

*Regulations 2025
Curriculum and Syllabi
(As approved by the 24th Academic Council)
August - 2025*

**M.Tech.
(Construction Engineering & Project
Management)**



REGULATIONS 2025 CURRICULUM AND SYLLABI
(As approved by 24th Academic Council)
August - 2025

M.TECH.
CONSTRUCTION ENGINEERING & PROJECT MANAGEMENT

VISION AND MISSION OF THE INSTITUTION

VISION

B.S. Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF CIVIL ENGINEERING**VISION AND MISSION****VISION**

To be a leading Department for Education, Training and Research in Civil Engineering for a better future of society and overall socio-economic progress of the country in a sustainable manner.

MISSION

- ✓ To offer world class undergraduate, postgraduate and research programs of industrial and societal relevance in civil engineering.
- ✓ To nurture ethically strong civil engineers to address global challenges through quality education and application-oriented research with emphasis on sustainability.
- ✓ To educate students on design, construction, and maintenance of infrastructure projects, and advancements in civil engineering for providing solutions to the advancement of society.
- ✓ To prepare competitive and responsible future citizens with good communication, leadership and managerial skills.
- ✓ To advance the best practices in various areas of civil & allied engineering through collaborations with Institutions of Excellence, Industries and Research Organizations.
- ✓ To provide a conducive environment for teaching, research, consultancy and extension activities.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.TECH. CONSTRUCTION ENGINEERING AND PROJECT MANAGEMENT

PROGRAMME EDUCATIONAL OBJECTIVES

- Exhibit expertise in advanced construction engineering and project management techniques to efficiently plan, design, execute, and manage complex projects with a focus on quality, safety, and sustainability.
- Demonstrate leadership and responsibility by applying best practices in construction management and fostering integrity within teams with emphasize on ethics and legal frameworks.
- Pursue Innovative Research, contributing to the advancement of construction engineering and management practices to address industry challenges through innovative and sustainable solutions.
- Exhibit strong communication and teamwork skills to manage stakeholders and achieve project goals collaboratively.
- Embrace lifelong learning and an entrepreneurial mindset to adapt to evolving industry trends, emerging technologies, and regulatory changes in construction project management.

PROGRAMME OUTCOMES

On successful completion of the programme, the graduates will be able to

- An ability to independently carry out research/investigation and development work to solve practical problems.
- An ability to write and present a substantial technical report/document.
- Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
- Manage construction projects by optimizing resources to promote sustainable infrastructure with societal relevance.

**B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND
TECHNOLOGY, CHENNAI – 600 048.**

REGULATIONS 2025

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

- i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)
- ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.
- iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.
- iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.
- v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.
- vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.
- vii) **"Dean (Student Affairs)"** means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare, conduct of co-curricular, extra-curricular events and discipline in the campus.
- viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.
- ix) **"Dean of the School"** means the Dean of the School of the department concerned.
- x) **"Head of the Department"** means the Head of the Department concerned.

2.0 ADMISSION REQUIREMENTS

2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 BRANCHES OF STUDY

3.1 The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

3.2 Programmes offered

S. No.	Name of the Department	Programmes offered
1.	Aeronautical Engineering	M.Tech. (Avionics)
2.	Civil Engineering	M.Tech. (Structural Engineering)
		M. Tech. (Construction Engineering and Project Management)
3.	Mechanical Engineering	M.Tech. (CAD/CAM)
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)

S. No.	Name of the Department	Programmes offered
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)
		M.Tech. (Artificial Intelligence and Data Science)
7.	Information Technology	M.Tech. (Information Technology)
8.	Computer Applications	MCA
9.	Mathematics	M.Sc. (Actuarial Science)
10.	Physics	M.Sc.(Physics)
11.	Chemistry	M.Sc.(Chemistry)
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology
		M.Sc. Biotechnology
		M.Sc. Microbiology
		M.Sc. Stem Cell Technology
		M.Sc. Clinical Embryology
		M.Tech. Biotechnology
		M.Tech. Food Biotechnology
13.	Commerce	M.Com
14.	Arabic and Islamic Studies	M.A. Islamic Studies

3.3 Eligible entry qualifications for admission to programmes

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
	M. Tech. (Construction Engineering and Project Management)	B.Tech. in Mechanical / Civil / Electrical and Electronics / Geo Informatics / B Plan / B. Des, and B.Arch.
3.	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
	M.Tech. (Artificial Intelligence and Data Science)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
7.	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2 level or equivalent degree in relevant field.
9.	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics / Electronics Science / Electronics

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		& Instrumentation or Equivalent degree in relevant field.
11.	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Stem Cell Technology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Sc. Clinical Embryology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
	M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
	M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.
13. .	M.Com	B.Com. / BBA
14. .	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or)

Sl. No.	Programme	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		Any under graduate degree with Part 1 Arabic (or) Any under graduate degree with Aalim Sanad / Diploma / Certificate in Arabic or Islamic Studies.

4.0. STRUCTURE OF THE PROGRAMME

4.1. The PG. programmes consist of the following components as prescribed in the respective curriculum:

- i. Core courses
- ii. Elective courses
- iii. Laboratory integrated theory courses
- iv. Project work
- v. Laboratory courses
- vi. Open elective courses
- vii. Seminar
- viii. Mini Project
- ix. Industry Internship
- x. MOOC courses (NPTEL- Swayam, Coursera etc.)
- xi. Value added courses

4.1.1. The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

4.1.2. For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

4.1.3. The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	80 - 86
MCA	80 - 86
M.Sc.	80 - 85
M.Com.	80 - 88
M.A.	80 - 84

4.1.4. Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

4.1.5. The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

4.1.6 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

4.1.7 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

4.1.8 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, alter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

4.1.9. Online courses

Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 Project work

3.5.1 Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to

have not completed the project work and shall re-register in the subsequent semester.

5.0 DURATION OF THE PROGRAMME

- 5.1.** The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

- 5.2** Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.
- 5.3** Medium of instruction, examinations and project report shall be in English.

6.0 REGISTRATION AND ENROLLMENT

- 6.1** The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

6.2 Change of a Elective Course

A student can change an enrolled elective course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

6.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

- 6.4** A student can enroll for a maximum of 36 credits during a semester including Redo / Predo courses.

7.0 BREAK OF STUDY FROM PROGRAMME

- 7.1** A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

7.1.1 Medical or other valid grounds

7.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

7.1.3 Debarred due to any act of indiscipline

- 7.2** The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

- 7.3** A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

- 7.4** During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

8.0 CLASS ADVISOR AND FACULTY ADVISOR

8.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

8.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the

students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

9.0 COURSE COMMITTEE

9.1 Each common theory / laboratory course offered to more than one group of students shall have a “Course Committee” comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

10.0 CLASS COMMITTEE

10.1 A class committee comprising faculty members handling the courses, student representatives and a senior faculty member not handling any courses for that class as chairman will be constituted in every semester:

10.2 The composition of the class committee will be as follows:

- i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department
- ii) Faculty members of all courses of the semester
- iii) All the students of the class
- iv) Faculty advisor and class advisor
- v) Head of the Department – Ex officio member

10.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous

assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

10.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

10.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

11.0 CREDIT REQUIREMENTS TO REGISTER FOR PROJECT WORK

11.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

11.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory (LIT) Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component (for a 4 credit LIT Course). Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

Component	Maximum Marks	Weightage for Final Grade	Mode of Assessment
Theory Component	100	75%	CAT1 (25%) + CAT2 (25%) + SEE (50%)
Practical Component	100	25%	Continuous assessment only
Final Grade Basis	Consolidated	100%	75% Theory + 25% Practical
Pass Requirement	-	-	Minimum 40% in Semester-End Theory Exam (SEE)

Note:

1. Proportionate weightage shall be assigned to LIT courses based on their credit value, whether 2 or 3 credits.
2. In Lab-Integrated Professional Elective courses, the laboratory component shall be assessed by the course faculty.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

Mini project work, shall be carried out individually or as a group activity involving a maximum of three students.

Each group shall identify a suitable topic within their domain, either disciplinary or interdisciplinary, based on the students' abilities and in consultation with the faculty mentor. The topic must lead to the development of a small-scale system or application.

The progress of the mini project shall be evaluated through three periodic reviews: two interim reviews and one final review. A project report shall be submitted by the end of the semester. The reviews shall be conducted by a committee of faculty members constituted by the Head of the Department / Dean of the School.

An oral examination (viva voce) shall be conducted as the semester-end examination by an internal examiner approved by the Controller of Examinations, based on the project report.

The weightage for assessment shall be as follows:

- Periodic Reviews: 50%
 - 25% by the Project Guide
 - 25% by the Review Committee
- Project Report: 20%
- Viva Voce Examination: 30%

The Project shall be carried out individually or as a group activity, involving a maximum of two or three students.

A committee of faculty members, constituted by the Head of the Department / Dean of the School, shall conduct three periodic reviews during the semester to monitor and assess the progress of the project.

At the end of the semester, students shall submit a project report, based on which a semester-end oral examination (viva voce) shall be conducted by an external examiner approved by the Controller of Examinations.

The assessment weightage shall be as follows:

- Periodic Reviews – 50%
 - 25% by the Project Guide
 - 25% by the Review Committee
- Project Report – 20%
- Viva Voce Examination – 30%

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. **There shall be no arrear or improvement examination for lab components.**

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

14.1 A student shall earn 100% attendance in the scheduled contact hours (such as lectures, tutorials, labs, etc.) for that course. However, a relaxation of up to 25% in attendance may be granted to account for valid reasons such as medical emergencies, participation in co-curricular or extracurricular activities with prior approval, or other genuine circumstances.

If a student's attendance falls below 75% in a particular course, even after considering the permissible relaxation, they will not be allowed to appear for the semester-end examination in that course. Instead, the student will be awarded an "I" grade (Incomplete) for the course

14.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

14.3 If a student's attendance in any course falls between 65% and 75% due to medical reasons (e.g., hospitalization, illness) or participation in institution-approved events, they may be granted exemption from the minimum attendance requirement and allowed to appear for the semester-end exam. The student must submit valid documents to the class advisor upon rejoining, with approval from the HoD/Dean. Final approval for **condonation** will be granted by the Vice Chancellor based on the Dean (Academic Affairs)'s recommendation.

14.4 A student who has obtained an "I" grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall **repeat** all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

14.5 The student awarded "I" grade, shall enroll and repeat the course when it is offered next. In case of "I" grade in an elective course either the

same elective course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

- 14.6** A student who is awarded “U” grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to **redo** the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains “U” grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.
- 14.7** If a student with “U” grade, who **prefers to redo** any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier “U” grade and continuous assessment marks shall continue.

15.0 REDO / PRE-DO COURSES

- 15.1** A student can register for a maximum of three redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the concerned department, based on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.
- 15.2** The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is **no provision for any substitute examination and withdrawal from a redo course.**
- 15.3** A student shall be permitted to pre-do a course offered by the concerned department, provided it does not affect the regular semester class schedule. Such permission shall be granted based on the availability of faculty members, the maximum permissible credit

limit of the semester, and the student's fulfillment of the necessary prerequisites for the course. The proposal shall be recommended by the Dean of the School and the Head of the Department, and shall require final approval from the Dean (Academic Affairs).

16.0 PASSING AND DECLARATION OF RESULTS AND GRADE SHEET

16.1 All assessments of a course shall be made on absolute marks basis.

The class committee without the student members shall meet to analyse the performance of students in all assessments of a course and award letter grades following the relative grading system. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
I	-
PA	-
FA	-

"W"- denotes withdrawal from the course

"I" - denotes "Incomplete" ie. inadequate attendance in the course and prevention from appearance of semester end examination

"U" - denotes unsuccessful performance in the course.

"PA" - denotes the 'Pass' of the zero credit courses.

"FA" - denotes the 'Fail' of the zero credit courses.

16.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be **repeated by the student for improvement of grade**.

16.3 Upon awarding grades, the results shall be endorsed by the chairman of the class committee and Head of the Department / Dean of the School. The Controller of Examinations shall further approve and declare the results.

16.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee, through proper application to the Controller of Examinations. Subsequently, the Head of the Department / Dean of the School offered the course shall constitute a revaluation committee consisting of chairman of the class committee as convener, the faculty member of the course and a senior faculty member having expertise in that course as members. The committee shall meet within a week to revalue the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

16.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from the first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course,

$$GPA = \frac{\sum_{i=1}^n (C_i)(GP_i)}{\sum_{i=1}^n C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I”, “W”, “PA” and “FA” grades are excluded for calculating GPA.
“U”, “I”, “W”, “PA” and “FA” grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks shall be as follows:

Percentage equivalent of marks = CGPA X 10

16.6 After successful completion of the programme, the degree shall be awarded to the students with the following classifications based on CGPA.

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the prescribed period of 8 semesters for all students (except lateral entry students) and 6 semesters for lateral entry students
First Class	6.50 and above and completing the programme within a maximum of 10 semesters for all students (except lateral entry students) and 8 semesters for lateral entry students
Second Class	Others

16.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the UG programme within the minimum prescribed period of study (except clause 7.1.1)

16.6.2 Eligibility for First Class

- A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 7.1.1)

16.6.3 The students who do not satisfy clause 16.6.1 and clause 16.6.2 shall be classified as second class.

16.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

17.0 SUPPLEMENTARY EXAMINATION

Final year students and passed out students can apply for supplementary examination for a maximum of **three** courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of **three** courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

18.0 DISCIPLINE

18.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which

tends to affect the reputation of the Institution.

18.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the Head of the Department / Dean of the School concerned shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

19.0 MULTI ENTRY AND MULTI EXIT (MEME) FRAMEWORK *

In accordance with the provisions of the National Education Policy (NEP) 2020, the programme shall support a Multi Entry – Multi Exit (ME-ME) framework to provide flexibility in the academic pathway of students.

*** At present (AY 2025-26), it is applicable only for all M.Tech. Programmes.**

19.1. Exit Option:

19.1.1 Credit Requirement for Award of M.Tech. Degree

To qualify for the award of a M.Tech. degree from the Institute, a student must successfully complete the total credit requirements as prescribed in the approved curriculum of the respective programme. The specific credit requirements are determined by the programme curriculum.

