhi.
5. Della D.E., and Giustina, (1996), "Safety and Environmental Management", Van Nostrand Reinhold International Thomson Publishing Inc.

Web links and Video Lectures (e-Resources):

- https://www.cdc.gov/niosh/index.htm
- https://nptel.ac.in/courses/114106017
- https://youtu.be/8nbOI-0U9Co
- https://youtu.be/Be9inw8xlw8
- https://youtu.be/n7oUOUCIblg
- https://youtu.be/gzgNLvHTrfY
- https://www.slideshare.net/engkhanmsh/introduction-to-osha-50289682

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- http://nptel.ac.in
- https://swayam.gov.in

SOLID WASTE MANAGEMENT		Semester	5
Course Code	**BCV515C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To facilitate the learners to understand fundamentals of key elements in solid waste management and governance.
- To impart knowledge to arrive strategies for waste management and selection of technologies for processing, treatment, and disposal.
- To examine and plan designs for material recovery facility, micro composting units, incinerators, biodigesters, and landfills

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Various types of innovative teaching techniques through videos, animation films may be adopted so that the delivered lesson can progress the students in theoretical, applied and practical skills.
2. Arrange visits to nearby solid waste disposal sites
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Seminars and Quizzes may be arranged for students in respective subjects to develop skills.

Module-1

Introduction to Solid waste management

Definition, Classification, need and Global perspective of solid waste management. Policies and legislative frameworks, Government initiatives on Solid waste management. Integrated solid waste management and concept of 3R's, Role of stakeholders.

Module-2

Waste generation and characterization

Factors affecting waste generation and methods to estimate the quantity of waste generated. Physical, chemical, and biological methods of waste characterization.

Module-3

Storage, collection, and Transportation of waste

Methods of storage, Storage container types and materials, onsite processing. Methods of collection and collection vehicles, Analysis, and design of Hauled and Stationary container systems with case studies. Transfer stations – feasibility and economic analysis.

Module-4

Waste processing and Disposal

Waste processing facilities- MRFs Landfills – Selection of liners, Design, Closure and Leachate management, Composting, Waste to Energy concepts – Incineration, Biogas recovery and Refuse derived fuels RDFs**.**

Module-5

Special Waste and Smart Solid Waste Management

Definition, Classification, Effects, treatment, disposal, Legislation and case studies of Hazardous waste, Construction and demolition waste, Electronic waste, Plastic, Biomedical waste and Radioactive waste. Life cycle assessment of solid waste management, Automation and IOT in storage, collection and treatment of

solid waste. Case studies.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Articulate the elements of solid waste management and categorize the waste based on physical, chemical, and biological characteristics.
2. Design a waste collection system for onsite collection, storage and demonstrate waste transfer and transport operations.
3. Evaluate and develop waste processing and treatment methods for solid and hazardous waste with sustainable practices.
4. Select appropriate disposal methods such as landfills, waste to energy plants and its handling in an efficient way.
5. Develop reduce, reuse, and recycling methods for special waste and prepare smart solutions for solid waste management.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Handbook of Solid Waste Management by Frank Kreith, George Tchobanoglous 1994
2. Management of Municipal Solid waste by T.V. Ramachandra 2009
3. Hazardous Waste management by Michael D LaGrega, Philip. L. Buckingham, Jeffery C. Evans 2001
4. Manuals and best practices in solid waste management by Swachh Bharat Mission

(https://swachhbharatmission.gov.in/sbmcms/technical-notes.htm)

Web links and Video Lectures (e-Resources):

- Introduction to solid waste https://www.youtube.com/watch?v=k0ktJRoRcOA
- Solid waste management https://www.youtube.com/watch?v=sMeUGwpvLtk
- Municipal Solid Waste Management (Civil Engineering) https://www.digimat.in/nptel/courses/video/105103205/L01.html
- Primary collection SWM https://www.digimat.in/nptel/courses/video/105103205/L09.html
- Solid waste types, methods, challenges and solutions https://www.youtube.com/watch?v=T_pIJiZ8JYI
- Types and sources of SWM https://www.digimat.in/nptel/courses/video/105103205/L03.html.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- http://nptel.ac.in
- https://swayam.gov.in
- https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham

REMOTE SENSING AND GIS		Semester	5
Course Code	**BCV515D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Understand concept of using photographic data to determine relative positions of points.
- Study the methods of collection of land data using Terrestrial and Aerial camera.
- Analyse the data gathered from various sensors and interpret for various applications.
- Apply the principles of RS, GIS and GPS in various scopes of Civil Engineering

Teaching-Learning Process (General Instructions)

These are sample Strategies, teachers can use to accelerate the attainment of the various course outcomes.

1. NPTEL courses on remote sensing and GIS has to be referred to students
2. online resources for remote sensing data to be made available in the lab
3. Open source software QGIS should be made available in the lab
4. YouTube videos
5. PowerPoint presentations.

Module-1

Remote Sensing-

Definition, types of remote sensing, components of remote sensing, electromagnetic spectrum, Black body, Atmospheric windows, energy interaction with earth surface features. Spectral reflectance curve. Platforms and sensors. Sensor resolutions. Types of satellites Indian and other remote sensing satellites (IRS, IKONS and Landsat). Principle of visual interpretation - key elements.

Module-2

Photogrammetry:

Introduction types of Photogrammetry, Advantages Photogrammetry, Introduction to digital Photogrammetry. Aerial Photogrammetry: Advantages over ground survey methods- geometry of vertical photographs, scales of vertical photograph. Ground coordination relief displacement, scale ground coordinates – flight planning.

