Indian Institute of Technology Indore

Course Structure of PG and Ph.D. Program in Civil Engineering and Syllabi of Courses

May 2026

[After incorporating decisions of the 63rd meeting of the Senate held on May 19, 2026]

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Course Structure for M. Tech. (2 year), M. Tech. + Ph.D. Dual Degree in Structural Engineering (w.e.f. AY 2023-24 to AY 2025-26)

Minimum Educational Qualification (MEQ): Four-year Bachelor's degree or five-year integrated degree (with first division as defined by the awarding Institute/ University for Indian applicants and equivalent to international applicants, as assessed by the Institute) in Civil Engineering. *Relaxation of 5% in qualifying degree is applicable for SC, ST and PwD category applicants.*

Qualifying Examination (QE):

(a) International Students: Valid score of TOEFL or IELTS, AND valid score of GRE

(b) Indian Students: Valid GATE qualification in Civil Engineering.

Categories of Admission:

International Students: (i) International self-financed (ISF) students; (ii) International students sponsored by non-government organizations or by a reputed industry (ISW); (iii) International students sponsored by a foreign government or its organizations or through mutual collaborative programs of India with other countries (GSW)

Indian Students: Teaching Assistantship (TA); (ii) Highly motivated sponsored candidate (SW) on full-time basis from highly reputed R & D organizations such as DRDO, ISRO, BHEL, C-DAC, ADE, ADA, etc. and highly reputed Industries; (iii) Defense Forces (DF): Candidates sponsored by the Defense Forces; (iv) Regular institute staff (IS) of IIT Indore on part-time basis only.

Candidates of SW, DF and IS categories will not be provided any scholarship.

Duration of Program: 2 years on full-time basis.

Annual Intake: 10 TA and no upper cap on the Non-TA students

Course Structure for two-year Full-time M. Tech. (Structural Engineering)

1st Year: Semester-I

Course code	Course Title	Contact Hours (L-T-P)	Credits
CE 601	Mechanics of Composite Materials and Structures	2-1-0	3
CE 603	Design of Steel-Concrete Composite Structures	2-1-0	3
CE 605	Condition Monitoring and Reliability Assessment	3-0-0	3
CE 607	Analysis and Design of Tall Buildings	2-1-0	3
CE 664/ CE 464*	Advanced Solid Mechanics	2-1-0	3
CE 651	Structural Engineering lab	0-0-6	3
Total minimum credits earned during the semester			**18**
Additional course (as per the requirement basis)			
HS 641	English Communication Skills	2-0-2	PP/NP

1st Year: Semester-II

Course code	Course Title	Contact Hours (L-T-P)	Credits
CE 616	Finite Element Methods for Structural Engineering	2-1-2	4
CE 662/ CE 462	Structural Dynamics	2-1-0	3
CE 648/ CE 448*	Prestressed Concrete Design	2-1-0	3
CE 684/CE 484	Advanced Concrete Technology	2-0-2	3
CE 698	PG Seminar Course	0-0-4	2
CE XXX	Elective-I	2-1-0	3
ZZ XXX	Elective-II	2-1-0	3
Total minimum credits earned during the semester			**21**

2nd Year: Semester-III

Coursecode	Course Title	Contact Hours (L-T-P)	Credits
CE 799	M. Tech. Research Project (Stage–I)	0-0-36	18
Total minimum credits earned during the semester			**18**

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2nd Year: Semester-IV

Coursecode	Course Title	Contact Hours (L-T-P)	Credits
CE 800	M. Tech. Research Project (Stage–II)	0-0-36	18
Total minimum credits earned during the semester			**18**
Total minimum credits to be earned during the program			**75**

Elective-I

Course code	Course Title	Contact Hours (L-T-P)	Credits
CE 628/ CE 428	Theory of Plates and Shells	2-1-0	3
CE 630/ CE 430	Elastic Stability	2-1-0	3
CE 612/ CE 412	Sustainable Construction	2-1-0	3
CE 610/ CE 410*	Offshore Engineering	2-1-0	3
CE 632/ CE 432*	Plastic Analysis and Design	2-1-0	3
CE 640	Industrial Wastewater Management	2-0-0	2

*Existing courses to be cross-listed

In addition to the elective courses, students may also opt for PG courses offered by the other Departments at IIT Indore.