19.1.2 Provision for Multiple Exit

In alignment with NEP 2020 guidelines, the Institute provides students enrolled in postgraduate programmes with the option of multiple exits, subject to the following conditions:

a. Exit at the End of First Year

Students may choose to exit the programme at the end of the first year, provided they have fulfilled the prescribed academic requirements.

b. Application for Exit

A student intending to exit must submit a formal written application

in the prescribed format at least **eight weeks prior to the scheduled end of the academic year.**

c. Departmental Recommendation

1. Upon receipt of the application, the concerned Department shall evaluate the academic record of the student and recommend the award of a **Post Graduate Diploma**, based on the credits earned.

2. In the case of arrear courses, the post graduate diploma will be conferred only after successful clearance of all pending arrears.

d. Notification of Completion

Once a student has fulfilled the requirements for the award of post graduate diploma, the Department shall notify the same to controller of examinations for further processing and issuance.

19.1.3 Award of Qualifications under Multiple Exit Scheme

Post graduate diploma: Awarded after successful completion of the first year, subject to earning the prescribed cumulative credits as per the respective programme curriculum (e.g., 44 credits from the first year) along with 3 credits of Skill Based Courses.

19.1.4 Conditions Governing Exit

1. The multiple exit facility is intended strictly for **genuine and exceptional circumstances**, such as prolonged illness, or securing an employment opportunity necessitating a temporary withdrawal from the programme.

2. Students opting for a temporary exit after the first year must obtain **prior approval from the Registrar through Dean (Academics)**, based on the recommendation of the respective Head of the Department.

19.1.5 Expectation of Programme Continuity

While the option for multiple exits exists, it is generally expected that students admitted to a post graduate programme shall pursue their

studies continuously until completion of the final degree requirements.

19.2. Entry Option:

Students seeking re-entry into the programme (multi-entry) must submit an application through the proper channel at the beginning of the odd semester. Admission shall be subject to fulfilment of institutional guidelines, credit mapping, and availability of seats.

19.3. Credits Requirement for the Certifications

Name of the Certificate Programme	Required Credits
Post graduate Diploma (Level 6.5 as per NEP 2020)	40* - 45

* The minimum number of credits that a student must earn (as per the respective curriculum) in order to get the above certification program

20.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

20.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

- i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the maximum period of 8 semesters from the date of admission, including break of study.
- ii. No disciplinary action is pending against him/her.
- iii. Enrolled and completed at least one value added course.
- iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

20.2 The award of the degree must have been approved by the Institute.

21.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

**B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND
TECHNOLOGY**

REGULATIONS 2025

**CURRICULUM & SYLLABI FOR
M. TECH. (CONSTRUCTION ENGINEERING & PROJECT MANAGEMENT)**

SEMESTER I

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
1.	PCC	CEF 6121	Project Planning and Control	3	1	0	4
2.	PCC	CEF 6122	Agile Project Management	3	0	0	3
3.	PCC	CEF 6123	Contracts Management and Arbitration	3	1	0	4
4.	PCC	CEF 6124	Construction Techniques and Equipment Management	3	0	0	3
5.	PCC	CEF 6125	Project Management Studio I	0	0	4	2
6.	PEC		Professional Elective I	3	0	0	3
Credits							19

SEMESTER II

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
1.	ES	GEF 6201	Research Methodology and IPR for Engineers	2	0	0	2
2.	PCC	CEF 6221	Project Finance and Risk Management	3	1	0	4
3.	PCC	CEF 6222	Safety and Quality Control in Projects	3	0	0	3
4.	PCC	CEF 6223	Project Management Studio II	0	0	4	2
5.	PEC		Professional Elective II	3	0	0	3
6.	PEC		Professional Elective III	3	0	0	3
7.	HS	ENF 6281	Professional Communication	0	0	2	1
8.	Mini Project		Mini Project	0	0	6	3
Credits							21

SEMESTER III

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
1.	PEC		Professional Elective IV	3	0	0	3
2.	PEC		Professional Elective V	3	0	0	3
3.	OEC		Open Elective (MOOC)	3	0	0	3
4.	Project	CEF 7121	Project Work (Phase I)	0	0	22	11 [#]
5.	Internship	CEF 7122	Internship*	0	0	4	2
6.	MOOC		MOOC **				0
Credits							11

SEMESTER IV

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
1.	Project	CEF 7121	Project Work (Phase II)	0	0	35	18
Credits				11 + 18 = 29			

Total Credits: 80

* Industrial training will be undertaken during the summer vacation of first-year for 30 days. The credit will be awarded in the 3rd Semester.

Credits for Project Work Phase I to be accounted along with Project Work Phase II in IV Semester

** The students shall pursue a MOOC course related to the project in the third semester, and the progress in this regard shall be monitored during Project Phase – I reviews.

Enrollment in at least one value-added course is mandatory.

M. Tech.	Construction Engineering & Project Management	Regulations 2025
----------	---	------------------

PROFESSIONAL ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
1.	CEFY 51	Lean Principles in Project Delivery	3	0	0	3
2.	CEFY 52	Personnel Management and Organisational Behaviour	3	0	0	3
3.	CEFY 53	Smart Building Systems and Facility Management	3	0	0	3
4.	CEFY 54	Construction Robotics and Digital Fabrication	3	0	0	3
5.	CEFY 55	Construction Informatics and Digital Solutions	3	0	0	3
6.	CEFY 56	Inventory and Supply Chain Management	3	0	0	3
7.	CEFY 57	Advanced Quantity Surveying and Valuation	3	0	0	3
8.	CEFY 58	Circular Economy in Construction Industry	3	0	0	3
9.	CEFY 59	Site Organisation and Workforce Management	3	0	0	3
10.	CEFY 60	Planning of Real Estate Projects	3	0	0	3
11.	CEFY 61	Urban Infrastructure and Smart Cities	3	0	0	3
12.	CEFY 62	Artificial Intelligence in Construction Management	3	0	0	3
13.	CEFY 63	Shoring, Scaffolding and Formwork	3	0	0	3
14.	CEFY 64	Condition Assessment of Buildings and Cost Estimation	3	0	0	3

SEMESTER I

CEF 6121	PROJECT PLANNING AND CONTROL	L	T	P	C
SDG: 9,11		3	1	0	4

COURSE OBJECTIVES: The course will impart knowledge on

COB1: planning construction projects using various methods.

COB2: scheduling the activities using network diagrams

COB3: advanced scheduling techniques like DSM, BDM

COB4: allocation and leveling of resources for construction projects.

COB5: controlling the cash flow and updating the schedule of the project

MODULE I CONSTRUCTION PLANNING L:9 T:3 P:0

Introduction – Planning in construction - Basic concepts in the development of construction plans - choice of technology, construction method and procurement affects project planning – functions and objectives of planning - types and stages of planning – Planning process for a project – design – construction stage – Pre tender - Pre-contract - Contract planning – Documents produced by planning team - Responsibilities of a planning Engineer – Challenges in planning - defining work tasks - work breakdown structure - coding systems

MODULE II SCHEDULING TECHNIQUES L:9 T:3 P:0

Project scheduling levels - defining precedence relationships among activities - Tools for scheduling - Gant Chart - Development of project network—AOA and AON diagrams- critical path method - construction schedules – scheduling calculations - float - scheduling for activity-on-node – PERT - scheduling with uncertain durations (stochastic scheduling)– PERT problems using Excel Software

MODULE III ADVANCED SCHEDULING TECHNIQUES L:9 T:3 P:0

Logic driven scheduling – PDM – PDM Problems with continuous and Non-continuous duration – LOB (Line of Balance) - Information driven scheduling - BDM (Beeline Diagramming Method) - DSM (Dependency Structure Matrix) modeling in projects – Resource driven scheduling - Qualitative scheduling - Other scheduling techniques in projects

MODULE IV RESOURCE PLANNING AND SCHEDULE L:9 T:3 P:0 COMPRESSION

Resource Definition – Resource management – Resource allocation - Resource Aggregation (Loading) - Resource Leveling (Smoothing) - Method of Moments for Resource Smoothing- Heuristic Procedure for Resource Smoothing- Scheduling with Limited Resource – Monte Carlo schedule simulation- Queuing problems- Case Study - crashing and time/cost tradeoffs.

MODULE V PROJECT CONTROL L:9 T:3 P:0

Work Progress – percentage complete determination - Scope, schedule, and cost baseline - Comparison of progress with baseline – variance - Cash flow analysis - control measures – S curve - Integrated system for project analysis - Project information management system (PIMS) for monitoring and reporting - Earned value management (EVM) – Issues EVM - Project definition and rating index (PDRI)

L – 45; T – 15; P – 0; Total Hours: 60

TEXT BOOKS:

1. Saleh Mubarak, "Construction Planning Scheduling and Control", John Wiley & Sons, Inc. 2nd Edition, 2019.
2. Andrew Baldwin and David Bordoli, "Handbook for construction planning and scheduling", John Wiley & Sons, Inc., 2023
3. Chitkara, K.K. "Construction Project Management: Planning, Scheduling and Control", New Delhi, Tata McGraw-Hill Publishing Company, 2019.
4. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders", Prentice Hall, Pittsburgh, 2003

REFERENCES:

1. Eppinger. S.D & T.R. Browning, "Design Structure Matrix Methods and Applications", MIT Press, 2016.
2. James P. Lewis, "Project Planning, Scheduling, and Control: The Ultimate Hands-On Guide to Bringing Projects in on Time and on Budget", Mc Graw Hill, New York, 2022.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** plan, and create a work breakdown structure for the given project
- CO2:** calculate the time for completion of a given construction project/design project / linear project
- CO3:** allocate the resource and perform resource levelling / smoothing for a given project

CO4: Perform earned value and cash flow analysis and prepare a variance report for the given project.

Board of Studies (BoS):

20th BoS of Department of Civil
Engineering held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2		3	3
CO3	2		3	3
CO4	2	2	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3- High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Statement:

The holistic understanding of planning and scheduling of time cost and resources to avoid unnecessary wastage of resources and sustainable development.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6122	AGILE PROJECT MANAGEMENT	L	T	P	C
SDG: 09		3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: life cycle of a project.

COB2: the inception phase and feasibility studies for project.

COB3: various stages involved in project delivery methods.

COB4: construction phase and project execution processes.

COB5: the procedures and documentation required during the project close-out phase.

MODULE I INTRODUCTION TO PROJECTS L:9 T: 0 P:0

Project management fundamentals – relationships among portfolios, programs, and projects – project life cycle and process groups – organizational structures and project governance – roles and responsibilities of the project manager – project stakeholders and team dynamics – project initiation and planning – project management methodologies (predictive, agile, hybrid) – tools and techniques in project management- IS 15883 (part 1).

MODULE II STRATEGIC PROJECT INCEPTION L:9 T: 0 P:0

Introduction and significance of feasibility reports – technical, financial, economic, and ecological analysis – flow diagram of project feasibility study – preliminary design and development — scope management - budgeting and cost estimation – project work plan and scheduling – preparation of contract documents– project team coordination and meeting management – progress reporting: weekly and monthly reports – drawing review and design team management – evaluation of design effectiveness – constructability review and post-design evaluation.

MODULE III PROJECT EXECUTION AND DELIVERY L: 9 T: 0 P:0

Selection of professional services – contract pricing strategies – project delivery methods: BOT, BOOT, BOLT, design-build - construction management, bridging, fast-track, and turnkey – design development and performance-based specifications – critical decisions in project delivery selection – terms and conditions of payment – identification of prospective bidders and bidder prequalification – Qualification-Based Selection (QBS) and bidding checklist – factors for successful project delivery and execution.

MODULE IV OPERATIONAL PROJECT MANAGEMENT L: 9 T: 0 P:0

Project execution phase – implementation strategies and resource mobilization – managing scope, schedule, and cost during execution - team communication, coordination, and stakeholder engagement – procurement planning and subcontractor management – progress monitoring, reporting systems, and documentation – managing change orders and field issues – application of project management software and digital tools for execution oversight.

MODULE V PROJECT CLOSE-OUT AND COMMISSIONING L: 9 T:0 P:0

System testing and commissioning – start-up and operational readiness – final inspection and handover procedures – guarantees, warranties, and lien releases – preparation of record and as-built drawings – project close-out checklist and duty allocation – disposition and archiving of project files – post-project review and performance evaluation – owner feedback and lessons learned – stakeholder feedback and satisfaction assessment.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. “Project Management Institute, A Guide to the Project Management Body of Knowledge” (PMBOK® Guide), 7th ed. Newtown Square, PA: PMI, 2021.
2. S. K. Sears, G. A. Sears, R. H. Clough, and J. R. Clough, “Construction Project Management: A Practical Guide to Field Construction Management”, 6th ed. Hoboken, NJ: Wiley, 2015.
3. C. Hendrickson, “Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects, and Builders”, 2nd ed. Pittsburgh, PA: Carnegie Mellon University, 2008.

REFERENCES:

1. F. Harris, R. McCaffer, and F. Edum-Fotwe, “Modern Construction Management”, 8th ed. Chichester, UK: Wiley-Blackwell, 2021.
2. S. A. Mubarak, “Construction Project Scheduling and Control”, 3rd ed. Hoboken, NJ: Wiley, 2015.
3. IS 15883 (Part 1 – Part 12), “Construction Project Management - Guidelines”, Bureau of Indian Standards, 2016.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** apply the foundational principles of project management.
- CO2:** analyze and evaluate the feasibility of projects under given conditions.
- CO3:** evaluate and select delivery method for a given construction project.
- CO4:** draft reports for execution phase of a given construction project.

CO5: Prepare checklist for commissioning and close out of given construction project.

Board of Studies (BoS):

20thBoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1			3	3
CO2	1		3	3
CO3	2		3	3
CO4	2	3	3	3
CO5	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3- High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

A comprehensive understanding of project management principles and execution strategies.

CEF 6123	CONTRACTS MANAGEMENT AND	L	T	P	C
SDG: 09	ARBITRATION	3	1	0	4

COURSE OBJECTIVES: The course will impart knowledge on

COB1: various elements and features of contract.

COB2: process of bidding and tendering procedures.