Module-3

Geographic Information System-

Introduction, Functions and advantages, sources of data for GIS. Database – Types, advantages and disadvantages. Data Analysis.-overlay operations, network analysis, spatial analysis. Outputs and map generation. GPS- components and working principles.

Module-4

Applications of GIS, Remote Sensing and GPS: (1)

Water Resources engineering and management- prioritization of river basins, water perspective zones and its mapping, Highway and transportation -highway alignment, Optimization of routes, accident analysis, Environmental Engineering- Geostatistical analysis of water quality, rainfall.

Module-5

Applications of GIS, Remote Sensing and GPS: (2)

Urban Planning & Management, urban sprawl, Change detection studies, forests and urban area, agriculture, Disaster Management. Layouts: Dead end, Radial, Grid iron, Circular system.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understand and remember the principle of Remote Sensing (RS) and Geographical Information Systems (GIS) data acquisition and its applications.
2. Apply RS and GIS technologies in various fields of engineering and social needs
3. Analyse and evaluate the information obtained by applying RS and GIS technologies.
4. Create a feasible solution in the different fields of application of RS and GIS

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Geographic Information System-An Introduction, Tor Bernharadsen, 2009, 3rd Edition, Wiley India Pvt. Ltd. New Delhi, ISBN - 9788126511389.
2. Principles of Remote sensing and Image Interpretation, Lillesand and Kiefer, 2011, 6th Edition,
3. John Wiley Publishers, New Delhi, ISBN – 8126532238.
4. Higher Surveying, Chandra A.M, 2015, 3rd Edition, New age international (P) Ltd, ISBN: 8122438121
5. Remote Sensing, Robert A. Schowengerdt, 2009, 3rd Edition, Elsevier India Pvt Ltd, New Delhi.
6. Remote Sensing and GIS, Bhatta B, 2011, Oxford University Press, New Delhi, ISBN - 0198072392

Web links and Video Lectures (e-Resources):

- NPTEL lecture videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Delineating the boundary for a watershed using SOI topomap as reference in GIS software
- Delineating the national highway and study the different components
- Delineating different features on land surface and create land use/land cover map using topomap and google earth image of specific region

Design of RCC Structures		Semester	6
Course Code	**BCV601**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory/practical		

Course objectives:

- Identify, formulate and solve engineering problems of RC elements subjected to different kinds of loading.
- Follow a procedural knowledge in designing various structural RC elements.
- Impart the usage of codes for strength, serviceability and durability.
- Acquire knowledge in analysis and design of RC elements.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos , NPTEL materials
4. Quiz/Assignments/Open book test to develop skills
5. Adopt problem based learning (PBL) to develop analytical and thinking skills
6. Encourage collaborative learning, site visits related to subject and impart practical knowledge..

MODULE-1

Introduction to working stress and limit State Design: Introduction to working stress method, Difference between Working stress and Limit State Method of design. Philosophy and principle of limit state design with assumptions. Partial Safety factors, Characteristic load and strength. Stress block parameters, concept of balanced section, under reinforced and over reinforced section. Limiting deflection, short term deflection, long term deflection, Calculation of deflection of singly reinforced beam only.

MODULE-2

Limit State Analysis of Beams: Analysis of singly reinforced, doubly reinforced and flanged beams for flexure and shear.

MODULE-3

Limit State Design of Beams:

Design of singly reinforced beams with check for shear, check for development length and other checks. Design of doubly reinforced beams and flanged sections without checks.

MODULE-4

Limit State Design of Slabs and Stairs: Introduction to one way and two way slabs, Design of Cantilever, simply supported and one way continuous slab. Design of two way slabs for different boundary conditions. Design of dog legged and open well staircases

MODULE-5

Limit State Deign of Columns and Footings: Analysis and design of short axially loaded RC column. Design of columns with uniaxial and biaxial moments, Design concepts of the footings. Design of Rectangular and square column footings with axial load.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Calculation of deflection of singly reinforced beam using Excel
2	Design of a simply supported RCC singly reinforced beam using Excel and draw the reinforcement details
3	Design of a simply supported RCC doubly reinforced beam using Excel and draw the reinforcement details
4	Design of singly reinforced beams with check for shear, check for development length and other checks using Excel.
5	Design of a cantilever beam using Excel and draw the reinforcement
6	Design a simply supported RCC one way slab with intermediate support and draw the reinforcement details
7	Design a two-way slab for the given data and prepare Bar bending schedule
8	Design a short axially loaded RC column using Excel
9	Design the reinforcement for RCC square column with isolated square footing
10	Design the reinforcement for RCC circular column with isolated square footing
11	Creation of models related to RC Structural elements. (Demonstration)
12	

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

- Understand the design philosophy and principles.
- Solve problems of RC elements subjected to flexure, shear and torsion.
- Demonstrate the procedure in designs of RC structural elements such as slabs, columns and footings.
- Owns professional and ethical responsibility.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the

theory component of IPCC (that is for **25 marks)**.

- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Unnikrishnan Pillai and Devdas Menon, " Reinforced Concrete Design" , McGraw Hill, New Delhi
2. N Subramanian, " Design of Concrete Structures" , Oxford university Press
3. H J Shah, "Reinforced Concrete Vol. 1 (Elementary Reinforced Concrete)" , Charotar Publishing House Pvt. Ltd.

