



Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Diploma in Civil Engineering / Diploma in Rural Engineering / Diploma in Construction Technology

With Effect From Academic Year: 2017 - 18

Program Code : CE/CR/CS

Duration of Program : 6 Semesters

Duration : 16 Weeks

Semester : Sixth

Scheme - I

| S. N. | Course Title | Course Abbreviation | Course Code | Teaching Scheme | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | Grand Total | |
|---------------------------------------|---|---------------------|-------------|-----------------|----------|----------------|--------------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|------------|------------|-------------|-----------|
| | | | | L | T | | P | Theory | | | | | | Practical | | | | | | |
| | | | | | | | | ESE | | PA | | Total | | ESE | | PA | | Total | | |
| | | | | | | | | Max Marks | Min Marks | Max Marks | Min Marks | Max Marks | Min Marks | Max Marks | Min Marks | Max Marks | Min Marks | Max Marks | | Min Marks |
| 1 | Management | MAN | 22509 | 3 | - | - | 3 | 90 Min | 70*# | 28 | 30* | 00 | 100 | 40 | -- | -- | -- | 100 | | |
| 2 | Contracts and Accounts | CAA | 22601 | 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25@ | 10 | 25 | 50 | 150 | |
| 3 | Maintenance and Repairs of Structures | MRS | 22602 | 4 | - | 2 | 6 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 50 | 150 | |
| 4 | Emerging Trends in Civil Engineering | ETC | 22603 | 3 | - | - | 3 | 90 Min | 70*# | 28 | 30* | 00 | 100 | 40 | -- | -- | -- | -- | 100 | |
| Elective – II (Select Any One) | | | | | | | | | | | | | | | | | | | | |
| | Building Services | BSE | 22604 | 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 50 | 150 | |
| | Solid Waste Management | SWM | 22605 | 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 50 | 150 | |
| 5 | Earthquake Resistant Buildings | ERB | 22606 | 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 50 | 150 | |
| | Advanced Design of Structures | ADE | 22607 | 3 | - | 2 | 5 | 4 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 50 | 150 | |
| 6 | Capstone Project - Execution & Report Writing | CPE | 22060 | - | - | 4 | 4 | -- | -- | -- | -- | -- | -- | -- | 50# | 20 | 50~ | 100 | 100 | |
| 7 | Construction Management | CMA | 22061 | 1 | - | 2 | 3 | -- | -- | -- | -- | -- | -- | -- | 25@ | 10 | 25~ | 50 | 50 | |
| 8 | Entrepreneurship Development | EDP | 22032 | 2 | - | 2 | 4 | -- | -- | -- | -- | -- | -- | -- | 50@ | 20 | 50~ | 20 | 100 | |
| Total | | | | 19 | - | 14 | 33 | -- | 350 | -- | 150 | -- | 500 | -- | 200 | -- | 200 | 400 | 900 | |



Student Contact Hours Per Week: **33 Hrs.**

Medium of Instruction: **English**

Theory and practical periods of 60 minutes each.

Total Marks : **900**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, @^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

➤ **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**



Program Name : Diploma in Automobile Engineering / Civil Engineering Group /
 Electronics Engineering Group / Diploma in Plastic Engineering /
 Diploma in Production Engineering /Diploma in Fashion &
 Clothing Technology/ Computer Engineering Group
Program Code : AE/CE/CR/CS/ DE/EJ/ET/EN/EX/EQ/IS/IC/IE/PG/PT/DC/
 CO/CM/CW/IF
Semester : Sixth
Course Title : Management
Course Code : 22509

1. RATIONALE

An engineer has to work in industry with human capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is therefore designed to provide the basic concepts in management principles, safety aspects and Industrial Acts.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Use relevant managerial skills for ensuring efficient and effective management.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

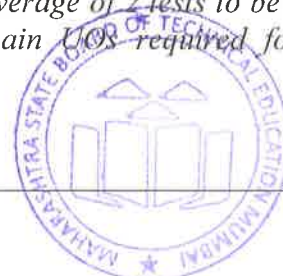
- Use basic management principles to execute daily activities.
- Use principles of planning and organising for accomplishment of tasks.
- Use principles of directing and controlling for implementing the plans.
- Apply principles of safety management in all activities.
- Understand various provisions of industrial acts.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|----------------|--------------------|------|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | - | 3 | 90 Min | 70*# | 28 | 30* | 00 | 100 | 40 | -- | -- | -- | -- | -- | -- |

(*#) Online Theory Examination.

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain COs required for the attainment of the Cos. (*#): Online examination



Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

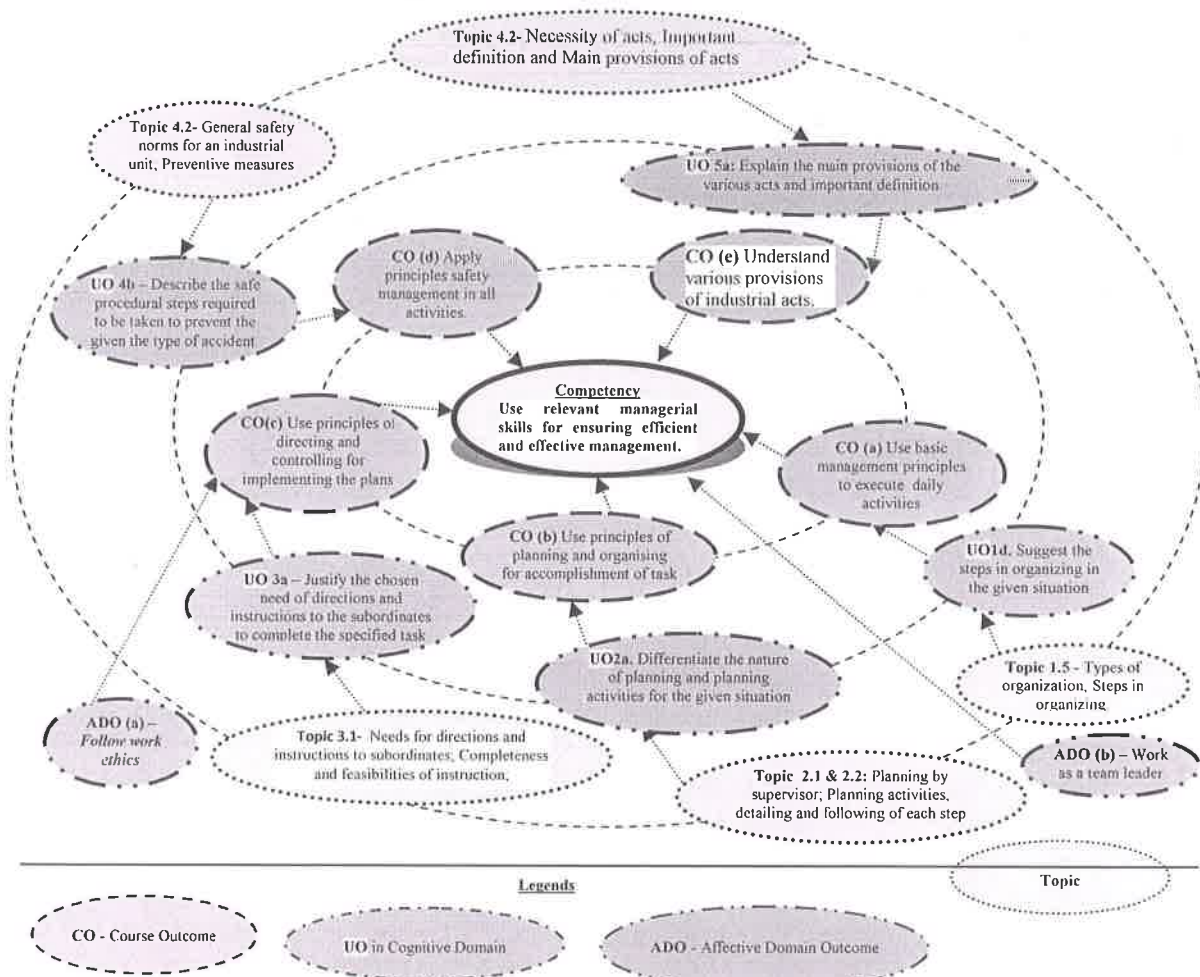


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable -

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

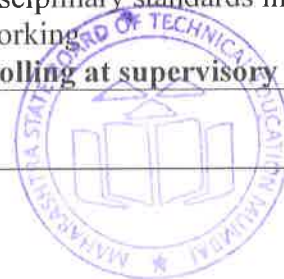
- Not applicable -

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|---|
| Unit – I Introduction to management concepts and managerial skills | 1a. Differentiate the concept and principles of management for the given situation. 1b. Explain functions of management for given situation. 1c. Compare the features of the given types of planning 1d. Suggest the steps in organizing in the given situation. 1e. Suggest suitable type of organization for the given example. 1f. Identify the functional areas of management for the given situation 1g. Suggest suitable managerial skills for given situation with justification | 1.1 Definitions of management, role and importance of management. 1.2 Management characteristics and principles, levels of management and their functions; management, administration and organization, relation between management and administration. 1.3 Functions of management: planning, organizing, leading/directing, staffing and controlling. 1.4 Types of planning and steps in planning 1.5 Types of organization, Steps in organizing 1.6 Functional areas of management. 1.7 Managerial skills. |
| Unit – II Planning and organizing at supervisory level | 2a. Differentiate the nature of planning and planning activities for the given situation. 2b. Suggest the step wise procedure to complete the given activity in the shop floor. 2c. Prepare materials and manpower budget for the given production activity. 2d. Describe with block diagrams the organization of the physical resources required for the given situation. 2e. Describe the human needs to satisfy the job needs for the specified situation. 2f. List the tasks to be done by the concerned individuals for completing the given activity. | Planning at supervisory level 2.1 Planning by supervisor. 2.2 Planning activities, detailing and following of each step. 2.3 Prescribing standard forms for various activities. 2.4 Budgeting for materials and manpower. Organizing at supervisory level 2.5 Organizing the physical resources. 2.6 Matching human need with job needs. 2.7 Allotment of tasks to individuals and establishing relationship among persons working in a group |
| Unit– III Directing and Controlling at supervisory level | 3a. Justify the chosen need of directions and instructions to the subordinates to complete the specified task. 3b. Select the feasible set of instructions to complete the given simple task, with justification 3c. Predict the possible mistakes for completing the given simple activity. 3d. Describe the managerial control | Directing at supervisory level 3.1 Needs for directions and instructions to subordinates; Completeness and feasibilities of instructions 3.2 Personal counselling advanced predictions of possible mistakes. 3.3 Elaborating decisions, laying disciplinary standards in overall working Controlling at supervisory level |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| | actions and remedial measures required to be taken for completing the given task successfully. | 3.4 Managerial control; Understanding team and link between various departments in respect of process and quality standards; Steps in control process 3.5 Controlling methods; Control over the performance in respect of quality, quantity of production, time and cost. Measuring performance, comparing with standards, correcting unfavorable deviations. |
| Unit – IV Safety Management | 4a. State the general safety norms required to be taken in the given case. 4b. Suggest preventive measures of plant activities in the given situation. 4c. Describe the safe procedural steps required to be taken to prevent the given the type of accident. 4d. Prepare a work permit in to conduct the given maintenance activity. 4e. Explain the causes of the specified type of accident in the given situation. 4f. Prepare the specifications of the firefighting equipment required for the given type of fire. | 4.1 Need for safety management measures 4.2 General safety norms for an industrial unit; Preventive measures. 4.3 Definition of accident, types of industrial accident; Causes of accidents; 4.4 Fire hazards; Fire drill. 4.5 Safety procedure 4.6 Work permits. |
| Unit – V Legislative Acts | 5a. Explain the purpose of the act 5b. Explain the main provisions of the various acts and important definition. | 5.1 Necessity of acts, Important definition and Main provisions of acts. 5.2 Industrial Acts: a. Indian Factory Act b. Industrial Dispute Act c. Workman Compensation Act d. Minimum Wages Act |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | Total Marks |
|----------|----------------------------|----------------|------------------------------|---------|---------|-------------|
| | | | R Level | U Level | A Level | |
| I | Introduction to management | 12 | 06 | 06 | 04 | 16 |

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| | concepts and managerial skills | | | | | |
| II | Planning and organizing at supervisory level | 08 | 04 | 06 | 04 | 14 |
| III | Directing and controlling at supervisory level | 08 | 04 | 06 | 04 | 14 |
| IV | Safety Management | 08 | 04 | 06 | 04 | 14 |
| V | Legislative Acts | 12 | 02 | 06 | 04 | 12 |
| Total | | 48 | 20 | 30 | 20 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
- Prepare/Download information about various industrial acts.
- Visit to any Manufacturing industry and prepare a report consisting of:
 - Organization structure of the organization/ Dept.
 - Safety measures taken in organization.
 - Mechanism to handle the disputes.
 - Any specific observation you have noticed.
- Give seminar on relevant topic.
- Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- 'L' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.



- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a. Study of management principles applied to a small scale industry.
- b. Study of management principles applied to a medium scale industry.
- c. Study of management principles applied to a large scale industry.
- d. Prepare case studies of Safety measures followed in different types of organization.
- e. Study of measures to be taken for ensuring cyber security.

13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|--------|---------------------------------------|------------------------------|--|
| 1 | Management and entrepreneurship | Veerabhadrapa, Havinal | New age international publishers, New Delhi, 2014: ISBN: 978-81-224-2602-1 |
| 2 | Principles of management | Chaudhry omvir Singh prakash | New Age international publishers, 2012, New Delhi ISBN: 978-81-224-3039-4 |
| 3 | Industrial Engineering and management | Dr. O. P. Khanna | Dhanpath ray and sons, New Delhi |
| 4 | Industrial Engineering and management | Banga and Sharma | Khanna Publication, New Delhi |

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://www.versesolutions.com/>
- b. <https://www.books.google.co.in/books?isbn=817758412X>
- c. <https://www.wwww.educba.com> › Courses › Business › Management



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Contracts and Accounts
Course Code : 22601

1. RATIONALE

For infrastructure development various construction projects are required to be undertaken. These projects are to be executed by entering into a legal contract. The diploma student shall have adequate knowledge of different types of contract and accounting procedures of organization about the projects are to be executed by entering in to legal contract. The procedure of execution of work by various organizations will be useful while working as an engineer in organization to execute various works. Concept of Tender and knowledge about preparation of tender documents, writing specification for different items of work will be helpful to prepare actual Tender papers and contract documents which are required before execution of construction. The information on procedures and different types of forms used by department will be useful to prepare bills and different modes of payment to contractors. This Course will help the student in implementing actual field practices, which will make student further more competent in the execution of civil engineering works.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Prepare tender documents for civil engineering projects.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Execute the method of PWD for initiating the works.
- Execute the contract for civil engineering works.
- Prepare the tender documents for civil engineering work.
- Use the relevant type of form used in PWD to pay the bill of the executed work
- Prepare the detailed specification for various items of construction.
- Justify the rent fixation of civil structures.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | Max | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25@ | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

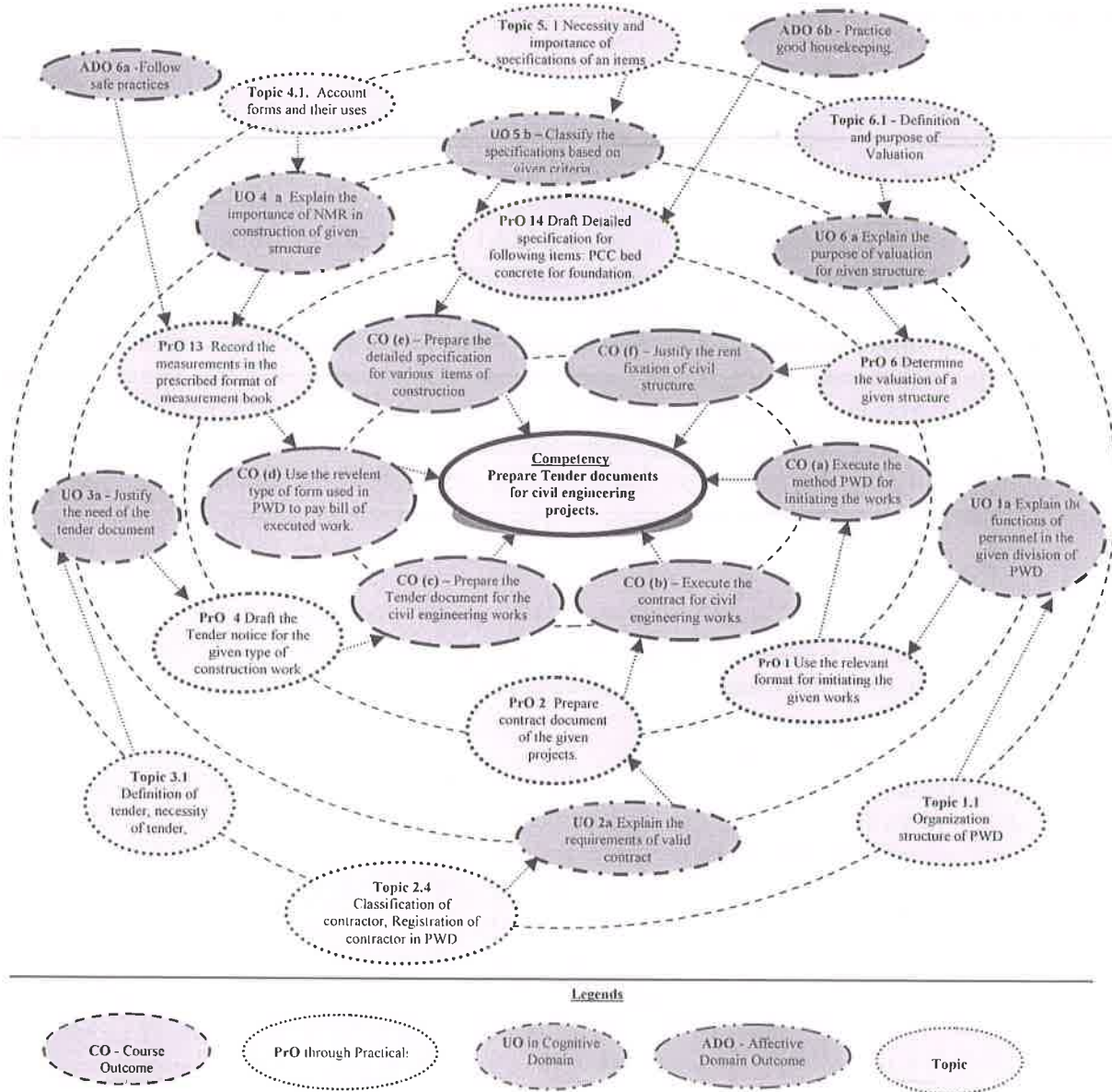
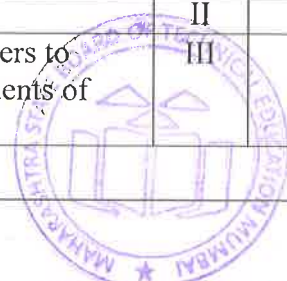


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 1 | Use the relevant format for initiating the given works | I | 02* |
| 2 | Prepare contract documents of the given project. | II | 02* |
| 3 | Examine any five tender notices published in news papers to write your comments with reference to various constituents of tender notice. | III | 02* |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------------|--|----------|-----------------------|
| 4 | Draft the Tender notice for the given type of construction work. | III | 02* |
| 5 | Draft the Tender notice for the given type of construction work to be executed by adopting the process of E-tendering. | III | 02* |
| 6 | Interpret the given set of tender document to comment on the components reflected in it. | III | 02* |
| 7 | Interpret the conditions and data furnished for E-tendering of the given project. | III | 02* |
| 8 | Prepare a power point presentation on the topic, " E-Tendering and its Evaluation" | III | 02 |
| 9 | Prepare Tender document for the given civil engineering structure in a group of five students on the basis of detailed estimate provided/collected by teacher/student.(Part 1) | III | 02* |
| 10 | Prepare Tender document for the given civil engineering structure in a group of five students on the basis of detailed estimate provided/collected by teacher/student.(Part 2) | III | 02 |
| 11 | Prepare Tender document for the given civil engineering structure in a group of five students on the basis of detailed estimate provided/collected by teacher/student.(Part 3) | III | 02 |
| 12 | Interpret the given case study on, 'Contract litigation resolution through arbitration' and submit your comments. | III | 02 |
| 13 | Record the measurements in the prescribed format of measurement book for the given items of works with abstract, completion certificate for payment. | IV | 02* |
| 14 | Draft Detailed specification for following items – a) P.C.C. bed concrete for foundation b) U.C.R.masonry in foundation and plinth c) Burnt brick masonry in CM in superstructure. d) RCC work M20 grade. e) Internal plaster in CM . | V | 02* |
| 15 | Draft Detailed specification for one item from each of the following system : a) Irrigation Engineering. b) Transportation engineering. c) P. H. Engineering. | V | 02 |
| 16 | Determine the valuation of a given structure and submits the valuation report in prescribed formats | VI | 02* |
| 17 | Determine the monthly rent of the given building/quarter as per PWD method/norms. | VI | 02* |
| Total | | | 34 |

Note

- i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:
- iii.