NOTE: 1. Request for conversion from M.Tech. to M.Tech. + Ph.D. dual degree will be considered after evaluating the research potential of the promising and motivated PG studentsat the end of the third semester of their program.

2. If the student opts for the Dual Degree Program but cannot complete the requirements of a Ph.D., an exit option with the M.Tech. Degree can be earned at the end of the final semester ofthe normal M.Tech. Program by getting the M.Tech. Research project examined in the standard manner as per the requirements for the award of an M.Tech. degree.

Course Structure for M. Tech. (2 year), M. Tech. + Ph.D. Dual Degree in Structural Engineering (w.e.f. AY 2026-27 Onwards)

Minimum Educational Qualification (MEQ): Four-year Bachelor's degree or five-year integrated degree (with first division as defined by the awarding Institute/ University for Indian applicants and equivalent to international applicants, as assessed by the Institute) in Civil Engineering. *Relaxation of 5% in qualifying degree is applicable for SC, ST and PwD category applicants.*

Qualifying Examination (QE):

(a) **International Students:** Valid score of TOEFL or IELTS, AND valid score of GRE

(b) **Indian Students:** Valid GATE qualification in Civil Engineering.

Categories of Admission:

International Students: (i) International self-financed (ISF) students; (ii) International students sponsored by non-government organizations or by a reputed industry (ISW); (iii) International students sponsored by a foreign government or its organizations or through mutual collaborative programs of India with other countries (GSW)

Indian Students: Teaching Assistantship (TA); (ii) Highly motivated sponsored candidate (SW) on full-time basis from highly reputed R & D organizations such as DRDO, ISRO, BHEL, C-DAC, ADE, ADA, etc. and highly reputed Industries; (iii) Defense Forces (DF): Candidates sponsored by the Defense Forces; (iv) Regular institute staff (IS) of IIT Indore on part-time basis only.

Candidates of SW, DF and IS categories will not be provided any scholarship.

Duration of Program: 2 years on full-time basis.

Annual Intake: 10 TA and no upper cap on the Non-TA students

Course Structure for two-year Full-time M. Tech. (Structural Engineering)

1st Year: Semester-I

Course code	Course Title	Contact hours (L-T-P-C)	Credits
CE 601	Mechanics of Composite Materials & Structures	2-1-0	3
CE 684/CE 484	Advanced Concrete Technology	2-0-2	3
CE 662/CE 462	Structural Dynamics	2-1-0	3
CE 607	Analysis & Design of Tall Buildings	2-1-0	3
CE 614/CE 414	Design of Short & Medium Span Bridges	2-1-0	3
CE 651	Structural Engineering Lab	0-0-6	3
Total minimum credits earned during the semester			**18**

1st Year: Semester-II

Course code	Course Title	Contact hours (L-T-P-C)	Credit
CE 6XX	Finite Element Methods	2-1-0	3
CE 670	Computational Lab	0-0-4	2

CE 6XX	Flexi Core I	2-1-0	1.5
CE 6XX	Flexi Core II	2-1-0	1.5
CE 6XX/CE 4XX	Elective I	2-1-0	3
CE 6XX/CE 4XX	Elective II	2-1-0	3
CE 6XX	Scientific Communication and Research Methodology	0-1-2	2
CE 6XX	Technical Immersion	0-0-2	1
ZZ 6XX	Institute Elective	2-1-0	3
Total minimum credits earned during the semester		**20**	**20**

2nd Year: Semester-III

Course code	Course Title	Contact hours (L-T-P-C)	Credit
CE 7XX	Design of Structures	0-1-10	6
CE 7XX	Master's Thesis (Stage I)	0-0-24	12
Total minimum credits earned during the semester			**18**

2nd Year: Semester-IV

Course code	Course Title	Contact hours (L-T-P-C)	Credit
CE 800	Master's Thesis (Stage II)	0-0-36	18
Total minimum credits earned during the semester		**18**	18
Total minimum credits to be earned during the program		**74**	74

List of Flexi Core (Half-semester courses)

Course code	Course Title	Contact hours (L-T-P-C)	Credit
CE 650/CE 450	Design of Long-span Bridges	2-1-0	1.5
CE 652/CE 452	Project Management	2-1-0	1.5
CE 654/CE 454	Precast And Prefabricated Construction	2-1-0	1.5
CE 656/CE 456	Elastic Stability	2-1-0	1.5