Reference Books:

1. P C Varghese, "Limit State design of reinforced concrete", PHI, New Delhi.
2. W H Mosley, R Husle, J H Bungey, "Reinforced Concrete Design", MacMillan Education, Palgrave publishers.
3. Kong and Evans, "Reinforced and Pre-Stressed Concrete", Springer Publications.
4. A W Beeby and Narayan R S, "Introduction to Design for Civil Engineers", CRC Press.
5. Robert Park and Thomas Paulay, "Reinforced Concrete Structures", John Wiley & Sons, Inc.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/105105105

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Students to prepare the models showing the reinforcement details in singly reinforced, doubly reinforced beams, Columns, Staircases and footings.

Irrigation Engineering and Hydraulic Structures		Semester	VI
Course Code	**BCV602**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:2:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Analyse and design gravity dams.
- Find the cross-section of earth dam and estimate the seepage loss.
- Design spillways and aprons for diversion works.
- Design CD works and chose appropriate canal regulation works.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos, NPTEL materials
4. Quiz/Assignments/Open book test to develop skills.
5. Adopt problem-based learning (PBL) to develop analytical and thinking skills.

Module-1

Irrigation: Definition. Benefits and ill effects of irrigation. System of irrigation: surface and ground water, flow irrigation, lift irrigation, Bandhara irrigation. Water Requirements of Crops: Duty, delta and base period, relationship between them, factors affecting duty of water crops and crop seasons in India, irrigation efficiency, frequency of irrigation.

Module-2

Canals: Types of canals. Alignment of canals. Definition of gross command area, cultural command area, intensity of irrigation, time factor, crop factor. Unlined and lined canals. Standard sections. Design of canals by Lacey's and Kennedy's method. Reservoirs: Definition, investigation for reservoir site, storage zones determination of storage capacity using mass curves, economical height of dam.

Module-3

Gravity dams:

Forces acting on a gravity dam, causes of failure of a gravity dam, elementary profile, and practical profile of a gravity dam, limiting height of a low gravity dam, Factors of Safety – Stability Analysis, Foundation for a Gravity Dam, drainage and inspection galleries.

Module-4

Earth dams:

Types of Earth dams, causes of failure of earth dam, criteria for safe design of earth dam, seepage through earth dam-graphical method, measures for control of seepage. Spillways: types of spillways, Design principles of Ogee spillways – Spillway gates. Energy Dissipaters and Stilling Basins Significance of Jump Height Curve and Tail Water Rating Curve – USBR and Indian types of Stilling Basins.

Module-5

Diversion Head works:

Types of Diversion head works- weirs and barrages, layout of diversion head work – components. Causes and failure of Weirs and Barrages on permeable foundations, -Silt Ejectors and Silt Excluders, Weirs on Permeable Foundations – Creep Theories – Bligh's, Lane's and Khosla's theories, Determination of uplift pressure-Various Correction Factors – Design principles of weirs on permeable foundations using Creep theories – exit gradient, U/s and D/s Sheet Piles – Launching Apron.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Know types of water retaining structures for multiple purposes and its key parameters considered for planning and designing
2. Understand details in any Irrigation System and its requirements
3. Analyse and Design of a irrigation system components

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Irrigation Engineering and Hydraulic structures by Santhosh kumar Garg, Khanna Publishers.
2. Irrigation engineering by K. R. Arora Standard Publishers.
3. Irrigation and water power engineering by Punmia & Lal, Laxmi publications Pvt. Ltd., New Delhi
4. Theory and Design of Hydraulic structures by Varshney, Gupta & Gupta
5. Irrigation Engineering by R.K. Sharma and T.K. Sharma, S. Chand Publishers 2015.
6. Irrigation Theory and Practice by A. M. Micheal Vikas Publishing House 2015.
7. Irrigation and water resources engineering by G.L. Asawa, New Age International Publishers.

Web links and Video Lectures (e-Resources):

- NPTEL Videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Site visit to a dam site and observe all the facility

DESIGN OF BRIDGES		Semester	6
Course Code	**BCV613A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

- Introduce students to various aspects of Bridge structures, its components.
- Understand the hydraulic design concepts of Bridges, various IRC loading standards.
- Design small span bridges like culverts, slab decks, and T-beam decks and post tensioned
- slabs.
- Understand various types of bearings, analysis of substructures, and foundations.
- Understand super structure construction methods and practices.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and Talk teaching.
2. Use of ICT (Video) material to show real world pictures of bridges and their construction.

Module-1

Introduction and Conceptual Design of Bridges

Introduction, components of a bridge and their functions, Site investigations prior to bridge construction, classification of bridges, IRC loading standards, IRC A, AA, and 70 R. Hydraulic design of bridges, natural and artificial water ways, afflux, Economical span, problems.

Module-2

Pipe culverts. Hydraulic design and structural design, IRC standards. Design problems.

Design of Box culverts, general procedure of design for all the conditions of culvert , reinforcement details, Design example (students should be given to design the culvert for any one condition of loading)

Module-3

Design of Deck slab (Limit state method):

Introduction, Design of deck slab. Effective dispersion of wheel load along the span and effective width concept, Arrangement of wheel loads of IRC A for obtaining maximum bending moment and shear force. Design example, Arrangement of IRC class AA obtaining maximum bending moment and shear force. Design example. Arrangement of IRC 70R loading for obtaining maximum bending moment and shear force. Design example.

Module-4

Introduction to T-beam bridges:

Code provisions, typical arrangement of longitudinal and cross girders, Pigeaud's method, design of interior panel (for IRC class AA & 70R), methods for finding load distribution among longitudinal girders (Courbon's, Hednry Jaguer's method), general steps of design (only design concepts).