| S. No. | Performance Indicators | Weightage in % |
|--------------|----------------------------|----------------|
| 1 | Collection of data. | 30 |
| 2 | Analysis of data | 20 |
| 3 | Preparation of report. | 30 |
| 4 | Answer to sample questions | 10 |
| 5 | Submit report in time | 10 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a) Practice good housekeeping.
- b) Work as a leader/a team member.
- c) Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

| S. No. | Equipment Name with Broad Specifications | PrO S. No. |
|--------|---|----------------|
| 1.1 | Computer systems with internet connection | 02,06,07,08,13 |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|---|
| Unit – I PWD Procedure to execute the work | 1a. Explain the functions of personnel in the given division of PWD. 1b. Explain the procedure adopted by the given government department for the construction of the given civil work. 1c. Explain the specified method used in PWD to carry out the given work. 1d. Select the relevant method of | 1.1 Organization structure of Public Works Department (PWD). 1.2 Functions of their personnel, Financial powers if any. 1.3 PWD Procedure of initiating the work 1.4 Administrative approval, Technical sanction, budget provision, Expenditure sanction. 1.5 Methods used in PWD for carrying out works- contract method, departmental method -rate list method, piece work method, day's work method, employing |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|--|
| | contracting for the given type of work with justification. | labours on daily wages basis. |
| Unit -II Contracts | 2a. Explain the requirements of valid contract in the given situation. 2b. Classify the civil engineering Contracts based on the given criteria. 2c. Select the type of contract for the given type of work with justification. 2d. Outline the Registration process of contractor in Public Works Department (PWD) in the given type of division office. 2e. Justify the importance of Built operate transfer (BOT) contract in the given situation. 2f. Explain the provisions of FIDIC contract relevant to the given situation. | 2.1 Definition of contract, Objects of contract, requirements of valid contract, Overview of Indian Contract Act 1872. 2.2 Types of engineering contract with advantages , disadvantages and their suitabilities- Lump sum contract, item rate contract, percentage rate contract, cost plus percentage, cost plus fixed fee, cost plus variable percentage and cost plus variable fee contract, labour contract, demolition contract, target contract, negotiated contract, All in contract, Engineering Procurement Construction Contract (EPC), Annuity Contract. 2.3 Introduction of FIDIC Conditions of contract. 2.4 Classification of contractor on basis of financial limits, Requirement of documents for registration of contractor in Public Works Department (PWD). 2.5 Built operate transfer (BOT) Project: Objectives, scope, advantages, Disadvantages, Nature of agreement, mode of payment, examples. |
| Unit-III Tender and Tender Documents | 3a. Justify the need of the tender document for the given situation. 3b. Draft tender notice for the given type of work. 3c. Explain the relevant provision of contract in the given situation as per Contract act 1872. 3d. Justify the provision of liability period in tender document of the given work. 3e. Explain the process of arbitration used in the given case of dispute. 3f. Justify the necessity of E-Tendering system for the given type of civil work. | 3.1 Definition of tender, necessity of tender, Types of tender-local, Global, open Limited and negotiated tender 3.2 Notice to invite Tender (NIT)- Points to be included while drafting tender notice, Drafting of tender notice. 3.3 Meaning of terms: - Earnest money Deposit (EMD), Security deposit, Additional Performance Security Deposit, Validity period, right to reject one or all tenders, corrigendum to tender notice and its necessity. 3.4 Tender documents – Index, tender notice, general instructions, special instructions, schedule A, Schedule B, schedule C, Terms related to tender documents – contract conditions- time limit, time extension, penalty, defective material and workmanship, termination of contract, suspension of work, subletting of contract, extra items, , price variation clause(escalation), defect liability Period, liquidated and un-liquidated Damages. 3.5 Arbitration- Meaning, Qualification of |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|--|
| | | <p>an arbitrator, appointment, Causes and Settlement of disputes, Powers and duties of Arbitrator, Award of result.</p> <p>3.6 Procedure of submitting filled tender Document (Two envelope system), procedure of opening tender, comparative statement, scrutiny of tenders ,award of contract, acceptance letter and work order.</p> <p>3.7 E -Tendering System – Online procedure of Submission of Tender in PWD.</p> <p>3.8 Unbalanced tender, ring formation.</p> |
| Unit –IV Accounts in PWD | <p>4a. Explain the importance of Nominal Muster Role (NMR) in the construction of the given structure.</p> <p>4b. Record the measurements in the measurement book for the given items of works for payment.</p> <p>4c. Explain the specified terms used in interim payment of the given civil work.</p> <p>4d. Select the criteria for granting advances to the Contractor in the given situation with justification.</p> <p>4e. Select the relevant bill form in the given situation with justification.</p> | <p>4.1 Various account forms and their uses – Measurement Books, E- Measurement book(E-MB) ,Nominal Muster Roll(NMR), imprest Cash, Indent, Invoice, Bill, Vouchers, Hand receipt Cash Book, Temporary Advance. Heads of Accounts.</p> <p>4.2 Mode of Payment to the contractor and its necessity -Interim Payment, Advance Payment, Secured Advance, Petty advance, Mobilization advance, First And Final, Final bill, Running account bill ,Retention money, Reduced rate payment, E- Payment.</p> |
| Unit –V Specifications | <p>5a. Draft the specifications for the given type of an item.</p> <p>5b. Classify the specifications based on the given criteria.</p> <p>5c. Propose the specifications for the construction of the given item of work.</p> <p>5d. Formulate the detailed specifications for the given item of irrigation work.</p> <p>5e. Draft a detailed specification for a given items of transportation engineering work.</p> | <p>5.1 Necessity and importance of specifications of an items, points to be observed in framing specifications of an item,</p> <p>5.2 Types of specification - Brief and Detailed, Standard and Manufacturers Specification.</p> <p>5.3 Preparing Detailed Specifications of items in civil engineering works from each of following- Building construction, Irrigation Engineering ,Transportation Engineering , Public health Engineering</p> |
| Unit –VI Valuations | <p>6a. Explain the purpose of valuation of the given structure in the given situation.</p> <p>6b. Classify the value of the given structure based on the given</p> | <p>6.1 Definition and purpose of Valuation, role of valuer. Define - Cost, Price and Value, Characteristics of Value, Factors Affecting Value.</p> <p>6.2 Types of Value - Book Value, Scrap Value, Salvage Value, Speculative Value,</p> |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|--|--|
| | criteria. 6c. Calculate depreciation of the given structure using relevant method for the given data. 6d. Classify the term, 'outgoings' in the given situation. 6e. Calculate monthly rent of the given building from the given data as per PWD norms. | Distress Value, Market Value, monopoly Value, Sentimental Value. Factors affecting value. 6.3 Depreciation, Obsolescence, Sinking Fund. Methods of Calculation of Depreciation – Straight Line Method, Sinking Fund Method, Constant Percentage Method. 6.4 Computation of capitalized value, Gross income, Outgoings, Net Income, Year Purchase, Types of outgoings. 6.5 Fixation of rent as per PWD Practice. 6.6 Lease – types of lease, lease hold property and free hold property, Mortgage – Mortgage deed, precautions to be taken while making mortgage. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|-----------------------------------|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | PWD Procedure to execute the work | 04 | - | 04 | 04 | 08 |
| II | Contracts | 12 | 02,02 | 04 | 04 | 12 |
| III | Tender and Tender Documents | 12 | 02 | 06 | 04,04 | 16 |
| IV | Accounts in PWD | 04 | 02 | 08 | - | 10 |
| V | Specification | 06 | 04 | - | 06 | 10 |
| VI | Valuations | 10 | 02 | 06 | 06 | 14 |
| Total | | 48 | 14 | 28 | 28 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journals based on practical performed in laboratory.
- Give seminar on relevant topic.
- Undertake micro-projects.
- Write a brief summary on procedure of opening of tenders.
- Write a brief summary on procedure of filling online tender.



- f) Preparing report on BOT type contract works executed at nearby location.
- g) Preparing report on procedure of registration as a contractor in different organizations.
- h) Preparing report on procedure of Indent and Invoice at the site.
- i) Preparing report on GST procedure in construction project.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b) '**L**' in *item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e) Guide student(s) in undertaking micro-projects.
- f) Procure various materials required for practical exercises.
- g) Arrange visit to nearby industries and workshops for understanding various construction materials.
- h) Use video/animation films to explain various processes like Manufacturing of construction materials, concrete mixing, and base preparation for painting, mortar laying, carpentry work, false ceiling.
- i) Use different instructional strategies in classroom teaching.
- j) Collect different samples of various construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
- k) Display various technical brochures of recent building materials.
- l) Visit the PWD office to demonstrate the procedure adopted for the payment of the work to the contractor and present the report on PWD Account forms with details of measurement book (M.B.), cash book, indent, RA bill, first and final bill, and final bill.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a) Compare the tender documents of three different organizations.



- b) Refer different websites related E- tendering and prepare report on it.
- c) Draft detailed specification for different items of work other than PWD.
- d) Prepare the report on online bids/auction through internet.
- e) Prepare valuation report of any residential.
- f) Collect relevant information about the software used in preparation of tender documents and write report on it.
- g) Visit to ongoing project and study various aspects related to contracts and tender document.
- h) Visit to ongoing project and study various aspects related to accounting process (MB, RA bill, various advances).

13. SUGGESTED LEARNING RESOURCES :

| S. No. | Title of Book | Author | Publication |
|--------|--|-----------------|---|
| 1 | Estimating and Costing in Civil engineering | Datta, B.N. | UBS Publishers Pvt. Ltd. New Delhi. ISBN:9788174767295 |
| 2 | Construction Management and Contract Practices | Raina, V. K. | Shroff Publishers & Distributers Pvt. Ltd. New Delhi ISBN: 9788184047875, |
| 3 | Estimating and Costing | Rangawala, S.C. | Charotar Publishing House PVT. LTD., Anand (Gujrat) Reprint -2011 |
| 4 | Estimating and Costing | Birdie,G.S. | Dhanpat Rai. New Delhi 2016 ISBN : 978-93-84378-13-4 |
| 5 | Civil Engineering Contracts and Estimates | Patil, B.S. | Orient Longman, Mumbai, Ed.2010 ISBN: 9788173715594, 8173715599 |
| 6 | Estimating and costing, specification and valuation in civil engineering | Chakraborti, M. | Monojit Chakraborti, Kolkata ISBN: 818530436. |

14. SOFTWARE/LEARNING WEBSITES

- a) www.mahapwd.com
- b) <https://mahatenders.gov.in>
- c) http://cpwd.gov.in/cpwde_tender.aspx
- d) <https://gem.gov.in>



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Maintenance and Repairs of Structures
Course Code : 22602

1. RATIONALE

It is absolutely necessary to maintain the building structure in order to preserve the assets and protect the building the building occupants. Normally, the external parts of a building get weathered quickly being exposed to the natural environment. Overlooked dilapidation and inadequate maintenance in the building lead to loose mortar, tiles and bricks of external walls, spalled concrete and thereby threaten public safety. Proper building maintenance ensures that the building and the environment remain healthy, clean and a safe place to work or reside. The strengthening of elements for sustaining loads in future enhances the life, use and raise the value of structures. Regular inspection and maintenance is therefore necessary for timely identification of deteriorated building elements. However, this requires a scientific approach through the investigation of failure pattern. The civil engineering technologists are required to prevent the deterioration of different types of buildings and also to repair the damages in the building. This course is therefore designed to develop the competency to do all these activities.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of building structures.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Select the relevant method of maintaining different building structures.
- Test the structures to predict its stability
- Select the relevant materials for repair of structures.
- Apply the relevant methods of repair for the masonry structures.
- Restore the damages of building structural elements using suitable method of repair.
- Prepare the structural audit and budget for the maintenance of structures.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|-------------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 4 | - | 2 | 6 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.



Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

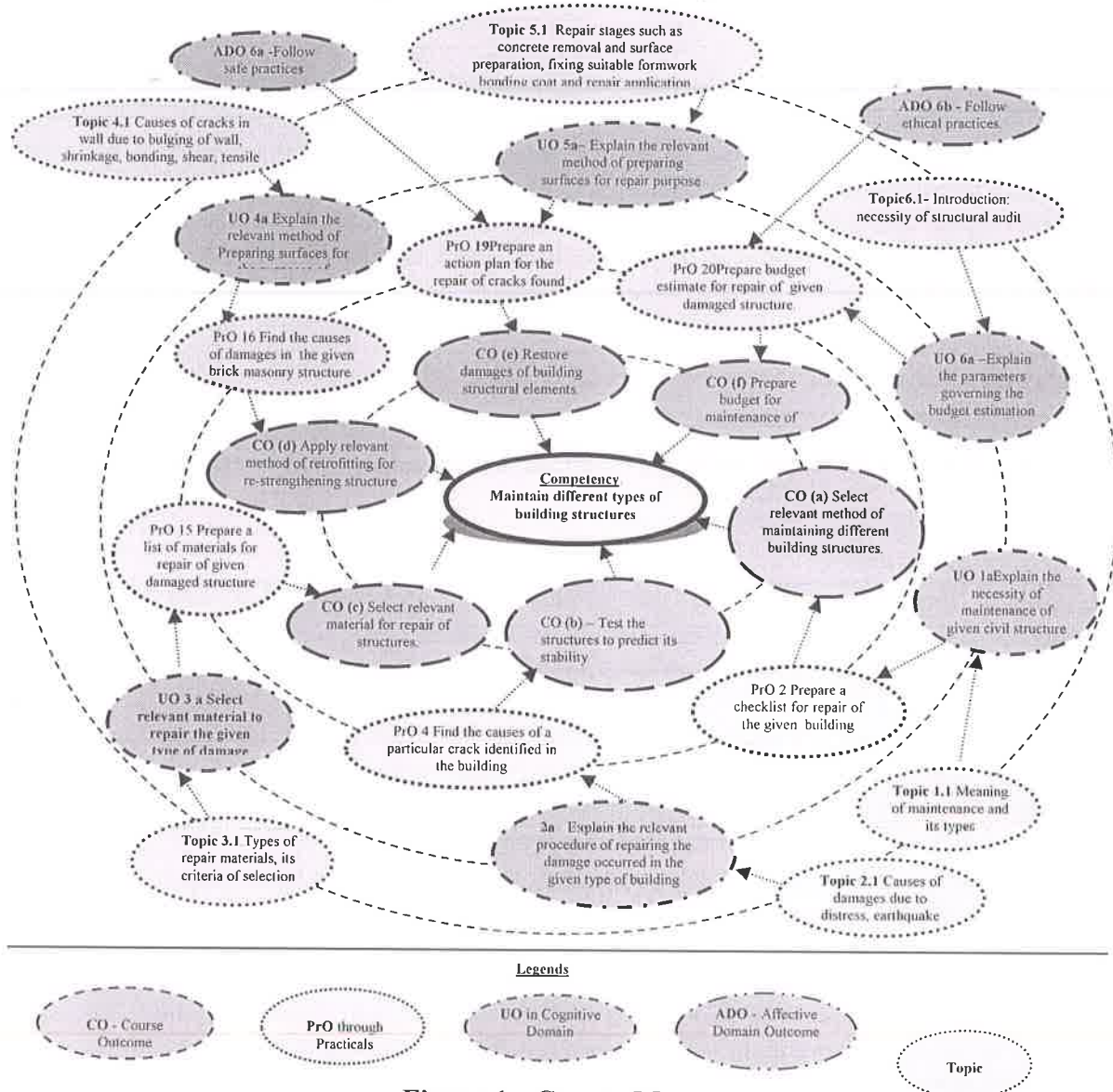


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practical's in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

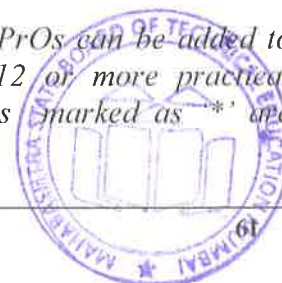
| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---|----------|-----------------------|
| 1 | Find the causes of damages for the given building elements. | I | 02* |
| 2 | Prepare the check list for materials required for repair of load bearing building and framed building. | I | 02 |
| 3 | Prepare a check list for repair of a load bearing building and framed building. | I & II | 02 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 4 | Determine the compressive strength of any two structural elements such as column, beam, slab etc for damaged or undamaged structure using Rebound Hammer . | II | 04* |
| 5 | Determine the extent of efflorescence in masonry or concrete for damaged or undamaged structure. | II | 02* |
| 6 | Determine the crack nature of any two structural elements such as column, beam, slab etc. for damaged structure using Ultrasonic Pulse Velocity test . | II | 02 |
| 7 | Determine the bond strength of any one structural element such as column, beam, and slab etc. using pull out test . | II | 02 |
| 8 | Determine the size, depth and location of reinforcing bar using Rebar locator of any two structural elements such as column, beam, slab etc. for damaged or undamaged structure. | II | 02 |
| 9 | Determine Maximum Chloride content in concrete in percent by weight of cement using Rapid Chloride Test of any one structural element such as column, beam, slab etc for undamaged structure. | II | 02* |
| 10 | Determine the depth of carbonation of concrete using phenolphthalein indicator of any two structural elements such as column, beam, slab etc. for undamaged structure. | II | 02* |
| 11 | Determine the moisture content using Moisture Meter of any two structural elements such as column, beam, slab etc. for damaged or undamaged structure. | II | 02 |
| 12 | Determine the corrosion of reinforcing bar using Half-cell Potentiometer of any two structural elements such as column, beam, slab etc for damaged or undamaged structure. | II | 02 |
| 13 | Determine the compressive strength of extractor core using Compression Testing Machine of any one structural element such as column, beam, slab etc. for damaged or undamaged structure. | II | 02 |
| 14 | Prepare a list of material requirements and check list for repair of wall cracks as per the damages found. | III | 02 |
| 15 | Prepare a report on damage assessment of non-residential structures such as dams, bridges, industrial buildings etc. | IV | 02* |
| 16 | Prepare a check list for repair and material requirement for flooring of given structure. | IV | 02 |
| 17 | Prepare a check list for materials required and resources for repair of sanitary unit of the building. | IV | 02 |
| 18 | Repair the cracks for a damaged plane concrete member of size of 100×100×500 mm or 150×150×750 mm | V | 02 |
| 19 | Prepare a budget estimation considering materials, task force, equipment's and methodology for the given damaged structure. | VI | 02* |
| 20 | Determine the flexural strength of repaired beam in practical no 18. | IV & V | 02 |
| | Total | | 40 |

Note

- i. A suggestive list of **PrOs** is given in the above table. More such **PrOs** can be added to attain the **COs** and competency. A judicious mix of minimum 12 of more practical **UOs/tutorials** need to be performed, out of which, the practicals marked as '*' are



compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

- ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

| S. No. | Performance Indicators | Weightage in % |
|--------------|--|----------------|
| 1 | Interpretation of given data and its presentation. | 10 |
| 2 | Selection of materials /Process of repairing of the given structural non structural components /writing of visit report. | 30 |
| 3 | Precision in check list for material list/equipment list and report and its neatness, cleanliness. | 30 |
| 4 | Individual work and working in groups | 20 |
| 5 | Submission of assigned work in time | 10 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Follow safety practices.
- Practice good housekeeping.
- Work as a leader/a team member.
- Follow ethical practices.

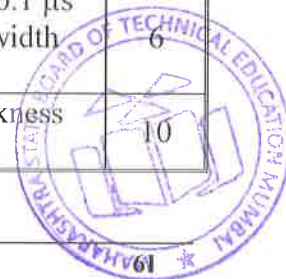
The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specifications mentioned here to retain uniformity in conduct of experiments, as well as aid to procure equipment by administrators

| S. No. | Equipment Name with Broad Specifications | PrO. S. No. |
|--------|--|-------------|
| 1 | Universal Testing machine of capacity 400kN,600 kN/1000kN, analog type/digital type with all attachments and accessories. | 4,7, 20 |
| 2 | Compression testing machine of capacity 2000KN, analog /digital type having facility to measure deformation with all attachments and accessories. | 4,13 |
| 3 | Rebound Hammer: Manual Test Hammer of W-M-250, BS-1881-202, weight: 2.7 kg, size: 127 x 76 x 355 mm, shipping weight: 2.7 kg and minimum verifiable strength is 10 MPa to 62 MPa. | 8 |
| 4 | Ultrasonic Pulse Velocity test apparatus: range 0.1-7930 μ s, resolution: 0.1 μ s to 1 μ s, display 7", color 800 x 480, pulse voltage 100 – 450 Vpp, bandwidth 20 – 500 kHz | 6 |
| 5 | Cover gauge: concrete thickness gauge model of CTG-2 (Concrete Thickness Gauges), battery powered, ASTM Standard, frequency resolution 10Hz, | 10 |

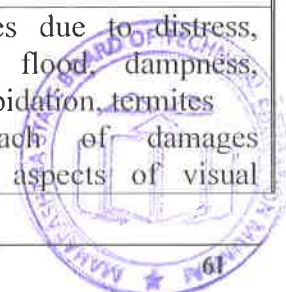


| S. No. | Equipment Name with Broad Specifications | PrO. S. No. |
|--------|--|-------------|
| | thickness range 81 mm to 50.8 cm in standard mode. | |
| 6 | Rapid chloride test apparatus: RCPT Apparatus is as per ASTM C 1202-05. 4 Port (230~250V AC power supply), plexi-glass chambers - 4 pairs, 500mm vacuum desiccator, consumables - good for 1 doz | 9 |
| 7 | Crack detection microscope: magnification = x 35, measuring Range = 4 mm, divisions = 0.02mm, weight including battery and box = 560gm, box dimensions = 150 x 100 50mm deep | 6 |
| 8 | Rebar locator: Model: GMS 120 professional, weight: 0.27 KG, detection depth for steel max : 120 mm and for copper max 80 mm | 8 |
| 9 | Moisture meter: as per IS 12175 code practices | 11 |
| 10 | Half-cell potentiometer; voltage 220, electric power source, frequency 50 Hz, corrosion monitoring technique standardized by ASTM | 12 |
| 11 | Water permeability meter: as per IS 5529(Part 2):2006 in-situ permeability test, two versions available: with gaskets for 150 mm cube specimens as 55-C0246/3 three place model and 55-C0246/6 six place model, air compressor, max. working pressure 8 bar. | 15 |
| 12 | Extensometer with least count 0.01mm, maximum extension 25 mm with single dial gauge/ digital display suitable for various gauge length | 13,14 |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|--|
| Unit – I Basics of maintenance and repairs | 1a. Explain the necessity of maintenance and repairs of the civil structure. 1b. Know the factors that influence on maintenance of given structure with justification. 1c. Explain the concept of retrofitting, re-strengthening, rehabilitation, and restoration 1d. Know the periodical maintenance and its manual, monsoon maintenance, maintenance history sheet. | 1.1. Maintenance and its classifications, repair, retrofitting, re-strengthening, rehabilitation and restoration. 1.2. Necessity, objectives and importance of maintenance and repairs. 1.3. Factors influencing the maintenance and repairs 1.4. Advantages and limitations of maintenance and repairs. 1.5. Approach of effective management for maintenance and repairs. 1.6. Periodical maintenance, maintenance manual containing building plan, reinforcement details, material sources, maintenance frequency, pre and post monsoon maintenance. |
| Unit– II Causes and detection of damages | 2a Explain the causes of damages occurred in the given structures. 2b Know the systematic approach of damages | 2.1 Causes of damages due to distress, earthquake, wind, flood, dampness, corrosion, fire, dilapidation, termites 2.2 Systematic approach of damages detection, various aspects of visual |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| | detection 2c Explain non-destructive test with respect to the given damaged structural elements 2d Explain the procedure of non-destructive test used to detect the damages. | observations for detection of damages. 2.3 Tests on damaged structures: rebound hammer, ultrasonic pulse velocity, rebar locator, cover gauge, crack detection microscope, chloride test, sulphate attack, pH measurement, half-cell potential meter. |
| Unit III- Materials for maintenance and repairs | 3a. Select the relevant materials to repair the given type of damages with justification. 3b. Explain the suitable materials for the anti-corrosion, adhesives and mortar repairs. 3c. Explain the relevant materials for waterproofing, and joint sealants for the repairing of given structure. 3d. Explain the relevant materials for surfacing coating and grout for the repairing of given structure. 3e. Choose the relevant materials for the repair of damaged structures with justification. | 3.1 Factors influencing the material selection for maintenance and repairs. 3.2 Anti-corrosion coating materials: cement slurry mortar, polymer modified cement slurry and epoxy zinc. 3.3 Adhesives materials: solvent free adhesives: epoxy adhesive, polyester adhesive, acrylic adhesive and water borne adhesives: polyvinyl acetate and vinyl acetate co-polymer. 3.4 Mortar repair materials: cementitious mortar, polymer modified cementitious mortar and resin mortar. 3.5 Joint sealants materials: oleo resinous mastics, bitumen/rubber based sealants and acrylic resin sealant. 3.6 Grout materials: cement grout, cement sand grout, cement sand grout with additives, polymer modified cement grout and normal epoxies. 3.7 Waterproofing roof materials: polyisobutylene (PIP) sheet, glass fiber reinforced plastics, bitumen and bituminous emulsion and latex cement coating. 3.8 Surface coating materials for concrete protection: bituminous cutbacks, chlorinated rubber coating, Vinyl coatings, epoxy coating and coal tar epoxy. 3.9 Additional repairing materials: plastic or aluminum nipples, polyester putty or 1:3 cement sand mortar and galvanized steel wire fabrics & clamping rods. |
| Unit –IV Maintenance and repair methods for masonry | 4a. Explain the various causes of wall cracks and their probable locations 4b. Select the relevant repair techniques for the damages in the given civil structures with justification. 4c. Explain the repairing | 4.1 Causes of wall cracks due to bulging of wall, shrinkage, bonding, shear and tension, differential settlement of foundation, thermal movement and vegetation. 4.2 Probable crack location such as junction of main & cross wall, junction of RCC column & wall, junction of slab & wall, |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|---|
| | <p>methods for the different crack types for the given structure.</p> <p>4d. Explain the damping effect and its repair techniques</p> <p>4e. Explain the various methods of improving the bearing capacity of foundation</p> | <p>cracks in masonry joints.</p> <p>4.3 Stages of repair: material removal and surface preparation, fixing suitable formwork, bonding/passivating coat and repair applications.</p> <p>4.4 Repair techniques: grouting, patch spalling replacement or delaminating and epoxy bonded mortar.</p> <p>4.5 Repairing methods for minor & medium cracks include epoxy injection, grooving & sealing, shotcrete, stitching, grouting and gunting.</p> <p>4.6 Repairing methods for major cracks (width more than 5mm) include fixing mesh across cracks, dowel bars, RCC band and installing ferro-cement plates at corners and propping.</p> <p>4.7 Effects of dampness in wall, damping repair techniques such as replacement or inserting DPC in brick wall, bituminous painting, painting using water proof solution and cement with adhesive gum.</p> <p>4.8 Causes and remedies of foundation settlement, improvement techniques by compaction, intruding sand piles, stone columns and grouting cement slurry.</p> |
| Unit –V Maintenance and repair methods for RCC | <p>5a. Explain the probable crack location in RCC and causes of RCC failure</p> <p>5b. Explain the causes of dampness in roof slab and its various repair techniques</p> <p>5c. Know the repair methods for the cracked RCC elements</p> <p>5d. Explain the relevant repair methods for cracks in RCC structures</p> <p>5e. Know the repair of corroded RCC elements, honeycomb and large voids in the given structure</p> | <p>5.1 Probable location of cracks in RCC elements, various causes of RCC failure.</p> <p>5.2 Causes of dampness in roof slab and its repair techniques such as mud phuska with brick tile topping, lime concrete terracing, ferro-cement topping and brick coba.</p> <p>5.3 Repair methods for cracks in RCC structures such as epoxy injection, grooving & sealing, stitching, rebaring, grouting, spalling replacement, jacketing, shotcrete and gunitting.</p> <p>5.4 Repair of corroded RCC element: exposing and undercutting rebar, cleaning reinforcing steel, compensating reinforcement and protective coating.</p> <p>5.5 Repair methods for honeycomb and larger voids.</p> |
| Unit –VI Structural audit and Budget | <p>6a. Explain the necessity and importance of structural audit & budget estimation</p> <p>6b. Explain the procedure involved in structural audit and budget estimation</p> | <p>6.1 Necessity and importance of structural audit and budget estimation</p> <p>6.2 Distress survey, detailed inspection, recommendations for budget estimation.</p> <p>6.3 Steps involved in structural audit and budget estimation.</p> |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|---|---|
| | 6c. Explain the step-by-step procedure for maintenance of the given structure. 6d. Know the formats preparation for the process of structural audit and budget preparation 6e. Explain the rules & regulations of structural audit and budget estimation as recommended by competent authority. | 6.4 Format preparation for structural audit including general information of building, building data, complain reported by users, inspection of internal and external areas of building. 6.5 Overview on rules and regulations of structural audit and budget estimation as recommended by competent authority such as Public Work Department. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Basics of maintenance and repairs | 06 | 04 | 04 | 0 | 08 |
| II | Causes and detection of damages | 10 | 02 | 04 | 04 | 10 |
| III | Materials for maintenance and repairs | 10 | 02 | 08 | 04 | 14 |
| IV | Maintenance and repair methods for masonry | 12 | 02 | 04 | 06 | 12 |
| V | Maintenance and repair methods for RCC | 14 | 02 | 06 | 06 | 14 |
| VI | Structural audit and budget | 12 | 02 | 04 | 06 | 12 |
| Total | | 64 | 14 | 30 | 26 | 70 |

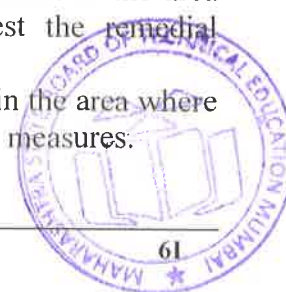
Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Collect six photographs of different types of damages in Masonry works in the area where student resides. Do the diagnosis of the ailments, suggest the remedial measures.
- Collect six photographs of different types of damages in RCC works in the area where student resides. Do the diagnosis of the ailments, suggest the remedial measures.