COB3: the concept of contract breach, claims and settlement.

COB4: process of dispute resolution in construction projects.

COB5: procedures and conditions of International Contracts.

MODULE I FUNDAMENTALS OF CONTRACTS L:9 T: 3 P:0

Definition and essentials of a valid contract - Indian Contract Act 1872 - salient feature of a contract - discharging of a contract - documents for an engineering contract - types of contracts - classification based on tendering process - economic consideration, tasks involved - main and sub contracts, features, merits, demerits, applicability of the various types of contracts - Tamil Nadu Transparency in Tenders Act - Standard forms of contract: International Federation of Consulting Engineers (FIDIC), Central Public Works Department (CPWD), Institution of Civil Engineers (ICE), New Engineering Contract (NEC) - Parties, roles, and responsibilities in a construction contract - contractual obligations and performance - Preparation of contract agreement - General conditions of contract - Special conditions of contract.

MODULE II TENDERING AND BIDDING PROCESS L:9 T: 3 P:0

Definitions and types of tenders, Standard tender documents, Earnest Money Deposit (EMD) and Security Deposit (SD). Preparation of tender and enquiry documents - Invitation for tenders – prequalification questionnaire - sale of documents, submission, receipt, and opening of tenders, evaluation of tenders - technical evaluation – commercial aspects- addendum, award of contract: Letter of Award (LoA), Letter of Intent (LoI), contract finalization. Issues in tendering process: pre-registration and pre-qualification - Nominated tendering and repeat orders- rejection and revocation of tenders, unbalanced bidding, cartel formation and collusion - e-tendering and digital procurement.

MODULE III CONTRACT PERFORMANCE & CLAIMS L: 9 T: 3 P:0

Responsibilities and liabilities of the principal and contractor - contract performance monitoring - quality control, and assurance - claims related to advances, billing, time

extensions, variations, and cost escalations - financial securities – security deposit - retention money, performance bond - liquidated damages, and penalties - statutory compliance - labor welfare, wage legislation and related laws - common breaches - damage assessment - quantum meruit, - force majeure.

MODULE IV DISPUTE RESOLUTION AND L: 9 T: 3 P:0 ARBITRATION

Causes and types of disputes in construction projects - overview of dispute resolution methods: Negotiation – Mediation – Conciliation - Dispute Resolution Boards (DRB) - Arbitration, and Litigation - key provisions of the Arbitration and Conciliation Act, 1996 (India) and its amendments - conciliation procedures - constitution and functioning of DRB, and arbitration processes including appointment – powers - awards, court interventions, and revocation- discussion of case studies related to contract.

MODULE V INTERNATIONAL CONTRACTS L: 9 T:3 P:0

International Competitive Bidding (ICB) procedures - domestic preference - FIDIC contract documents - general conditions - currency of bid and payment - escalation in foreign currency- international project financing - applicable laws - dispute settlement mechanisms - international arbitration procedures - discussion of select international arbitration case studies related to construction contracts.

L – 45; T – 15; P – 0; Total Hours:60

TEXT BOOKS:

1. Bhandari, M.C., "Law of Contract and Tender", 5th Edition, Whytes & Co., 2024.
2. Burr, A., "Delay and Disruption in Construction Contracts", 6th Edition, Routledge, New York, 2024.
3. Murdoch, J., Hughes, W., and Champion, R., "Construction Contracts: Law and Management," 5th Edition, Routledge (Taylor & Francis Ltd), 2015.
4. Bockrath, J.T., & Plotnick, F.L., "Contracts and the Legal Environment for Engineers and Architects", McGraw Hill, 2013.
5. FIDIC, "Conditions of Contract for Construction", 2017.

REFERENCES:

1. Pollock & Mulla, "The Indian Contracts Act 1872", Lexis Nexis Publications, 2022.
2. Dr. S.C. Tripathi, "Arbitration and Conciliation Act 1996", Central Law Publications, 2021.
3. Patil. B.S, "Civil Engineering Contracts and Estimates", Universities Press Private Limited, India, 2019.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** draft the contract agreement, general conditions, and special conditions of contract for a given construction project.
- CO2:** prepare tender documents and execute standard procedures for bid submission and evaluation for a given construction project.
- CO3:** analyze contract performance issues, claims, and statutory compliances in construction projects.
- CO4:** evaluate construction disputes and suggest suitable dispute resolution mechanisms for the given conditions.
- CO5:** explain strategies for managing international contracts, currency risks, and arbitration procedures.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2	3	3	2
CO2	2	3	3	2
CO3	3		3	2
CO4	3		3	2
CO5	2		3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of construction contracts drafting, management and dispute resolution fosters resilient, innovative and sustainable infrastructure.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6124	CONSTRUCTION TECHNIQUES AND	L	T	P	C
SDG: 11	EQUIPMENT MANAGEMENT	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: modern construction methods and substructure techniques.

COB2: earthmoving, excavation pile driving and equipments for concreting.

COB3: the superstructure construction techniques, formworks and related equipments.

COB4: construction of special structures and the application of heavy lifting and rigging equipment.

COB5: construction equipment planning, utilization, maintenance, cost estimation, and management practices.

MODULE I SUBSTRUCTURE CONSTRUCTION L:9 T: 0 P: 0 TECHNIQUES

Overview of construction methods - cast-in-situ – precast – prefabrication - modular construction - substructure techniques - box jacking - pipe jacking – jacking systems - thrust blocks - diaphragm walls - basement construction –tunneling - open excavation – trenchless technology - diaphragm walls - dewatering systems-soil stabilization methods- pile foundations and pile driving techniques.

MODULE II EARTHMOVING, EXCAVATION, AND L:9 T: 0 P: 0 CONCRETE EQUIPMENTS

Earthmoving equipments– bulldozers – scrapers – loaders - excavators –shovels – backhoes - working principles- types and application - tunneling equipments - Tunnel Boring Machines (TBM) - road headers – drill and blast equipment - pile driving equipments - drop hammers - steam hammers, diesel hammers - vibratory hammers -hauling & grading equipments - dump trucks, graders, rollers- concrete equipment-mixers - batching plants– mixers - transit mixers – pumps – vibrators- curing equipment for concreting - problems on productivity of equipments.

MODULE III CONSTRUCTION TECHNIQUES FOR L:9 T: 0 P: 0 SUPERSTRUCTURE

Construction of superstructures - tall buildings – long span structures – dams – bridges -relevant equipment and systems - erection of tall and large span structures – tower cranes - mobile cranes - scaffolding systems - bridge construction (cable-stayed,

bowstring, box decks) – launching girders, push launching equipment. - formwork and shoring systems - lift slab - drop slab - slip forms.

MODULE IV CONSTRUCTION OF SPECIAL STRUCTURES AND HEAVY LIFTING EQUIPMENT L:9 T: 0 P: 0

Techniques for constructing special structures - cooling towers – chimneys – silos – domes - sky scrapers – jetties – breakwaters - lattice towers - transmission lines - articulated structures - space decks – heavy lifting and support systems - crawler cranes - telescopic boom cranes, and temporary supports for equipment erection.

MODULE V EQUIPMENT PLANNING AND MANAGEMENT L:9 T: 0 P: 0

Planning and selection of construction equipment based on project requirements - equipment utilization planning, maintenance, replacement strategies - safety management - ownership and operating cost estimation - introduction to caterpillar and peurifoy methods for equipment cost estimation - preparation of equipment utilization charts and cost control practices.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. Peurifoy, R., Schexnayder, C., Shapira, A., & Schmitt, R., “Construction Planning, Equipment, and Methods”, 10th ed., McGraw-Hill, 2023.
2. Arora S.P. and Bindra S.P., “A text book on Building Construction”, Dhanpat Rai and Sons, 2020.
3. Bhavikatti, S.S., “Building Construction”, Revised Edition, Vikas Publication, India, 2025.
4. Gransberg, D. D., Popescu, C. M., & Ryan, R. C., “Construction Equipment Management for Engineers, Estimators, and Owners”, 2nd ed., CRC Press, 2020.

REFERENCES:

1. Punmia, B.C., “Building Construction”, 12th Edition, Laxmi Publications, India, 2023.
2. Emmitt, S., Barry's “Advanced Construction of Buildings”, Wiley, United Kingdom, 2018.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Identify and explain substructure construction techniques suitable for the given conditions.
- CO2:** explain the working principles, types, and applications of various earthmoving and concrete equipment, and calculate their productivity.
- CO3:** Suggest methods and equipment suitable for the construction of the given superstructure project.
- CO4:** explain the processes involved in the construction of the given special structures and the equipment used.
- CO5:** estimate the cost of the given equipment using the specified method and prepare equipment utilization charts.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering held on
08.07.2025

Academic Council:

24th AC held on
26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	2
CO2	2		3	2
CO3	2		3	2
CO4	2		3	2
CO5	2		3	2

Note: 1- Low Correlation 2- Medium Correlation 3 - High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

The holistic understanding of construction techniques and equipment management leads to responsible usage of resources and techniques, and, development of sustainable buildings.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6125	PROJECT MANAGEMENT STUDIO I	L	T	P	C
SDG: 11		0	0	4	2

COURSE OBJECTIVES: The course will impart knowledge on

COB1: Evaluating the duration and creating a master schedule of the construction project using software.

Exercise 1 : Draw an CAD drawing for a given project and estimate the quantities and duration

Exercise2 : Create a project, Edit calendars, Create a Work Breakdown Structure , Define roles and resources, Assign roles

Exercise 3: Entering Tasks in Project - Linking Tasks and Dependencies in Project

Exercise 4 : Resources allocation , Analyze resources, Optimize the project plan

Exercise5 : Resources Different Views - costs

Exercise6 : Baselines & Critical Paths - Formatting a Gantt Chart –

Exercise 7 :Tracking Progress in Project

Exercise8 : Earned Value analysis

Exercise 9 : Risk Analysis and Reports generation.

Exercise10 : Assign constraints, Create reports, Format schedule data, Execute the project

L – 0; T – 0; P – 60; Total Hours: 60

REFERENCES:

1. Chukwuemeka Okoro , “Project Management, Planning & Scheduling with Primavera P6: A Practical Guide, 2020
2. Ahmed M Abdel Aziz., “Practical Construction Planning and Control Using Microsoft Project: An Illustrative Guide”, Kindle Edition, 2025.

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: Create a project and allocate resource for a given project

CO2: Create a base line schedule and generate report for the given activities using software.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2	3	3	2
CO2	2	3	3	3

Note: 1- Low Correlation 2- Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable

The holistic understanding of scheduling the project can improve the productivity and avoid wastage of resources.

GEF 6201	RESEARCH METHODOLOGY AND	L	T	P	C
SDG: 4, 8, 9	IPR FOR ENGINEERS	2	0	0	2

COURSE OBJECTIVES:

- COB1:** To apply a perspective on research
- COB2:** To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation
- COB3:** To analyze the research design by using optimization techniques.
- COB4:** To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN 8

Research - objectives – types - Research process, solving engineering problems -Identification of research topic - Formulation of the research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation, and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA 8

Sources of Data, Use of the Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision –limitations, Application of Computer in Research- Importance of statistics in research - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES 6

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics, Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of the written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism –

Thesis writing, - Organization of contents - style of writing- graphs, charts, and Presentation tool - Referencing, Oral presentation, and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search

L – 30; Total Hours: 30

TEXT BOOKS:

1. Ganesan R., "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
2. George E. Dieter., "Engineering Design", McGraw Hill – International edition, 2020.
3. Kothari C.R., "Research Methodology" – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., "Genetic Algorithms for optimization", Kangal report, No.2001002.
5. Rajkumar S. Adukia, "Handbook on Intellectual Property Rights in India", TMH Publishers, 2020.

REFERENCES:

1. Holeman, J.P., "Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. Govt. of India, "Intellectual Property Laws; Acts, Rules & Regulations", Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, "Intellectual Property Rights". 1st Edition, Excel Books, 2012.
4. Derek Bosworth and Elizabeth Webster. "The Management of Intellectual Property", Edward Elgar Publishing Ltd., 2013

COURSE OUTCOMES:

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

- COB1:** Formulate the research problem
- COB2:** Design and Analyse the research methodology
- COB3:** Analyse and interpret the data to construct and optimize the research hypothesis
- COB4:** Report the research findings as publications, copyright, trademarks and IPR

Board of Studies (BoS) :20th BoS of Civil held on 08.07.2025**Academic Council:**24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	1	2	1
CO2	2	3	3	2
CO3	3	2	2	3
CO4	1	3	2	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements.

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6221	PROJECT FINANCE AND RISK	L	T	P	C
SDG: 11	MANAGEMENT	3	1	0	4

COURSE OBJECTIVES: The course will impart knowledge on

COB1: Accounting systems for construction

COB2: Methods to manage costs and profits

COB3: Cash flow management and choosing from different alternatives based on time value of money

COB4: Tools used for making financial decisions in construction projects

COB5: Risk management in projects.