List of Elective I & II

Course code	Course Title	Contact hours (L-T-P-C)	Credit
CE 612/CE 412	Sustainable Construction	2-1-0-3	3
CE 648/CE 448	Prestressed Concrete Design	2-1-0-3	3
CE 632/CE 432	Plastic Analysis and Design	2-1-0-3	3
CE 603	Design of Steel-Concrete Composite Structures	2-1-0-3	3
CE 610/CE 410	Offshore Engineering	2-1-0-3	3
CE 605	Condition Monitoring & Reliability Assessment	2-1-0-3	3

CE 628/ CE 428	Theory of Plates and Shells	2-1-0-3	3
CE 664/ CE 464	Advanced Solid Mechanics	2-1-0-3	3
CE 658/ CE 458	Time-series Analysis	2-1-0-3	3
CE 660/ CE 460	AI/ML Applications in Civil Engineering	2-1-0-3	3
CE 668/ CE 468	Bayesian Inference and Reliability	2-1-0-3	3

In addition to this elective course list, a student can also opt for the PG courses being offered by the other disciplines.

Institute Elective

Course code	Course Title	Contact hours (L-T-P-C)	Credit
RDT 401/601	Design Thinking for Rural Application	2-1-0	3
IE 601	Foundation for Entrepreneurship	2-1-0	3

suggestive list. The students can take courses other than those mentioned in this list.

Course Structure of M. Tech. Program in Water, Climate and Sustainability
(From AY 2023-24 to AY 2025-26)
{From AY 2026-27 onwards, M. Tech in Water, Climate and Sustainability is offered under the Mehta Family School of Sustainability)

Minimum Educational Qualification: Four-year Bachelor's degree or five-year integrated degree (with first division as defined by the awarding Institute/ University for Indian applicants and equivalent to International applicants, as assessed by the Institute) in Civil/Agricultural/ Infrastructure/Environmental/Geomatics Engineering. *Relaxation as per GoI norms in qualifying degree is applicable for SC and ST category applicants.*

Qualifying Examination:

a) Indian students: Valid GATE qualification in Civil Engineering (CE)/ Agricultural Engineering (AG)/ Environmental Science and Engineering (ES)/ Geomatics Engineering (GE)

b) International students: Valid score of TOEFL or IELTS or valid score of GRE.

Categories of Admission:

a) Indian Students: Teaching Assistantship **(TA)**; (ii) Highly motivated sponsored candidate **(SW)** on full-time basis from highly reputed R and D organizations, and highly reputed Industries; (iii) Defense Forces **(DF)**: Candidates sponsored by the Defense Forces; (iv) Regular institute staff **(IS)** of IIT Indore on part-time basis only.

b) International Students: (i) International self-financed **(ISF)** students; (ii) International students sponsored by non-government organizations or by a reputed industry **(ISW)**; (iii) International students sponsored by foreign government or its organizations or through mutual collaborative programs of India with other countries **(GSW)**

Candidates of SW, DF and IS categories will not be provided any scholarship.

- **Duration of Program:** 2 years on full-time basis.
- **Selection criteria:** GATE Score and/ or Interview (Valid GATE score compulsory for TA category)
- Total Intake: 10 (direct admission under TA category) + Sponsored candidates

Course Structure of 2-Year Full Time M. Tech. Program in Water, Climate and Sustainability

1st Year: Semester-I

Course Code	Course Title	Contact hours (L-T-P)	Credits
CE 635*	Water and Climate, Sustainability and Policies	2-1-0	3
AA 481/AA 681	Introduction to Climate and Climate Change	2-0-0	2
CE 621	Water Quality and Treatment	2-0-2	3
HS 618*	Sustainability Studies	2-1-0	3
Program Elective -I • AA 607/ AA 407: Remote sensing for Atmospheric and Space Sciences (2-0-2-3) • CE 623: Glaciology (2-1-0-1.5#)		X-X-X	3

• CE 625: Water Supply & Distribution Systems (2-1-0-1.5#) • BSE 641: Engineered Systems Analysis (2-1-0-3) • HS 626: Environment and Natural Resource Economics (2-1-0-3)			
ZZ XXX	Institute Electives -I	X-X-X	3
CE 653	Technical Site Visit (s)- Immersion Program	0-0-2	PP/NP
Total minimum credits earned during the semester			**17**
Additional course (as per the requirement basis)			
HS 641	English Communication Skills	2-0-2	PP/NP