- c) Collect the brand names and uses of repair materials available in the market in the area where student resides.
- d) Download the videos related to the repairs of water leakages of RCC water tank, plumbing works, sanitary works, flooring repairs, door and window frames/panels repairs.
- e) Prepare a power point presentation on the activity (d)
- f) Carrying a Repairing work of spalling of plaster from a ceiling.
- g) Analyzing light and ventilation of a room having common walls and suggesting remedies.
- h) Prepare journals based on practical performed in laboratory.
- i) Give seminar on relevant topic.
- j) Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b) '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in Lab.
- i) Demonstrate students thoroughly before they start doing the practice.
- j) Encourage students to refer different websites to have deeper understanding of subject.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty

- a) Collect the information of various materials used in actual practice for repairs of cracks.



- b) Collect the details of various types of the agencies working for repairs and maintenance of structures in actual practice.
- c) Collect the details of new techniques used for repair.
- d) Compare damages caused by various natural hazards.
- e) Prepare a budget with respect to material, task force, equipment's and methodology for the historical structure in your vicinity.
- f) Prepare collection of photographs showing various types of cracks in damaged structures.
- g) Carry out market survey for at least five materials used for repairs with respect specification, supplier, packaging and costing.
- h) Cast three RCC beams and three plain concrete beams and find the various types of cracks by applying one point load, two point loads etc. and find the flexural strength.
- i) Repair the above beams and find out the strength regained by the beams.
- j) Suggest the repair material and methods for the above beam as per type of crack developed.
- k) Micro projects relevant on topics as per the guidance subject teacher.

13. SUGGESTED LEARNING RESOURCES :

| S. No. | Title of Book | Author | Publication |
|--------|---|------------------------------|---|
| 1 | Building Repair and maintenance management | Gahlot, P. S. Sharma, Sanjay | CBS Publishers & Distributors Pvt. Ltd. New Delhi, ISBN: 81-239-1243-9 |
| 2 | Maintenance Engineering for civil Engineers | Nayak B. S. | Khanna Publication, New Delhi ISBN: 978-81-7409-051-7 |
| 3 | Maintenance and Repairs of Buildings | Guha, P. K. | New Central book Agencies, New Delhi, ISBN 10: 8173810737 ISBN: 9788173810732 |
| 4 | Maintenance and Repairs of Buildings | Hutchin Son, BD | Newnes-Butterworth, London (UK) ISBN : 0408001917 |

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.youtube.com/watch?v=7ypSU6ZDJlwhhttps://www.youtube.com/watch?v=zX8HNbHmToM>
- b) <https://www.youtube.com/watch?v=zZsstKuF14s>
- c) <https://www.youtube.com/watch?v=zXg1x8BXR-Y>
- d) <https://www.youtube.com/watch?v=EmmzpQd5I0E>
- e) <https://www.youtube.com/watch?v=ANORiqAJ7kc>
- f) https://www.youtube.com/watch?v=Zp4f_ReeSO0
- g) <https://www.youtube.com/watch?v=wPBq0yVLEa8>
- h) <https://www.youtube.com/watch?v=lqwt0HpWgbU>
- i) <https://www.youtube.com/watch?v=y1rOtvvxRzY>
- j) https://www.youtube.com/watch?v=q_JeGja1Yb4
- k) <https://www.youtube.com/watch?v=tztOejzcGEO>
- l) <https://www.youtube.com/watch?v=eEXAWukRfD4>
- m) <https://www.youtube.com/watch?v=CJUDJk1ffB0>
- n) https://i.ytimg.com/an_webp/reuxFdNJcLk/mqdefault_6s.webp?du=3000&sqp=CILn4ewF&rs=AOn4CLC_MQ_GI3_HKKE-zVEilBfG0gSwFA



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Emerging Trends in Civil Engineering
Course Code : 22603

1. RATIONALE

Civil Engineering sector has completed number of projects with conventional techniques to meet the needs of the society. But, in recent two decades, various new innovative techniques are being used worldwide, which our practicing engineers, are also partially using to achieve their goals. The emerging trends in Civil Engineering help to complete the undertaken projects within prescribed schedule, saves the natural resources and to make the projects eco-friendly. This subject helps to make awareness about soft computing techniques, new materials, advanced machineries, sustainable resource management and advancement in Civil Engineering.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Recommend emerging techniques in civil engineering.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented COs* associated with the above mentioned competency:

- Reveal different applications of software's for planning, designing and execution of projects.
- Suggest the advanced materials as per site condition.
- Recommend the suitable tools and equipments for the given situation.
- Suggest the advanced resource management techniques for the given project.
- Use the feasible advance techniques for various civil engineering projects.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|-----|-----|----------------|--------------------|------|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | |
| 3 | - | - | 3 | 90 Min | 70*# | 28 | 30* | 00 | 100 | 40 | -- | -- | -- | -- | -- | -- |

(*#): Under the theory ESE; Total 70 marks of **online exam** will be conducted.

(*): Under the theory PA; Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 mark is the average of 2 tests (**MCQ type**) to be taken during the semester for the assessment of the UOs required for the attainment of the COs.



Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

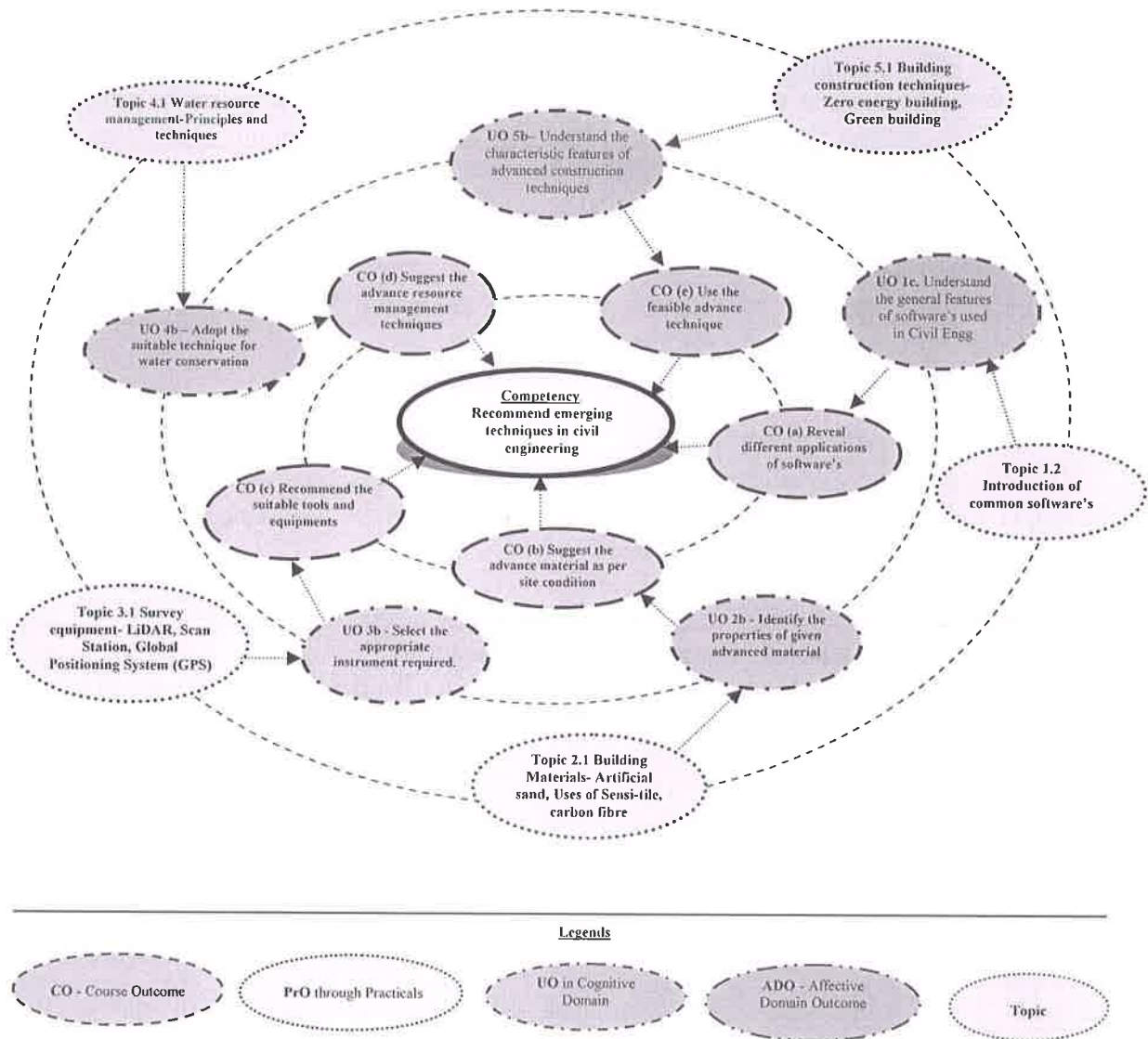


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---------------------------|----------|-----------------------|
| 1. | Not Applicable | | |

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

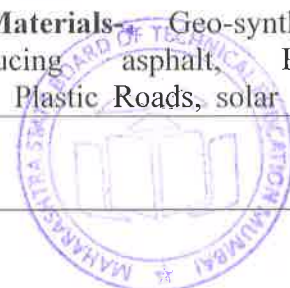
The major equipment with broad specification mentioned here will usher in uniformity in conduct of theory.

| S. No. | Equipment Name with Broad Specifications | UOs. S. No. |
|--------|--|-------------|
| 1.1 | Computer system (Any computer system with basic configuration) | All |
| 1.2 | LCD Projector with accessories | All |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|--|
| Unit – I Soft Computing Techniques | 1a. Enlist the characteristic uses of soft computing techniques in civil engineering. 1b. Identify merits and demerits of soft computing techniques. 1c. Understand the general features of software's used in Civil Engg 1d. Suggest the suitable software/s for the given construction activity. | 1.1 Introduction of soft computing techniques and its types, Merits and demerits of soft computing technique, Graphical User Interface Software (GUI) . 1.2 Introduction, salient features and applications of software's - REVIT, ETAB, 3D Architect Home, Build-Master, HEC-RAS, STRAP, WaterGEMS, Tekla, ArcGIS, QuikGrid, STAAD.Pro, SAFE, RISA-Connection, Civil 3D, Site 3D, SkyCiv Structural 3D, SAP 2000, MIDAS, LUSAS, BricsCAD, Estimate Master, ProEst, WinEst, Clear Estimate, Procure, Buildertrend, Building Management System (BMS), Plant Design and Management System (PDMS), Building Information Modeling (BIM), Primavera Pro, Microsoft Project (MSP) |
| Unit– II Recent Construction Materials | 2a. List the advanced construction materials for given construction project. 2b. Identify the properties of given advanced material. 2c. Enumerate the applications of given form of material/s in civil engineering. | 2.1 Building Materials- Artificial sand, Sensi tile, carbon fibre, Bricks made up of cigarette butts, 3D printed bricks, Translucent wood, laminated timber, 3D Tiles 2.2 Road Materials- Geo-synthetics, Noise-reducing asphalt, Porous Pavement, Plastic Roads, solar roads, |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| | 2d. Identify the situations to use the given material. 2e. Justify the use of given material for given site condition. | Anti Icing Roads, Piezoelectric roads 2.3 Concrete Materials- Portland Pozzolana Cement, Portland Slag Cement, New admixtures – Masterglanium, Polycarboxylic Ether, Self Healing Concrete, Fibre-Reinforced Concrete, High Strength concrete, High Performance Concrete, Nano concrete, Light transmitting concrete. 2.4 Sustainable Materials- Ground Granulated Glass Blast-furnace Slag (GGBS) concrete, Aero-gel insulation, Cooling bricks, Green concrete, Timbercrete, Ferrock |
| Unit III- Latest Tools and Equipments | 3a. Identify the correct use/s of given advanced tool/equipment. 3b. Select the appropriate instrument required for the given construction activity. 3c. Identify the situation for the use of given advance equipment/instrument. | 3.1 Survey equipment- LiDAR, Scan Station, Global Positioning System (GPS), Geographical Information System (GIS), Photogrammetry, Drones, Direct Reading Grade Rods, 3D Laser scanning, laser level 3.2 Construction Equipment- Earth moving equipment-Skid and crawler loaders, trenchers, scrappers, wheeled loading shovels, advanced plastering machine, Bridge launcher. 3.3 Material handling equipment- Cranes, conveyors, hoists, forklifts, mobile concrete mixer, paver, road header, tunnel boring machine. |
| Unit-IV Sustainable Resource Management | 4a. Elaborate the principle of water resource management. 4b. Adopt the suitable technique for water conservation. 4c. Justify the need of 4R principle in waste management. 4d. Recommend the use of waste for the given civil construction work. 4e. Suggest the appropriate safety technique for given site condition. | 4.1 Water resource management- Principles and techniques 4.2 4R's in waste management-Reduce, Reuse, Recycle and Recover, Concept of Zero Waste 4.3 Reuse of waste in construction-Fly Ash, Slag and Plastic 4.4 Renewable energy sources-solar energy, biomass, wind energy, ocean wave energy, Geo thermal energy and hybrid power system. 4.5 Energy Audit-Necessity and methods. 4.6 Natural disaster management- Flood , Earthquake, Tsunami, Volcanic Eruption, Hurricanes, Landslides. 4.7 Site Safety-necessity, principles, tools, techniques, laws, rules and regulations. |
| Unit –V | 5a. Select the appropriate | 5.1 Building construction techniques- |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------------------------------------|---|--|
| Advancement in Construction | <p>advanced techniques for the given construction project.</p> <p>5b. Understand the characteristic features of advanced construction techniques</p> <p>5c. Recommend the use of appropriate construction techniques as per site condition.</p> <p>5d. Identify the application of given construction technique</p> | <p>Zero energy building, Green building, Mass housing-precast housing, prefab homes, pre-engineering building, Solar Paints, Building Integrated Photovoltaic (BIPV), Earthquake Resisting Controls-Isolation and Dissipation.</p> <p>5.2 Road construction techniques- 3D Printing, Road Printer, smart roads</p> <p>5.3 Coastal construction techniques- Sound Proofing walls, water resistant roofs, high performance doors and windows, air and moisture barriers.</p> <p>5.4 Ground improvement techniques- Advanced piling techniques - Stone Column, Vibro Floatation, Micro Piles, Soil Nailing, Vertical drains- Sand Drains, Pre-Fabricated Vertical Drains, Thermal Methods- soil heating and soil freezing.</p> |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|---------------------------------|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Soft Computing Techniques | 08 | 06 | 04 | 02 | 12 |
| II | Recent Construction Materials | 10 | 04 | 06 | 04 | 14 |
| III | Latest Tools and Equipments | 10 | 06 | 04 | 04 | 14 |
| IV | Sustainable Resource Management | 08 | 04 | 06 | 02 | 12 |
| V | Advancement in Construction | 12 | 06 | 08 | 04 | 18 |
| Total | | 48 | 26 | 28 | 16 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare



reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a. Visit the appropriate website and observe the relevant videos and other related learning material.
- b. Group discussion on sustainable resource management.
- c. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b. '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e. Guide student(s) in undertaking micro-projects.
- f. Demonstrate the particular situation before undertaking the task in practice.
- g. Show video clips of emerging trends in civil engineering and undertake the discussion.
- h. Show picture clips/photographs of advance construction techniques available online.
- i. Arrange expert lectures of various practicing engineers from various construction sites.
- j. Arrange the brain storming sessions on recent modifications in construction methodology, projects undertaken, innovative materials etc.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. **In special situations** where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. Prepare the chart showing software and their applications.
- b. Prepare a model of any one construction material or machinery used in recent days.



- c. Prepare a report on advanced machinery and materials.
- d. Elaborate the process of mass housing, pre-engineered buildings etc.
- e. Make posters showing site safety and its awareness.
- f. Prepare the charts showing different types of safety rules and regulations of site.

13. SUGGESTED LEARNING RESOURCES :

| S. No. | Title of Book | Author | Publication |
|--------|---|--|--|
| 1 | Emerging Materials for Civil Infrastructure: State of the Art | Roberto Lopez-Anido, Tarun Naik | American Society of Civil Engineers (31 July 2000), ISBN-13: 978-0784405383 |
| 2 | Sustainable Construction Materials | Ravindra K. Dhir OBE Jorge de Brito Rui Silva Chao Qun Lye | Woodhead Publishing, 9th January 2019, eBook ISBN: 9780081009918 Hardcover ISBN: 9780081009857 |
| 3 | Learning Manual on "Emerging Trends in Civil Engineering" | MSBTE, Mumbai. | -- |

14. SOFTWARE/LEARNING WEBSITES

- a. <https://www.engineeringcivil.com/software>.
- b. <https://www.nbmew.com/tech-articles/concrete/3725-new-construction-materials-for-modern-projects.html>
- c. <https://geniebelt.com/blog/10-innovative-construction-materials>
- d. <https://www.viatechnik.com/blog/modern-construction-machines-theyre-used/>
- e. https://www.academia.edu/28172313/ADVANCED_BUILDING_CONSTRUCTION_EQUIPMENT
- f. <https://theconstructor.org/construction/sustainability-construction-civil-engineering/9492/>
- g. https://www.designingbuildings.co.uk/wiki/Advanced_construction_technology
- h. <https://www.constructionjunkie.com/blog/2018/1/7/the-16-most-interesting-advances-in-construction-technology-of-2017>
- i. https://mysubs.in/buy/recent-trends-in-civil-engineering-and-technology-journal-subscription?gclid=Cj0KCQjw6lfoBRCiARIsAF6q06scZ5teDlexIYz_j85yy2ZH_v1kiQcytNvYf3AelfE3LcZndTbhrOwaAqv2EALw_wcB.
- j. <https://www.flatworldsolutions.com/engineering/articles/6-latest-trends-in-civil-engineering.php>.



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Building Services (Elective-II)
Course Code : 22604

1. RATIONALE

Buildings serve several societal needs – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. Building services are the systems installed in buildings to make them comfortable, functional, efficient and safe. They can include fire safety, HVAC (heating, ventilation and air conditioning), lighting, plumbing, ICT (information and communications technology), and so on. Building Services Engineers are the people who make this happen. The knowledge of building services is necessary to maintain the functional requirements of the building by a civil technologists. As buildings are becoming more complex and more modern, it is essential to include the same in the Civil Engineering curriculum. This course is designed to enhance the employability with the skills required for building service industries.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Execute the building services for creating human comfort in the buildings.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Identify the building services for the requisite functional requirements.
- Estimate the space requirements for vertical communication services.
- Propose the fire safety requirements for multi-storeyed buildings.
- Devise the water supply and sanitation system for buildings.
- Evaluate the potential of rain water harvesting and solar water heater system for the buildings.
- Execute the relevant system of lighting, ventilation and acoustics for buildings.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate attainment of COs and the remaining 20 marks for tests and assignments given by the teacher.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P- Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and Topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the Course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map.

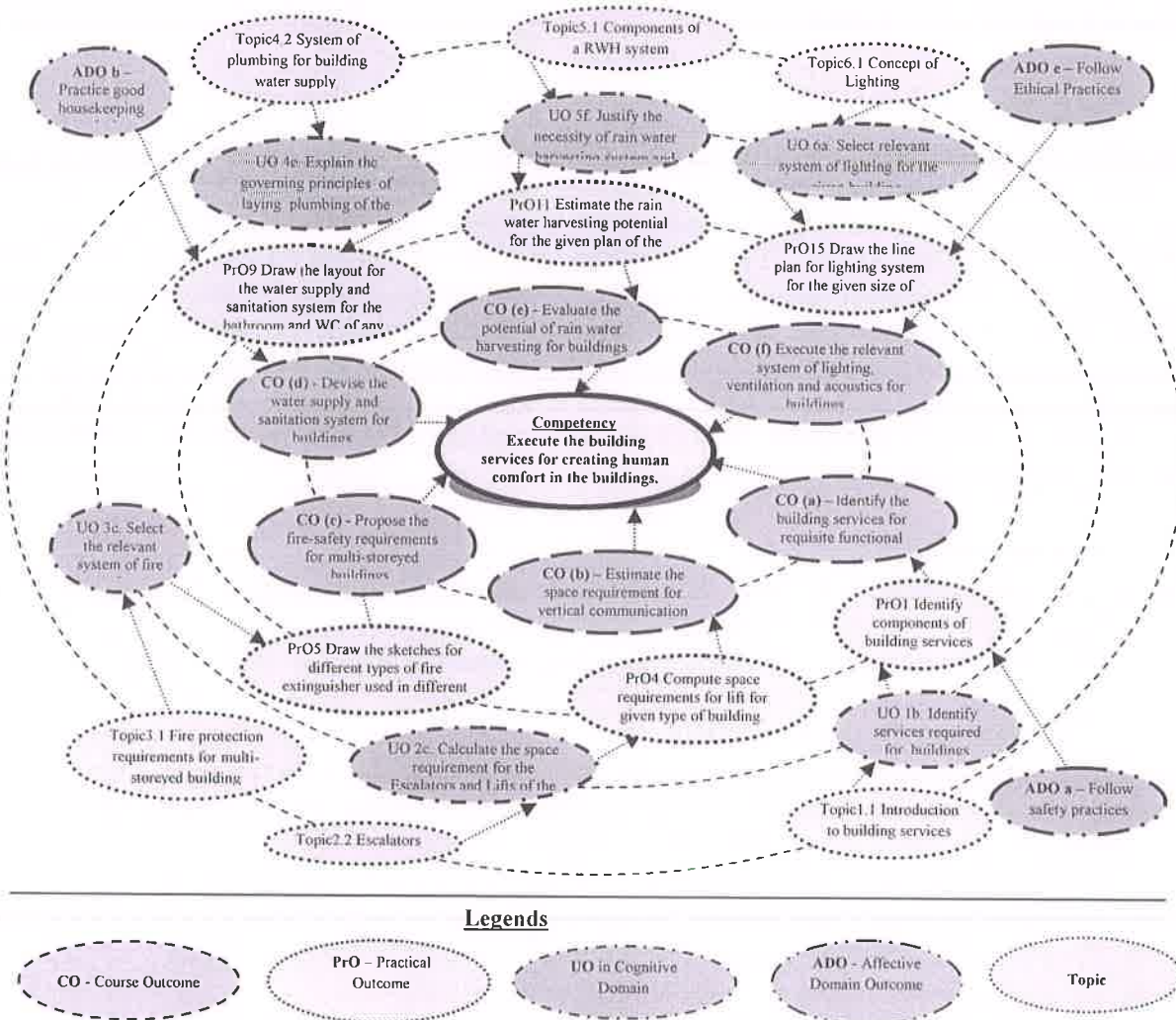
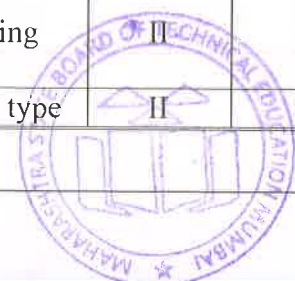


Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

The practical/exercises/tutorials in this section are psychomotor domain PrOs (i.e. sub-components of the COs) are to be developed and assessed in the student to lead to the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|--|----------|-----------------------|
| 1 | Identify components of building services available in your institute building and prepare a report. | I | 02 |
| 2 | Compute the space requirements for the rain water harvesting system for the given type of building. | I | 02 |
| 3 | Compute the space requirements for the escalator for the given type of building as per guidelines of national building code. | | 02* |
| 4 | Compute the space requirements for the lift for the given type | II | 02* |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|---|----------|-----------------------|
| | of building as per guidelines of national building code. | | |
| 5 | Submit your observations along with your comments on the specifications and working of the fire extinguisher by viewing the relevant video/simulation/photographs. | III | 02* |
| 6 | View the relevant video/simulation/photographs and then draw a line plan showing the provisions of fire safety system in any multi storied residential building/anyone public building in your locality. | III | 02 |
| 7 | Submit your observations along with your comments on the layout for the water supply and sanitation system for the bathroom and WC of any multi-storey building including design parameters by viewing the relevant video/simulation/photographs. | IV | 02* |
| 8 | Submit your observations along with your comments on the layout for the water supply and sanitation system for the bathroom and WC of any local public building including design parameters by viewing the relevant video/simulation/photographs. | IV | 02* |
| 9 | Submit your observations along with your comments (labeled sketch, specifications) on the working of valves, pipes of different sizes and fittings (five each) by viewing the relevant video/simulation/photographs. | IV | 02* |
| 10 | Estimate the rain water harvesting potential for the given plan of the residential building (single storey load bearing structure) and given data. | V | 02* |
| 11 | Plan the proposed rain water harvesting system for data produced in practical no.10 with necessary sketch, diagram, specifications. | V | 02 |
| 12 | Estimate the rain water harvesting potential for the given plan of the residential building (multi storey framed structure) and given data. | V | 02* |
| 13 | Submit your observations along with your comments on the specifications and data required for installation and maintenance of the solar water heating system for a dwelling unit with provided data by viewing the relevant video/simulation/photographs. | V | 02* |
| 14 | Submit your observations along with your comments on the components and working of solar water heating system for the given type of dwelling unit with provided data by viewing the relevant video/simulation/photographs. | V | 02 |
| 15 | Submit your observations along with your comments on the laying of lighting system to be provided for the given size of room of a dwelling unit by viewing the relevant video/simulation/photographs. | VI | 02 |
| 16 | Estimate the quantities of the electrical points, switches and wiring system required for the given type of dwelling unit and Prepare a budget for it with summarization of all relevant information in the form of a report. | VI | 02* |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|--|----------|-----------------------|
| 17 | Submit your observations along with your comments on natural and artificial ventilation for the public building by viewing the relevant video/simulation/photographs. | VI | 02 |
| 18 | Submit your observations along with your comments on natural and artificial ventilation for the residential building by viewing the relevant video/simulation/photographs. | VI | 02 |
| | Total | | 36 |

Note:

- i. A suggestive list of PrOs is given in above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practical marked as '*' are compulsory so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

| S. No. | Performance Indicators | Weightage in % |
|--------|---|----------------|
| 1 | Preparation of practical set up | 10 |
| 2 | Setting and operation | 10 |
| 3 | Safety measures | 20 |
| 4 | Observations and Recording | 20 |
| 5 | Interpretation of result and Conclusion | 20 |
| 6 | Answer to sample questions | 10 |
| 7 | Submission of report in time | 10 |
| | Total | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

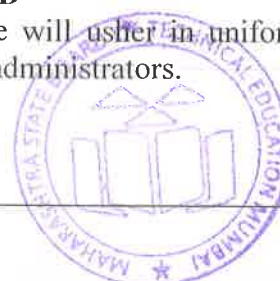
- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Work as a leader/a team member.
- d) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

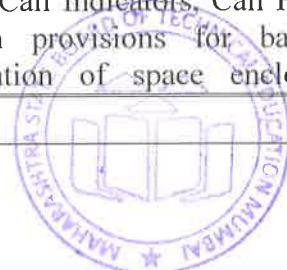


| S. No. | Equipment Name with Broad Specifications | PrO S. No. |
|--------|--|------------|
| 1 | Model of a civil engineering structure depicting various components. | 1,2 |
| 2 | Chart showing detailing of lift, escalator and ramp. | 3,4 |
| 3 | Model of various material used in water supply and sanitary drainage system such as fixtures, fittings, pipe section, joints and valves. | 7, 8 and 9 |
| 4 | Model of a civil engineering structure depicting various components of Rain Water Harvesting system. | 10 |
| 5 | Model of a civil engineering structure depicting various components of Solar Water Heating system. | 12 |

8. UNDERPINNING THEORY COMPONENTS

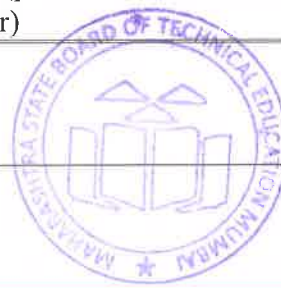
The following topics/subtopics should be taught and assessed in order to develop the same UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|--|--|
| Unit – I Overview of Building Services | 1a. Classify the building based on the basis of the given type of occupancy with reference to the provisions of National Building Code. 1b. List the relevant type of services required for the given building with justification. 1c. Explain the different components of the given building services provided in the given building. 1d. Explain the salient characteristics of BMS required for the given type of building. 1e. Describe the relevant parameters to convert the given type of building into a smart building. 1f. Justify the necessity of providing the relevant building services in the given type of building. | 1.1 Introduction to building services, Classification of buildings as per national building code, Necessity of building services, Functional requirements of building. Different types of building services i.e. HVAC (Heat, Ventilation and Air Conditioning), escalators and lifts, fire safety, protection and control, plumbing services, rain water harvesting, solar water heating system, lightening, acoustics, sound insulation and electric installation etc. 1.2 Role and responsibility of Building Service Engineer, Introduction to BMS (Building Management Services), Role of BMS, concept of smart building. |
| Unit – II Modes of vertical communication | 2a. Suggest the civil engineering requirements for the Escalators to be installed in the given type of civil structure with justification. 2b. Explain the safety measures required for installing the Escalators and Lifts in the given type of civil structure. 2c. Explain the method of | 2.1 Objectives and modes of Vertical Communication in building. Lifts: Different types of lifts and its uses Component parts of Lift- Lift Well, Travel, Pit, Hoist Way, Machine, Buffer, Door Locks, Suspended Rope, Lift Car, Landing Door, Call Indicators, Call Push etc., Design provisions for basic size calculation of space enclosure to |



| | | |
|--|--|--|
| | <p>computing the space requirement for the Escalators and Lifts of the given type of civil structure.</p> <p>2d. Suggest the specifications for the elevator required in the given building with justification.</p> <p>2e. Draft the specifications required for construction of ramp required for physically handicapped and elderly persons for the given type of the building structure.</p> | <p>accommodate lift services, Safety measures.</p> <p>2.2 Escalators: Different Types of Escalators and its Uses. Components of escalators, Design provisions for basic size calculation of space enclosure to accommodate escalator services, Safety measures.</p> <p>2.3 Ramp: Necessity, design consideration, gradient calculation, layout and Special features required for physically handicapped and elderly.</p> |
| Unit- III Fire Safety | <p>3a. Justify the provision of the fire safety system for the given type of buildings.</p> <p>3b. Explain the working principle of the given type of fire protection systems provided in the given type of building.</p> <p>3c. Select the relevant system of fire safety for the given structure with justification.</p> <p>3d. Explain the national building code requirements of providing Fire protection system for the given type of multi-storeyed building.</p> <p>3e. Specify the provisions of NBC for the installation of fire extinguishing equipments in the given type of building.</p> | <p>3.1 Fire protection requirements for multi-storeyed building. Causes of fire in building. Fire detecting and various extinguishing system. Working principles of various fire protection systems.</p> <p>3.2 Safety against fire in residential and public buildings (multi-storeyed building), National Building Code provision for fire safety, Fire resisting materials and their properties, Fire resistant construction, procedures for carrying out fire safety inspections of existing buildings. Provisions for evacuation.</p> |
| Unit- IV Water supply and sanitation services | <p>4a. Explain the significance of AHJ approval in laying the plumbing system in the given type of building.</p> <p>4b. Select the fixtures required for laying the plumbing system for the given type of building.</p> <p>4c. Explain the governing principles of laying the plumbing services (water supply/drainage/vent) in the given type of building.</p> <p>4d. Select the relevant type of valves, pipe material and fittings required for laying the water supply and drainage system for the given site condition with justification.</p> <p>4e. Suggest the relevant plumbing</p> | <p>4.1 Importance of plumbing, AHJ (Authority Having Jurisdiction) approval, Plumbing Terminology and fixtures: Terms used in plumbing, Different types of plumbing fixtures, shapes/ sizes, capacities, situation and where used, Traps, Interceptors.</p> <p>4.2 System of plumbing for building water supply: sources of water, storage of water, hot and cold water supply system.</p> <p>4.3 System of plumbing for building drainage: types of drainage system such as two pipe system, one pipe system, types of Vents and purpose of venting, Concept of gray water and reclaimed water.</p> <p>4.4 Different pipe materials, and jointing methods, fittings, hanger, supports</p> |

| | | |
|---|--|---|
| | system for the given type of building with justification. | and valves used in plumbing and their suitability. |
| Unit-V Natural resources conservation services | <p>5a. Propose the relevant components required for the design of rain water harvesting system in the given type of building structure.</p> <p>5b. Explain the method of estimating the rain water harvesting potential for the given type of structure.</p> <p>5c. Explain the procedure for designing the rain water harvesting system for the given type of structure.</p> <p>5d. Select the relevant Solar water heater system required for the given site condition with justification.</p> <p>5e. Draft the specifications for setting a solar water heating system in the given type of building.</p> <p>5f. Justify the necessity of rain water harvesting system and solar water heating system in the given situation.</p> | <p>5.1 Components of a RWH system (Catchments, gutters, conduits, filters, Storage facility, Recharge structures etc.), Advantages of RWH, Application of RWH, RWH potential and factors affecting RWH potential, planning, designing, construction and maintenance of RWH for residential and institutional buildings, colonies, industries, public areas like parks, airports, forested areas.</p> <p>5.2 Concept of SWH (Solar water heating), component parts of SWHS, various system of SWH (heat transfer, propulsion, passive direct system, active direct system, Do-it-yourself), SWHS design principles, specification, installation and maintenance, cost effect, energy production, life cycle energy assessment and applications of SWHS.</p> |
| Unit- VI Lighting, Ventilation, and Acoustics. | <p>6a. Select relevant system of lighting for the given building with justification.</p> <p>6b. Suggest the lumen capacity required for the given size of the room.</p> <p>6c. Describe the methods used for the ventilation purposes in the given type of building.</p> <p>6d. Explain the significance of providing air conditioning system in the given type of building.</p> <p>6e. Justify the need of acoustic treatment in the given type of building structure.</p> <p>6f. Explain the relevant method of acoustic treatment for the given type of building structure.</p> | <p>6.1. Concept of lighting, types of lighting (natural and artificial), factors influencing the brightness of room, factors affecting selection of artificial lighting, installation of light (direct, half-direct, indirect, half-indirect and direct-indirect), types of light control (manual switch, remote switch, timer switch and photo-electric cell switch), types of lamps (incandescent, tungsten halogen and electric discharge), Lamp selection as per room sizes. Conversion from Lumen (unit of measurement indicating the visible light output of a light source) to Lux (the metric system of luminance).</p> <p>6.2. Concept of ventilation, necessity and types of ventilation, Overview of Air Conditioning system for building.</p> <p>6.3. Building Acoustic, Objectives, acoustic Control in a building, acoustic material (porous absorber and cavity resonator)</p> |



Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|---|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Overview of Building Services | 02 | 02 | 02 | - | 04 |
| II | Modes of Vertical Communication | 10 | 04 | 04 | 06 | 14 |
| III | Fire Safety | 08 | 02 | 04 | 06 | 12 |
| IV | Water Supply and Sanitation System | 10 | 04 | 04 | 06 | 14 |
| V | Natural Resources Conservation Services | 10 | 04 | 04 | 06 | 14 |
| VI | Lighting, Ventilation, and Acoustics | 08 | 04 | 04 | 04 | 12 |
| Total | | 48 | 20 | 22 | 28 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

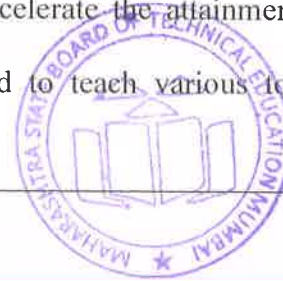
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Prepare journals based on practical performed in laboratory.
- b) Give seminar on relevant topic.
- c) Undertake micro-projects.
- d) Visit any three buildings near by your institute and classify them in accordance with the provisions made in National Building Code in report form.
- e) Identify the components of building services by inspecting the nearby buildings to prepare a detailed report w.r.t. adequacy, deficiency and exceeding the requirement.
- f) Collect the technical brochures of the different components of building services from the local market/internet to present in report form.
- g) Visit any building certified by Building Management Services to record the important features that has converted it into green building and submit a report.
- h) Estimate the RWH and SWH potential for your house and institute building.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.



- b) '**L**' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e) Guide student(s) in undertaking micro-projects
- f) Arrange visit to nearby construction sites for understanding various construction activities.
- g) Use of video/animation films to explain various processes of building construction.
- h) Use different instructional strategies in classroom teaching.
- i) Demonstration of different small activities related to building services.
- j) Display of various technical brochures of modern building services.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a) Prepare a sketchbook consisting of components of modern building services (for Sketches which are not included in Practical sketch book).
- b) Collect the relevant information of recent technologies in elevators and prepare a report on it.
- c) Prepare a report on BMS including a case study.
- d) Collect the relevant information of different techniques for RWH or SWHS and submit a report on it.
- e) Prepare a summary report with reference to lighting, ventilation and acoustic system of a building.
- f) Prepare a report on modern Fire Safety, Detection and Protection systems.

13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|--------|--|-------------------|---|
| 1 | The A to Z of Practical Building Construction and its Management | Mantri, Sandeep | Satya Prakashan, New Delhi ISBN-13: 978-8176849692 |
| 2 | Plumbing Design and Practice | Deolalikar, S. G. | McGraw-Hill, New-Delhi, 2004 ISBN: 9780074620694 |



| | | | |
|---|---|--------------------|--|
| 3 | Fire Services in India: History, Detection, Protection, Management | Bag, S. P. | Mittal Publications, New Delhi, 1995, ISBN 8170995981 |
| 4 | Principles of Fire Safety Engineering: Understanding Fire and Fire Protection | Akhil Kumar Das | PHI Learning Pvt. Ltd, New Delhi. 2014, ISB:9788120350380 |

BIS/ International Codes of Practice:

| S. No. | Title of Book | Author | Publication |
|--------|--|--------|---|
| 1 | National Building Code Part1, 4, 8, 9 | BIS | Bureau of Indian Standard, New Delhi |
| 2 | IS 12183(Part 1):1987 Code of practice for plumbing in multistoried buildings | BIS | |
| 3 | 2008 Uniform plumbing code – India (UPC-I) | BIS | |

14. SOFTWARE/LEARNING WEBSITES

- a) <http://bis.org.in>
- b) <https://www.capterra.com>
- c) <http://bmsbuildingservice.com>
- d) <http://www.plumbingservices.com>



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Solid Waste Management (Elective-II)
Course Code : 22605

1. RATIONALE

Industrialization and urbanization is increasing day by day. As a result of this, the generation of solid waste is a major problem all over the country within the urban as well as rural area and it is increasing day by day. In view of this, the management of solid waste produced is of prime need to keep the environment safe and clean. Information on classification and characteristics of solid waste will enable to decide appropriate technology about the collection and transportation of waste produced. Various disposal methods of solid waste will enable to recommend suitable method of disposal of solid waste with economy and acceptable environmental constraints including reuse and recycle wherever applicable. Content on other types of solid waste such as biomedical waste, construction waste, E-waste and plastic waste will be useful in deciding appropriate method for collection, transportation and disposal of these wastes. Thus, the knowledge of solid waste management with the concept like recycling, recovery and reuse will lead to proper disposal with acceptability. This will further lead to keeping the natural resources condemnation free.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Manage the solid waste effectively to maintain the hygienic conditions.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Identify the different sources of solid wastes.
- Execute the relevant method of collection and transportation of solid wastes.
- Execute an action plan for disposal of solid wastes.
- Implement the relevant method for disposal of Bio-medical wastes.
- Implement the relevant method for disposal of Industrial wastes and E-waste.
- Implement the relevant laws related to solid waste management.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|-------------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.



Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

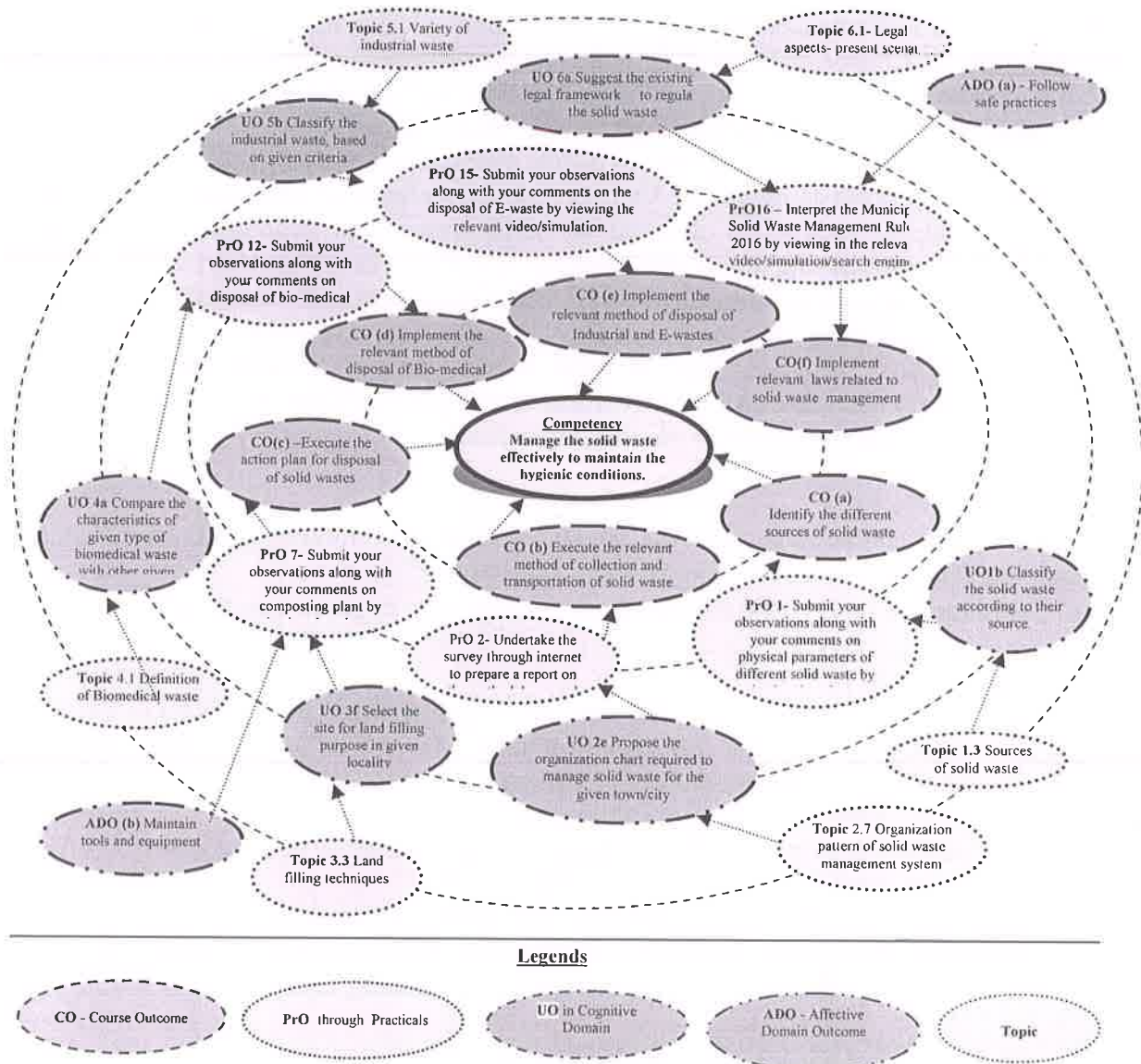


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---|----------|-----------------------|
| 1 | Submit your observations along with your comments on physical parameters of different solid waste by viewing the relevant video/simulation/photographs. | I | 02 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 2 | Undertake the survey through internet to prepare a report on the methodology used in collection and transportation of Solid waste including equipments, specifications used therein | II | 02* |
| 3 | View the relevant video/simulation/photographs/print material/non-print material of the operations in transfer station to draw the flow chart for the same. | II | 04* |
| 4 | Design the organization chart for the agency managing solid waste for a given area with a report on w.r.t. population to be served, pattern, machineries, equipment, manpower used. | II | 02* |
| 5 | Submit your observations along with your comments on solid waste management techniques by viewing the relevant video/simulation. | II | 02 |
| 6 | Submit your observations along with your comments on solid waste disposal plant by viewing the relevant video/simulation/photographs. | III | 04* |
| 7 | Submit your observations along with your comments on composting plant by viewing the relevant video/simulation/photographs. | III | 04* |
| 8 | Submit your observations along with your comments on Bio gas plant by viewing the relevant video/simulation/photographs. | III | 04 |
| 9 | Prepare the specifications of vermin-composting plant for the given type of building with suggested action plan to implement it by viewing the relevant video/simulation/photographs.. | III | 04* |
| 10 | Submit your observations along with your comments on working of vermin-composting plant by viewing the relevant video/simulation. | III | 02 |
| 11 | Submit your observations along with your comments on solid waste management system by landfills techniques by viewing the relevant video/simulation. | III | 02 |
| 12 | Submit your observations along with your comments on disposal of bio-medical waste by viewing the relevant video/simulation. | IV | 04* |
| 13 | Prepare the specifications for the disposal of bio-medical waste by viewing the relevant video/simulation. | IV | 04* |
| 14 | Submit your observations along with your comments on the problems of human agencies dealing with solid waste management by viewing the relevant video/simulation. | IV | 02 |
| 15 | Submit your observations along with your comments on the disposal of E-waste by viewing the relevant video/simulation. | V | 02 |
| 16 | Submit your observations along with your comments on the disposal of Industrial waste by viewing the relevant video/simulation. | V | 02 |
| 17 | Compile the relevant provisions Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) pertaining to solid waste management by viewing in the relevant video/simulation/search engine.. | V | 02 |
| 16 | Interpret the Municipal Solid Waste Management Rules, 2016 by viewing in the relevant video/simulation/search engine.. | VI | 02* |
| 17 | Interpret the Biomedical Waste Management Rules, 2016 by viewing in the relevant video/simulation/search engine. | VI | 02 |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------------|--|----------|-----------------------|
| 18 | Interpret the E- Waste Management Rules, 2016. by viewing in the relevant video/simulation/search engine. | VI | 02 |
| 19 | Interpret the Construction and demolition Waste Management Rules, 2016” by viewing in the relevant video/simulation/search engine. | VI | 02 |
| 20 | Interpret the Hazardous and other waste Management Rules, 2016; by viewing in the relevant video/simulation/search engine. | VI | 02 |
| 21 | Interpret the Plastic Waste Management Rules, 2016 by viewing in the relevant video/simulation/search engine | VI | 02 |
| Total | | | 60 |

Note

- i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practicals marked as ‘*’ are compulsory, so that the student reaches the ‘Precision Level’ of Dave’s ‘Psychomotor Domain Taxonomy’ as generally required by the industry.
- ii. The ‘Process’ and ‘Product’ related skills associated with each PrO is to be assessed according to a suggested sample given below:

| S. No. | Performance Indicators | Weightage in % |
|--------------|------------------------------|----------------|
| 1 | Safety measures during visit | 20 |
| 2 | Observations and Recording | 30 |
| 3 | Answer to sample questions | 20 |
| 4 | Submission of report in time | 30 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Work as a leader / team member.
- d) Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl’s ‘Affective Domain Taxonomy’ should gradually increase as planned below:

- ‘Valuing Level’ in 1st year.
- ‘Organization Level’ in 2nd year.
- ‘Characterization Level’ in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will be useful in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