MODULE I FINANCIAL MANAGEMENT L:9 T:3 P:0

Financial Management - Difference in Construction Financial Management - Responsible for Construction Management - Cost Reporting versus Cost Control - The General Ledger - Method of Accounting - The Balance Sheet - The Income Statement - The Job Cost Ledger - The Equipment Ledger – Accounting transactions in construction projects - Committed Costs and Estimated Cost at Completion - Overbillings and Underbillings - Internal Controls - Computerized Accounting Systems – Analysis of financial statements -

MODULE II MANAGING COSTS AND PROFITS L:9 T:3 P:0

The Profit Equation - Contribution Margin - Projecting Break-Even Volume of Work - Projecting Break-Even Contribution Margin Ratio - Adjusting the Financial Mix - Profit and Overhead Markup - Sources of Profit Allocation of General Overhead - Profit Center Analysis - Crews - Project Management - Estimators - Types of Jobs - Customers - Equipment – Sources of Finance - Selecting a Banker - Applying for a Loan - Loan Documents

MODULE III CASH FLOW MANAGEMENT IN PROJECTS L:9 T:3 P:0

Cash Flow for Projects with Progress Payments - Cash Flow for Projects with a Single Payment – Projecting income taxes – cash flow in construction projects – time value of money - quantifying alternatives for decision making - Equivalence- various interest factors - Arithmetic gradient - Geometric gradient – Present, future and annual worth method of comparing alternatives

MODULE IV TOOLS FOR FINANCIAL DECISIONS L:9 T:3 P:0

Sunk Costs - MARR (Minimum Attractive Rate of Return) - Adjusting Life Spans - Study Period - Shortening an Alternative's Life - Lengthening an Alternative's Life - Repurchasing an Alternative - Net Present Value or Present Worth - Incremental Net Present Value - Future Worth - Annual Equivalent - Rate of Return - Incremental Rate of Return - Capital Recovery with Return - Payback Period without Interest - Payback Period with Interest - Project Balance – Noneconomic Factors in Decision Making - break-even comparisons - capitalized cost analysis - benefit-cost analysis

MODULE V RISK MANAGEMENT IN PROJECTS L:9 T:3 P:0

Definitions of risk - elements of risk management - causes of risk –Identifying risk, preparing for risk identification, risk categories, referring to historical information – perspectives of risk – risk analysis: sensitivity analysis - scenario analysis - breakeven analysis - simulation analysis - decision tree analysis – Selection of a Project and Risk Analysis in Practice managing/mitigating risk

L – 45; T – 15; P – 0; Total Hours: 60

REFERENCES:

1. Harris, F., McCaffer, R. and Edum-Fotwe, F., "Modern Construction Management", 6th ed., Blackwell Publishing, 2021.
2. Peterson, S. J., "Construction Accounting and Financial Management", Upper Saddle River, New Jersey, Pearson Education, 2019
3. Prasanna Chandra, "Projects: Planning, Analysis, Financing, Implementation and Review", New Delhi, Tata McGraw-Hill Publishing Company Ltd., 2019.
4. Yunfeng Chen and Frederick Barnes Muehlhausen., "Practical Construction Accounting and Financial Management (Purdue Handbooks in Building Construction), 2023.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Prepare a profit and loss statement and income statement for the given accounting transactions
- CO2:** Calculate the cost and profit of a given project
- CO3:** Evaluate the given different alternatives based on the time value of money
- CO4:** Suggest financial decisions in construction projects using the given tools
- CO5:** interpret and apply various risk analysis methods to manage/ mitigate risk.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	2	3	3
CO2	3		3	3
CO3	3		3	3
CO4	3		3	3
CO5	2	3	3	1

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable

The holistic understanding of construction finance and value of money can lead to proper selection of equipment and resources leading to a sustainable environment

M. Tech.	Construction Engineering & Project Management	Regulations 2025
CEF 6222	SAFETY AND QUALITY CONTROL IN PROJECTS	L T P C 3 0 0 3

SDG: 09

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** key safety practices and risk factors in construction environments.
- COB2:** Safety policies and promote awareness to enhance health and safety in construction activities.
- COB3:** principles, systems, and guidelines governing construction quality management.
- COB4:** quality planning, assurance, and improvement techniques in construction projects.
- COB5:** statistical quality control tools and implement ISO standards in the construction industry.

MODULE I SAFETY MANAGEMENT L:9 T: 0 P:0

Construction safety management – OSHA guidelines and regulatory framework – roles and responsibilities of top management, site managers, supervisors, and safety officers – safety practices in construction operations – accident prevention and risk management at construction sites – formation and functions of safety committees – safety monitoring and compliance audits – preparation of safety manuals, checklists, and inspection reports – site safety planning and control measures- safety meetings.

MODULE II SAFETY COMPLIANCE L:9 T: 0 P:0

Personal protective equipment (PPE) and safety gear used on construction sites – on-site first aid and emergency response – safety training and awareness programs – economic impact and cost implications of workplace accidents – incentive schemes for promoting safe practices – safety policies, procedures, and equipment standards – job safety analysis (JSA) – job hazard analysis (JHA) and risk assessment methods.

MODULE III FUNDAMENTALS OF QUALITY L: 9 T: 0 P:0 **MANAGEMENT**

Introduction to construction quality – objectives and influencing factors – roles and responsibilities – quality policies, objectives, and methods in construction- quality circles – preparation of quality manuals and procedures - quality system requirements and documentation – quality training and implementation – TQM concepts and tools– deming’s theory - third-party certification.

MODULE IV STRATEGIC QUALITY PLANNING AND L: 9 T: 0 P:0 **CONTROL**

Quality planning and guidelines – tools– Taguchi’s quality concepts – relevant codes and standards – inspection and testing procedures – total quality assurance and quality control (QA/QC) programs and cost of quality - impact of internal and external failure costs – techniques and importance of QA/QC – quality appraisal methods – key aspects of quality and failure mode analysis – identification of critical and major failures.

MODULE V QUALITY IMPROVEMENT AND L: 9 T: 0 P:0 **STANDARDS**

Quality improvement strategies – selection and evaluation of new materials – impact of drawings, detailing, specifications – ISO standardization – IS 15883 (part 4) – quality considerations – site quality checklists and compliance – staff qualification and competency requirements – quality audits – inspection of key construction components – reports and quality records.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. P. Manu, G. Shang, P. J. S. Bartolo, V. Francis, and A. Sawhney, Eds., “Handbook of Construction Safety, Health and Well-being in the Industry 4.0 Era”, 1st ed. Abingdon, UK: Routledge, 2023.
2. K. N. Jha, D. A. Patel, and A. Singh, “Construction Safety Management”, 1st ed. Noida, India: Pearson Education India, 2023.
3. Er. BasuRoy.S.C, “Modern Concept of Total Quality Control and Management for Construction”, Nabhi Publication, 2013.

REFERENCES:

1. R. Issa and J. Flood, Eds., "Quality Management in Construction Projects: Best Practices, Tools, and Case Studies", 1st ed. Boca Raton, FL: CRC Press, 2024.
2. A. Oakland, "Total Quality Management and Operational Excellence: Text with Cases", 5th ed. Abingdon, UK: Routledge, 2014.
3. Jimmie W. Hinze, "Construction Safety", Prentice Hall, 2006.
4. IS 15883 (Part 1 – Part 12), "Construction Project Management - Guidelines", Bureau of Indian Standards, 2016.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Prepare safety documents, such as safety manuals and safety policies, and assign responsibilities for various roles within a given construction project.
- CO2:** Analyse risks and provide solutions for various hazards in construction projects.
- CO3:** Draft quality policies/manuals / standard operating procedures and explain the importance of TQM in construction.
Describe the tools for quality planning, assurance & control and analyse the cost implications.
- CO4:**
- CO5:** Prepare quality checklists and reports on ISO standardisation.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2	3	3	3
CO2	2		3	3
CO3	2	3	3	3
CO4	2		3	3
CO5	2	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of construction quality and safety management ensures the delivery of high-quality construction projects.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6223	PROJECT MANAGEMENT STUDIO II	L	T	P	C
SDG: 09		0	0	4	2

COURSE OBJECTIVES: The course will impart knowledge on

COB1: BIM concepts and introduce industry-standard tools.

COB2: 2D drafting and 3D architectural modeling using software.

COB3: Quantity takeoff, scheduling, and model coordination for practical BIM applications.

PRACTICALS

List of Experiments

1. Overview of BIM concepts and industry applications.
2. 2D drafting and basic plan development.
3. Getting started digital modeling: interface navigation and project setup.
4. Architectural modeling of walls, doors, and windows.
5. Modeling structural grids, levels, beams, and columns.
6. Designing floors, roofs, and stairs in digital environment.
7. Creating sections, elevations, and 3D visualizations.
8. Applying materials and exploring rendering techniques.
9. Generating schedules and quantity takeoff reports.
10. MEP modeling and clash detection in coordinated models.

L – 0; T – 0; P – 60; Total Hours:60

TEXT BOOKS:

1. R. Teulier and M. Bagieu, "Building Information Modeling: Shared Modeling, Mutual Data, the New Art of Building", Hoboken, NJ: John Wiley & Sons, Jan. 2024.
2. E. Wing, "Revit 2024 for Architecture: No Experience Required", 3rd ed. Indianapolis, IN: Sybex, Dec. 2023.

REFERENCES:

1. D. J. Stine, "Design Integration Using Autodesk Revit 2024: Architecture, Structure and MEP", 1st ed. Falls Church, VA: SDC Publications, Jul. 2023.
2. S. T. Tickoo, "Exploring Autodesk Revit 2023 for MEP, 9th ed. Boston, MA: CADCIM Technologies", 2022.

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: create 2D layouts and 3D building models.

CO2: model architectural and structural components and generate construction drawings.

CO3: Perform quantity takeoff, rendering, and clash detection for coordinated BIM models.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	M	H	H	H
CO2	M	H	H	H
CO3	M	H	H	H

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of BIM and its importance in the construction industries.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 6224	MINI PROJECT	L	T	P	C
SDG: 9		0	0	6	3

COURSE OBJECTIVES: The students will impart knowledge to

COB1: Select and execute a project in the area of construction management

GENERAL GUIDELINES

The project aims to impart knowledge in

- The project allows students to generalise, apply and synthesise the concepts learned over the duration of the course.
- The students will be given opportunity to select a project topic of his/her interest. The areas of the projects can be on Construction planning and scheduling, Building Information and Modelling, Estimation and costing and any other area related to construction management.
- A project mentor is identified in the beginning of the course for each student for conduct of periodic reviews and monitoring the performance of the students throughout the project period.
- Project review schedules, weightage for each review and rubrics for evaluation will be prepared by the project co-coordinator in line with the academic calendar and informed to the students in advance.
- The Head of the Department / Dean of School shall constitute a project progress review committee comprising competent senior faculty members as members to continuously monitor the progress made by students during the mini project.
- The project coordinator shall arrange to conduct three progress review meetings to ascertain the progress of the work and award the marks based on the performance on expected metrics.
- The students are expected to finalise the area of the project / project title during the first review meeting. During the second review the students are expected to complete the 50 % of the work and submit the draft report in the third review.
- An oral examination (viva voce) shall be conducted as semester end examination. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

- The project co-ordinator shall arrange for final viva-voce examination to ascertain the overall performance in Project work.

L – 0; T – 0; P – 90; Total Hours: 90

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: Execute the project in the areas of construction management

CO2: Prepare a report and showcase presentation skill during the project reviews

Board of Studies (BoS):

20th BoS of Department of Civil
Engineering held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3		3	3
CO2		3	3	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The knowledge of estimation, planning and scheduling will help in timely completion of the project and improve the sustainability.

SEMESTER III

CEF 7121	PROJECT WORK - PHASE I	L	T	P	C
SDG: 11		0	0	22	11*

COURSE OBJECTIVE:

The Project Work aims to provide opportunity for the students to exhibit their capacity in executing a project work which deals with study on materials /analysis / design / experimental works related to Construction Engineering and Project Management domain.

GENERAL GUIDELINES:

- At post-graduate level, project work shall be carried out by the student individually.
- The students are encouraged to execute their project work (Phase I & II) in collaboration with Industry / R&D organization / Eminent Academic Institutions etc.
- The students will be given opportunity to select a project topic of his/her interest and are advised to interact with potential faculty members to discuss their project ideas for better understanding.
- A project coordinator is identified in the beginning of III semester for every batch who coordinates various activities viz. dissemination of research thrust areas of Construction Engineering and Project Management domain, faculty expertise, allocation of project guides, conduct of periodic reviews and monitoring the performance of the students throughout the project period.
- The project guide is nominated based on the preference of students and consent of the faculty concerned.
- The Project work Phase – I, shall be carried out by the students under the guidance of allotted project guide.
- In case, the students pursuing their project in the Industry / R & D organization / Eminent academia, a competent person from the project offering organization is assigned as co-guide as per the discretion of the head of the firm, in addition to the Department allotted guide.
- In the Project work – Phase I, the students are expected to identify the project topic, refer related literatures / data / information to identify the research problem (i.e., need for the present study). The students shall conduct meticulous literature review to identify the research gap, and frame the objectives to address the same.

- The students are encouraged (i) to frame the methodology to achieve the desired objectives, (ii) to conduct study on properties of various materials used in the study as per relevant codal provisions, (iii) to acquire knowledge on relevant software (if applicable) to conduct analytical investigation, (iv) to acquire knowledge on various experiments / techniques to conduct experimental experimentation etc.
- The Head of the Department / Dean of School shall constitute a project progress review committee comprising competent senior faculty members as members to continuously monitor the progress made by students during the Project Phase I.
- The project coordinator shall arrange to conduct three progress review meetings to ascertain the progress of the work and award the marks based on the performance on expected metrics.
- Project review schedules, weightage for each review and rubrics for evaluation will be prepared by the project co-coordinator in line with the academic calendar and informed to the students in advance.
- At the end of Phase –I period, students shall submit a project report covering the various aspects of project work. The typical components of the project report in Phase I shall include objectives, introduction, need for the present study, scope for investigation, literature review and methodology.
- An oral examination (viva voce) shall be conducted as semester end examination. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.
- The project co-ordinator shall arrange for final viva-voce examination to ascertain the overall performance in Project work.

COURSE OUTCOMES:

After completion of this course, the students will be able

CO1: To identify research problem in the area of Construction Engineering and Project Management, conduct review of literature, frame objectives and methodology to address the research gap.

CO2: To exhibit competency to conduct core scientific / application oriented research in the field of Construction Engineering and Project Management by employing relevant software tools/ experimental investigation as per codal provisions.

CO3: To exhibit good communication and report writing skills.