 # Half semester course

1st Year: Semester-II

Course Code	Course Title	Contact hours (L-T-P)	Credits
CE 602/ CE 402	Water Resources Engineering	2-1-0	3
AA 410/610	Spatial Informatics (Including Geographic Information Systems)	2-1-0	3
CE 620	Climate Applications and Practices	2-0-2	3
CE XXX	PG Seminar Course	0-2-0	2
CE XXX	Technical Field Visit –Design Thinking	0-0-2	1
Program Elective II CE 640: Industrial Wastewater Management (2-0-0-2) HS 6XX: Water Governance and Conflict: A Sociological Approach (2-0-0-2) CE 646: Climate Hazards and Disaster Mitigation (2-0-0-2)		X-X-X	2
ZZ XXX	Institute Elective II	X-X-X	3
Total minimum credits earned during the semester			**17**

2nd Year: Semester-III

Course Code	Course Name	Contact hours (L-T-P)	Credits
CE 799	M. Tech. Research Project (Stage-I)	0-0-36	18
Total minimum credits earned during the semester			**18**

2nd Year: Semester-IV

Course Code	Course Name	Contact hours (L-T-P)	Credits
CE 800	M. Tech. Research Project (Stage-II)	0-0-36	18
Total minimum credits earned during the semester			**18**
Total minimum credits earned during the program			**70**

***Already approved course**

† In addition to this course list, a student can also opt from the PG courses being offered by the other Depts.

NOTE:

1. Request for conversion from M. Tech. to M. Tech. + Ph.D. dual degree will be considered after evaluating the research potential of the promising and motivating PG students at the end of the **third semester of their program.**
2. If the student opts for the Dual Degree Programme but cannot complete the requirements of a Ph.D., an **exit option** with the M. Tech. Degree can be earned at the end of the final semester of the normal M. Tech. Programme by getting the M. Tech. Research Project examined in the standard manner as per the requirements for the award of an M. Tech. degree.
3. The enhancement in the scholarship from M. Tech. to Ph.D. will be from the beginning of the fifth semester or from the date on which all requirements for the award of M. Tech. degree are fulfilled whichever is later**.**

Course Structure of M. Tech. / M. Tech. + Ph.D. Dual Degree Program in Transportation Systems Engineering from AY 2026-2027
{Senate Resolution 58.6}

Minimum Educational Qualification (MEQ): Four-year Bachelor's degree in Civil Engineering with First Division (as defined below *). For International Applicants: Equivalent qualification, as assessed by the Institute. Relaxation: 5% in qualifying degree marks for SC, ST, PwD applicants.

Qualifying Examination (QE):

(a) Indian Students: Valid GATE qualification in Civil Engineering (CE).
(b) International Students: Valid score of TOEFL or IELTS, and a valid score of GRE

Categories of Admission:

(a) Indian Students: Teaching Assistantship (TA); (ii) Highly motivated sponsored candidate (SW) on full-time basis from highly reputed R & D organizations such as DRDO, ISRO, BHEL, C-DAC, ADE, ADA, etc. and highly reputed Industries; (iii) Defense Forces (DF): Candidates sponsored by the Defense Forces; (iv) Regular institute staff (IS) of IIT Indore on part-time basis only.
(b) International Students: (i) International self-financed (ISF) students; (ii) International students sponsored by non-government organizations or by a reputed industry (ISW); (iii) International students sponsored by foreign government or its organizations or through mutual collaborative programs of India with other countries (GSW).

Candidates of the SW, DF, and IS categories will not be provided with any scholarship.

Duration of Program: 2 years on a full-time basis with a maximum extension of one semester.

Annual Intake: 10 TA and no upper cap on the non-TA students

* Marks /CGPA/ CPI/ Percentage requirements in Qualifying Degrees:

1. For UR/EWS/OBC(NCL) category:
   - A minimum of 60% marks in aggregate, OR
   - A First class as specified by the university, OR
   - A minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of 6.0 on a scale of 0 – 10, OR
   - An equivalent to 6.0 CGPA/ CPI on other corresponding proportional requirements when the scales are other than 0 – 10.
2. For SC/ST/PwD category
   - A minimum of 55% marks in aggregate, OR
   - A First class as specified by the university, OR
   - A minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of 5.5 on a scale of 0 – 10, OR

- An equivalent to 5.5 CGPA/ CPI on other corresponding proportional requirements when the scales are other than 0 – 10.