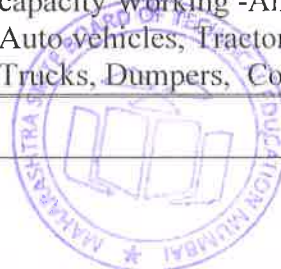


| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|--------|---|----------|
| 1 | Specific Uniform, Helmet, Goggle, Hand Gloves, specific shoes etc. | 6-11 |
| 2 | Use of specific models and charts for explanation regarding solid waste management practices. | 6-11 |
| 3 | Demonstration of specific Documentary, films or animated film related to solid waste management practices | 6-11 |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|---|
| Unit I Fundamentals of solid waste management | 1a. Explain the principles of waste reduction in the given condition. 1b. Classify the given solid wastes according to their sources. 1c. Describe the characteristics of the given solid wastes. 1d. Justify the need of solid waste management in the given situation. 1e. Assess the impact of solid waste management on the environment in the given situation. 1f. List the factors generating solid wastes in the given specific area with justification. | 1.1 Definition of solid waste 1.2 Meaning of different solid waste – Domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste 1.3 Sources of solid waste, Classification of solid waste – hazardous and non- hazardous waste. 1.4 Physical and chemical characteristics of municipal solid waste. 1.5 Impact of solid waste on environment. 1.6 Solid waste management techniques – solid waste management hierarchy, waste prevention and waste reduction techniques. 1.7 Factors affecting the solid waste generation. |
| Unit- II Storage, Collection and Transportation of Municipal Solid Waste | 2a. Suggest the relevant method of storage of solid waste for the given site conditions with justification. 2b. Explain the relevant method of collecting the solid waste in the given situation. 2c. Implement the relevant techniques for management of solid waste in the given area. 2d. Suggest the relevant transportation system for | 2.1 Storage of solid waste 2.2 Collection methods of solid waste 2.3 Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical road sweepers, Community bin - like movable and stationary bin 2.4 Transportation of municipal waste. 2.5 Transportation vehicles with their capacity Working -Animal carts, Auto vehicles, Tractors or Trailers, Trucks, Dumpers, Compactor |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|--|---|
| | <p>transporting the municipal solid waste at the given location with justification.</p> <p>2e. Propose the organization chart required to manage solid waste for the given village / town / city of your locality.</p> | <p>vehicles. Transfer station-meaning, necessity, location</p> <p>2.6 Role of rag pickers and their utility for society</p> <p>2.7 Organization pattern of solid waste management system, practices according to Population of the town or city.</p> |
| <p>Unit- III Disposal of Municipal Solid Waste</p> | <p>3a. Explain the principles of preparing the compost for the given site.</p> <p>3b. List the relevant factors affecting the given composting process with justification.</p> <p>3c. Describe the different steps of executing the relevant method of composting for the given site.</p> <p>3d. Suggest the design criteria adopted in execution of vermicomposting for the given area with justification.</p> <p>3e. Explain the relevant operating method of sanitary land filling for the given site condition and given type of waste.</p> <p>3f. Select the site suitable for the land filling purpose in the given locality with justification.</p> <p>3g. State the relevant parameters to select a site for land filling with justification.</p> <p>3h. Propose the relevant method to control the liquid Leachate generated in the given land filling site.</p> <p>3i. Suggest the relevant situation for disposal of given type of solid waste through incineration process with justification.</p> <p>3j. Select the relevant type of incinerator for the given type of solid waste.</p> | <p>3.1 Concept of composting of waste, Principles of composting process. Factors affecting the composting process</p> <p>3.2 Methods of composting –</p> <p>A) Manual Composting – Bangalore method, Indore Method</p> <p>B) Mechanical Composting – Dano Process</p> <p>C) Vermicomposting.</p> <p>3.3 Land filling technique, Factors to be considered for site selection</p> <ul style="list-style-type: none"> • Land filling methods-Area method, Trench method and Ramp method. • Leachate and its control, Biogas from landfill • Advantages and disadvantages of landfill method • Recycling of municipal solid waste <p>3.4 Incineration of waste:</p> <ul style="list-style-type: none"> • Introduction of incineration process. • Types of incinerators - Flash, Multiple chamber Incinerators, • Products of incineration process with their use, • Pyrolysis of waste – Definition, Methods <p>3.5 Products of incineration process</p> <ul style="list-style-type: none"> • Advantages and disadvantages of incineration process |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| Unit– IV Biomedical Waste management and Health aspects and public Involvement in Solid Waste Management | 4a. Compare the characteristics of the given type of biomedical waste with other given type of waste material. 4b. Describe the different sources of generating the given type of biomedical waste in the given locality. 4c. Classify the biomedical waste on the basis of given criteria. 4d. Explain the method of executing the disposal of the given type of biomedical waste in the given area. 4e. Explain the ill effects on the health of humans handling the given type of solid waste in the given area. 4f. Justify the need of public participation in effective implementations of schemes managing the given type of solid waste in the given area. | Biomedical Waste Management 4.1 Definition of Bio medical Waste. 4.2 Sources and generation of Biomedical Waste 4.3 Classification of Biomedical Waste. 4.4 Management technologies. Health aspects and public Involvement in solid waste management 4.4. Health aspects during handling and processing 4.5. Health problems during time of segregation, recovery, recycling and reuse of solid waste. 4.6. Public involvement and participation in solid waste management practices. |
| Unit –V Industrial waste management and E-waste management | 5a. Explain the relevant method of disposal of given type of industrial waste. 5b. Classify the industrial waste based on the given criteria. 5c. Describe the process of controlling the generation of Given type of industrial waste at the given site. 5d. Suggest the relevant appliance for the disposal of given type of E-waste with justification 5e. Explain the ill effects of given type of E-waste on the environment of that area. 5f. Suggest the relevant method of recycling and disposal of the given type of E-waste in the given situation. | Industrial waste Management : 5.1. Variety of industrial waste 5.2. Collection and disposal of industrial waste, 5.3. Control measures for industrial waste, 5.4. Recycling of industrial waste. E-waste Management 5.5. Definition of E- waste, Varieties of E- wastes, Dangers of E- waste, 5.6. Recycling of E- waste. 5.7. Disposal of E- waste. |
| Unit –VI Legal aspects of solid waste management. | 6a. Suggest the existing legal framework to regulate the given type of solid waste with justification. 6b. Explain the relevant major provisions of Municipal Solid | Legal Aspects : 6.1. Legal aspects- present scenario 6.2. Municipal Solid Waste Management Rules, 2016 6.3. Biomedical Waste Management Rules, 2016 |



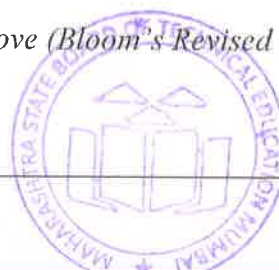
| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|---|---|
| | Waste Management Rules, 2016 for disposal of the given type of solid waste. 6c. Explain the different major provisions of Biomedical Waste Management Rules, 2016 for managing the given type of bio-medical waste. 6d. Compile the major features of Construction and demolition Waste Management Rules, 2016 for the disposal of the given type of waste. 6e. Explain the salient features of Hazardous and other wastes Management Rules, 2016 for the disposal of the given type of waste. 6f. Explain Role of CPCB (Central Pollution Control Board) and MPCB (Maharashtra Pollution Control Board) in managing the given type of solid waste. | 6.4. E- Waste Management Rules, 2016 6.5. Construction and demolition Waste Management Rules, 2016 6.6. Hazardous and other wastes Management Rules, 2016 6.7. Plastic Waste Management Rules, 2016 6.8. Role of Central Pollution Control Board and Maharashtra Pollution Control Board in management of solid waste from various sources. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Fundamental of Solid Waste Management. | 04 | 02 | 04 | --- | 06 |
| II | Storage, Collection and Transportation of Municipal Solid Waste | 10 | 04 | 04 | 06 | 14 |
| III | Disposal of Municipal Solid Waste | 14 | 02 | 06 | 08 | 16 |
| IV | Biomedical Waste Management and Health Aspects and Public Involvement in Solid Waste Management. | 08 | 04 | 04 | 06 | 14 |
| V | Industrial waste management and E- Waste Management | 08 | 04 | 04 | 06 | 14 |
| VI | Legal aspects of Solid Waste Management. | 04 | 02 | 04 | -- | 06 |
| Total | | 48 | 18 | 26 | 26 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)



Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Preparation of charts showing solid waste management techniques.
- b) Preparation of charts showing tools, equipment, vehicles and machineries used in solid waste management practices.
- c) Preparation of compost using decomposable waste material at home adopting appropriate method.
- d) Preparation of compost using decomposable waste material at the institute adopting appropriate method..
- e) Preparation of vermicompost using decomposable waste material and worms at home.
- f) Preparation of vermicompost using decomposable waste material and worms at institute.
- g) Recycling of plastic wastes obtained from various sources and study the machineries and outcome product.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

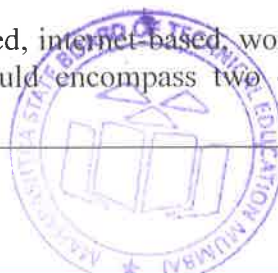
These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- b) '**L**' in **item No. 4** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About **15-20% of the topics/sub-topics**, which is relatively simpler or descriptive in nature, is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e) Guide student(s) in undertaking micro-projects.
- f) Arrange visit to nearby newly started site for understanding various solid waste management practices.
- g) Show video/animation films to explain various instruments used in solid waste management practices.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he can contribute to the projects of the industry or society in future. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs



which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the micro-project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project report by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a) Carry out comparative study of vehicles used for collection of solid wastes from various sources.
- b) Collect the relevant technical and commercial information of tools, equipment, vehicles and machineries used for collection, segregation, transportation, processing and disposal of solid waste with specifications
- c) Preparation of report about route used for collection and transportation of solid waste of the city and optimization of it.
- d) Preparation of report regarding solid waste management practices adopted in the campus of the institute
- e) Writing a report on case studies for solid waste management practices of specific cities
- f) of the country.
- g) Writing a detailed report on legal aspects about Municipal Solid Waste Management
- h) Rules, 2016
- i) Writing a detailed report on legal aspects about Biomedical Waste Management Rules,
- j) 2016
- k) Writing a detailed report on legal aspects about E- Waste Management Rules, 2016
- l) Writing a detailed report on legal aspects about Construction and demolition Waste Management Rules, 2016
- m) Writing a detailed report on legal aspects about Hazardous and other wastes
- n) Management Rules, 2016
- o) Writing a detailed report on legal aspects about Plastic Waste Management Rules, 2016
- p) Develop a specific model regarding solid waste management practices.
- q) Preparation of models concerned with solid waste management practices like incineration, pyrolysis etc.
- r) Preparation of charts, PPT presentation concerned with solid waste management practices
- s) Creation of awareness about good habits of scientific; better solid waste management practices
- t) Any other suitable topic for various solid waste management practices in the area, town, city or country as a whole

13. SUGGESTED LEARNING RESOURCES

| S. No | Title | Author | Publisher |
|-------|------------------------|--------------------------------------|---|
| 1 | Solid Waste Management | Bhide A. D. | Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2 |
| 2 | Solid Waste | Techobanoglous George; Kreith, Frank | McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237 |
| 3 | Environmental Studies | Manjunath D. L. | Pearson Education Publication, New Delhi, 2006 ISBN-13: 978-8131709122 |

| | | | |
|---|--|----------------|---|
| 4 | Solid Waste Management | Sasikumar K. | PHI learning, New Delhi, 2009 ISBN 8120338693 |
| 5 | Environmental Pollution | Khopkar S. M. | New Age International limited, Delhi, 2007, ISBN 8122415075 |
| 6 | Environmental Studies | Basak Anindita | Pearson Publication, Delhi, 2009 ISBN : 8131785688, 9788131785683 |
| 7 | Environmental Pollution Control Engineering | Rao C. S. | New Age International, 2006, New Delhi, ISBN-13: 978-8122418354 |
| 8 | Prospect and Perspectives of Solid Waste Management | Hosetti B. B. | New Age International Publisher, 2006 New Delhi, ISBN-13: 978- 8122417777 |

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a) www.hsagolden.com
- b) www.almitrapatel.com
- c) www.yousee.in
- d) www.skgsangha.org
- e) www.epa.gov/epaoswer/non-hw/municipal/index.htm
- f) En.wikipedia.org/waste-management



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Earthquake Resistant Buildings (Elective-II)
Course Code : 22606

1. RATIONALE

This course is the specialized subject for Civil Engineering. The students having interest in structural engineering and perceive career in this field have a better option to choose this course. Earthquake is a natural disaster phenomenon which could not be denied, but its impact on the structure can be reduced by proper analysis and design of buildings to minimize loss of properties and lives. In recent past, a major part of the peninsular India experienced earthquakes periodically; therefore study of earthquake engineering is introduced in the curriculum of sixth semester civil engineering diploma students.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Execute construction of earthquake resistant buildings using relevant IS code provisions.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Execute the principles of earthquake resistant buildings in the constructions.
- Relate the failure in the structures on the basis of the intensity of damage.
- Select the relevant shape of building for seismic sustainability of structures.
- Execute the relevant method of removal of defect in structures causing failure.
- Execute the relevant provisions of IS code in construction of earthquake resistant buildings.
- Execute the post-earthquake management system.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|-----|-----|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| Max | Min | Max | Min | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | | |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)



This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

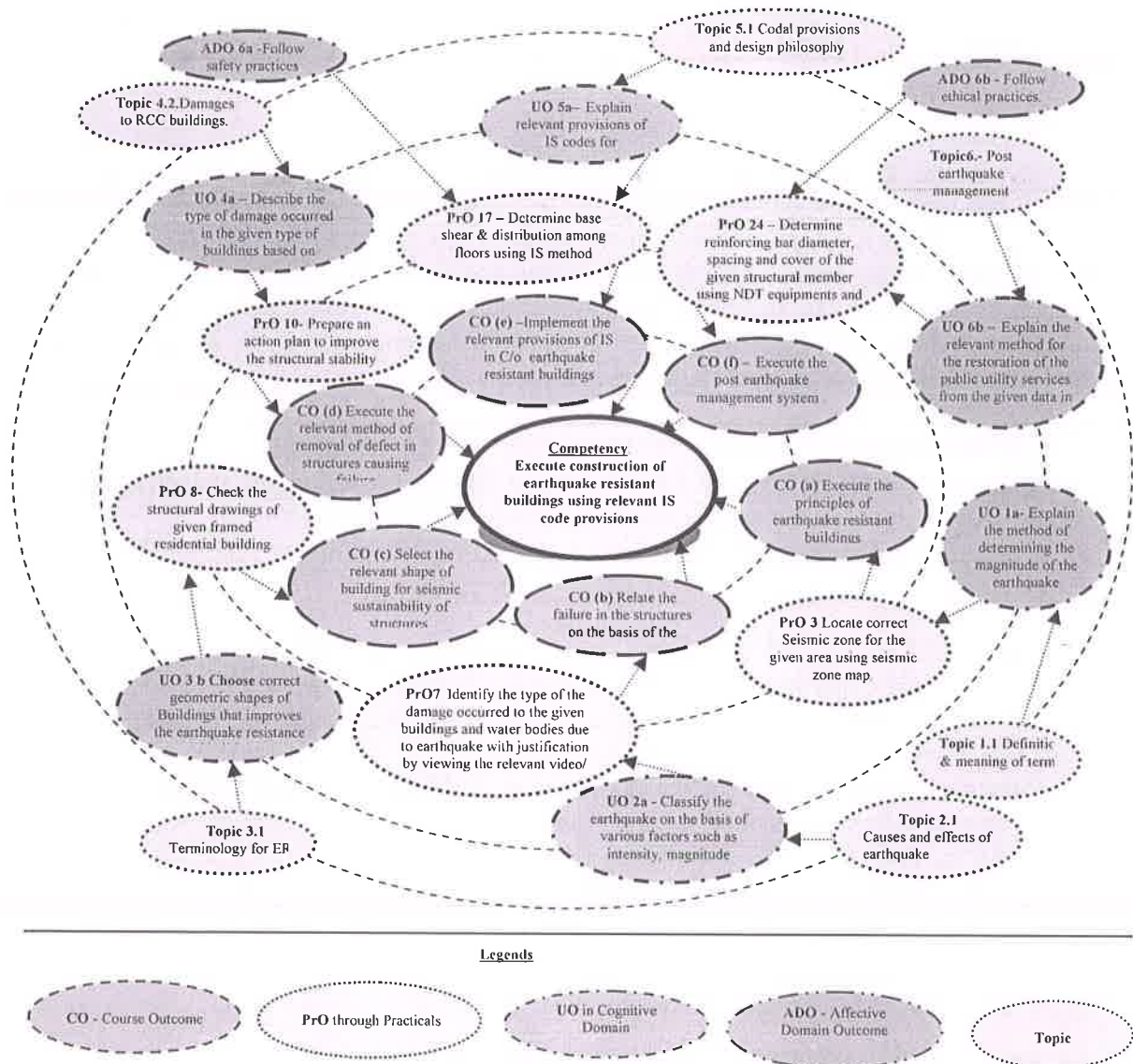
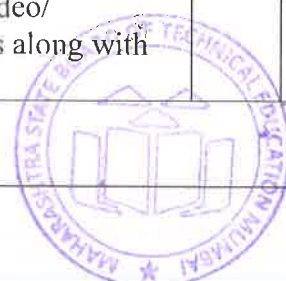


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 1 | Interpret the past earthquake having magnitude less than 6 (richter scale) through internet survey and submit your report including sketches/photos wherever necessary. | I | 02* |
| 2 | Relate magnitude of the earthquake occurred in the given area to the severity of the damages by viewing the relevant video/ simulation/ photographs and Submit your observations along with your comments. | I | |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 3 | Locate correct Seismic zone for the given area using seismic zone map. | I | |
| 4 | Interpret the past earthquake having magnitude more than 6 (richter scale) through internet survey and submit your report including sketches/photos wherever necessary. | I | 02 |
| 5 | Mark various seismic zones on a printed map of India with earthquake magnitude as per the guidelines provided in IS: 1893-2002 to list four cities in India in each earthquake zone. | I | 02* |
| 6 | Interpret the damages to the masonry and concrete structures from the relevant information of any two past earthquakes from India w.r.t.type of structures, zones, site conditions, type of failures etc. | II | 02* |
| 7 | Identify the type of the damage occurred to the given buildings and water bodies due to earthquake with justification by viewing the relevant video/ simulation/ photographs and Submit your observations along with your comments.. | II | 02 |
| 8 | Check the structural drawings of the given framed residential building for seismic vulnerability for the given seismic zone | III | 02* |
| 9 | Check the structural drawings of the given framed public building for seismic vulnerability for the given seismic zone | III | 02 |
| 10 | Prepare an action plan to improve the structural stability of the given structure against earthquake. | IV | 02 |
| 11 | Draw the sketches of the given method of retrofitting for improving seismic resistance of existing framed building with a report on its procedure including other methods of retrofitting. | IV | 02 |
| 12 | Determine strength of any two given structural members of framed building using rebound hammer and comment on its seismic stability | IV | 02* |
| 13 | Classify damages occurred in the given buildings based on earthquake intensity in the given seismic zone by viewing the relevant video/ simulation/ photographs and Submit your observations along with your comments.. | IV | 02 |
| 14 | Identify the failure pattern observed in the building failure occurred due to earthquake in the given seismic zone by viewing the relevant video/ simulation/ photographs and Submit your observations along with your comments. | IV | 02 |
| 15 | Check the stability of the given two members of framed building using ultrasonic pulse velocity and comment on its seismic stability. | IV | 02 |
| 16 | Determine compressive strength of the given member of framed structure by taking core from cubes or from existing concrete structures and comment on its seismic stability. | IV | 02 |
| 17 | Determine base shear and distribution among floors using IS method for two bay single storey RCC building. | V | 02* |
| 18 | Calculate base shear and distribution among floors using any ETAB software for two bay single storey RCC building. | V | 02 |
| 19 | Calculate base shear and distribution among floors using Indian Standard method for three storied RCC building. | V | 02 |
| 20 | Calculate base shear and distribution among floors using software for single bay three storey RCC building. | V | 02 |
| 21 | Draw typical sketches of beam, column and beam-column joint | V | 02* |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---|----------|-----------------------|
| | showing reinforcement details as per I.S. 13920-1993. | | |
| 22 | Draw the sketches to represents the methods to strengthen steel structure with roof truss against earthquake damages with a brief note on it. | VI | 02 |
| 23 | Draw the sketches to represents the methods to strengthen steel structure with gable frame against earthquake damages with a brief note on it. | VI | 02 |
| 24 | Determine reinforcing bar diameter, spacing and cover of the given structural member using NDT equipments and comment on ductile detailing requirement. | VI | 02 |
| 25 | Submit your observations along with your comments on case study of an earthquakes occurred in India by viewing the relevant video/simulation/photographs. | VI | 02* |
| 26 | Carryout the earthquake simulation for the given type of building structure using software STADDPRO/E-TABS/ABAQUS/ SAP | VI | 02 |
| | Total | | 48 |

Note

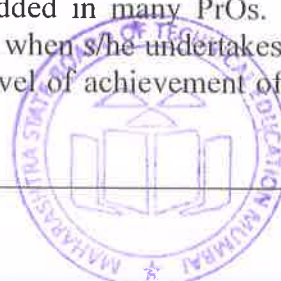
- i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

| S. No. | Performance Indicators | Weightage in % |
|--------|--|----------------|
| 1 | Interpretation of data and its presentation. | 10 |
| 2 | Selection of case studies/ collection of data and its relevance/process followed in analysis, estimate, drawing and interpretation | 30 |
| 3 | Precision in drawing sketches /data collection/ presentation, neatness, cleanliness, relevance with COs | 30 |
| 4 | Individual work and working in groups | 20 |
| 5 | Submission of assigned work in time | 10 |
| | Total | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Work as a leader/a team member.
- d. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs



according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

| S. No. | Equipment Name with Broad Specifications | PrOs. S. No. |
|--------|--|--------------|
| 1 | Concrete core cutter | 10 |
| 2 | Rebound Hammer | 8 |
| 3 | Ultrasonic Pulse Velocity Equipment | 9 |
| 4 | Compression Testing Machine, capacity minimum 2000 kN. | 10 |
| 5 | Any design related software such as STAAD Pro/ STRUDS etc. | 14 |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| Unit – I Basics of earthquake phenomena | 1a. Explain the method of determining the magnitude of the earthquake occurred in the given type of structure in the specified seismic zone. 1b. Classify seismic waves on the basis of given criteria in the given situation. 1c. Select the relevant Seismic zone for the given area using seismic zone map. 1d. Describe the different safety measures required to minimize the damage in the given zone. 1e. Explain the procedure to increase resistance against earthquake of the given building in the given seismic zone. | 1.1 Definition and meaning of terms: Focus, Epicenter, Focal depth, foreshocks, aftershocks, magnitude and intensity of Earthquake. Seismic waves, Body waves. 1.2 Natural period, fundamental natural period, nodal natural period, response spectrum, seismic mass, seismic weight, structural response factor, time history analysis, earthquake zones, zone map, zero period acceleration. 1.3 Measurement of earthquake shaking and its working principle, Richter scale. 1.4 Guidelines for Earthquake preparedness: Individual, Home and community planning. |
| Unit– II Causes and effects of earthquake | 2a Classify the earthquake on the basis of given criteria. 2b Explain the procedure of formation of the earth and movement of tectonic plates for the given earthquake zone. 2c Explain the elastic rebound theory method of determining the | 2.1 Causes and effects of earthquake 2.2 Formation of earth and its cores. Formation, types and movement of tectonic plates, Elastic rebound theory, Types of earthquake and Faults. 2.3 Ground shaking, Ground failure, |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | <p>intensity of earthquake occurred in the specified zone.</p> <p>2d Compare the given type of failure of building with another type of failure occurred due to earthquakes in the specified zone based on the given criteria.</p> | Tsunami and fire. |
| Unit III- Planning and design aspects | <p>3a. Establish relationship between mass centers, stiffness from the given data.</p> <p>3b. Choose correct geometric shapes of the given Buildings to improve its resistance against earthquake with justification.</p> <p>3c. Select the most relevant site for constructing earthquake resistant building on the basis of the given data of soil strata with justification.</p> <p>3d. Justify significance of seismic base shear in the design of the given earthquake resistant building in the given zone.</p> <p>3e. Explain the effect of given geometric shape on the damages due to earthquake for the given zone.</p> | <p>3.1 Terminology for Earthquake resistant Building - Base, base dimensions, centre of mass, centre of stiffness, design eccentricity, design seismic base shear (V_b), diaphragm, storey drift, storey shear, weak storey</p> <p>3.2 Plan of Building- symmetry, regularity, separation of blocks, simplicity, enclosed area, separate building for different functions, soft storey effect</p> <p>3.3 Choice of site- Stability of slopes, loose sand</p> |
| Unit –IV Concrete and masonry buildings | <p>4a. Describe the type of damage occurred in the given type of buildings based on earthquake intensity in the given seismic zone.</p> <p>4b. Explain the causes of the failure observed in the given type of the building from the given seismic zone.</p> <p>4c. Correlate damage of building for the given type of masonry building for the given data.</p> <p>4d. Compare the types of damages before and after earthquake with reference to the given data.</p> | <p>4.1 Typical damage and failure patterns of brick masonry, causes of damages in brick masonry.</p> <p>4.2 Damage to RCC buildings: Sliding of roof support, falling of infill walls, crushing of column ends, diagonal cracking of column beam joints, pulling out of reinforcement bars, foundation sinking and tilting.</p> <p>4.3 Typical damage and failure of stone masonry, causes of damages in stone masonry</p> |
| Unit –V Codal provisions and design philosophy | <p>5a. Explain the relevant provisions of IS codes for construction of earthquake resistant building for the given seismic zone.</p> <p>5b. Check reinforcement requirements for the given structural element from the given data as per IS:13920-1993.</p> <p>5c. Explain the relevant method of calculating the base shear for the</p> | <p>5.1 Codal Provision and Design Philosophy :</p> <p>5.2 IS: 1893 (part I)-2002: General provisions and principles for design of earthquake resistant buildings: Definition of seismic zone factor, Importance factor, damping, critical damping, floor spectra, seismic mass, seismic weight, meaning of soft storey,</p> |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|--|---|
| | <p>given building frames as per relevant IS provision.</p> <p>5d. Explain the provisions of IS: 4326:1993 to improve seismic behavior of masonry buildings in the given seismic zone.</p> <p>5e. Integrate the relevant provisions of IS: 13920 in design of earthquake resistant building to be constructed in the given seismic zone.</p> | <p>storey drift, assumptions in earthquake resistant design of structure.(No numerical)</p> <p>5.3 IS:13920-1993 Ductile detailing, meaning of ductility, need of ductility in concrete structure, critical sections in the building where ductile detailing is required, typical sketches with reinforcement details of columns, beams and beam column connections showing longitudinal steel , splicing of steel, transverse steel, stirrups as per IS:13920. (No numerical)</p> <p>5.4 Determination of design base shear using equivalent static lateral force method, distribution of design base shear.</p> <p>5.5 IS:4326:1993 Recommended provisions to improve seismic resistance of buildings earthquake resistance of masonry buildings: mortar, wall enclosure, openings in walls, masonry bond, horizontal bands, section of bands, dowels at corners and junctions, vertical reinforcement in walls</p> |
| Unit –VI Post-earthquake management | <p>6a. Suggest action plan required to handle the earthquake of building in the given area with justification.</p> <p>6b. Explain the relevant method for the restoration of the public utility services from the given data in the given area after earthquake.</p> <p>6c. Explain the process of executing the plan for restoration of the given public utility services in the given area/zone.</p> <p>6d. Suggest with justification the precautions to be taken in design and construction of earthquake affected zone.</p> | <p>6.1 Post-earthquake handling of building, Lifelines, Roads, Bridges, communication systems, electricity, water distribution systems</p> <p>6.2 Learning from Prominent past earthquakes in India such as Koyna, Killari(Latur), Jabalpur, Bhuj.</p> |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.