Module-5

Bridge substructures, abutments and Piers:

Types of abutments and piers, stability analysis of piers and abutments, base pressure distribution. Bridge bearings, types and their suitability.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Select the type of the bridge based on the site investigation inputs and be able to compute design discharge, linear water way , economic span and depth of scour (L2 & L3)
2. Design pipe culverts.
3. Design deck slabs for critical loads (L3 & L4)
4. Analyse the stability of bridge piers and abutments. (L3 & L4)
5. Recommend suitable bearings for the given type of bridge and support condition

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. D. Johmson Victor, Essentials of Bridge Engineering, 6 th edition, Oxford IBH publications, New Delhi, 2019 ,ISBN:978-81-204-1717-5
2. T.R.Jagadeesh & M A Jayaram, Design of Bridge Structures, 3 rd edition, PHI, New Delhi, 2020, ISBN:978-81-203-3385-29
3. Krishna Raju N, Design of Bridges, Oxford-IBH publishing, 5 th edition, New Delhi
4. Rajagopalan, Bridge Super Structures, Narosa Publishing House, 2013, ISBN :817-31-964-78
5. IRC : 112- 2020: Code of Practice for Concrete Bridges, July 2020, New Delhi

Web links and Video Lectures (e-Resources):
• https://www.youtube.com/watch?v=hc9Vj_wuQlg • https://www.youtube.com/watch?v=XFRqwmpR7JE • https://www.youtube.com/watch?v=2Dw4vbpPx54 • https://www.youtube.com/watch?v=Hfq9cqZFOkc • https://www.youtube.com/watch?v=Hfq9cqZFOkc • https://www.youtube.com/watch?v=unys9j1qxw4.
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Students in groups (not more than two)need to garner data pertaining to a short span bridge/ box culvert and perform the redesign of the bridge and submit the report.

DESIGN OF FORMWORK AND SCAFFOLDING		Semester	6
Course Code	**BCV613B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To select the appropriate formwork system
- To design the formwork system
- To compute the bill of quantity for the formwork system
- To incorporate safer design and construction aspects including assembling and dismantling to prevent formwork failures
- To comprehend plan, layout and detailed drawing for formwork systems

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos, NPTEL materials
4. Quiz/Assignments/Open book test to develop skills.
5. Adopt problem-based learning (PBL) to develop analytical and thinking skills.

Module-1

Introduction to Formwork

Classification, benefits, objectives, areas of competitiveness, selection of Formwork, formwork materials, accessories and consumables, application of Tools. Formwork for Foundation, Wall, Columns, Slab and Beam. Conventional drawings. Vertical Application of Conventional Foundation Formwork, Formwork components,

Components, assembly and de-shuttering of formwork System, Flex System, Heavy Duty Tower System, safety of work, Formwork for stairs, Load Bearing Tower.

Module-2

Planning and Design of formwork

Formwork planning and monitoring, basics of formwork design, design assumptions and design methods. Design of wall formwork, slab formwork and checks. Formwork drawing Concept and Preparation Guidelines, BOQ Calculation and Checklist.

Module-3

Formwork cost estimation and optimization

Schedule of formwork, Mobilization distribution, BOQ, Quantity Calculation, Cost optimization

Module-4

Modular and Special formwork, scaffolding

Modular and Special formwork: Advantages and Limitations, Shuttering and de-shuttering, applications, Aluminium formwork - Drawings & Components, Activities, High rise construction, Table lifting system.

Scaffolding: Modular scaffold Installation sequence, Tie and material specification, Ladder safety, Loading Classification, application, Components of L&T Modular Scaffolding system, Access scaffold Do's and Don'ts. Innovation and Global practices.

Module-5

Formwork building and erection, Formwork Failures

Formwork assembly for Wall & Column Panels, Equipment and Layout, Plant and Machinery, Formwork erection and safety, Inspection and Corrections, Plant and Machinery, Code and Contractual Requirements.

Formwork Failures: Causes, design deficiency, safety in formwork, prevention of formwork failures.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Analyse the project, and decide appropriate formwork materials and suitable formwork system
2. Design formwork systems as per Industrial requirement
3. Estimate the bill of quantity and optimize the formwork cost
4. Prepare the layout and detailed drawing for the formwork system

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Jha, K.N., Formwork for Concrete Structures, First Edition, McGraw Hill. 2012
2. Robert L. Peurifoy and Garold D. Oberiender, Formwork for Concrete Structures, McGraw-Hill, 1996.
3. IS 14687 -Guidelines for falsework for concrete structures
4. Concrete pressure on formwork (R108D) - CIRIA
5. IS 456: Plain and Reinforced Concrete - Code of Practice

Web links and Video Lectures (e-Resources):

- NPTEL and YouTube Videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to construction sites to understand form work

APPLIED GEOTECHNICAL ENGINEERING		Semester	6
Course Code	**BCV613C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- Appreciate basic concepts of soil mechanics applied in the design of foundations
- Learn concepts of Geotechnical investigations required for civil engineering projects emphasizing in situ investigations
- Conceptually learn various theories related to bearing capacity of soil and their application in the design of shallow foundations and estimation of load carrying capacity of pile foundation
- Estimate internal stresses in the soil mass and application of this knowledge in proportioning of shallow and deep foundation fulfilling settlement criteria
- Study about assessing stability of slopes and earth pressure on rigid retaining structures.