Board of Studies (BoS):

20th BoS of CIVIL held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	-	3	2
CO2	3	-	3	2
CO3	-	3	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Statement:

The project work course will help the students to explore and innovate new sustainable ideas and materials for implementation in construction industry.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEF 7122	INTERNSHIP	L	T	P	C
SDG: 11		0	0	4	2

COURSE OBJECTIVES: The course will impart knowledge on

COB1: professional competency / Industrial Exposure / research interests of the students

COB2: Issues faced in the industry and solving of real life problems

GENERAL GUIDELINES:

1. The course carries two credits for 30 days / four weeks of Internship with a minimum duration of 160 hrs.
2. The students shall pursue Internship in Industry (Government departments / Private Constructions Companies / Private consulting firms etc.,) / Research organizations (PMI, RICS etc.,) / Eminent Academic Institutions (IIT/ NIT/ Government or Private Universities) based on their field of interest.
3. The students shall obtain permission from Head of the Department / Dean of School by submitting an 'induction to internship certificate' provided by the firm (as per the given template) before commencement of Internship.
4. The students shall submit a report at the end of internship elaborating knowledge acquired during the internship period.
5. The student shall also submit the internship completion certificate issued by the Industry/ Research Organization / Academic Institution along with confidential feedback provided by them (in a specified format) in a sealed cover to the Class Advisor.
6. A committee comprising of faculty members constituted by the Head of the Department / Dean of School shall evaluate the Internship report, and also conduct an oral examination.
7. The weightage of marks for internship report and viva-voce examination are 60 % and 40% respectively.
8. Based on the assessment of internship report, and performance of the students in viva-voce examination, relative grade is awarded.

L – 0; T – 0; P – 160; Total Hours: 160

COURSE OUTCOMES: On completion of the course, students will be able to

CO1: To execute a particular activity, such as the preparation of contract documents/execution of a construction project / create a master schedule etc., in a given project.

CO2: Prepare documents such as reports/minutes of meetings / weekly, monthly reports / daily productivity reports and deliver a good presentation.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	3	3	3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable

The practical training in construction sites will lead to the development of sustainable buildings

SEMESTER IV

CEF 7121	PROJECT WORK - PHASE II	L	T	P	C
		0	0	35	18

SDG: 11**COURSE OBJECTIVE:**

The Project aims to provide an opportunity for the students to exhibit their capacity in executing a project work which deals with the study of materials/analysis/design/experimental works related to the Construction Engineering and Project Management domain.

GENERAL GUIDELINES:

- Project work Phase II is a continuation of phase I following the same guidelines.
- The project co-coordinator shall arrange to conduct three reviews to ascertain the progress of the work and award the marks based on the performance of students on desired metrics.
- Detailed experimental investigation and in-depth analytical study shall be performed in line with the objectives of the investigation.
- The students are expected to analyze the obtained results and discuss the same in an elaborate manner by preparing necessary charts/tables/curves to get an inference.
- The important conclusions need to be drawn and the scope for further research also to be highlighted.
- The outcome of project work shall preferably be published in journals/conferences of National or International importance.
- At the end of project Phase II, students shall submit a detailed report, and it shall include Experimental investigation and analytical study, Results & Discussion of experimental/analytical work, Conclusions, References etc., in addition to work completed in Phase I viz. Introduction, Literature and Methodology.
- The project co-ordinator in consultation with the Dean/ Head of the department and Controller of Examination, shall arrange for a semester-end oral examination by following SOP of the Institution to ascertain the overall performance of the students in Project work.

- The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

COURSE OUTCOMES:

After completion of this course, the students will be able

CO1: Able to interpret analytical/experimental data by applying critical thinking, scientific principles/ context, etc.

CO2: Able to provide conclusions and recommendations to a problem with emphasis on professional ethics, care for safety and society and environment and sustainability.

CO3: Exhibit good communication and report writing skills.

Board of Studies (BoS):

20th BoS of CIVIL held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	-	3	3
CO2	3	-	3	3
CO3	-	3	-	-

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable.

Statement:

The project work course will help the students to explore and innovate new sustainable ideas and materials for implementation in the construction industry.

CEFY 51	LEAN PRINCIPLES IN PROJECT	L	T	P	C
SDG: 11	DELIVERY	3	0	0	3

COB1:	drawbacks in traditional practices, lean concepts and its evolution.
COB2:	lean methods.
COB3:	lean tools like VSP, work sampling, last planner system.
COB4:	activities for lean implementation in the construction industry.
COB5:	lean integration in project delivery.

Problems with current construction management techniques -Toyota's management principle - history of lean construction – key lean concepts - variation - value & waste in construction - concept of flow, push vs pull & flow efficiency - concept of batch vs single piece flow in construction - continuous improvement – Plan-Do-Check-Act (PDCA) - respect for people - culture of collaboration - trust & team work - Total Quality Management (TQM) .

Collaborative planning - value stream mapping – work sampling - foreman delay survey- lean work structuring - gemba visits - lean problem solving - just in time – Heijunka - visual management - digitalisation - kaizen/ kata - root cause analysis - workplace organising- Takt Time - crew balance chart- total productive maintenance.

Target value design - set-based design - choosing by advantages - last planner system - milestone pull planning - look ahead pull planning - weekly work planning - daily huddles – six sigma - seven wastes (Muda elimination) - big room - A3 reporting – fishbone diagram - pareto analysis - poka yoke.

MODULE IV LEAN ACTIVITIES**L:9 T: 0 P:0**

Brainstorming sessions - 5S implementation-constraints log - issue log – bottleneck analysis- PPC analysis – heijunka – jidoka - reason for non-completion analysis - daily update – hoshin Kanri - kanban boards - andon systems – key performance indicators - six big losses – visual factory- standardised work- on-job trainings - work observation.

MODULE V LEAN ENABLED PROJECT DELIVERY**L:9 T: 0 P: 0**

Integrated Project Delivery (IPD) - Lean based project delivery methods - comparison of IPD-with design bid – build and design build – building information modeling for lean construction - international and Indian case studies on lean implementation - metrics for evaluating lean performance – cost - time, quality - safety, and client satisfaction - lean in large scale infrastructure - commercial, and residential projects - challenges, barriers, and roadmap for lean adoption.

L – 45; T – 0; P – 0; Total Hours:45**TEXT BOOKS:**

1. Forbes. L.H. & Ahmed. S.M., “Lean Project Delivery and Integrated Practices in Modern Construction” (2nd Ed.), Routledge, 2020.
2. González. V.A., Hamzeh. F. & Alarcón. L.F., “Lean Construction 4.0: Driving a Digital Revolution of Production Management in the AEC Industry”, Routledge, 2023.
3. Corfe, C. and Clip, B., “Implementing lean in construction: Lean and the sustainability agenda”, CIRIA, London, 2013.
4. Gao, S. & Low, S.P., “Lean Construction Management: The Toyota Way”, Springer, 2016.
5. Dave, B., Koskela, L., Kiviniemi, A., Owen, R. & Tzortzopoulos, P., “Implementing Lean in Construction: Lean Construction and BIM”, CIRIA, London, 2013.

REFERENCES:

1. Kashyap. A., Raghavan. N. (Eds.), “Sustainable Lean Construction: Select Proceedings of ILCC 2022”, Springer, Singapore, 2023.
2. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., “Site implementation and Assessment of Lean Construction Techniques”, Lean Construction Journal, 2005.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** explain lean construction concepts and principles, and identify wastes and value-adding activities in construction processes.
- CO2:** apply lean problem-solving methods for construction projects.
- CO3:** analyze project scenarios using lean tools and prepare process improvement reports.
- CO4:** Select appropriate lean techniques to optimize productivity in construction projects.
- CO5:** evaluate and apply lean-based project delivery methods in construction projects.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2		3	3
CO3	2	3	3	3
CO4	2	3	3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic understanding of improving the productivity to save time and resources used in construction.

CEFY 52	PERSONNEL MANAGEMENT AND	L	T	P	C
SDG: 8	ORGANISATIONAL BEHAVIOUR	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: personnel management and workforce planning.

COB2: performance appraisal, compensation, and labor relations.

COB3: individual behavior, motivation, and emotional intelligence.

COB4: group dynamics, leadership, and team communication.

COB5: organisational structure, culture, and change management.

MODULE I INTRODUCTION TO PERSONNEL MANAGEMENT L:9 T: 0 P: 0

Scope - nature and functions of personnel management - role of personnel manager in projects - workforce planning and job analysis – recruitment - selection, and placement - training and skill development for site productivity and safety.

MODULE II PERFORMANCE, COMPENSATION, AND LABOR RELATIONS L: 9 T: 0 P: 0

Performance appraisal techniques for project based roles - performance metrics - productivity analysis of project crew - career planning - employee development - wage and salary administration – incentive plans and employee benefits - compensation – employee empowerment - General Provident Fund (GPF) – Employees' Provident Fund (EPF) – group insurance – housing - pension - industrial relations and dispute resolution mechanisms - workforce welfare- retention.

MODULE III FOUNDATIONS OF ORGANISATIONAL BEHAVIOUR L: 9 T: 0 P: 0

Nature and Importance of organisational behavior (OB) - OB models – autocratic – custodial – supportive – collegial system - individual behavior – personality – perception - attitudes, and learning - motivation theories and applications - maslow, herzberg, mccllland - emotional intelligence and self-awareness.

MODULE IV GROUP DYNAMICS AND L: 9 T: 0 P: 0 **LEADERSHIP**

Group Behavior – types - development, and decision making - group behavior and communication in cross functional project teams – self managing work teams - team building and conflict resolution - leadership theories and styles- communication in organizations - types, barriers, and effective practices.

MODULE V ORGANISATIONAL SYSTEMS AND L: 9 T: 0 P: 0 **CULTURE**

Organisational structure and design - organisational culture and climate - change management and organisational development- stress management - employee well being –work life balance - contemporary issues in organisational behaviour – diversity – ethics - remote work - workforce planning in labor intensive and mechanised projects – Human resource related issues in projects – health – safety –welfare - case studies on organisational success/failure in large projects.

L – 45; T – 0; P – 45; Total Hours:45

TEXT BOOKS:

1. Robbins, S.P. & Judge, T.A., “*Organizational Behavior*”, 19th Ed., Pearson Education, 2022.
2. Aswathappa, K., “*Human Resource Management*”, 8th Ed., McGraw-Hill Education India, 2020.
3. Koontz, H. & Weihrich, H., “*Essentials of Management: An International, Innovation and Leadership Perspective*”, 11th Ed., McGraw-Hill Education India, 2020.
4. Noe, R.A., Hollenbeck, J.R., Gerhart, B. & Wright, P.M., “*Fundamentals of Human Resource Management*”, 9th Edition, McGraw Hill, USA, 2023.
5. Armstrong, M. & Taylor, S., “*Armstrong’s Handbook of Human Resource Management Practice*”, 16th Edition, Kogan Page, UK, 2023.

REFERENCES

1. Griffin, R.W., Phillips, J.M. & Gully, S.M., “*Organizational Behavior: Managing People and Organizations*”, 14th Edition, Cengage Learning, USA, 2023.
2. Government of India, “*The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act*”, Government of India.
3. Construction Industry Development Council (CIDC), *Guidelines on Site Management and Labour Welfare*, CIDC.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** explain the scope, functions, and processes of personnel management in construction projects.
- CO2:** to identify and apply appropriate performance appraisal, compensation, and welfare measures to improve productivity and workforce retention in construction projects.
- CO3:** apply organizational behavior models and theories to understand and manage workforce behaviour.
- CO4:** evaluate group dynamics, leadership styles, and communication strategies in to strengthen teamwork and conflict resolution in projects.
- CO5:** analyze organisational systems and culture to implement strategies for change, employee well-being, and sustainable project outcomes.

Board of Studies (BoS):

20th BoS of Department of Civil
Engineering held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1			3	
CO2	2		3	3
CO3	2		3	3
CO4	2		3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

This course supports SDG 8 by imparting knowledge and skills for effective human resource management and ethical organizational behavior. It enhances employee well-being and productivity, contributing to decent work and inclusive growth.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEFY 53	SMART BUILDING SYSTEMS	L	T	P	C
SDG: 11	AND MANAGEMENT	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** concepts of smart buildings
- COB2:** Working principle of HVAC, electrical, plumbing, STP and other safety system in buildings
- COB3:** working principles of building automation systems and communication systems in buildings

MODULE I INTRODUCTION **L: 9 T:0 P:0**

Introduction to intelligent/smart buildings - basic concepts of intelligent buildings - intelligent building automation - building automation system- cost analysis of intelligent buildings – introduction to smart materials and embedded sensor technology – BMS and energy savings – BMS benefits - High performance buildings – Best practices

MODULE II SMART COMFORT SYSTEM **L: 9 T:0 P:0**

HVAC fundamentals - indoor environmental quality - Active and Passive cooling - different types of HVAC systems, energy efficient HVAC systems - under floor air distribution – chilled beams – Commissioning of services - Electrical equipment, wiring and raceways, - lighting systems with sensors – solar lights.

MODULE III BUILDING SERVICES **L: 9 T:0 P:0**

vertical transportation in buildings, - Escalators — Installation and Commissioning of services - Waterproofing systems, types of plumbing systems, sanitary works - internal and external sanitary systems – STP - Interiors in buildings, automated car parking management

MODULE IV INTELLIGENT SAFETY SYSTEM **L: 9 T:0 P:0**

Life safety factors – designing a security system- intrusion sensors and space sensors -closed circuit television & surveillance systems; access control & management system - portrait id system, swipe card access control system, biometric access control system; fire protection systems - smoke detection- automatic fire alarm detection – sprinklers - hose reels hydrants-foam systems - microprocessor based alarm. emergency control of elevator, doors - security & alarm system

MODULE V BUILDING MANAGEMENT SYSTEM L: 9 T:0 P:0

BMS documents - IO List and Schematic Diagrams - Riser Diagram - DGP Drawings - Sequence of Operation (SOO) – IT Networking - IP address, MAC address and Subnetting - Subnet and VLAN - BMS Network Examples - communication protocol - Introduction to BACnet - BACnet Objects - BACnet Services - BACnet IP and MSTP - Introduction to Modbus - Modbus RTU - Modbus Mapping - Testing and commissioning – Smart building case studies.