Course Structure of 2-Year Full-Time M. Tech. Program in Transportation Systems Engineering

1st Year: Semester-I

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 609/409	Advanced Traffic Engineering	2-1-0	3
CE 611/411	Transportation Planning	2-1-0	3
CE 615/415	Geometric Design of Roads	2-1-0	3
CE 617/417	Pavement Materials	2-1-0	3
CE 613	Computational Traffic Studio	0-0-3	1.5
CE 655	Pavement Materials Characterization Lab	0-0-3	1.5
CE 6XX/CE 4XX	Elective I	2-1-0	3
Total minimum credits earned during the semester			**18**

1st Year: Semester-II

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 6XX	Pavement Analysis and Design	2-1-0	3
CE 6XX	Flexi Core I	2-1-0 [Half]	1.5
CE 6XX	Flexi Core II	2-1-0 [Half]	1.5
CE 6XX/CE 4XX	Elective II	2-1-0	3
CE 6XX/CE 4XX	Elective III	2-1-0	3
CE 6XX	Technical Immersion	0-0-2	1
CE 6XX	Scientific Communication and Research Methodology	0-1-2	2
ZZ 6XX	Institute Elective	2-1-0	3
Total minimum credits earned during the semester			**18**

2nd Year: Semester–III

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 7XX	Transportation Systems Design and Integration	0-1-10	6
CE 7XX	M. Tech. Research Project (Stage-I)	0-0-24	12
Total minimum credits to be earned during the semester			**18**

2nd Year: Semester–IV

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 800	M. Tech. Research Project (Stage-II)	0-0-36	18
Total minimum credits to be earned during the semester			**18**
Total minimum credits to be earned during the program			**72**

List of Flexi Core (Half-semester courses)

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 6XX	Sustainable Transportation Systems	2-1-0	1.5
CE 6XX	Transportation Data Analysis & AI	2-1-0	1.5
CE 6XX	Road Asset Management	2-1-0	1.5
CE 6XX	Road Safety and Management	2-1-0	1.5

List of Elective I

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 619/CE 419	Urban Freight and Logistics Planning	2-1-0	3
CE 627/CE 427	Transport Economics	2-1-0	3
CE 641/CE 441	Ground Improvement Techniques	2-1-0	3
CE 629/CE 429	Transportation System Analysis	2-1-0	3
CE 631/CE 431	Airport Planning and Design	2-1-0	3

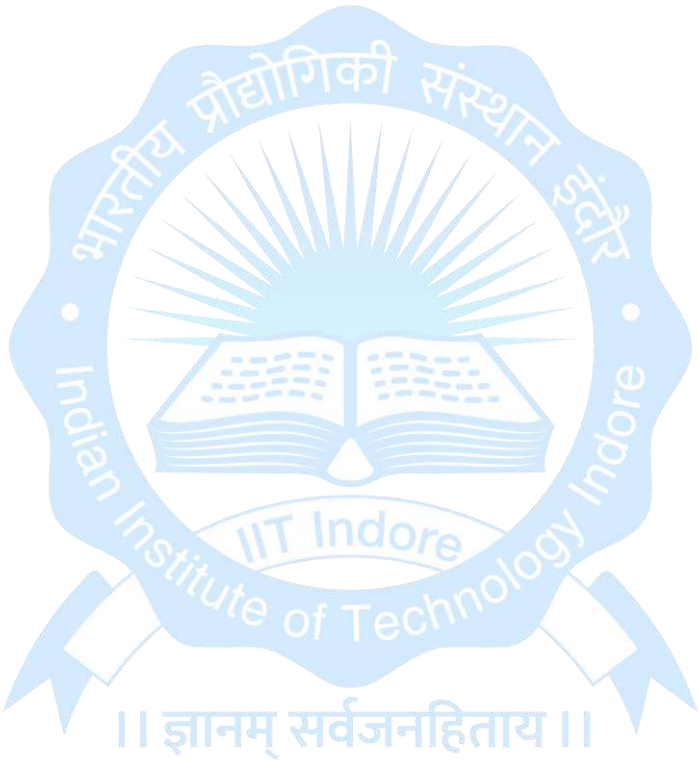
List of Electives II & III

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 6XX/CE 4XX	Urban Mass Transit Systems	2-1-0	3
CE 6XX/CE 4XX	Highway Construction Technology	2-1-0	3
CE 6XX/CE 4XX	Pavement Maintenance and Rehabilitation	2-1-0	3
CE 6XX/CE 4XX	Viscoelastic Modelling of Pavement Materials	2-1-0	3
CE 6XX/CE 4XX	Rural Road Engineering	2-1-0	3
CE 6XX/CE 4XX	Intersection Design and Control	2-1-0	3
CE 6XX/CE 4XX	Advanced Railway Engineering	2-1-0	3

@ In addition to this elective course list, a student can also opt for the PG courses being offered by the other disciplines.