Teaching-Learning Process (General Instructions)

These are sample Strategies, teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and talk
2. PPT
3. You Tube video lectures
4. Open book test to understand the concepts.

Module-1

Soil Exploration:

Introduction, Objectives and Importance, Stages and Methods of exploration- Test pits, Borings, stabilization of boreholes, Sampling techniques, Undisturbed, disturbed and representative samples, sample disturbance and Bore hole log.

Module-2

Drainage and Dewatering:

Drainage and Dewatering methods, estimation of depth of GWT (Hvorslev's method)

Flownets: Importance, properties and applications, Phreatic Lines, Seepage in earth dams (with and without

Module-3

Lateral Earth Pressure:

Active, Passive and earth pressure at rest, Rankine's theory for cohesionless and cohesive soils, Factors influencing lateral earth pressure, Geotechnical design of gravity and cantilever retaining walls.

Module-4

Stability of Slopes:

Assumptions, infinite and finite slopes, factor of safety, Swedish slip circle method for C and C-ø (Method of slices) soils, Fellineous method for critical slip circle, use of Taylor's stability charts. Causes for slope instability, Methods of stabilisation of slopes

Module-5

Stresses in Soil:

Geodesic stress and Stress due to structures, Boussinesq's Stress distribution in ground for point load, line load and uniformly distributed loads, Newmark's Chart, Contact Pressure, Pressure bulbs. Types of settlements and importance, Computation of immediate and consolidation settlement, permissible differential and total settlements (IS 8009 part 1).

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Ability to plan and execute geotechnical site investigation program for different civil engineering projects
2. Understanding of stress distribution and resulting settlement beneath the loaded footings on sand and clayey soils
3. Ability to estimate factor of safety against failure of slopes and to compute lateral pressure distribution behind earth retaining structures
4. Ability to determine settlement in footing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Murthy V.N.S., Principles of Soil Mechanics and Foundation Engineering,UBS PublishersandDistribu tors, NewDelhi.
2. K.R.Arora, Soil Mechanics and Foundation Engineering, Standard Publisher Distributors, NewDelhi.
3. PC Varghese, Foundation Engineering, PHI India Learning Private Limited, NewDelhi.
4. Punmia BC, Soil Mechanics and Foundation Engineering (2017), 16th edition, LaxmiPublicationsco., New Delhi.

Web links and Video Lectures (e-Resources):

- Online study material
- NPTEL video lectures..

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Site visit to understand the practical difficulty in construction of earth retaining strucures
- Assignment to students on design of an earth retaining structures

DESIGN AND CONSTRUCTION OF HIGHWAY PAVEMENTS		Semester	6
Course Code	**BCV613D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3;0:0:0	SEE Marks	50
Total Hours of Pedagogy	40Hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To impart a fundamental understanding to the basics of highway geometric design features
- To introduce the evaluation of pavement material characteristics to identify their suitability for construction
- To study the principles and design of flexible and rigid pavements according to IRC specifications
- To skill up for executing pavement construction with quality control and assurance along with Plants and Machinery selection

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Blackboard teaching
2. Power point Presentation
3. Videos, NPTEL materials
4. Quiz/Assignments/Open book test to develop skills.
5. Adopt problem-based learning (PBL) to develop analytical and thinking skills.

Module-1

Introduction and Subgrade Materials: Overview of highway - Classification of roads, Pavement Layers – Components and Functions, Highway alignment and Survey, road development in India, Components and
Geometric Standards of Highway Design

Pavement subgrade material: Soils, Soil Characteristic Evaluation, desirable properties, tests (Virtual) - Liquid Limit, Plastic limit, Shrinkage Limit, Grain size analysis - Wet sieve and Hydrometer analysis, Water Content, Specific gravity, Free swell index, Relative density, Heavy compaction, California Bearing Ratio.

Module-2

Pavement Materials

Stone aggregates: Desirable properties, tests (Virtual) - Sieve analysis, Specific gravity, Water absorption, Bulk density, Wet Sieve analysis, Aggregate crushing value, Aggregate impact value, Combined Flakiness and Elongation index, Aggregate abrasion value, Soundness of aggregate, Characteristic evaluation

Bituminous binders: Desirable properties, tests (Virtual) - Specific gravity, Penetration, Softening Point, Ductility, Elastic recovery, Flash point, Separation, Loss on heating, Matter soluble in trichloro ethylene, Absolute, Kinematic and Rotational Viscosity, Aging of Bitumen, Characteristic evaluation.

Bituminous paving mix: Desirable properties, tests (Virtual) - Stripping value of coarse aggregate, Stone polishing value of coarse aggregate, Maximum specific gravity of bituminous mix, Marshall stability & flow, Binder content, Bulk specific gravity and density, Indirect tensile strength, Resilient Modulus (indirect tension test), Resistance of compacted asphalt mixtures to moisture-induced damage, Characteristic evaluation

Cement: Desirable properties, tests (Virtual) - Consistency, Initial Setting Time, Final Setting Time, Mortar Cube compressive strength, Fineness of cement, Specific gravity of cement, Soundness of cement, Characteristic evaluation

Concrete: Desirable properties, requirements, tests (Virtual) - Workability, Compressive Strength, Flexural strength, Characteristic evaluation