L – 45; T – 0; P – 0; Total Hours: 45

REFERENCES:

1. Fair G.M., Geyer J.C. and Okun .D, “Water and waste Engineering“, Vol. II, John Wiley & sons, Inc., New York. 2008.
2. Hopkinson . R.G and Kay .J .D, “The Lighting of buildings, Faber and Faber, London, 2009.
3. Handbook for Building Engineers in Metric systems, NBC, New Delhi, 2008.
4. Time-saver Standards for Architecture Design Data, Callendar JH, McGraw Hill, 2004.
5. Philips Lighting in Architecture Designs, McGraw Hill, New York, 2004.
6. William H. Severns and Julian R. Fellows, “Air conditioning and refrigeration”, John Wily and sons, London, 2008.
7. Derek Clements Croome, “Intelligent Building Design, Management and Operations”, 2nd edition, ICEP Publishers, London, 2013.
8. Ehrlich, C., “Intelligent Building Dictionary: Terminology for Smart, Integrated Green Building Design, Construction, and Management”, San Francisco, Hands-on-Guide, 2007.
9. Shengwei Wang, “Intelligent Buildings and Building Automation, Spon Press”, London, 2009.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Identify and select the facilities required for a given building and calculate the energy required for the same.
- CO2:** Select a ventilation system and type of air conditioning required for a given building, and also identify the electrical fixtures in a building.
- CO3:** electrical, plumbing, and other building services for any given building based on the requirements.
- CO4:** Demonstrate the difference between different safety systems and select the safety system required for a given building

CO5: Identify different types of IO and software points and understand the basics of IT networking, including IP & MAC addresses, VLANs, and subnets.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	M		H	M
CO2	M		H	M
CO3	M		H	
CO4	M		H	M
CO5			H	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

The holistic understanding of the building management systems will lead to sustainable buildings.

M. Tech.	Construction Engineering & Project Management	Regulations 2025
----------	---	------------------

CEFY 54	CONSTRUCTION ROBOTICS AND DIGITAL	L	T	P	C
SDG: 09	FABRICATION	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** the fundamentals of construction robotics and automation.
- COB2:** the components and mechanisms of construction robots.
- COB3:** digital fabrication processes such as 3D printing and robotics.
- COB4:** real-world applications of robotics and automation in construction.
- COB5:** the challenges and safety protocols associated with robotics in construction.

MODULE I FUNDAMENTALS OF CONSTRUCTION ROBOTICS L:9 T: 0 P:0

Introduction to construction automation and robotics - evolution and history of construction robotics - types of robots used in construction (industrial, mobile, collaborative, autonomous) - workspaces - role of robotics in productivity, safety, and quality enhancement - comparison of manual vs automated construction methods - overview of robotics standards.

MODULE II ROBOTIC SYSTEMS AND COMPONENTS IN CONSTRUCTION L:9 T: 0 P:0

Components of construction robots: actuators, sensors, controllers, end effectors - robotic locomotion: tracked, wheeled, legged, and aerial systems - site automation - path planning and motion control in robotic construction - human-robot interaction (HRI) and collaboration on construction sites.

MODULE III DIGITAL FABRICATION TECHNIQUES AND PROCESSES L: 9 T: 0 P:0

Introduction to digital fabrication in architecture and construction - 3D printing – process - types of 3D printing - major structures by 3D printing - robotic arm-based fabrication systems - automation in reinforcement bending, modular assembly, and tile-laying - material constraints and structural implications of digital fabrication

MODULE IV APPLICATIONS IN CONSTRUCTION AUTOMATION L: 9 T: 0 P:0

Robotic bricklaying, drywall installation, and painting - on-site concrete printing systems and contour crafting - drones for surveying, inspection, and progress monitoring - robotic demolition and deconstruction - case studies of large-scale automated construction projects - robotic prefabrication and modular construction.

MODULE V CHALLENGES AND SAFETY IN CONSTRUCTION ROBOTICS **L: 9 T:0 P:0**

Barriers to adoption: cost, training, infrastructure, and resistance to change - safety protocols, risk assessments, and robot certification requirements - regulatory and ethical considerations in automation - sustainability analysis of automated construction methods - autonomous site vehicles.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. E. NoroozinejadFarsangi and M.Noori, “Automation in Construction Toward Resilience: Robotics, Smart Materials & Intelligent Systems”, 1st ed. London, UK: RIBA Books, 2023.
2. T. Bock and T. Linner, “Construction Robots: Elementary Technologies and Single-Task Construction Robots”, vol. 3 of Cambridge Handbooks in Construction Robotics, 1st ed. Cambridge, UK: Cambridge Univ. Press, 2016.

REFERENCES:

1. Javad Majrouhi Sardroud, “Automated Management of Construction Projects”, LAP Lambert Academic Publishing, 2011.
2. Majrouhi Sardroud Javad, “Automation in Construction Management”, Scholars' Press, 2014.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Describe the fundamentals, types, and evolution of construction robotics.
- CO2:** Identify key components and control systems of construction robots.
- CO3:** Apply digital fabrication techniques such as 3D printing and robotic assembly in construction processes.
- CO4:** Suggest the possible automation in a given construction project.
- CO5:** Recommend safety protocols and sustainability considerations in deploying robotics in construction projects.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1			3	1
CO2			3	1
CO3	2		3	3
CO4	2		3	2
CO5	2		3	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of robotics and digital fabrication in transforming construction processes.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEFY 55	CONSTRUCTION INFORMATICS	L	T	P	C
SDG: 09	AND DIGITAL SOLUTIONS	2	1	2	4

COURSE OBJECTIVES: This course will impart knowledge on

COB1: Digital construction

COB2: Virtual reality and augmented reality

COB3: AI in construction management

MODULE I INTRODUCTION L: 9 T:0 P:0

Digital Construction – Benefits of digital construction technology – Best practices adopted – Examples of digital construction - Cloud-based software applications and filing systems - Mobile technology - IoT, smart sensors, and wireless networks - Unmanned aerial vehicles (UAVs) - Machine learning AI and Big Data analytics - Digital twins - Digital Uses and Benefits-Need for Digital Twins - Working principle.

MODULE II INFRASTRUCTURE REQUIRED L: 9 T:0 P:0

Building Blocks of Digital Twin - Digital Twin Technology Drivers and Enablers - Physics-Based Modelling - Data-Driven Modelling - Big Data Cybernetics: Art of Steering - Infrastructure and Platforms - Human-Machine Interface.

MODULE III DIGITAL TWIN MODELLING L: 9 T:0 P:0

Types of Digital Twin - Based on Product and Process - Based on Product and Process Based on Functionality - Based on Maturity - Development considerations - Overview of Data Modelling Environment - Digital Twin in Construction.

MODULE IV VIRTUAL REALITY IN CONSTRUCTION L: 9 T:0 P:0

The historical development of VR - Scientific landmarks, Computer Graphics - Real-time computer graphics - Flight simulation- Virtual environments, Requirements for VR - benefits of Virtual reality – Applications in construction, case study

MODULE V AUGMENTED REALITY IN CONSTRUCTION L: 9 T:0 P:0

Basics of augmented reality –Development process, Difference between other applications similar - virtual reality - Hardware needed to view AR content - Benefits of augmented reality – Applications in construction – case study

L – 45; T – 0; P – 0; Total Hours: 45

REFERENCES:

1. Amador Caballero, "Essentials of Digital Construction: Lessons learned from digital transformation", 2024
2. Bruno Daniotti , Marco Gianinetto , Stefano Della Torre , "Digital Transformation of the Design, Construction and Management Processes of the Built Environment (Research for Development)" Springer, 2019

COURSE OUTCOMES: The student will be able to

- CO1:** Describe the application of digital construction and artificial intelligence in construction management
- CO2:** Identify the infrastructure required for digital modeling
- CO3** Explain the process of digital modeling
- CO4** Describe the use of VR in the construction of buildings
- CO5** Apply the AR in the construction of buildings

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	2
CO2	2		3	2
CO3	2		3	2
CO4	2		3	2
CO5	2		3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

The holistic knowledge of the digital solutions will help in the sustainable development of infrastructure.

CEFY 56	INVENTORY AND SUPPLY CHAIN	L	T	P	C
SDG: 09	MANAGEMENT	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** fundamental concepts of supply chain management and inventory systems
- COB2:** planning and managing inventory
- COB3:** forecasting methods and control strategies in inventory
- COB4:** supply chain networks, logistics systems, and distribution channels
- COB5:** emerging technologies and data analytics

MODULE I INTRODUCTION L:9 T: 0 P:0

Introduction to supply chain management (SCM) - evolution and objectives of supply chains - components and flows in a supply chain (material, information, financial) - types of supply chains (push/pull, lean/agile, global/local) - overview of inventory management and classification (ABC, VED) - role of logistics and warehousing - bullwhip effect: causes and mitigation - case studies on global supply chains.

MODULE II INVENTORY PLANNING AND MANAGEMENT L:9 T: 0 P:0

Inventory control - terms and definitions - types of inventory - time of purchase, quantity of material, sources, transportation, delivery and distribution - reasons for maintaining inventory - different tools for inventory - performance metrics - challenges and best practices in inventory control.

MODULE III INVENTORY FORECASTING AND CONTROL L: 9 T: 0 P:0

Demand forecasting techniques (qualitative and quantitative) - inventory costs and performance metrics –inventory analysis- economic order quantity (EOQ), reorder point (ROP) - safety stock calculations and service level analysis - multi-echelon inventory systems - continuous and periodic review systems - vendor managed inventory (VMI) - inventory optimization using software tools.

MODULE IV SUPPLY CHAIN NETWORK DESIGN AND LOGISTICS L: 9 T: 0 P:0

Supply chain network configuration and facility location models - capacity planning and production scheduling - transportation and distribution management - cross-docking and last-mile delivery - global sourcing and outsourcing strategies - role of 3PL and 4PL providers - freight cost analysis and route optimization - case studies in logistics network design.

MODULE V TECHNOLOGY AND ANALYTICS IN SCM L: 9 T:0 P:0

Enterprise resource planning (ERP) and SCM software platforms - role of internet of things (IOT) and RFID in SCM - use of artificial intelligence (AI) - supply chain visibility and control towers - data analytics for demand planning and forecasting - electronic commerce - IT for supply chain excellence - service oriented architecture.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. K. S. Bhat, "Logistics and Supply Chain Management", Mumbai, India: Himalaya Publishing House, 1st ed., 2022.
2. L. C. Jhamb, "Inventory Management", Everest Publishing House, May 2022.

REFERENCES:

1. Sunil Chopra and Peter Meindl, "Supply Chain Management", Prentice Hall, New Jersey, 2013.
2. Richard J. Tersine, "Modern Materials Management", John Hardin Campbell – 2007.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Explain the principles of inventory and supply chain management.
- CO2:** Apply appropriate forecasting, control, and optimization techniques
- CO3:** Analyse the given inventory using various models.
- CO4:** suggest efficient supply chain networks and logistics strategies
- CO5:** Identify the technologies to be adopted to enhance supply chain visibility and performance.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	
CO2	2		3	
CO3	2		3	3
CO4	2		3	2
CO5	2		3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of inventory and supply chain management.

M. Tech.	Construction Engineering & Project Management	Regulations 2025
----------	---	------------------

CEFY 57	ADVANCED QUANTITY	L	T	P	C
SDG: 9	SURVEYING AND VALUE				
	ENGINEERING	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: the scope, fundamental principles, and practices of quantity surveying.

COB2: standard specifications, CPWD schedule of rates, and techniques for analysis of rates.

COB3: detailed estimates, and bar bending schedules.

COB4: principles of valuation.

COB5: methods and legal framework related to valuation

MODULE I QUANTITY SURVEYING L: 9 T: 0 P: 0

Quantity Surveying - basic principles - role/responsibility of quantity surveyor at various stages of construction – estimates - contingencies - bill of quantity – format - item of works - identify various item of work from the drawings- units of measurement of various materials and works -detailed estimate - preparation of detailed measurement using centre line method - short wall long wall (separate wall) method for reinforced cement concrete(RCC) single storied building (flat roof) including stair cabin - residential/office/school building – Bill of Quantities (BOQ) preparation of a single storied RCC building work - material quantity calculation of the items of work- rubble - brick work - concrete work – plastering.

MODULE II SPECIFICATIONS AND RATE L: 9 T: 0 P: 0 **ANALYSIS**

Introduction to Central Public Works Department (CPWD) / Public Works Department (PWD) schedule of rates as per latest Delhi Schedule of Rates (DSR) - Analysis of rate as per latest Delhi Analysis of Rates (DAR) Specifications-General Specification of all items of a residential building - detailed specification - CPWD specifications of major item of work - earth work excavation in foundation – masonry - reinforced cement concrete - finishing of building - work analysis of rates for earth work in excavation – foundation – mortars - reinforced cement concrete works - finishing work - masonry work - stone works - flooring with Reference to Latest DSR and latest DAR.

MODULE III DETAILED ESTIMATE**L: 9 T: 0 P: 0**

Detailed estimate prepared for building work - data for unit quantity- Bar Bending Schedule (BBS) - preparation of BBS of RCC beams – slabs - column footings - retaining wall - road estimation - estimation of earthwork from longitudinal section- metaled road. estimation of sanitary and water supply work - water tank, septic tank - manhole.

MODULE IV PRINCIPLES OF VALUATION**L: 9 T: 0 P: 0**

Valuation – purpose, and scope of valuation - factor affecting valuation - role of a valuer in real estate and infrastructure projects - introduction to terms – value – cost – price - kinds of values income- gross income, net income, outgoings, annuity - sinking fund - year's purchase – depreciation - obsolescence -free hold and leasehold properties - methods of calculating depreciation – straight line method – constant percentage method, sinking fund method and quantity survey method.

MODULE V LAND AND REAL ESTATE VALUATION**L: 9 T: 0 P: 0**

Methods of valuation- direct comparison approach- income capitalization approach- the cost approach – profit approach – residual approach- government acts and regulations for valuation - land acquisition act - real estate regulation and development act (RERA)- transfer of property act - valuation standards - legal framework for valuation- international valuation standards - Indian valuation standards - valuation of special properties - agricultural land - commercial properties - industrial properties- rental properties and leasehold land- valuation reports- format and preparation of valuation reports-case studies of valuation in residential and commercial projects

L – 45; T – 0; P – 0; Total Hours : 45**TEXT BOOKS:**

1. Dutta, B.N., "Estimating and Costing in Civil Engineering: Theory and Practice", CBS Publishers & Distributors, India, 2022.
2. Rangwala, S.C., "Valuation of Real Properties", Charotar Publishing House, 2020.
3. Roshan H. Namavati, "Theory and Practice of Valuation", Lakhani Book Depot, 2018.
4. Datta, D. N., "Principles of Valuation", UBS Publishers, 2017.