NOTE:

1. Request for conversion from M.Tech. to M.Tech. + Ph.D. dual degree will be considered after evaluating the research potential of the promising and motivated PG students at the end of the third semester of their program.
2. If the student opts for the Dual Degree Program but cannot complete the requirements of a Ph.D., an exit option with the M.Tech. Degree can be earned at the end of the final semester of the normal M.Tech. Program by getting the M.Tech. Research Project examined in the standard manner as per the requirements for the award of an M.Tech. degree.
3. The enhancement in the scholarship from M.Tech. to Ph.D. will be from the beginning of the fifth semester or from the date on which all requirements for the award of M.Tech. degree are fulfilled whichever is later.



Course Structure of M.Tech. / M.Tech. + Ph.D. Dual Degree Program in Geotechnical Engineering from AY 2025-2026
{Senate Resolution 58.6}

Minimum Educational Qualification (MEQ): Four-year Bachelor's degree in Civil Engineering with First Division (as defined below *). For International Applicants: Equivalent qualification, as assessed by the Institute. Relaxation: 5% in qualifying degree marks for SC, ST, PwD applicants.

Qualifying Examination (QE):
(a) Indian Students: Valid GATE qualification in Civil Engineering (CE).
(b) International Students: Valid TOEFL/IELTS score and valid GRE score.

Categories of Admission:
(a) Indian Students: (i) Teaching Assistantship (TA); (ii) Sponsored (SW): Full-time candidates from reputed R&D organizations (DRDO, ISRO, BHEL, C-DAC, ADE, ADA, etc.) and reputed industries; (iii) Defense Forces (DF): Sponsored by Defense Forces; (iv) Institute Staff (IS): IIT Indore staff on a part-time basis only.

(b) International Students: (i) International Self-Financed (ISF); (ii) International Sponsored (ISW): Sponsored by NGOs or reputed industry; (iii) Government Sponsored (GSW): Sponsored by foreign governments/organizations or through collaborative programs with India.

Note: Candidates under SW, DF, IS categories will not be provided any scholarship.

Duration of Program: 2 years (full-time basis).

Annual Intake: 10 TA and no upper cap on the non-TA students

* Marks /CGPA/ CPI/ Percentage requirements in Qualifying Degrees:

3. For UR/EWS/OBC(NCL) category:
   - A minimum of 60% marks in aggregate, OR
   - A First class as specified by the university, OR
   - A minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of 6.0 on a scale of 0 – 10, OR
   - An equivalent to 6.0 CGPA/ CPI on other corresponding proportional requirements when the scales are other than 0 – 10.
4. For SC/ST/PwD category
   - A minimum of 55% marks in aggregate, OR
   - A First class as specified by the university, OR
   - A minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of 5.5 on a scale of 0 – 10, OR
   - An equivalent to 5.5 CGPA/ CPI on other corresponding proportional requirements when the scales are other than 0 – 10.

Course Structure of 2-Year Full-Time M. Tech. Program in Geotechnical Engineering

1st Year: Semester-I

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 633/CE 433	Advanced Soil Mechanics	2-1-0	3
CE 637/CE 437	Foundation Engineering and Design	2-1-0	3
CE 639/CE 439	Environmental Geotechnics	2-1-0	3
CE 641/CE 441	Ground Improvement Techniques	2-1-0	3
CE 657	Advanced Soil Mechanics Laboratory	0-0-3	1.5
CE 659	Geotechnical Modelling and Simulation Laboratory	0-0-3	1.5
CE 6XX/CE 4XX	Elective I	0-0-3	3
Total minimum credits earned during the semester			**18**