Module-3
Principles and Design of Pavements **Flexible Pavement:** Introduction, composition, factors governing design, design of flexible pavements as per IRC; Bituminous mix design (Marshall method), IIT Pave Software; Case study - Design Problem **Rigid pavement:** Introduction, composition, factors governing design, DLC and PQC mix design; design of concrete pavements as per IRC; Joints; Case study – Design Problem
Module-4
Plants and Machinery: Introduction; Asphalt Hot Mix Plant, Concrete Batching Plant, Wet Mix Macadam Plant, Earthmoving and Excavation Equipment, Paving Equipment, Slipform Paver, Paver Milling and Road Marking Equipment; Factors affecting output of Plant & Equipment; Initiatives to improve quality **Construction Planning:** Concept of Highways, Planning; Schedules in Planning; Monitoring; Software in Planning
Module-5
Subgrade and Base Layer: Construction Practices and Quality Control; Granular Sub-base Construction Activities; Cement Treated Sub-base Construction Activities **Flexible Layers**: Wet Mix Macadam; Construction Practices of Wet Mix Macadam; Hot Mix Asphalt; Construction Practices of Hot Mix Asphalt Layer, Quality Control of Flexible Layers **Rigid Layers:** Dry Lean Concrete; Construction Practices of Dry Lean Concrete; Pavement Quality Concrete; Construction Practices of Pavement Quality Concrete, Quality Control of Rigid Layers **Pavement Evaluation:** Introduction, Pavement Condition Survey, Pavement Evaluation Functional and Structural, Distresses - Flexible and Rigid Pavement, Overlay Design of Flexible Pavement.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. Develop an understanding of the fundamentals of pavement layer behaviour. 2. Comprehend the material specifications by interpreting the relationship between material properties and pavement behaviour. 3. Conduct different tests on road construction materials to evaluate their characteristics 4. Carry out the design of flexible and rigid pavements 5. Acquire skilful knowledge of pavement construction practices, plant and machinery selection and quality control

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. Partha Chakraborty, "Principles of Transportation Engineering", PHI Learning,
3. Principles and Practices of Highway Engineering by Kadiyali L.R and Dr.Lal N.B., Khanna Publishers, New Delhi, 2003
4. Relevant IRC and IS Codes of Practices, MoRTH Specification

Web links and Video Lectures (e-Resources):

- NPTEL and YouTube Videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to road construction site

GEOGRAPHIC INFORMATION SYSTEM		Semester	6
Course Code	**BCV654B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To introduce the fundamentals and components of Geographic Information System
- To provide details of spatial data structures and input, management and output processes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and talk
2. PPT
3. You Tube video lectures
4. Open book test to understand the concepts..

Module-1

Fundamentals of GIS:

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions– History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

Module-2

Spatial Data Models;

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

Module-3

Data Input and Topology:

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input –Digitiser – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

Module-4

Data Quality and Standards:

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure.

Module-5

Data Management and Output:

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion -
Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GISdistributed GIS.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Have basic idea about the fundamentals of GIS.
2. Understand the types of data models.
3. Get knowledge about data input and topology.
4. Gain knowledge on data quality and standards.
5. Understand data management functions and data output

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.
3. Lo.C.P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

Web links and Video Lectures (e-Resources):

- NPTEL VIDEOS.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to KSRSAC and ISRO

Integrated Waste Management for a Smart City		Semester	6
Course Code	**BCV654C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	6
Examination type (SEE)	Theory		

Course objectives:

- To introduce the fundamentals of Solid Waste Management
- To provide details of Sustainable Cities
- Understand the Sustainable Development Goals.

Teaching-Learning Process (General Instructions)

These are sample Strategies, teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and talk
2. PPT
3. You Tube video lectures
4. Open book test to understand the concepts..

Module-1

Introduction to Solid Waste Management

Municipal Solid Waste Characteristics and Quantities generation rates and waste composition; Integrated waste management issues, collection, recovery, reuse, recycling, energy-from-waste, and landfilling;

Module-2

Biological treatment of the organic waste fraction ;

Direct land application, composting, and anaerobic digestion.

MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program

Module-3

Biochemical Processes and Composting

Energy Recovery from Municipal Solid Waste.

Current Issues in Solid Waste Management and Review of MSW Management Status in First List of 20 Smart Cities in the Country

Module-4

Construction and Demolition (C&D) Waste

Management - Overview

C&D Waste – Regulation, Beneficial Reuse of C&D Waste Materials

Module-5

Electronic Waste (E-Waste)

Management – Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understand basic idea about Sustainable Development.
2. Get knowledge about Sustainable Cities.
3. Gain knowledge on Saving Biodiversity.
4. Understand Sustainable Development Goals.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

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Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. William A Worrell and P. Aarne Veslind Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)
2. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, Tata McGraw Hill
3. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization(CPHEEO), India
4. MSW Management Rules 2016, Govt. of India, available online at CPCB website.
5. Electronic Waste Management Rules 2016, Govt. of India, CPCB website.

Web links and Video Lectures (e-Resources):

- NPTEL VIDEOS.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to landfill and waste management site

SUSTAINABLE DEVELOPMENT GOALS		Semester	6
Course Code	**BCV654D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0;0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To introduce the fundamentals and components of Sustainable Development
- To provide details of Sustainable Cities
- Understand the Sustainable Development Goals.

Teaching-Learning Process (General Instructions)

These are sample Strategies, teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and talk
2. PPT
3. You Tube video lectures
4. Open book test to understand the concepts..

Module-1

Sustainable Development:

Introduction to Sustainable Development

Economic Growth and Progress, Continuing Poverty, Environmental Threats, Business as Usual Versus Sustainable Development

Module-2

Sustainable Cities:

The Patterns of Urbanization Around the World, development of Sustainable city, Smart Infrastructure, Urban Resilience, Planning for Sustainable Development.