9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Basics of Earthquake Phenomenon | 06 | 02 | 04 | 04 | 10 |
| II | Causes and Effects of Earthquake | 08 | 02 | 04 | 06 | 12 |
| III | Planning and Design Aspects | 08 | 02 | 04 | 06 | 12 |
| IV | Concrete and Masonry Buildings | 08 | 02 | 04 | 06 | 12 |
| V | Codal Provisions and Design Philosophy | 10 | 04 | 04 | 08 | 16 |
| VI | Post-Earthquake Management | 08 | 02 | 00 | 06 | 08 |
| Total | | 48 | 14 | 20 | 36 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journals based on practical performed in laboratory/data collection/case studies.
- Give seminar on relevant topic.
- Undertake micro-projects.
- Study any two case studies of past earthquake in Maharashtra.
- Study any two case studies of past earthquakes in India
- Study any two case studies of past earthquakes in World
- Study of minimum earthquake related to magnitude, intensity, epicenter and damages caused.
- Study of tsunami after earthquake.
- Indian standard provisions for earthquake resistant structures for your regions.
- Behavior of old masonry structures during earthquake.
- Effect of earthquakes on reservoirs/dams.
- Behavior of steel structures during earthquake.
- Effect of earthquakes on liquefaction of soils during earthquake.
- Behavior of buildings with open parking during earthquake.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- 'L' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About 15-20% of the topics/sub-topics which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the

- development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
 - e) Guide student(s) in undertaking micro-projects.
 - f) Demonstrate students thoroughly before they start doing the practice.
 - g) Encourage students to refer different websites to have deeper understanding of the subject.
 - h) Observe continuously and monitor the performance of students in Lab.
 - i) Demonstrate students thoroughly before they start doing the practice.
 - j) Encourage students to refer different websites to have deeper understanding of the subject.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a) Write 5 to 6 page report with sketches and photographs on case study of any one earthquake occurred in India in past covering following: focal length, focus, intensity, magnitude, natural period, damages occurred in terms of property and lives with reasons, pre earthquake preparation of local administration and post-earthquake handling of situation, lesson learned and corrective measures taken for future.
- b) Visit a site of earthquake resistant building construction and prepare a report based on building foundation and RCC work with detailed sketches (only sample members be taken).
- c) Visit structural designer's office and collect data about ductile detailing of any one structure in progress.
- d) Carry out market survey and collect data of new building materials more suitable for earthquake resistant construction.
- e) Visit web site of prominent institutes (IIT Kanpur) having research and development cell on earthquake engineering and prepare a report.
- f) Visit seismic data analysis and measurement centre of Government of Maharashtra for your district and prepare a report.
- g) Collect data of any three non-destructive equipments and prepare a report giving technical specifications, make, cost, nature of test, degree of accuracy of results etc.
- h) Study effect of pure parking space at ground floor without bracing of walls.



13. SUGGESTED LEARNING RESOURCES :

| S. No. | Title of Book | Author | Publication |
|--------|---|--|--|
| 1 | Earthquake Resistant Design of Structures | Agarwal, Pankaj Shrikhande, Manish | PHI Learning, Delhi, 2011 ASIN: B00K7YFYVE ISBN-13 9788120328921 |
| 2 | Elements of Earthquake Engineering | Jai Krishna , A. R. Chandrashekharan Chandra, B. | South Asian Publishers Pvt Ltd, Delhi, 2014, ISBN13 9788180142192 |
| 3 | Earthquake Resistant Design of Structures | Duggal, S. K. | Oxford University Press, Delhi, 2013 ISBN-13 9780198083528 |

I.S. Codes:

- 4 IS 1893(Part I):2002 ,Indian Standard Criteria for Earthquake Resistant Design of Structures- General Provisions and Buildings , BIS, New Delhi.
- 5 IS 13920:1993 Ductile Detailing of Reinforced Concrete Structures subjected to Seismic forces-Code of Practice, BIS, New Delhi.
- 6 IS 456:2000 - Plain and Reinforced concrete code of Practice
- 7 I.S. 875 (Part 1-5) - 1987 code of practice of design loads for Buildings and structures
- 8 IS 13935- Repair and seismic strengthening of building: Guidelines
- 9 IS 4326-1993 Earthquake resistant design and construction of buildings
- 10 IITK-BMTPC Earthquake Tips- IIT Kanpur
- 11 A CD on Earthquake Engineering- An ICJ Compilation

14. SOFTWARE/LEARNING WEBSITES

- a) www.nptel.ac.in
- b) <https://youtu.be/uBMqJMXhs4M>
- c) https://youtu.be/n0_LNyfQTJg
- d) https://youtu.be/DR_PQyYMaA0
- e) www.tn.gov.in/tsunami/digitalibrary/ebooks
- f) <https://www.nicee.org/EQTips.php>



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Advanced Design of Structures (Elective-II)
Course Code : 22607

1. RATIONALE

A Civil Engineering technologist needs to understand the behaviour of various structural components for developing insight for the design concept. Advanced Design of Structures is the core subject for the Civil Engineering which comprises of knowhow of Analysis and Design concept of Steel and Reinforced Concrete structures. For the design of steel components, the properties of steel, available sections, grades and strength characteristics are used along with IS: 800-2007. In the design of RCC structures Limit State Method is to be used as per IS: 456-2000 for analysis and design and IS: 875-1987 is to be used for Loading Standards.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Design Steel and RCC structural components using relevant software.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Design the steel tension members under different loading conditions.
- Design the steel compression members under different loading conditions.
- Design the doubly-reinforced rectangular RCC beams under different loading conditions.
- Design the Flanged RCC beams under different loading conditions.
- Design waist slabs of RCC dog legged staircase.
- Design the circular columns and the isolated RCC rectangular column footings.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | 2 | 5 | 4 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)



This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

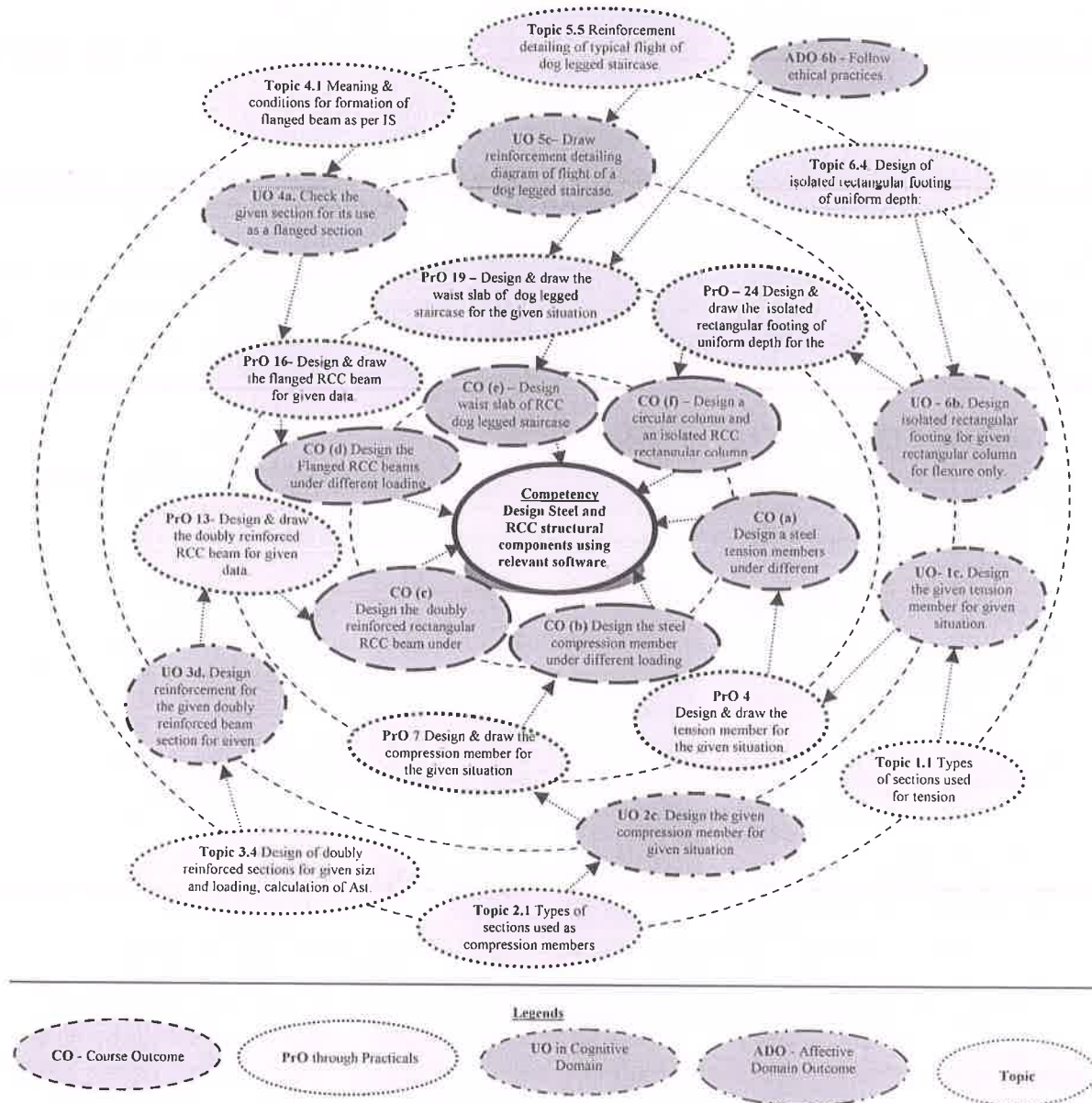


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---|----------|-----------------------|
| 1 | Draw labeled sketches of five given rolled steel sections and built up sections.. | I | 2 |
| 2 | Write the provisions of IS 800-2007 required for the design of the given tension member. | I | 2 |
| 3 | Determine the load carrying capacity of the given tension member for the given situation. | I | 2 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|-----------|-----------------------|
| 4 | Design and draw a tension member for the given situation. | I | 2* |
| 5 | Compile relevant clauses from IS 800-2007 required for the design of a compression member and submit it in report form. | II | 2 |
| 6 | Determine the effective length of the given compression member for various configurations under different end conditions with neat sketches using the relevant software. | II | 2 |
| 7 | Design and draw a compression member for the given situation using the relevant software. | II | 2* |
| 8 | Determine the load carrying capacity of compression member for the given situation using the relevant software.. | II | 2 |
| 9 | Draw sketches for single & double lacing of given built up columns. | II | 2 |
| 10 | Draw sketches for battening of given built up columns. | II | 2 |
| 11 | Write the provisions of IS800-2007 pertaining to design of lacing and battening along with its significance by viewing the relevant video/simulation | II | 2 |
| 12 | Draw cross section, strain diagram and stress diagram for doubly reinforced section by viewing the relevant software. | III | 2 |
| 13 | Design and draw a doubly reinforced RCC beam for given data using relevant software. | III | 2* |
| 14 | Draw reinforcement details of the doubly reinforced RCC beam designed in PrO No. 13. | III | 2# |
| 15 | Draw stress diagrams for Flanged sections for all cases of Neutral axis. | IV | 2 |
| 16 | Design and draw a flanged RCC beam for given data using relevant software.. | IV | 2* |
| 17 | Draw reinforcement details of the flanged RCC beam designed in PrO No 16. | IV | 2# |
| 18 | Draw the neat sketches of the different staircases used in your institute building mentioning its type, tread, rise, thickness of waist slab. | V | 2 |
| 19 | Design and draw the waist slab of dog legged staircase for the given data using relevant software. | V | 2* |
| 20 | Draw reinforcement details of waist slab for typical flight of a dog legged staircase designed in PrO No 19. | V | 2*# |
| 21 | Design and draw a circular column with spiral ties for the given situation using relevant software. | VI | 2 |
| 22 | Draw sketches of different types of column footings. | VI | 2 |
| 23 | Write procedural steps for design of a rectangular RCC footing from the given data as per the relevant IS code. | VI | 2 |
| 24 | Design and draw the isolated rectangular footing of uniform depth for the given situation using relevant software. | VI | 2* |
| 25 | Draw reinforcement details of the isolated rectangular footing designed in PrO No 24. | VI | 2# |
| 26 | Interpret the given RCC Structural Drawings with reference to reinforcement details of various structural elements. | III to VI | 2* |
| 27 | Prepare a checklist for reinforcement provided from the given drawings for various structural elements. | III to VI | 2 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------------|--|-----------|-----------------------|
| 28 | Show the reinforcement detailing of structural elements like beams, columns, staircase and footing of the given structure. | III to VI | 2* |
| 29 | Draw the sketches of given rolled steel tension & compression members provided in the given structures. | I and II | 2 |
| Total | | | 58 |

Note

- i. A suggestive list of **PrOs** is given in the above table. More such **PrOs** can be added to attain the **COs** and competency. A judicious mix of minimum 12 or more practical **LOs/tutorials** need to be performed, out of which, the practicals marked as '*' are compulsory, and marked as '#' indicates use of auto **CAD** software for drawing so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each **PrO** is to be assessed according to a suggested sample given below:

| S. No. | Performance Indicators | Weightage in % |
|--------------|--|----------------|
| 1 | Interpretation of given data and its presentation. | 10 |
| 2 | Selection of sketches /Process of designing of the given structural components using relevant I.S. Codes /writing of visit report. | 30 |
| 3 | Precision in sketch book, sheets and report and its neatness, cleanliness. | 30 |
| 4 | Individual work and working in groups | 20 |
| 5 | Submission of assigned work in time | 10 |
| Total | | 100 |

The above **PrOs** also comprise of the following social skills/attitudes which are Affective Domain Outcomes (**ADOs**) that are best developed through the laboratory/field based experiences:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Work as a leader/a team member.
- d) Follow ethical Practices.

The **ADOs** are not specific to any one **PrO**, but are embedded in many **PrOs**. Hence, the acquisition of the **ADOs** takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the **ADOs** according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.



| S. No. | Equipment Name with Broad Specifications | PrO. S. No. |
|--------|--|--------------------|
| 1 | Computers | 14, 17, 20 and 25. |
| 2 | Printers | 14, 17, 20 and 25. |
| 3 | Available CAD software | 14, 17, 20 and 25. |

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|---|--|
| Unit – I Design of Steel Tension Members (Limit State Method). | 1a. Suggest the type of the steel sections from the given data that can be used as tension member in the given structure with justification. 1b. Explain the method of computing the capacity of the given tension member for given end connection. 1c. Design the given tension member for the given situation from the specified data. | 1.1 Types of sections used for Tension members. 1.2 Strength of tension member governed by yielding of section, rupture of net cross-section and block shear. 1.3 Design of axially loaded single angle and double angle tension members with bolted and welded connections. |
| Unit– II Design of Steel Compression Members (Limit State Method). | 2a Suggest the type of the given steel sections that can be used as a compression member with justification. 2b Explain the method of computing the capacity of the given compression member for given end conditions. 2c Design the given compression member for the specified situation from the given data. 2d Explain with sketches the single and double lacing system for the given built up columns of the specified structure. 2e Explain with sketch the battening system for the given built up columns of the given structure. | 2.1 Types of sections used as compression member. Calculation of effective length, radius of gyration and slenderness ratio. Permissible values of slenderness ratio as per IS 800. Design compressive stress. 2.2 Strength of axially loaded single and double angle struts connected by bolted and welded connections with gusset plate only. Limits of width to thickness ratios to prevent local buckling. 2.3 Design of axially loaded single angle and double angle compression members with bolted and welded connections. 2.4 Introduction to built up sections, lacing and battening (Meaning and purpose). Diagrams of single and double lacing and battening system. (No numerical problems) |
| Unit III- Analysis and Design of Doubly Reinforced Rectangular Concrete Sections by | 3a Check the given section for its use as doubly or singly reinforced section from the given data. 3b Calculate the Young's modulus for the given parameters of the specified doubly reinforced beam. 3c Describe the method of determining ultimate moment of resistance of | 3.1 Meaning and conditions for providing doubly reinforced sections. 3.2 Stress in steel (f_{sc}) for different values of d'/d ratio. 3.3 Analysis of doubly reinforced sections, strain and stress diagrams, numerical problems on ultimate |



| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|--|--|
| Limit State Method. | doubly reinforced beam from the given data. 3d Design reinforcement for the given doubly reinforced beam section for the specified conditions. | moment of resistance of a doubly reinforced beam. 3.4 Design of doubly reinforced sections for given size and loading, calculation of A_{st} and A_{sc} only. |
| Unit –IV Analysis and Design of Flanged Concrete Beams by Limit State Method | 4a. Determine the reinforcement for the specified section for its use as a flanged section from the given data. 4b. Explain the procedure of calculating the effective flange width of the specified flanged beam under given situation. 4c. Explain the method of computing ultimate moment of resistance of the given flanged section. 4d. Calculate A_{st} required for the specified flanged beam for case of neutral axis lying in the flange from the given data. | 4.1 Meaning and conditions for formation of flanged (T and L) beams as per IS 456:2000, comparison with rectangular beams, effective width of flange. 4.2 Analysis of singly reinforced flanged beams having neutral axis in flange or web. Determination of Moment of Resistance. 4.3 Determination of reinforcement in a singly reinforced flanged beam for the given dimensions. (Neutral axis lies in flange only). |
| Unit –V Design of RCC Staircase Slab by Limit State Method. | 5a. Explain the procedure to calculate different loads on the waist slab of the given dog legged staircase from the given data. 5b. Design the waist slab of the given dog legged staircase from the given data. 5c. Draw reinforcement detailing diagram for the flight from the given data of the given dog legged staircase. 5d. Describe the method of determining the live load for the given type of the building. | 5.1 Various clauses in IS456-2000 regarding effective span and load calculation for typical flight of a dog legged staircase. 5.2 Live load on staircase of different types of buildings such as residential, office, commercial, public, factory etc. 5.3 Load calculation for a typical flight of a dog legged staircase with load distribution on landing slab as per IS 456-2000. 5.4 Design of waist slab of a dog legged staircase for given rise, tread, width, and number of steps, with supporting beams at the ends of flight, parallel to steps. 5.5 Reinforcement detailing of typical flight of dog legged staircase. |
| Unit –VI Design of RCC Circular Column and Rectangular Footing by Limit State Method | 6a. Design the given axially loaded short circular column with spiral ties for the given data. 6b. Design the given isolated rectangular footing for given rectangular column for flexure from the given data. 6c. Draw the reinforcement detailing for the specified type of footing from the given data. 6d. Describe the method of determining the load on the given axially loaded short column of the specified structure. | 6.1 Introduction to rectangular and circular columns and related codal provisions in IS 456-2000. 6.2 Procedure and numerical problems on design of axially loaded short circular columns with lateral and spiral ties. 6.3 Procedure and numerical problems on design of axially loaded short rectangular and circular columns with lateral and spiral ties 6.4 Introduction to various types of RCC footings like isolated, stepped and sloped footings, |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|--|---|
| | | combined footings, piles, raft, eccentric footing. 6.5 Design of isolated rectangular footing of uniform depth. Flexural design with checks for one-way shear, two-way shear and bond. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|---|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Design of Steel Tension Members (by Limit State Method) | 08 | 2 | 4 | 6 | 12 |
| II | Design of Steel Compression Members (by Limit State Method) | 10 | 2 | 6 | 6 | 14 |
| III | Analysis and Design of Doubly Reinforced Rectangular Concrete Sections by Limit State Method. | 08 | 0 | 6 | 6 | 12 |
| IV | Analysis and Design of Flanged Concrete Beams by Limit State Method. | 08 | 2 | 4 | 6 | 12 |
| V | Design of RCC Staircase Slab by Limit State Method. | 06 | 0 | 2 | 6 | 08 |
| VI | Design of RCC Circular Column and Rectangular Footing by Limit State Method | 08 | 2 | 4 | 6 | 12 |
| Total | | 48 | 8 | 26 | 36 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journals based on practical performed in laboratory.
- Give seminar on relevant topic.
- Undertake micro-projects.



11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b) '*L*' in *item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
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- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in Lab.
- i) Demonstrate students thoroughly before they start doing the practice.
- j) Encourage students to refer different websites to have deeper understanding of the subject.

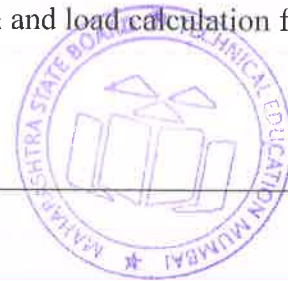
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The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a) Collect the information of various types steel sections used in actual practice.
- b) Prepare a report on any structural software used for analysis/design of steel structure.
- c) Prepare a report on any structural software used for analysis/design of RCC structure.
- d) Prepare an excel program for analysis of steel tension member.
- e) Prepare an excel program for analysis of steel compression member.
- f) Prepare a chart showing capacity of various angle struts for different slenderness ratio.
- g) Procure actual working drawing / blue print of structural design and write report after checking actual reinforcement placed at site.
- h) Prepare an excel program for analysis of doubly reinforced RCC beam.
- i) Prepare an excel program for analysis of flanged RCC beam.
- j) Prepare a video report/ recording of actual placement of reinforcement on site.
- k) Collect data from IS 456-2000 regarding effective span and load calculation for typical flight of a dog legged staircase.