REFERENCES:

1. Patil, B.S., "Civil Engineering Contracts and Estimates", University Press, 2019.
2. *Bureau of Indian Standards*, "IS 1200-1968: Methods of Measurement of Building & Civil Engineering Works", *BIS*, 1968.
3. *Central Public Works Department (CPWD)*, "Delhi Schedule of Rates (DSR) 2023" and "Departmental Approved Rates (DAR) 2023", *Government of India*, 2023.
4. Government of India, "Real Estate (Regulation and Development) Act", 2016.

COURSE OUTCOMES: The students will be able to

- CO1:** estimate the quantities for construction works.
- CO2:** calculate item rates using CPWD specifications and standard analysis methods.
- CO3:** analyze detailed estimates, BOQs, and bar bending schedules for building works.
- CO4:** evaluate building assets using appropriate valuation and depreciation methods.
- CO5:** select and recommend appropriate methods and legal frameworks for different types of real estate properties.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2	1	3	2
CO2	2	1	3	2
CO3	2	3	3	2
CO4	2		3	2
CO5	2		3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The principles of quantity surveying and valuation techniques enable accurate cost planning and resource optimization, fostering sustainable infrastructure development and efficient industrial practices.

M. Tech.	Construction Engineering & Project Management	Regulations 2025
----------	---	------------------

CEFY 58	CIRCULAR ECONOMY IN	L	T	P	C
SDG: 9	CONSTRUCTION INDUSTRY	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: principles of circular economy

COB2: Impact of materials and energy level on circular economy

COB3: Life cycle assessment of buildings

COB4: Criteria and indicators for circularity

COB5: Role of stakeholders

MODULE I CIRCULAR ECONOMY 9

Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy. Circular economy – Butterfly Diagram – Principles – 10 R Strategy – Circular economy in built environment – Existing structures – New buildings – Selection of materials – Modularity and prefabrication – Reversible and transformable buildings – case studies

MODULE II CIRCULAR ECONOMY- MATERIAL LEVEL AND ENERGY LEVEL 9

Challenges in implementation – Building Level – Component level – Reusing components – Refurbishment (Repair-Repaint-Retrofit) and Upgrading – Material Level – Circular Materials – Concrete – Steel – timber – Masonry – Additive Manufacturing – Energy Level – Energy Efficiency and sources – Building Services – Material Use – and Reuse – Net Zero Energy Buildings – Photo voltaic – Wind Energy – Thermal solar collectors – Geothermal energy

MODULE III LIFE CYCLE ASSESSMENT 9

Life Cycle Assessment – ISO Standard (ISO 14040 – 14043)– LCA of Building - EN 15, 978 - Stages – Life Cycle phases of buildings – Design Framework – ReSOLVE - Frameworks of design strategies to achieve established circular principles - Frameworks of design strategies to be implemented throughout phases of the building life cycle.

MODULE IV CRITERIA AND INDICATORS**9**

Circularity Criteria for Construction Materials – Classification of building materials – CE Criteria – Traditional building Materials – Novel Sustainable construction materials - Strategic Indicators Based on Material flow analysis – Resource Potential Indicator - Material Circularity Indicator – Longevity Indicator– a multicriteria decision analysis - Construction and Demolition Waste Management Indicators - Water Consumption Indicators - Environmental and Economic Impact of Construction Materials - Carbon Footprint Impact of Construction Materials - Circularity Criteria and Indicators at the Building Component and System Level - Circularity Criteria and Indicators at the Whole Building Design Level

MODULE V STAKEHOLDERS' ROLE AND CASE STUDIES**9**

Stakeholders' Role, Inter-Relationships, and Obstacles in the Implementation of Circular Economy - Circular Value Chain Management—Barriers and Opportunities - Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG. Business models, Solid Waste Management / Wastewater, Plastics: A case study, Extender Polluter Responsibility : polluters pay principle, Industrial symbiosis/ Eco-parks.

L – 45; Total Hours: 45**TEXT BOOKS:**

1. Sheng-Hong Chen, Marco di Prisco, Ioannis Vayas, Sanjay Kumar Shukla, "Circular Economy Design and Management in the Built Environment", Springer Tracts in Civil Engineering, 1st Edition 2025
2. Walter R Stahel, "The Circular Economy: A User's Guide", Routledge; 1st Edition, 2019
3. Shalini Goyal Bhalla, "Circular Economy: (Re) Emerging Movement", Invincible Publisher, 2021

REFERENCES:

1. María-Laura Franco-García, Jorge Carlos Carpio-Aguilar, Hans Bressers Towards Zero Waste: Circular Economy Boost, Waste to Resources. Springer International Publishing 2019.
2. Strategic Management and the Circular Economy, Routledge 2018.
3. Sadhan Kumar Ghosh, "Circular Economy: Global Perspective", Springer, 2020.
4. Marcello Tonelli, Nicolo Cristoni, "The Circular Economy: A User's Guide Stahel, Walter R., Routledge, 2019.
5. Lerwen Liu, Seeram Ramakrishna, "An Introduction to Circular Economy", Springer Singapore 2021.

COURSE OUTCOMES: The student will be able to

- CO1:** Differentiate between linear and circular economic models and describe the circular economy in the built environment
- CO2:** Select the material and energy for the building using the circular economy principle.
- CO3:** Perform the life cycle assessment of a given building
- CO4:** Identify the criteria and indicators for material or a whole building
- CO5:** Perform a case study analysis of a given building

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	L	-	H	H
CO2	L	-	H	H
CO3	L	M	H	H
CO4	L	-	H	H
CO5	L	M	H	H

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement: The holistic understanding of circular economy fosters sustainable industrialization by promoting innovation in product design, resource efficiency, and waste minimization.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEFY 59	SITE ORGANISATION AND WORKFORCE	L	T	P	C
SDG: 8	MANAGEMENT	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** principles and practices of site organisation and planning.
- COB2:** site administration, material management, and communication.
- COB3:** manpower planning, labour management, and productivity optimisation.
- COB4:** labour laws and frameworks governing industrial relations.
- COB5:** safety practices, risk assessments, and labour welfare on construction sites.

MODULE I SITE ORGANISATION AND PLANNING L:9 T: 0 P:0

Principles of site layout planning – zoning- storage – access – logistics - site mobilization – demobilization strategies - temporary facilities – offices – stores – labor camps – sanitation- coordination between design – procurement – construction on site- site investigation and preparation – soil survey – fencing – leveling- Health, Safety and Environmental (HSE) management on site – hazard identification – waste control- plant, equipment and resource allocation – cranes – batching plants – energy and water management- communication and information flow – site documentation – Building Information Modeling (BIM) - enabled logistics- quality control in site organization – inspection – testing - risk and contingency planning – emergency response – insurance provisions.

MODULE II SITE ADMINISTRATION AND COMMUNICATION L:9 T: 0 P:0

Roles and responsibilities of site personnel - organisational hierarchy at construction site – reporting structure – chain of command - material handling – storage – inventory control – coordination with subcontractors and suppliers- documentation – site diaries – inspection logs – checklists – reporting - internal and external communication protocols – digital tools for documentation- labor management – workforce allocation – productivity monitoring- health, safety and welfare responsibilities – toolbox talks – safety induction- quality control and assurance – inspection – testing – compliance with codes and regulations- conflict management – dispute resolution – ethical practices and professional conduct.

MODULE III MANPOWER PLANNING**L:9 T: 0 P:0**

Manpower planning and labor forecasting – organizing – staffing – directing - controlling - Human Resource Development (HRD) in construction- training – skill development – career progression- motivation and incentives – wage systems – performance-based rewards- labour - classes of labour - cost of labour – labour schedule -optimum use of labour - measurement of actual resources required - tools for measurement of resources – workforce productivity analysis – factors affecting productivity – benchmarking methods- use of digital tools for manpower planning – erp systems – building information modelling integration – workforce tracking apps.

MODULE IV LABOR LAWS AND INDUSTRIAL RELATIONS L:9 T: 0 P:0

Overview of applicable labor laws – Contract Labour (Regulation and Abolition) Act (CLRA) - Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act (BOCW) – Employees' Provident Fund (EPF) – Employees' State Insurance (ESI) - Minimum wages act - social security measures – gratuity – maternity benefits – insurance provisions - compliance and record keeping - trade unions - strikes, and grievance redressal - contractor subcontractor labor management issues- collective bargaining and negotiation strategies - role of government agencies in labor regulation and enforcement -dispute resolution mechanisms.

MODULE V SAFETY, AND WELFARE**L:9 T: 0 P:0**

Safety policies – site specific risk assessments - safety audits - toolbox talks - behavioral safety practices - Occupational Safety and Health Administration (OSHA) and national building code safety provisions for construction sites - hierarchy of hazard control – elimination – substitution – engineering – administrative – Personal Protective Equipment - safety training and induction programs - safety performance indicators – lagging and leading indicators - ergonomics in construction work – prevention of musculoskeletal disorder-- integration of technology in safety – wearables – IoT monitoring – drone safety inspections- labor welfare facilities and statutory provisions. Incident / accident reporting and emergency response systems - welfare amenities – housing, canteens, medical facilities, recreation, crèches.

L – 45; T – 0; P – 45; Total Hours:45

TEXT BOOKS:

1. Chudley, R., Greeno, R., "Building Construction Handbook", Routledge, UK, 2023.
2. Sengupta, B., "Construction Management and Site Administration", PHI Learning, India, 2021.
3. Gahlot, P.S., Dhir, B.M., "Construction Planning and Management", New Age International Publishers, India, 2020.
4. Sharma, S.C., "Labor and Industrial Laws", Sultan Chand & Sons, India, 2022.
5. Hinze, J., "Construction Safety", Pearson, USA, 2018.

REFERENCES:

1. Peurifoy, R.L., Schexnayder, C.J., Shapira, A., "Construction Planning, Equipment, and Methods", McGraw Hill, USA, 2019.
2. Chudley, R., Greeno, R., "Building Construction Handbook", Routledge, UK, 2023.
3. Varghese, P.C., "Building Construction", Prentice Hall of India, New Delhi, 2022.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** analyze and recommend effective site layout and management strategies to ensure safe and efficient construction site operations.
- CO2:** evaluate and suggest site administration and communication practices to optimize workflow and ensure compliance.
- CO3:** select appropriate manpower strategies to achieve optimal labor utilization.
- CO4:** apply labor laws and dispute resolution mechanisms for effective workforce management.
- CO5:** analyze and suggest appropriate safety and welfare measures.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2	1	3	3
CO3	2		3	3
CO4	2		3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

This course promotes decent work and economic growth by enhancing site management, labor planning, and safety practices to improve productivity and ensure inclusive, safe working environments.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEFY 60	PLANNING OF REAL ESTATE PROJECTS	L	T	P	C
SDG: 09		3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: comprehensive understanding of the real estate development process

COB2: planning frameworks and governance laws

COB3: planning approvals and regulatory processes

COB4: development regulations and building rules

COB5: risk assessment and sustainability in real estate projects

MODULE I INTRODUCTION TO REAL ESTATE DEVELOPMENT L:9 T: 0 P:0

Overview of real estate sector: scope, types - lifecycle of a real estate project: inception to completion - key stakeholders: developers, investors, consultants, end-users, government - economic significance of real estate and its impact on urban growth - real estate project typologies and trends in urban india - role of real estate in smart cities and urban renewal missions - real estate investment models (REITs, PPPs).

MODULE II PLANNING AND GOVERNANCE LAWS L:9 T: 0 P:0

Evolution of town and country planning in india - introduction to urban and regional planning acts - 74th constitutional amendment and role of urban local bodies (ULBs) - institutional framework: role of DTP, DTCP, UDA, municipal corporations - development plans, master plans, and zonal plans - legal instruments for land acquisition and land pooling - land use planning and zoning regulations

MODULE III PROJECT PLANNING AND APPROVALS L: 9 T: 0 P:0

Site selection criteria and due diligence - project formulation and feasibility analysis - stages of real estate project planning and scheduling - regulatory approvals and clearance process - role of RERA in project transparency and accountability - application of project management tools - time and cost estimation frameworks

MODULE IV DEVELOPMENT REGULATIONS AND BUILDING RULES

L: 9 T: 0 P:0

Introduction to building bye-laws and national building codes - floor area ratio (FAR), ground coverage, setbacks, and height regulations - building permissions, occupancy certificates, and completion certificates - parking norms, green building codes, and accessibility standards - fire safety, disaster resilience, and environmental norms - TDR (transfer of development rights), density controls, and incentives - special regulations for heritage zones and eco-sensitive areas.

MODULE V RISK MANAGEMENT AND SUSTAINABILITY IN REAL ESTATE PROJECTS

L: 9 T:0 P:0

Identification and classification of risks: legal, financial, environmental, market - risk mitigation strategies in real estate development - financial risks and funding models: loans, equity, joint ventures - sustainability in real estate: concepts and benchmarks (LEED, IGBC) - lifecycle cost analysis and sustainable materials - climate-responsive planning and disaster risk reduction - case studies of sustainable and failed real estate projects.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. Government of India, Model Building Bye-Laws 2016, Ministry of Housing & Urban Affairs, New Delhi, Dec. 2023.
2. Real Estate (Regulation and Development) Act, 2016; Parliament of India, enacted 25 Mar 2016, fully effective 1 May 2017.

REFERENCES:

1. P. Das and D. Sharma, "Real Estate Finance in India", Saptakala Real Estate & Housing Society, India, 2024.
2. Tamil Nadu municipal authorities, Tamil Nadu Combined Development and Building Rules, 2019, Chennai, India.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Coordinate and plan various real estate projects
- CO2:** Identify and apply development control rules and building bye-laws
- CO3:** Apply project planning principles, feasibility analysis, and regulatory approval processes
- CO4:** Review the development control regulations, building bye-laws, and environmental codes
- CO5:** Identify risks and sustainability measures in real estate projects

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1			3	
CO2	1		3	1
CO3	2	2	3	1
CO4	2	1	3	2
CO5	2	1	3	2

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of planning rules and regulations.