Module-3

Curbing Climate Change

The Basic Science of Climate Change, Consequences, Mitigation, Adaptation, Mitigation Policies:

Module-4

Saving Biodiversity:

Concept of Biodiversity, Biodiversity Under Threat, Oceans and Fisheries, Deforestation International Dynamics.

Module-5

Sustainable Development Goals

Introduction to Sustainable Development Goals, Goal-Based Development, Financing for Sustainable Development, Principles of Good Governance, Feasibility of Sustainable Development.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understand basic idea about Sustainable Development.
2. Get knowledge about Sustainable Cities.
3. Gain knowledge on Saving Biodiversity.
4. Understand Sustainable Development Goals.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Ram Kumar Mishra, Ch Lakshmi Kumari, Sandeep Chachra, P.S. Janaki Krishna "Smart Cities for Sustainable Development" Springer, 2022 Edition
2. The Sustainable Development Goals Report 2020 Kindle Edition, Department of Economic and Social Affairs
3. 'The Sustainable Development Goals" Hardcover – December 4, 2018 United Nations.

Web links and Video Lectures (e-Resources):

- NPTEL VIDEOS.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to Industry to understand sustainability goals adopted

Software Application Lab		Semester	6
Course Code	**BCVL606**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives:

- Use industry standard software in a professional set up.
- Understand the elements of finite element modelling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.
- Develop customized automation tools..

Sl.NO	Experiments
1	Analysis of plane trusses, continuous beams using software
2	Analysis of portal frames using software
3	Understanding basic features of Project management software. Constructing Project: create WBS, Activities, and tasks and Computation Time using Excel spread sheet and transferring the same to Project management software.
4	Identification of Predecessor and Successor activities with constrain. Constructing Network diagram (AON Diagram) and analyzing for Critical path,
5	Critical activities and Other non-Critical paths, Project duration, Floats. Study on various View options available
6	Basic understanding about Resource Creation and allocation g. Understanding about Splitting the activity, Linking multiple activity, assigning Constrains, Merging Multiple projects, Creating Baseline Project
7	GIS applications using open source software: To create shape files for point, line and polygon features with a map as reference. To create decision maps for specific purpose.
8	Computation of earthwork, Design of horizontal curve by offset method, Design of super elevation Using Excel
	Demonstration Experiments (For CIE)
9	Creating structural model and analysis of high rise structures
10	Creating a model of building and the effect of earth quake
11	Create a model of large span roof and analyse
12	Crate a plan and set of structural drawings for a multi-storied building

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Use software for analysis and design of structural elements.
- Design using excel spread sheet
- Modelling of structural elements of buildings

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Training manuals and User manuals and Relevant course reference books

Structural Health Monitoring Using Sensors		Semester	6
Course Code	BCV657B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- To provide an understanding of the principles of SHM and its importance in the field of civil engineering.
- To familiarize students with different types of sensors used in SHM and their principles of operation
- To teach students how to design and implement a sensor-based monitoring system for a civil engineering structure.
- To provide students with the knowledge of data acquisition, processing, and analysis techniques for SHM.
- To demonstrate the application of SHM in the assessment of civil engineering structures

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Blackboard teaching
- Power point Presentation
- Videos, NPTEL materials
- Quiz/Assignments/Open book test to develop skills.

Module-1

Introduction on SHM: Introduction to Structural Health Monitoring, Definition and importance of SHM in civil engineering, History and evolution of SHM,SHM system components and their functions.

Module-2

Types of Sensors for Structural Health Monitoring: Overview of different types of sensors, Principles of operation and selection of sensors for different structures, Advantages and disadvantages of different sensors, SHM using Optical Fibres and other sensors

Module-3

Structural Health Monitoring and Smart Materials: Structural Health Monitoring versus Non Destructive Evaluation, Health Monitoring and Demolition Techniques, Long term health monitoring techniques, Understanding Piezoelectric materials

Module-4

Design of Sensor-based Monitoring System: System design considerations, Sensor placement and installation, System calibration and validation

Module-5

Applications of Structural Health Monitoring: Monitoring of buildings, bridges, and dams, Case studies of SHM applications in civil engineering, Future trends and challenges in SHM.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Understand the concept of structural health monitoring and various methods applied for monitoring of structures and structural safety
2. Analyze the sensor systems in structural health monitoring.
3. Design and implement a sensor-based monitoring system for a civil engineering structure.
4. Apply the application of SHM in the assessment of engineering structures

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", John Wiley and Sons, 2006
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components", John Wiley and Sons, 2000
3. E-resources 1. E-learning content on L&T EduTech Platform

Web links and Video Lectures (e-Resources):

- L&T EduTech Lecture Videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Site visit to understand the structural health monitoring systems

DATA ANALYTICS FOR CIVIL ENGINEERS		Semester	6
Course Code	**BCV657C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1;0:0:0	SEE Marks	50
Total Hours of Pedagogy	20Hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- Get an overall view of data analysis based on CRISP-DM process model.
- Study data quality assessment and visualization techniques for data involving two attributes and for higher dimensional data.
- Understand principles of modelling by going through various data modelling techniques.
- Get a detailed account of data preparation phase.
- Study statistical concepts related to data analysis.
- Enable students to independently perform data analytic procedures on data pertaining to civil engineering using Excel and R.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and Talk teaching.
2. Collection of data from allied fields of civil engineering and selecting appropriate data analytic method.
3. Use of ICT material to show graphical simulations related to dimension reduction, scattering, parallel plots , star diagrams, Radar plots etc....