13. SUGGESTED LEARNING RESOURCES :

| S. No. | Title of Book | Author | Publication |
|--------|--|----------------------------------|---|
| 1 | Design of Steel Structures | Dayarathnam, P. | S. Chand and Company, Delhi, 2012 ISBN-13: 978-8121923200 |
| 2 | Design of Steel Structures | Sairam, K.S. | Pearson Publication, Delhi, 2015 ISBN-13:9332516308 |
| 3 | Fundamentals of Reinforced Concrete | Sinha N.C. Roy S.K. | S. Chand and Co., New Delhi, 2007. ISBN-13: 978-8121901277 |
| 4 | Reinforced Concrete Design Principles and Practice | Krishna Raju, N.Pranesh, R.N. | New Age International, umbai, 2018 ISBN-13: 9788122414608 |
| 5 | Reinforced concrete Design | Pillai, S.U. Menon, Devdas | McGraw Hill Publications, New Delhi, 2017; ISBN: 978-0070141100 |
| 6 | Limit State Design of Reinforced Concrete | Varghese, P. C. | PHI Learning Private Limited, Delhi, 2008, ISBN: 978-8120320390 |

I.S. Codes:

- 1 IS 800-2007 Indian Standard code of practice for use of structural steel in general building construction , BIS New Delhi.
- 2 IS-875-1987 Part-1 to 5: Indian Standard Code for Loading Standards.
- 3 IS hand book No. 1 Properties of structural steel rolled section.
- 4 Steel tables
- 5 IS 456:2000 - Plain and Reinforced concrete code of Practice
- 6 SP16- Design Aids for reinforced concrete to IS 456
- 7 I.S. 875 (Part 1-5) - 1987 code of practice of design loads for Buildings and structures.
- 8 SP 24 - Explanatory Handbook on IS 456
- 9 SP34: 1987 - Handbook on concrete reinforcement and Detailing.

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.youtube.com/watch?v=mtRR-5fzKo8>
- b) <https://www.youtube.com/watch?v=X8WhkG70tAc>
- c) <https://www.youtube.com/watch?v=-JNMIMg-CE>
- d) freevideolectures.com › Civil Engineering › IIT Guwahati
- e) www.youtube.com/playlist?list=PLF5B83BDDDBB8FCBE3
- f) nptel.ac.in/noc/individual_course.php?id=noc17-ce21
- g) <http://freevideolectures.com/Course/2686/Design-of-Reinforced-Concrete-Structures>
- h) <https://www.youtube.com/watch?v=hVaB0jGcyB4>
- i) <https://www.youtube.com/watch?v=AfHmpWlcq4>
- j) <https://www.youtube.com/watch?v=PDJPcQq3PZE>
- k) <https://www.youtube.com/watch?v=GgatFNtQrBo>
- l) <https://www.youtube.com/watch?v=A9JUGWhEW5A>
- m) freevideolectures.com › Civil Engineering › IIT Madras
- n) https://www.youtube.com/watch?v=zwtVO3-_iNQ
- o) <https://www.youtube.com/watch?v=wJWt0dcgafs>
- p) <https://www.youtube.com/watch?v=csK9eNk6S1c>
- q) au.autodesk.com/au-online/classes-on.../class...steel/msf11860



Program Name : Diploma in Computer Engineering Group/ Diploma in Mechanical /Chemical Engineering /Diploma in Electronics Engineering Group/ Diploma in Fashion & Clothing

Program Code : CO/CM/CW/DC/EJ/ET/EN/EX/EQ/IE/ME/CH

Semester : Sixth

Course Title : Entrepreneurship Development

Course Code : 22032

1. RATIONALE

Globalisation, liberalization and privatization along with revolution in information technology have opened up new opportunities transforming lives of masses. In this context, there is immense opportunity of establishing manufacturing, service, trading, marketing and consultancy enterprises by diploma engineer. Our fast growing economy provides ample scope for diploma engineers to succeed as an entrepreneur. Entrepreneurship requires distinct skill sets which are attempted to be developed through this course. To begin with, this course aims to develop the competency and the related outcomes in order to start small enterprises.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop project proposals to launch small scale enterprises.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Identify your entrepreneurial traits.
- Identify the business opportunities that suits you.
- Use the support systems to zero down to your business idea.
- Develop comprehensive business plans.
- Prepare plans to manage the enterprise effectively.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 2 | - | 2 | 4 | -- | -- | -- | -- | -- | -- | -- | 50@ | 20 | 50~ | 20 | 100 | 40 |

@ : Internal examination

(~): For the **practical only courses**, the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 11) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P-Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

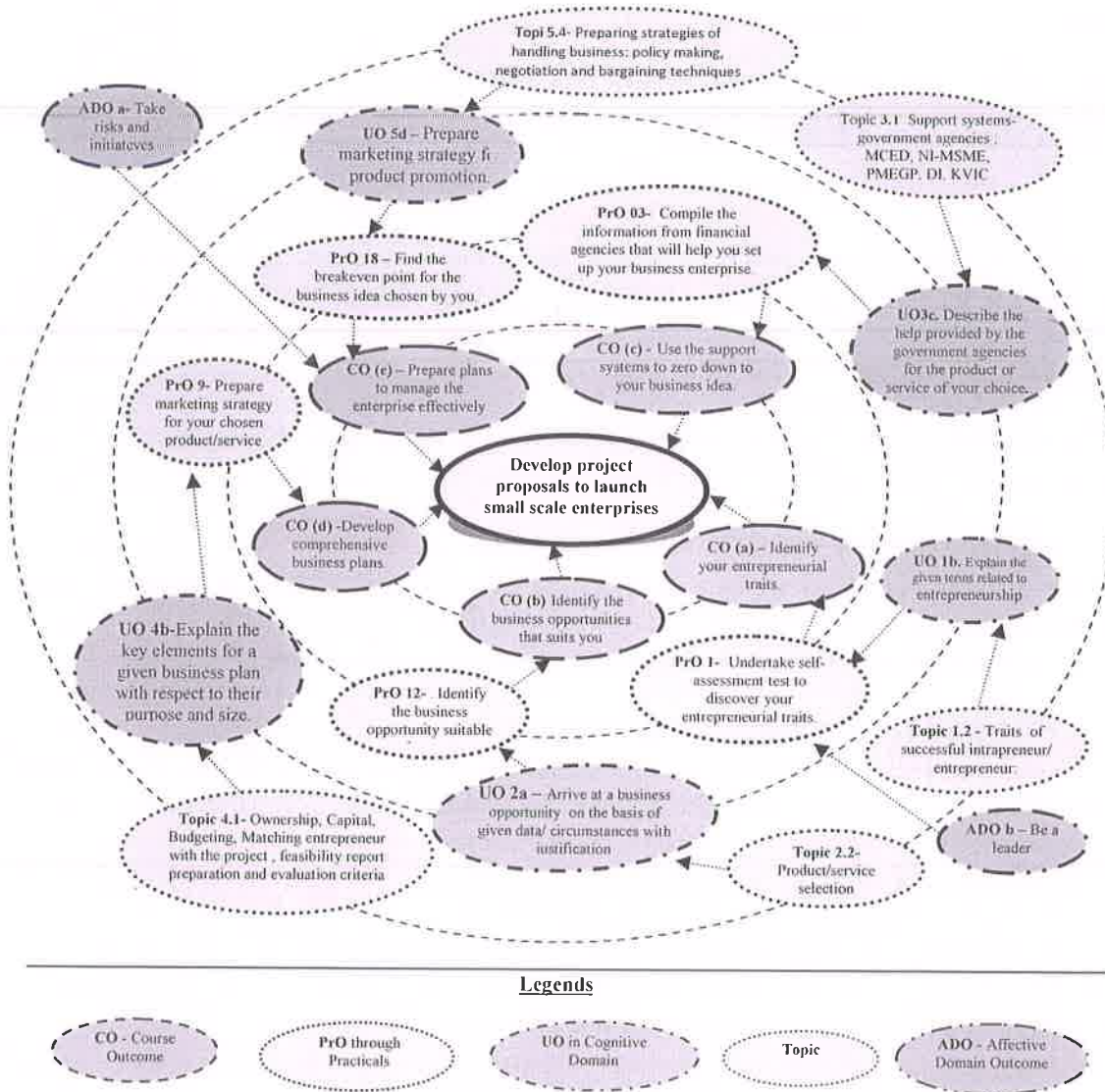


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|---|----------|-----------------------|
| 1 | Submit a profile summary(about500words) of a successful entrepreneur indicating milestone achievements. | I | 02* |
| 2 | Undertake SWOT analysis to arrive at your business idea of a product/service. | I | 02 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|--------|--|----------|-----------------------|
| 3 | Generate business ideas(product/service) for intrapreneurial and entrepreneurial opportunities through brainstorming. | II | 02* |
| 4 | Undertake self-assessment test to discover your entrepreneurial traits. | II | 02* |
| 5 | Identify the business opportunity suitable for you. | II | 02 |
| 6 | Arrange an exhibition cum sale of products prepared out of waste. | II | 02 |
| 7 | Survey industries of your stream, grade them according to the level of scale of production, investment, turnover, pollution to prepare a report on it. | II | 02* |
| 8 | Visit a bank/financial institution to enquire about various funding schemes for small scale enterprise. | III | 02* |
| 9 | Collect loan application forms of nationalise banks/other financial institutions. | III | 02* |
| 10 | Compile the information from financial agencies that will help you set up your business enterprise. | III | 02* |
| 11 | Compile the information from the government agencies that will help you set up your business enterprise. | III | 02* |
| 12 | Prepare Technological feasibility report of a chosen product/service. | III | 02* |
| 13 | Prepare financial feasibility report of a chosen product/service. | III | 02* |
| 14 | Craft a vision statement and enabling mission statements for your chosen enterprise. | III | 02 |
| 15 | Prepare a set of short term,medium and long term goals for starting a chosen small scale enterprise | III | 02* |
| 16 | Prepare marketing strategy for your chosen product/service. | IV | 02* |
| 17 | Compile information about various insurance schemes covering different risk factors. | IV | 02 |
| 18 | Organize a funfair of your class and write a report of profit/loss | V | 02 |
| 19 | Find the breakeven point for the business idea chosen by you. | V | 02 |
| 20 | Arrange a discussion session with your institute's pass out students who are successful entrepreneurs. | V | 02 |
| 21 | Prepare a business plan for your chosen small scale enterprise | V | 02* |
| | Total | | 42 |

Note:

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

Sample Products that can be manufactured under SME

1. Badges cloth embroidered and metals



2. Bags of all types i.e. made of leather, cotton, canvas and jute etc. including kit bags, mail bags, sleeping bags and water-proof bag
3. Bandage cloth
4. Basket cane (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
5. Bath tubs of plastic
6. Battery Charger
7. Belt leather and straps
8. Bolts and Nuts
9. Boot Polish
10. Brooms
11. Domestic Brushes of different types
12. Buckets of all types of plastic
13. Button of all types
14. Chappals and sandals
15. Cleaning Powder
16. Cloth Covers for domestic use
17. Cloth Sponge
18. Coir mattress cushions and matting
19. Cotton Pouches
20. Curtains mosquito
21. Domestic Electric appliances as per BIS Specifications: Toaster Electric, Elect. Iron, Hot Plates, Elect. Mixer, Grinders Room heaters and convectors and ovens
22. Dust Bins of plastic
23. Dusters Cotton all types except the items required in Khadi
24. Electronic door bell
25. Emergency Light (Rechargeable type)
26. Hand drawn carts of all types
27. Hand gloves of all types
28. Hand numbering machine
29. Hand Pump
30. Hand Tools of all types
31. Handles wooden and bamboo (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
32. Haver Sacks
33. Honey
34. Invalid wheeled chairs.
35. Iron (dhobi)
36. Lamp holders
37. Letter Boxes
38. Nail Cutters
39. Oil Stoves (Wick stoves only)
40. Paper conversion products, paper bags, envelopes, Ice-cream cup, paper cup and saucers and paper Plates
41. Pickles, Chutney and Pappads
42. Pouches for various purposes
43. Safe meat and milk
44. Safety matches
45. Safety Pins (and other similar products like paper pins, staples pins etc.)
46. Shoe laces



47. Sign Boards painted
48. Soap Liquid
49. Spectacle frames
50. Steel Chair
51. Umbrellas
52. Utensils all types

Sample Services that can be offered under SME

1. Marketing Consultancy
2. Industrial Consultancy
3. Equipment Rental & Leasing
4. Typing Centres
5. Photocopying Centres (Zerowing)
6. Industrial photography
7. Industrial R & D Labs.
8. Industrial Testing Labs.
9. Desk Top publishing
10. Advertising Agencies
11. Internet Browsing/Setting up of Cyber Cafes
12. Auto Repair, services and garages
13. Documentary Films on themes like Family Planning, Social forestry, energy conservation and commercial advertising
14. Laboratories engaged in testing of raw materials, finished products
15. 'Servicing Industry' Undertakings engaged in maintenance, repair, testing or electronic/electrical equipment/ instruments i.e. measuring/control instruments servicing of all types of vehicles and machinery of any description including televisions, tape recorders, VCRs, Radios, Transformers, Motors, Watches.
16. Laundry and Dry Cleaning
17. X-Ray Clinic
18. Tailoring
19. Servicing of agriculture farm equipment e.g. Tractor, Pump, Rig, Boring Machines.
20. Weigh Bridge
21. Photographic Lab
22. Blue printing and enlargement of drawing/designs facilities
23. ISD/STD Booths
24. Teleprinter/Fax Services
25. Sub-contracting Exchanges (SCXs) established by Industry Associations.
26. Coloured or Black and White Studios equipped with processing laboratory.
27. Ropeways in hilly areas.
28. Installation and operation of Cable TV Network:
29. Operating EPABX under franchises
30. Beauty Parlours
31. Creches.

| S. No. | Performance Indicators | Weightage in % |
|--------|----------------------------|----------------|
| 1 | Leadership skills | 20 |
| 2 | Team work | 20 |
| 3 | Lateral/creative thinking | 10 |
| 4 | Observations and recording | 10 |
| 5 | Self learning | 20 |



| S. No. | Performance Indicators | Weightage in % |
|--------------|------------------------------|----------------|
| 6 | Answer the sample questions | 10 |
| 7 | Submission of report in time | 10 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a. Follow safe practices
- b. Practice good housekeeping
- c. Practice energy conservation
- d. Demonstrate working as a leader/a team member
- e. Maintain tools and equipment
- f. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|--------|---|----------|
| 1 | Seminar Hall equipped with conference table, chairs and multimedia facilities | All |
| 2 | Modern desktop Computer with internet connection. | All |

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (In cognitive domain) | Topics and Sub-topics |
|--|---|--|
| Unit – I Entrepreneurship Development - Concept and Scope | 1a. Describe the procedure to evaluate your entrepreneurial traits as a career option for the given product to be manufactured or services to be rendered. 1b. Explain the given terms related to Entrepreneurship | 1.1 Entrepreneurship as a career 1.2 Traits of successful intrapreneur/ entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking. 1.3 Entrepreneurship : scope in local and |

| Unit | Unit Outcomes (In cognitive domain) | Topics and Sub-topics |
|--|--|--|
| | 1c. Describe the salient features of the resources required for starting the specified enterprise. 1d. Identify the characteristics for a given type of enterprise. | global market. 1.4 Intrapreneur and entrepreneur 1.5 Types of enterprises and their features : manufacturing, service and trading. 1.6 Steps in setting up of a business. |
| Unit – II Entrepreneurial Opportunities and selection process | 2a. Arrive at a business opportunity on the basis of given data/circumstances with justification. 2b. Describe the scheme(s) offered by the government for starting the specified enterprise. 2c. Suggest a suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. 2d. Suggest the steps for the selection process of an enterprise for the specified product or service with justification. 2e. Describe the market study procedure of the specified enterprise. | 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development. 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Industries Commission[KVIC] |
| Unit – III Support Systems | 3a. Describe the support system required for the specified enterprise. 3b. Describe the help provided by the government agencies for the specified product/service. 3c. Describe the help provided by the non-governmental agencies for the specified product/service. 3d. Compute the breakeven point for the specified | 3.1 Categorisation of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment and return on sales. |



| Unit | Unit Outcomes (In cognitive domain) | Topics and Sub-topics |
|--|--|---|
| | business enterprise, stating the assumptions made. | |
| UNIT IV Business Plan Preparation | 4a. Justify the importance of the business plan for the given product/service. 4b. Explain the key elements for the given business plan with respect to their purpose/size 4c. Prepare the budget for the given venture. 4d. Prepare the details of the given component of the given startup business plan. | 4.1 Sources of Product for Business : Feasibility study 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project , feasibility report preparation and evaluation criteria 4.3 Business plan preparation |
| Unit –V Managing Enterprise | 5a. Justify the USP of the given product/ service from marketing point of view. 5b. Formulate a business policy for the given product/service. 5c. Choose the relevant negotiation techniques for the given product/ service with justification. 5d. Identify the risks that you may encounter for the given type of business/enterprise with justification. 5e. Describe the role of the incubation centre for the given product/service. | 5.1 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 5.2 Preparing strategies of handling business: policy making, negotiation and bargaining techniques. 5.3 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, angel investors, venture capitalist. 5.4 Incubation centres: Role and procedure. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Develop two products from household waste (attach photographs).
- Download product development and innovative films from internet.
- Prepare a collage for 'Traits of successful entrepreneurs'.
- Invite entrepreneurs, industry officials, bankers for interaction.
- Identify your hobbies and interests and convert them into business idea.



- f. Convert your project work into business.
- g. Choose a product and design a unique selling proposition, brand name, logo, advertisement (print, radio, television), jingle, packing, packaging, label for it.
- h. Develop your own website. Share your strengths and weakness on it. Declare your time bound goals and monitor them on the website.
- i. Choose any advertisement and analyse its good and bad points.
- j. Decide any product and analyse its good and bad features.
- k. Select any product and prepare its cost sheet.
- l. Choose any product and study its supply chain.
- m. Arrange brainstorming sessions for improvement of any product.
- n. Study schemes for entrepreneurship promotion of any bank.
- o. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
- p. Open a savings account and build your own capital.
- q. Organise industrial visit and suggest modifications for process improvement.
- r. Interview at least four entrepreneurs or businessmen and identify Charms of entrepreneurship and Traits of successful entrepreneurs.
- s. Analyse case studies of any two successful entrepreneurs.
- t. Perform a survey and identify local resources available for setting up of an enterprise.
- u. Engage in marketing of products.
- v. Carry out a demand supply gap analysis for a particular product.
- w. Organise a prototype development competition.
- x. Arrange fairs, events in the institute and try for sponsorships.
- y. Select any performance criteria and continuously compete with yourself.
- z. On any performance criteria continuously compete with others.
- aa. Foresee your dream and make a long term plan for its accomplishment.
- bb. Dream for something unique and make a write-up.
- cc. Read articles, books on creativity.
- dd. Using morphological analysis technique, reduce cost or increase quality of a product.
- ee. Conduct a market survey for a project. Collect data on machinery specifications, price, output/hr, power consumption, manpower requirement, wages, raw material requirement, specification, price, competitor's product price, features, dealer commissions, marketing mix.
- ff. Prepare a business plan and organize a business plan competition.
- gg. Select a social cause, set objectives, plan and work for its accomplishment.
- hh. Videograph as many as possible from the above and upload on your website, YouTube, facebook.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- b. '**L**' in **item No. 4** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs/UOs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.



- e. Use Flash/Animations to explain various maintenances techniques.
- f. Guide student(s) in undertaking micro-projects.
- g. Instructors should emphasise more on deductive learning. Students should learn to recognise, create, shape opportunities, and lead teams for providing economic-social value to society.
- h. Business simulations should be used to enhance behavioural traits of successful intrapreneurs and entrepreneurs amongst students. Emphasis should be on creating entrepreneurial society rather than only setting up of enterprise.
- i. They must be encouraged to surf on net and collect as much information as possible.
- j. Each student should complete minimum twenty activities from the suggested list. Minimum possible guidance should be given for the suggested activities.
- k. Students should be promoted to use creative ideas, pool their own resources, finish their presentation, communication and team skills.
- l. Alumni should be frequently invited for experience sharing, guiding and rewarding students.
- m. Display must be arranged for models, collages, business plans and other contributions so that they motivate others.

11. SUGGESTED MICRO-PROJECTS

One Business Plan as a micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he should submit it by the end of the semester to develop the industry oriented COs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation in the middle of the semester and one at the end of the semester before submission of the project proposal incorporating the concepts taught during semester. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course.

- a. Choose any advertisement and analyse its good and bad points.
- b. Decide any product and analyse its good and bad features.
- c. Select any product and prepare its cost sheet.
- d. Choose any product and study its supply chain.
- e. Arrange brainstorming sessions for improvement of any product.
- f. Study schemes for entrepreneurship promotion of any bank.
- g. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
- h. Open a savings account and build your own capital.
- i. Organise industrial visit and suggest modifications for process improvement.

12. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Books | Author | Publication |
|--------|---|----------------|--|
| 1 | The Entrepreneurial Instinct : How Everyone Has the Innate Ability to Start a Successful Small Business | Mehta, Monica | McGraw-Hill Education, New Delhi, 2012, ISBN 978-0-07-179742-9 |
| 2 | Entrepreneurship | Hisrich, R. D. | McGraw-Hill Education, New Delhi, 2013 ISBN-13: 978-1259001635 |
| 3 | Part I Readings in Entrepreneurship Education | Sareen, S.B. | Entrepreneurship Development Institute of India (EDI), GOI, |

| S. No. | Title of Books | Author | Publication |
|--------|--|------------------------|---|
| | | | Ahmedabad, 2016; ISBN: 978-0078029196 .. |
| 4 | Reading Material of Entrepreneurship Awareness Camp | Gujral, Raman | Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad, |
| 5 | Product Design and Manufacturing | Chitale, A K | PHI Learning, New Delhi, 2014; ISBN: 9788120348738 |
| 6 | Entrepreneurship Development Small Business Entrepreneurship | Charantimath, Poornima | Pearson Education India, New Delhi; ISBN: 9788131762264 |
| 7 | Entrepreneurship Development: Special edition for MSBTE | CPSC, Manila | Tata Mc-Graw Hill, New Delhi, |
| 8 | Entrepreneurship and Small Business Management | Khanka, S.S. | S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6 |
| 9 | Entrepreneurship Development | S, Anil Kumar | New Age International, New Delhi, ISBN: 9788122414349 |

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

| | | |
|----|---|---|
| 1 | MCED Books links | http://www.mced.nic.in/UdyojakSpecial.aspx?linktype=Udyojak |
| 2 | MCED Product and Plan Details | http://www.mced.nic.in/allproduct.aspx |
| 3 | The National Institute for Entrepreneurship and Small Business Development Publications | http://niesbud.nic.in/Publication.html |
| 4 | Courses : The National Institute for Entrepreneurship and Small Business Development | http://niesbud.nic.in/docs/1standardized.pdf |
| 5 | Entrepreneur.com | https://www.entrepreneur.com/lists |
| 6 | GOVT. SPONSORED SCHEMES | https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530 |
| 7 | NABARD - Information Centre | https://www.nabard.org/Tenders.aspx?cid=501andid=24 |
| 8 | NABARD – What we Do | http://www.nabard.org/content1.aspx?id=8andcatid=8andmid=488 |
| 9 | Market Review | http://www.businesstoday.in/markets |
| 10 | Start Up India | http://www.startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action |
| 11 | About - Entrepreneurship Development Institute of India (EDII) | http://www.ediindia.org/institute.html |
| 12 | EDII - Centres | http://www.ediindia.org/centres.html |
| 13 | EDII - Publications | http://www.ediindia.org/publication.html |
| 14 | Business Plans: A Step-by-Step Guide | https://www.entrepreneur.com/article/247574 |
| 15 | The National Science and Technology Entrepreneurship Development Board (NSTEDB) | http://www.nstedb.com/index.htm |



| | | |
|----|---|---|
| 16 | NSTEDB - Training | http://www.nstedb.com/training/training.htm |
| 17 | Tata Exposures | http://www.tatasocial-in.com/project-exposure |
| 18 | Ministry Of Micro, Small And Medium Enterprises | http://www.dcmsme.gov.in/schemes/TEQUPEtail.htm |
| 19 | List of Business Ideas for Small Scale Industry | https://smallb.sidbi.in/%20thinking-starting-business/big-list-business-ideas-small-business |
| 20 | Thinking of Entrepreneurship | https://smallb.sidbi.in/entrepreneurship-stage/thinking-entrepreneurship |
| 21 | List of services for Small Scale Industry | http://www.archive.india.gov.in/business/Industry_services/illustrative.php |
| 22 | NSIC Schemes and Services | http://www.nsic.co.in/SCHSERV.ASP |



Program Name : All Branches of Diploma in Engineering and Technology.
Program Code : CE/CR/CS/CH/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/
MU/EE/EP/EU/IS/IC/AE/FG/ME/PG/PT/DC/TX/TC
Semester : Sixth
Course Title : Capstone Project – Execution & Report Writing
Course Code : 22060

1. RATIONALE

This course on 'Capstone Project–Execution and Report Writing' is the continuation of the previous semester course on 'Capstone Project–Planning'. So, in this semester, the students are to implement the detailed Capstone Project Plan, which they have prepared in the preceding semester. Therefore, to successfully complete this Capstone Project by the end of this semester, it is necessary to incorporate the suggestions of the guide/examiners of the preceding semester. Hence, it is of utmost importance for the student to again re-capitulate and comprehend the importance, concept and need of the 'Capstone Projects' which are well explained in the 'Capstone Project–Planning' course in the previous semester.