M. Tech.	Construction Engineering & Project Management	Regulations 2025			
CEFY 61	URBAN INFRASTRUCTURE AND	L	T	P	C
SDG: 11	SMART CITIES	0	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

- COB1:** Basic concepts of Smart infrastructure
- COB2:** Infrastructure required for Water supply and drainage systems
- COB3:** Smart city planning using GIS applications
- COB4:** Transportation systems for smart city
- COB5:** E-Government and IoT

MODULE I SMART INFRASTRUCTURE L: 9 T:0 P:0

Introduction to Smart Cities- urban Planning Fundamentals - Smart City Frameworks and Models - Technology and Infrastructure & Data Analytics and Urban Intelligence – Urban Planning and Design Principles - Urban Infrastructure and Services - Sustainable Urban Development - Social Inclusion and - Future Trends and Ethical Considerations - Smart Governance and Policy - Urban Health and Well-being - Environmental Planning - Urban Innovation and Entrepreneurship - Cultural and Historical Urban Landscapes

MODULE II WATER SUPPLY AND DRAINAGE L: 9 T:0 P:0

Water Demand and Supply Planning in Smart Cities - Smart Water Grids: Real-Time Monitoring and Management - Advanced Wastewater Treatment and Recycling Techniques - Integration of IoT in Water and Drainage Systems - Sustainable Urban Drainage Systems (SUDS) - Case Studies: Smart Water Management Systems.

MODULE III GIS APPLICATIONS IN SMART CITY PLANNING L: 9 T:0 P:0

Geographic Information Systems (GIS) in Urban Planning Fundamentals of GIS - Role of GIS in Urban Planning and Development - Spatial Data Analysis and Visualisation for Smart Cities - Applications in Infrastructure Management: Roads, Utilities, and Land Use - Integration of GIS with IoT and Big Data - Mapping and Decision-Making Tools.

MODULE IV SMART URBAN TRANSPORTATION SYSTEMS L: 9 T:0 P:0

Principles of Smart Transportation Systems - Intelligent Transportation Systems (ITS):
Sensors and Communication - Role of AI and Machine Learning in Traffic Management
- Integration of Public Transport with Smart Technologies - EV Infrastructure and
Sustainable Urban Mobility - Case Studies: Successful Smart Transportation Projects.

MODULE V E – GOVERNANCE AND IOT

L: 9 T:0 P:0

Role of E-Governance in Smart Cities - Internet of Things (IoT): Concepts and Applications in
Urban Management - Smart Governance Platforms and Citizen Services - Data Analytics and
Decision Support Systems - Cybersecurity Challenges in Smart Cities - IoT and Smart City
Infrastructure - Energy-Efficient Buildings and Sustainable Construction - Smart Healthcare
and Urban Resilience - Urban Climate Change Mitigation and Adaptation - Urban Safety and
Security - Cyber-Physical Systems CPS in Smart Cities

L – 45; T – 0; P – 0; Total Hours: 45

TEXT BOOKS:

1. John R. Vacca, "Solving Urban Infrastructure Problems Using Smart City Technologies: Handbook on Planning, Design, Development, and Regulation", Science Direct, 2020.
2. G. R. Kanagachidambaresan, "Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions", Scrivener Publishing, Wiley, 2020.

REFERENCES:

1. Saleem Gregory Zoughbi, "Planning and Designing Smart Cities in Developing Nations, IGI Global publishing, 2022.
2. Rodolfo I. Meneguette, Robson E. De Grande, Antonio A. F. Loureiro. "Intelligent Transport System in Smart Cities", Springer, 2018.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** to explain the importance of urban infrastructure and smart cities to mitigate climate change, and for urban development.
- CO2:** Integrate the water supply and drainage system in IoT for a given project.
- CO3:** Perform spatial data analysis using GIS for the given data.
- CO4:** Plan the drainage and transportation systems for any given city.
- CO5:** Describe the implementation of e - governance in smart cities

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2		3	3
CO3	2		3	3
CO4	2		3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable

The holistic understanding of infrastructure planning leads to development of sustainable cities

The holistic understanding of infrastructure planning leads to development of sustainable cities

MODULE IV AI IN COST ESTIMATION AND RISK MANAGEMENT L: 9 T: 0 P:0

Data-driven cost estimation techniques using machine learning - predictive analytics for cost overruns and delay forecasting - historical data mining for estimation models - AI-based risk identification and impact assessment - simulation-based scenario planning - integration of AI with ERP and financial systems in construction.

MODULE V EMERGING TRENDS AND ETHICAL CONSIDERATIONS IN AI FOR CONSTRUCTION L: 9 T:0 P:0

Introduction to generative design in construction - natural language processing (NLP) in project documentation and communication – blockchain and AI integration for smart contracts - ethical considerations - AI policy frameworks and regulatory issues - The future of AI in construction: trends, opportunities, and challenges - discussion: responsible AI adoption in the built environment.

L – 45; T – 0; P – 0; Total Hours:45

TEXT BOOKS:

1. S. Heggond, "Artificial Intelligence and Machine Learning for Smart Construction: Enhancing Real-Time Monitoring and Decision Making", Bagalkot, India: Deep Science Publishing, Mar. 2025.
2. R. Sinha, "The Powerful Impact of Artificial Intelligence on Construction Management," Int. J. Multidisciplinary Res., Jan. 2024.

REFERENCES:

1. M. Nehdi, H. Arora, K. Kumar (eds.), "Artificial Intelligence Applications for Sustainable Construction", Oxford: Woodhead Publishing, Feb. 2024.
2. R. Taiwo et al., "Generative AI in the Construction Industry: A State-of-the-art Analysis," arXiv, Feb. 2024.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Understand the fundamentals, components, and applications of AI in construction industry
- CO2:** Apply AI techniques for optimizing project planning, scheduling, and resource allocation
- CO3:** Utilize intelligent systems and AI-enabled technologies for real-time execution
- CO4:** Implement AI-driven methods for cost estimation, risk prediction, and integration with financial management systems.

CO5: Evaluate emerging AI trends, ethical concerns, and responsible adoption practices in the construction sector.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2		3	3
CO3	2		3	3
CO4	2		3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Statement:

The holistic understanding of integrating AI in Construction Management.

M. Tech.	Construction Engineering & Project Management	Regulations 2025
----------	---	------------------

CEFY 63	SHORING, SCAFFOLDING AND	L	T	P	C
SDG: 11	FORMWORK	3	0	0	3

COURSE OBJECTIVES: The course will impart knowledge on

COB1: planning of formwork, plant and site equipment's required for formwork.

COB2: design of forms for various elements such as slabs, beams, columns, walls, shells and tunnels.

COB3: advanced methods of form construction.

COB4: erection of forms for various elements such as slabs, beams, columns, walls, shells and tunnels.

COB5: erection of forms domes and tunnels

MODULE I PLANNING, SITE EQUIPMENT & PLANT FOR L:9 T: 0 P:0 FORM WORK

Introduction - forms for foundations, columns, beams walls etc., general objectives of formwork building - planning for safety - development of a basic system - key areas of cost reduction - planning examples- overall planning - detailed planning - standard units - corner units - pass units - calculation of labour constants - formwork hours - labour requirement - overall programme - detailed programmes - costing - planning crane arrangements - site layout plan - transporting plant - formwork beams - scaffold frames - framed panel formwork - formwork accessories.

MODULE II MATERIALS ACCESSORIES, PROPRIETARY L:9 T: 0 P:0 PRODUCTS & PRESSURES

Lumber - types - finish - sheathing boards working stresses - repetitive member stress - plywood - types and grades - jointing boarding - textured surfaces and strength - reconstituted wood - steel - aluminum - hardware and fasteners - nails in plywood - allowable withdrawal load and lateral load. pressures on formwork - examples - vertical loads for design of slab forms - uplift on shores - laterals loads on slabs and walls.

MODULE III DESIGN OF FORMS AND SHORES

L:9 T: 0 P:0

Basic simplification - beam formulae - allowable stresses - deflection, bending - lateral stability - shear, bearing - design of wall forms - slab forms - beam forms - column forms - examples in each. simple wood stresses - slenderness ratio - allowable load vs. length behaviour of wood shores - form lining design tables for wall formwork - slab formwork - column formwork - slab props - stacking towers - free standing and restrained - rosette shoring - shoring tower - heavy duty props.

MODULE IV BUILDING AND ERECTING THE FORM WORK L:9 T: 0 P:0

Carpentry shop and job mill - forms for footings - wall footings - column footings - sloped footing forms - strap footing - stepped footing - slab form systems - sky deck and multiflex - customised slab table - standard table module forms - swivel head and uniportal head - assembly sequence - cycling with lifting fork - moving with table trolley and table prop. Various causes of failures - aci - design deficiencies - permitted and gradual irregularities.

MODULE V FORMS FOR DOMES AND TUNNELS, SLIP FORMS AND SCAFFOLDS L:9 T: 0 P:0

Hemispherical, parabolic, translational shells - typical barrel vaults folded plate roof details - forms for thin shell roof slabs design considerations - building the forms - placing concrete - form removed - strength requirements - tunnel forming components - curb forms invert forms - arch forms - concrete placement methods - cut and cover construction - bulk head method - pressures on tunnels - continuous advancing slope method - form construction - shafts. slip forms - principles - types - advantages - functions of various components - planning - desirable characteristics of concrete - common problems faced - safety in slip forms special structures built with slip form technique - types of scaffolds - putlog and independent scaffold - single pole scaffolds - truss suspended - gantry and system scaffolds.

L – 45; T – 0; P – 0; Total Hours:45

REFERENCES:

1. Austin, C.K., "*Formwork for Concrete*", Cleaver-Hume Press Ltd., London, Latest Edition, 2021. Hurd, M.K., "*Formwork for Concrete*", American Concrete Institute, Detroit, 9th Edition, 2022.
2. Robert L. Peurifoy, Garold D. Oberlender & Robert L. Peurifoy Jr., "*Formwork for Concrete Structures*", McGraw-Hill Education, 5th Edition, 2020.
3. Kumar Neeraj Jha, "*Formwork for Concrete Structures*", Tata McGraw Hill Education, 2nd Edition, 2023.
4. Sidney M. Levy, "*Construction Process Planning and Management*", Elsevier, 2022.

COURSE OUTCOMES: On completion of the course, students will be able to

- CO1:** Select and optimize site equipment and formwork systems for efficient construction operations.
- CO2:** Calculate loads and pressures for safe design
- CO3:** Design formwork and shoring systems by applying structural design principles and allowable stress criteria.
- CO4:** Evaluate formwork erection methods and identify causes of failure based on field practices and standards.
- CO5:** Analyse, plan, and implement advanced formwork techniques for complex structures.

Board of Studies (BoS):

20th BoS of Department of Civil Engineering
held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	2		3	3
CO2	2		3	3
CO3	2		3	3
CO4	2		3	3
CO5	2		3	3

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable.

The holistic understanding of scaffoldings and its design leads to development of sustainable buildings

MODULE IV	STRENGTHENING OF STRUCTURAL ELEMENTS: ESTIMATION AND COST ANALYSIS	9
------------------	---	----------

Rehabilitation techniques for beams, columns, slab, floor, beam-column joint, and structural cracks – overview, significance and selection methods – overlays – pressure grouting – RC jacketing technique – Plate bonding technique – FRP jacketing technique - ferrocement – galvanic anode cathodic protection – Estimation and cost analysis

MODULE V	MAINTENANCE OF STEEL STRUCTURES, PAVEMENTS AND MASONRY STRUCTURES: ESTIMATION AND COST ANALYSIS	9
-----------------	--	----------

Maintenance of steel structures: critical observation of joints for bimetallic corrosion – method for rust removal – application of protective coating. Patch repair of flexible and rigid pavements, and bridge decks - rehabilitation of delaminated deck slabs and piers using galvanic anodes – Maintenance of masonry structures from surface deterioration, cracks, etc. – Estimation and cost analysis.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Perkins, P.H., “Repair, Protection and Waterproofing of Concrete Structures”, Third edition, E & FN Spon, 1997.
2. Emmons, P.H., “Concrete Repair and Maintenance Illustrated: Problem Analysis; Repair Strategy; Techniques”, RSMeans Publishers, 2002.

REFERENCES:

1. Santha Kumar, A.R., “Concrete Technology”, Oxford University Press, New Delhi, 2007.
2. Shetty.M.S., and A.K. Jain “Concrete Technology (Theory and Practice)”, S. Chand and Company Ltd., 2010.
3. Brooks, J.J. and Neville, A.M., “Concrete Technology”, Pearson, 2019.
4. Kumar Mehta. P. and Paulo J.M. Monteiro., “Concrete: Microstructure, Properties, and Materials” 4th Edition, McGraw Hill Education (India) Pvt. Ltd., 2014.
5. Hand Book on “Repair and Rehabilitation of RCC Buildings”, Central Public Works Department, Government of India, 2002.

6. Malhotra, V.M. and Carino, N.J., "Handbook on Non-destructive Testing of Concrete", CRC Press, 2004.
7. John Broomfield, "Corrosion of Steel in Concrete – Understanding, Investigation and Repair", CRC Press, London, 2003.
8. Yoshihiko Ohama, "Hand Book of Polymer Modified Concrete and Mortars", Noyes Publications, U.K., 3rd Edition, 2013.

COURSE OUTCOMES: At the end of the course, students will be able to

CO1: Perform estimation of the quantity of work and related cost for condition assessment of buildings using NDT techniques

CO2: perform cost analysis for materials used for different repair works.

CO3: perform estimation and costing for surface and near-surface distress in structures

CO4: perform estimation and costing for strengthening of structural elements.

CO5: arrive cost for maintenance of steel structures, pavements, and masonry structures.

Board of Studies (BoS) :

20th BoS of Department of Civil

Engineering held on 08.07.2025

Academic Council:

24th AC held on 26.08.2025

	PO1	PO2	PO3	PO4
CO1	3	2	2	
CO2	1	2	2	
CO3	1	2	3	
CO4	1	2	3	
CO5	1	2	2	

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

SDG 11 : Make cities and human settlements inclusive, safe, resilient and sustainable

1. Make the existing human settlements safe and resilient by performing condition assessment of RC structures using NDT and, by adopting suitable repair materials and techniques for its maintenance and rehabilitation.
2. Development of sustainable infrastructure by executing repair and rehabilitation works using sustainable materials and techniques at an affordable cost.