Module-1

Introduction to Data Analytics: Data and knowledge, criteria to assess the knowledge, descriptive statistics of the data, inferential statistics, exploratory data analysis, knowledge discovery in data bases, data analysis processes, SEMMA, CRISP-DM, methods, tasks and tools.

Module-2

Understanding the Data : Attribute understanding, kinds of attributes (nominal, interval, ratio types). Characteristics of one dimensional data, location measures, dispersion measures, and shape measures. Characteristic measures of multidimensional data, data quality, visual analytics of one dimensional data, density plots, box plots, scatter plots. Correlation and covariance. Methods for multidimensional data (just briefing). ***Analysis of data pertaining to civil engineering.***

Module-3

Principles of Data Modelling : The four steps of modeling, model classes, black-box models, fitting criteria and score functions, error functions for classification problems, measure of interestingness, closed form algorithm for model fitting. Types of errors. Model validation (briefing on methods). ***Modelling on the data specific to civil engineering***.

Module-4

Data Preparation : Selection of data, feature selection, selecting top ranked subset of data, cross product, wrapper approach, and correlation based filter. Cleaning data, improving data quality, dealing with missing values, construct data, providing operability, assuring impartiality and maximize efficiency. Complex data types. Implementation of methods on data specific to civil engineering.

Module-5

Finding patterns in data: Clustering – methods. Hierarchical clustering. Dissimilarity measures, Minkowisci, Euclidian, Manhattan, Chebyshev, and cosine. Deviation measures. Association rules. Brief introduction to self organizing maps. Implementation of methods on data specific to civil engineering.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each methods and tasks involved. Apply CRISP-DM data analysis processes to civil engineering related data in decision making.
2. Apply appropriate data visualization techniques and perform correlation analysis on the real world data pertaining to allied areas of civil engineering.
3. Develop appropriate model for the data using the suitable algorithm and validate the so developed model using appropriate validation technique.
4. Decide on appropriate method/ technique for data preparation and provide operability by assuring impartiality and integrity to the given real world data drawn from various sub domains of civil engineering.
5. Perform similarity analysis using similarity metrics and to implement simple clustering techniques of the given data set in one and multiple dimensions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.
4. **The duration of the examinations shall be defined by the concerned board of studies**

Suggested Learning Resources:

Books

1. Michel R. Berthold, Christian Borgelt, Frank Hoopner, Guide to Intelligent Data Analysis, Springer- Verlag

Publications, ISBN 978-1-84882-259-7, DOI 10.1007/978-1-84882-260-3, London , 2010
2. Charles M.Zudd, Garry H.Mcchelland, Carry S.Ryan, Data Analysis: A Model Comparison Approach, Routledge Publication, NY, 2009.
3. Allan Agresty, An Introduction to Categorical Data Analysis, 2nd Edition, Wiley Publication.

Web links and Video Lectures (e-Resources):

- https://www.kdnuggets.com
- www.kaggle.com
- www.datameer.com.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Students in groups (not more than two)need to garner data pertaining to civil engineering from resources (Internet, standard Journal papers, experimental data....) apply all the methods learnt during the course, implement the methods using Excel and prepare a small report.

Quality Control and Quality Assurance		Semester	6
Course Code	BCV657B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- Appreciate the concept of Quality
- Articulate the Implication of Quality in construction
- Implement QA & QC Programs
- Realise the importance of QMS in Civil Engineering.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Chalk and talk
2. Power point Presentation, video
3. Site Visit
4. Industry interaction.

Module-1

Overview of Quality: Quality History, Quality Definition, Quality Inspection, Quality Control, Quality Assurance, Quality Engineering, Quality Management, Quality Gurus: Philip B. Crosby, W. Edwards Deming etc, PDCA Cycle, Costs associated with Quality, Reasons for Poor Quality

Module-2

Quality Management: Management Practices: TQM, Vision and Quality policy, Quality Function Deployment, Bench marking and performance evaluation, ISO 9000 Quality Management System, ISO 14000 Environmental Management System

Module-3

Statistical Quality Control: Importance of SQC in construction, Statistical parameters: sampling, population and sampling, measure of variability, measure of central tendency, Recommendations of IS 456:2000 on sampling, testing and acceptance criteria for concrete.

Module-4

QA and QC in Construction: Errors in concrete construction; Frequency of material testing and reporting of basic construction materials (cement, sand, coarse aggregate, bricks, steel), Norms for accepting and rejecting criteria of basic construction materials as per relevant IS codes.

Module-5

On-Site Quality: Achieving quality at different stages of construction: Conceptual Design, Preliminary Design, Detailed Design, Construction, Testing, Commissioning, and Handover. Quality assessment of concrete through NDT: rebound hammer and USPV tests and guidelines for accepting and rejecting.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Realize the importance of quality in construction
2. Apply SQC techniques in different aspects of construction
3. Implement QMS programs at different levels of construction

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Juran J M and Gryna F M, Quality Planning and Analysis
2. Hutchins G, John L Ashford, The Management of Quality in Construction
3. Mohamed A. El-Reedy, "Concrete and Steel Construction, Quality Control and Assurance", CRC Press, Taylor and Francis Group
4. M. S. Shetty, Concrete Technology, S Chand Publications
5. Relevant IS Codes

Web links and Video Lectures (e-Resources):

- Online study material
- You Tube videos.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Industrial visit – preparation of checklists for different activities in construction
- Collection of typical reports on testing of basic construction materials