Often, the jobs in the industry, which the diploma holders will come across when they join it and will be in the form of small or large projects. Such projects are generally an integration of the various types of skills which cut across the three major domains of learning i.e. cognitive, psychomotor and affective domain which must have acquired during their journey from first semester to the last semester. Hence, it is essential that students are also given an opportunity to do large projects which require more time compared to the micro-projects in order to develop and integrate the highly essential industry oriented competencies and associated skills in the students. Therefore, in this semester the 'Capstone Project – Execution and Report Writing' will continue to integrate some more additional competencies along with those in the previous semester and hence build up greater confidence to face such situations in the world of work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Implement the Capstone Project Plan to solve the identified problem/task faced by industry/user related to the concerned occupation by integrating the various types of skills acquired during the programme.**

3. COURSE OUTCOMES (COs)

Depending upon the nature of the projects undertaken, the following could be some of the major course outcomes that could be attained, although, in case of some projects few of the following course outcomes may not be applicable.

- Implement the planned activity individually and/or as team.
- Select, collect and use required information/knowledge to solve the identified problem.
- Take appropriate decisions based on collected and analysed information.
- Ensure quality in product.
- Incorporate energy and environment conservation principles.
- Consider the ethical issues related to the project (if there are any).
- Assess the impact of the project on society (if there is any).
- Communicate effectively and confidently as a member and leader of team.



- i) Prepare project report after performing due plagiarism check using appropriate tools.

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|-----|-----|----------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| Max | Min | Max | Min | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | | |
| - | - | 4 | 4 | -- | -- | -- | -- | -- | -- | -- | 50# | 20 | 50~ | 20 | 100 | 40 |

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment

5. Course details

As the implementation of the Capstone project progresses and which has to be submitted at the end of project work, one of the outputs of this course is a detailed **Project Report** that is continuously prepared by the student. There will also be regular progressive assessment by the teacher as per the criteria no 7 on the basis of rubrics mentioned in **Appendix –C** and in the formats as shown in **Appendix-B** and also for the end-of-semester examination.

5.1 Guidelines for Capstone Project–Execution and Report Writing

- The students would like to revise the ‘Capstone Project – Plan’ based on the feedback received in the fifth semester examination.
- This revised ‘Capstone Project – Plan’ would be again approved by the project guide. As soon as the revised plan is approved by the teacher, the student will begin to work according to it and would also continue to maintain a dated ‘**Project Diary**’ for the whole semester. This is a sort of a ‘weekly diary’ indicating all the activities conducted by the student every week in the semester – to complete the project. This ‘Project Diary’ should be got signed by the teacher at regular intervals for progressive assessment. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the **Final Project Report** at the end of the semester by him/her.

6. Project report

During the final Semester, the student will prepare a 'Project Report' in continuation with the activities conducted in fifth semester under Project Planning having following sub-titles:

Suggested contents of the Project report

- Title page (with name of team members and mentor teacher)
- Certificate (in the Format given in this document as annexure A)
- Acknowledgements (this may need revision at the end of the final semester)
- Abstract (in one paragraph not more than 150 words)
- Content Page

Chapters

- Chapter–1 Introduction (background of the Industry or User based Problem/Task)
- Chapter–2 Literature Survey (to finalise and define the Problem Statement)
- Chapter–3 Scope of the project
- Chapter–4 Methodology
- Chapter-5 Details of designs, working and processes



6. Chapter-6 Results and Applications
7. Chapter-7 Conclusions And future scope
8. Appendix (if any)
9. References and Bibliography

Note:

- i. The report should contain as many diagrams, figures and charts etc as relevant for the project.
- ii. Originality of the report (written in own words) would be given more importance rather than quality of printing and use of glossy paper or multi-colour printing

7. ASSESSMENT OF PROJECT WORK

Project work has two components, first is Progressive Assessment (PA), while another is End Semester Examination (ESE).

7.1. Progressive Assessment (PA) Guidelines and Criteria

Project guide is supposed to carry out this assessment. It is a continuous process, during which for developing desired qualities in the students, faculty should orally give **informal feedback** to students about their performance and interpersonal behaviour while guiding them on their project work every week. Following criteria should be considered while assessing students informally or formally during different stages of the project work.

The following factors need consideration for both Capstone Project-Planning and Capstone Project-Execution and Report Writing.

- a) Students should be assessed during the project work so that students can also get feedback for further improvement.
- b) It should be kept in mind that project work is mainly experiential learning and it is not the research work, so emphasis should be on work based learning or learning from experience and development of attitudes and skills as mentioned in course outcomes. So focus of assessment should also be on learning from the process of completing project work rather than on novelty or innovation in the project work.
- c) For progressive assessment at the end, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the major project work they have to carry out in future)
- d) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
- e) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking some help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
- f) Originality of the report (written in own words) would be given more importance.
- g) The Project Guide will assure the quality of project done by his group.



Criteria of Marks for PA for Capstone Project -Execution and Report Writing.

| S. No. | Criteria | Marks |
|--------------|--|-----------|
| 1 | Project Proposal /Identification | 10 |
| 2 | Punctuality and overall contribution | |
| 3 | Project Diary | |
| 4 | Execution of Plan during sixth semester | 20 |
| 5 | Project Report including documentation | 15 |
| 6 | Presentation | 05 |
| Total | | 50 |

7.2 END SEMESTER EXAMINATION (ESE)

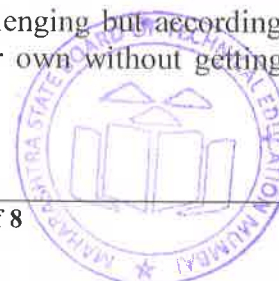
Evaluation shall be carried out according to following criteria. For each project, students from the concerned group should be asked to make presentation of their project, in front of the external and internal examiners which should be followed by question answer session to ascertain the contribution made by each student.

Criteria of Marks for ESE for Capstone Project -Execution and Report Writing

| S. No. | Criteria | Marks |
|--------------|---|-----------|
| 1 | Project Proposal | 05 |
| 2 | Punctuality and overall contribution | |
| 3 | Project diary | |
| 4 | Execution of Plan during sixth semester | 10 |
| 5 | Project Report including documentation | 10 |
| 6 | Presentation | 10 |
| 7 | Question and Answer | 15 |
| Total | | 50 |

8. SPECIAL TEACHING STRATEGIES (If any)

- a) Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator
- b) Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.
- c) *Teachers should come out of the mindset that there should be compulsorily some innovation and novelty in the project work. Because as discussed earlier, project is mainly opportunity for work based or experiential learning, the aim of which is to develop higher order cognitive skills and attitudes. Project at diploma level is not research or innovation.* The main thing teachers have to ensure is that students choose a task or problem for their project work which is challenging but according to their capability i.e. a task which they can complete on their own without getting it done from market.



- d) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.
- e) Teachers should motivate students to maintain project document project diary and project report. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.
- f) Project Guide should ensure that students submit chapter of report one by one to him/her as per schedule and should check the content of the chapters. The Project guide should monitor that schedule is maintained and report writing is not left till last few weeks. It should not be a problem since first three chapters of the report should have been written in fifth semester itself.
- g) Teachers should also encourage students to openly discuss their weaknesses and shortcomings .Teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them.
- h) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.
- i) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Appendix–A

CERTIFICATE

This is to certify that Mr./Ms.....
 fromInstitute having Enrolment No:
 has completed project of final year having title during the
 academic year20__-20__. The project completed by individually/ in a group consisting
 of..... persons under the guidance of the Faculty Guide.

.....

Name & Signature of Guide:

Telephone:.....



Appendix-B

PROGRESSIVE ASSESSMENT (PA) OF CAPSTONE PROJECT – EXECUTION AND REPORT WRITING

Evaluation Sheet for Internal Assessment

Name of Student:

Name of Programme:..... **Semester: Sixth**

Course Title: Capstone Project : Execution and Report Writing **Code:22060.**

Title of the Capstone Project:

.....

A. POs addressed by the Capstone Project (Mention only those predominant POs)

a)

b)

c)

d)

B. COs addressed by the Capstone Project (Mention only those predominant POs)

a)

b)

c)

d)

C. OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT

1. Unit Outcomes (Cognitive Domain)

a)

b)

c)

d)

2. Practical Outcomes (in Psychomotor Domain)

a)

b)

c)

d)

3. Affective Domain Outcomes

a)

b)

c)

d)



| PROGRESSIVE ASSESSMENT (PA) Sheet | | |
|-----------------------------------|---|-----------|
| S. No. | Criteria | Marks |
| 1 | Project Proposal /Identification | 10 |
| 2 | Punctuality and overall contribution | |
| 3 | Project Diary | |
| 4 | Execution of Plan during sixth semester | 20 |
| 5 | Project Report including documentation | 15 |
| 6 | Presentation | 05 |
| Total | | 50 |

Appendix–B

Suggested Rubric for Capstone Project – Execution and Report Writing

| S. No. | Characteristic to be assessed | Poor | Average | Good | Excellent |
|--------|--|--|---|---|--|
| 1 | Problem/Task Identification (Project Title) | Relate to very few POs Scope of Problem not clear at all | i. Related to some POs ii. Scope of Problem/Task vague | i. Take care of at-least Three POs ii. Scope of Problem/task not very specific | • Take care of more than three POs ii. Scope of problem/task very clear |
| 2 | Literature Survey /Industrial Survey | Not more than ten sources (primary and secondary), very old reference | At-least 10 relevant sources, at least 5 latest | At –least 15 relevant sources, most latest | About 20 relevant sources, most latest |
| 3 | Project proposal | Methods are not appropriate, All steps not mentioned, Design of prototype not started (if applicable). | Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete. (if applicable) | Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable) | Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable) |
| 4 | Project Diary | Entries for most weeks are missing. There is no proper sequence and details are not correct. | Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide. | Entries were made every week but are not in detail. Signed and approved by guide every week | Entries were made every week in detail, signed and approved by guide every week |
| 5 | Final Report Preparation | Very short, poor quality sketches, Details about methods, material, precaution and conclusions | Detailed, correct and clear description of methods, materials, precautions and | Conclusions. Sufficient Graphic Description. | Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables, |



| S. No. | Characteristic to be assessed | Poor | Average | Good | Excellent |
|--------|-------------------------------|--|--|--|--|
| | | omitted, some details are wrong | | | charts and sketches |
| 6 | Presentation | Major information is not included, information is not well organized . | Includes major information but not well organized and not presented well | Includes major information and well organized but not presented well | Well organized, includes major information ,well presented |
| 7 | Defense | Could not reply to considerable number of question. | Replied to considerable number of questions but not very properly | Replied properly to considerable number of question. | Replied to most of the questions properly |

Appendix C
Suggestive Project Diary format

| |
|-----------------------------------|
| Week no: |
| Activities planned: |
| Activities Executed: |
| Reason for delay if any |
| Corrective measures adopted |
| Remark and Signature of the Guide |



Program Name : Civil Engineering Program Group
Program Code : CE/CR/CS
Semester : Sixth
Course Title : Construction Management
Course Code : 22061

1. RATIONALE

Civil engineering projects are costly and involve various resources like men, materials, machinery, time and money. Therefore these projects need to be efficiently managed to utilize the resources to the optimum so that they are completed at least cost and within stipulated time duration. Civil engineers at the site and office are responsible to manage the projects efficiently. Therefore Civil engineering diploma holders working in the projects should be conversant with the various aspects of managing the resources. This course is designed to develop competencies in the diploma holders and enable them to manage the resources efficiently and use specialized, project management techniques to oversee the planning, design, and construction of a project, from its beginning to its end. at construction projects. The purpose of Construction Management is to control a project's time, cost and quality.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Manage various resources for optimised completions of construction projects.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Organize the human resources for the Civil engineering project.
- Prepare networks and bar charts for the given construction project.
- Apply safety measures at construction projects

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|-----------------|---|---|-------------------|--------------------|-----|-----|-----|-----|-------|-----------|-----|-----|-----|-----|-------|-----|
| L | T | P | | Theory | | | | | | Practical | | | | | | |
| | | | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 1 | - | 2 | 3 | -- | -- | -- | -- | -- | -- | -- | 25# | 10 | 25~ | 10 | 50 | 20 |

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)



This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

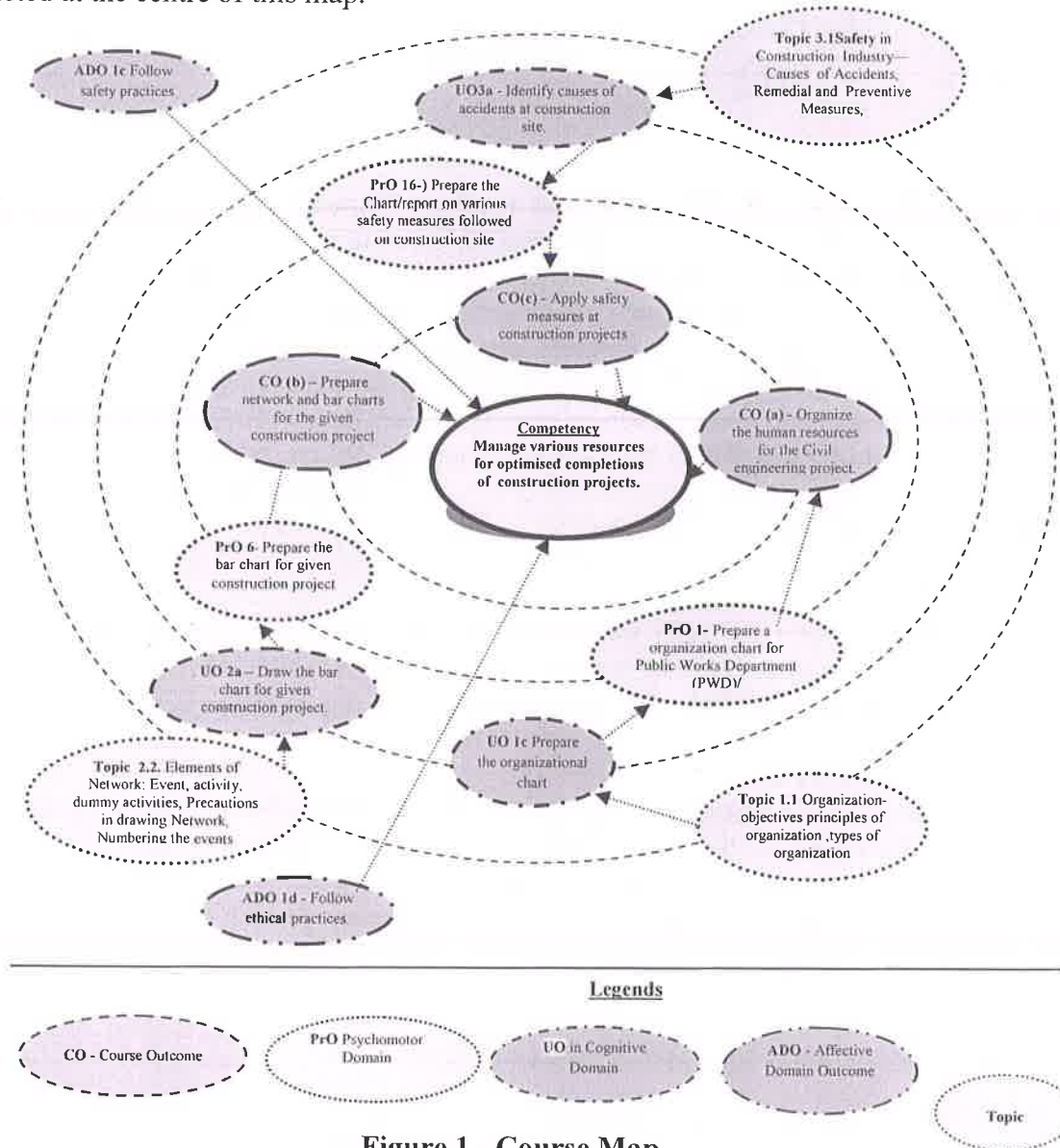


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|--|----------|-----------------------|
| 1 | Prepare the organization chart of any one government/public sector organization executing any major civil engineering projects in your area. | I | 02* |
| 2 | Prepare the organization chart of any one private organization executing any major civil engineering projects in your area. | I | 02 |
| 3 | Prepare the list of roles and responsibilities of various personnel in any Government Construction organization. | I | 02 |



| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|--|----------|-----------------------|
| 4 | Prepare the list of roles and responsibilities of various personnel in any Private Construction organization. | I | 02 |
| 5 | Check the breakdown structure of the given typical construction project to justify its role in managing its relevant activities. | II | 02* |
| 6 | Prepare the bar chart for given construction project. | II | 02* |
| 7 | Prepare the time schedule of different activities for practical no 5 | II | 02 |
| 8 | Prepare a network for given construction project to identify the critical activity in a project.(to develop the critical path) | II | 02* |
| 9 | Compute activity times, event times and floats for network drawn in above practical number 8 | II | 02 |
| 10 | Carry out cost optimization of the given project. | II | 02 |
| 11 | Carry out labor resource levelling for the given project | II | 02* |
| 12 | Prepare Job layout for the given construction site | II | 02* |
| 13 | Carry out the ABC analysis of the given items in a store. | II | 02 |
| 14 | Determination of EOQ (Economic order quantity) based on the given data. | II | 02* |
| 15 | Prepare the action plan to reduce the accidents on given construction project. | III | 02 |
| 16 | Prepare the charts/power point presentation on various safety devices used at construction site. | III | 02* |
| | | | 32 |

Note

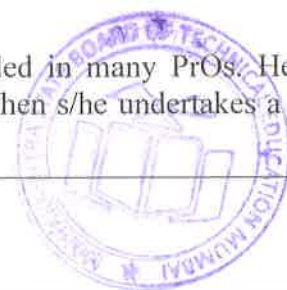
- A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical UOs/tutorials need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

| S.No. | Performance Indicators | Weightage in % |
|--------------|----------------------------------|----------------|
| 1 | Collecting information. | 20 |
| 2 | Interpretation of data collected | 20 |
| 3 | Preparing the report. | 30 |
| 4 | Answer to sample questions. | 10 |
| 5 | Submission of report in time. | 10 |
| 6 | Attendance and punctuality | 10 |
| Total | | 100 |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Follow safety practices on site.
- Work as a leader/a team member.
- Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of



practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organization Level' in 2nd year.
- 'Characterization Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Not applicable.

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|--|--|--|
| Unit – I Constructi on industry and managem ent | 1a Identify the roles of different agencies in the given construction industry with justification. 1b Prepare organizational chart for the given organization 1c Identify the functions of specified personnel in the given organization with justification. 1d Prepare job layout for the given construction site. | 1.1 Organization-objectives principles of organization ,types of organization government/public and private construction industry roles of various personnel in construction organization 1.2 Agencies associated with construction work-owner, promoter, builder, designer, architects. 1.3 Job layout for construction site |
| Unit- II Planning and scheduling | 2a Draw the bar chart for the given construction project. 2b Draw the network for the given construction project. 2c Compute activity times, event times, floats and duration of the given construction project. 2d Calculate optimum cost and duration of the given project. 2e Carry out resource levelling for the given project. 2f Calculate EOQ in the given situation. 2g Identify the ABC analysis for the given items of store. 2h Identify the forms pertaining to the given store item with justification. | 2.1 Identifying broad activities in construction work & allotting time to it based on rate analysis, Methods of Scheduling , Development of bar charts, Merits & limitations of bar chart 2.2 Elements of Network: Event, activity, dummy activities, Precautions in drawing Network, Numbering the events. 2.3 CPM networks, activity time estimate, Event Times by Forward Pass & Backward Pass Calculation, start and finish time of activity, project duration, Floats, Types of Floats-Free, independent and total floats, critical activities and critical path , 2.4 Purpose of crashing a network. Normal Time & Normal Cost, Crash Time and Crash Cost, Cost slope. Optimization of cost and duration. 2.5 Material management- Ordering cost, inventory carrying cost, EOQ 2.6 Store management various records related to store management, inventory control by |

| | | |
|--|---|--|
| | | ABC technique. |
| Unit– III Safety in Constructi on | 3a Identify causes of accidents at construction site in the given situation with justification. 3b Suggest safety measures to avoid accidents for the given construction site 3c Apply relevant labor law/s in the given situation of a construction industry | 3.1 Safety in Construction Industry—Causes of Accidents, Remedial and Preventive Measures, 3.2 Labor laws related to construction industry. |

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

-Not applicable –

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journals based on practical performed in laboratory.
- Give seminar on relevant topic.
- Undertake micro-projects.
- Collect organizational set up of various departments.
- Collect and interpret the bar charts or networks from construction sites.
- Solve the numerical on bar chart, CPM and cost optimization
- Collect and interpret various store forms from PWD, WRD, MJP.
- Download the labour laws documents from internet and wrote a brief summary on it.
- Compile various safety slogans displayed at various sites with sources and write a brief summary on it.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Arrange visit to nearby industries and workshops for understanding various construction materials.



- g) Use video/animation films to explain various processes like Manufacturing of construction materials, concrete mixing, and base preparation for painting, mortar laying, carpentry work, false ceiling.
- h) Use different instructional strategies in classroom teaching.
- i) Display various technical charts related to construction management process.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a) Use any software of Construction Management to prepare the scheduling of a project.
- b) Use any software of Construction Management to determine the critical path for the given construction project.
- c) Interpret the network figures used in given civil engineering projects.
- d) Prepare a report on different forms of inventory storage along with your interpretation
- e) Collect the information about latest safety measures adopted at construction project
- f) Compare various construction management software.
- g) Use a relevant software to collect information about modern techniques of material management like JIT/SAP/ERP

13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|--------|--|----------------------------------|---|
| 1 | Construction planning and management | Gahlot, P.S. Dhir, B.M. | New Age International (P) Ltd., New Delhi. 2016, ISBN 978-81224-04111 |
| 2 | Construction planning and management | Shrivastava, U.K. | Galgotia Publication Pvt Ltd. New Delhi ISBN 10: 817515246X |
| 3 | The A To Z of Practical Building Construction and its Management | Mntri, Sandip | Satya Prakashan New Delhi, 2015 ISBN-8176842052 |
| 4 | Industrial engineering and management | Khanna, O.P. | Dhanpat Rai New Delhi ISBN-10: 818992835X |
| 5 | Project Planning and Controlling with PERT And CPM | Punmia, B.C. Khandelwal, K.K. | Laxmi Publications (P)Ltd. New Delhi, ISBN 9788170083092 |
| 6 | Construction Management and accounts | Harpal, Singh | Mc-Graw Hill, New Delhi ISBN: 978-0070966437 |
| 7 | Industrial engineering and | Bangal, T. R. | Khanna Publications, New Delhi |

| S. No. | Title of Book | Author | Publication |
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| | management | Sharma, S.C. | ISBN: 978-9386173072 |

IS, BIS and International Codes:

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| 8 | IS 4082:1996 | Recommendations on stacking and storage of construction materials and components at site |
| 9 | IS 7293:1974 | Safety code for working with construction machinery |
| 10 | IS 7969:1975 | Safety code for handling and storage of building materials |
| 11 | IS 10067:1982 | Material constants in building works |
| 12 | IS 15883-1:2009 | Construction project management - Guidelines, Part 1: General |
| 13 | IS 15883-2:2013 | Construction project management - Guidelines, Part 2: Time Management |

14. SOFTWARE/LEARNING WEBSITES/LEARNING RESOURCES

- a) https://docs.google.com/spreadsheets/d/e/2PACX-1vQOHER38F_mi8Nj0n4NOrrvIigNWQcyBiPtSRjj1gvRiaxL4py3UYem0o8nP0LLKk78qfC2bdedBTaw/pubhtml
- b) Prima-Vera P6b
- c) MS Project