1st Year: Semester-II

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 6XX	Geohazards	2-1-0	3
CE 6XX	Flexi Core I	2-1-0 [Half]	1.5
CE 6XX	Flexi Core II	2-1-0 [Half]	1.5
CE 6XX/CE 4XX	Elective II	2-1-0	3
CE 6XX/CE 4XX	Elective III	2-1-0	3
CE 6XX	Technical Immersion	0-0-2	1
CE 6XX	Scientific Communication and Research Methodology	0-1-2	2
ZZ 6XX	Institute Elective	2-1-0	3
Total minimum credits earned during the semester			**18**

2nd Year: Semester-III

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 7XX	Geotechnical Infrastructure Design	0-1-10	6
CE 7XX	Master's Thesis (Stage I)	0-0-24	12
Total minimum credits earned during the semester			**18**

2nd Year: Semester-IV

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 8XX	Master's Thesis (Stage II)	0-0-36	18
Total minimum credits earned during the semester			**18**
Total minimum credits to be earned during the program			**72**

List of Flexi Core (Half-semester courses)

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 6XX	Introduction to Soil Dynamics	2-1-0	1.5
CE 6XX	Safety of Earth Structures and Reliability	2-1-0	1.5
CE 6XX	Introduction to Soil Behaviour	2-1-0	1.5
CE 6XX	Introduction to Earthquake Engineering	2-1-0	1.5

List of Elective I

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 617/CE 417	Pavement Materials	2-1-0	3
CE 643/CE 443	Reinforced Earth Structures	2-1-0	3
CE 645/CE 445	Unsaturated Soil Mechanics	2-1-0	3
CE 647/CE 447	Computational Geotechnics	2-1-0	3

List of Electives II & III

Course code	Course Title	Contact hours (L-T-P)	Credits
CE 486/CE 686	Rock Mechanics and Tunnelling Technology	2-1-0	3
CE 496/CE 696	Safety of Dams and Reservoirs	2-1-0	3
CE 605	Condition Monitoring & Reliability Assessment	2-1-0	3
CE 410/CE 610	Offshore Engineering	2-1-0	3
CE 612/CE 412	Sustainable Construction	2-1-0	3
CE 618/CE 418	Disaster Management	2-1-0	3
CE 434/CE 634	Numerical Methods in Civil Engineering	2-1-0	3
CE 484/CE 684	Advanced Concrete Technology	2-1-0	3
CE 6XX/ CE 4XX	Soil-Structure Interaction	2-1-0	3
CE 6XX/ CE 4XX	Pavement Geotechnics	2-1-0	3
CE 6XX/ CE 4XX	Geosynthetics	2-1-0	3
CE 6XX/ CE 4XX	Instrumentation and Monitoring	2-1-0	3

CE 6XX/ CE 4XX	AI/ML Applications in Civil Engineering	2-1-0	3

Institute Elective

Course code	Course Title	Contact hours (L-T-P)	Credits
RDT 401/601	Design Thinking for Rural Application	2-1-0	3
AA 610/410	Spatial Informatics	2-0-2	3
IE 601	Foundation for Entrepreneurship	2-1-0	3

Note: This is a suggestive list. The students can take courses other than those mentioned in this list.

Course Structure for Ph.D. Program in Civil Engineering

(A) Semester-I (autumn / spring)

Sr. No.	Course code	Course Title	L-T-P-Credits
1	ZZ xxx	Elective-I	x-x-x-3
2	ZZ xxx	Elective-II	x-x-x-3
3	ZZ xxx	Elective-III +	x-x-x-3
4	CE 797* / CE 798*	Ph.D. Seminar Course	0-2-0-2

(B) Semester-II (spring / autumn)

Sr. No.	Course code	Course Title	L-T-P-Credits
1	ZZ xxx	Elective- IV +	x-x-x-3
2	ZZ xxx	Elective-V +	x-x-x-3
3	ZZ xxx	Elective-VI +	x-x-x-3
4	CE 798* / CE 797*	Ph.D. Seminar Course	0-2-0-2

Note

1. A Ph.D. student having **M.Tech./M.E./M.Phil.** qualification has to do one semester coursework (with 2-3 Ph.D. level courses). Minimum number of courses will be 2 Ph.D. level courses and one Ph.D. seminar course i.e. *(minimum coursework of 8 credits)*.
2. A Ph.D. student having **B.Tech./ B.E. / M.Sc. or equivalent qualification** admitted to Ph.D. Program in an **Engineering discipline** shall do 6-8 courses of at least 3 credits each and 1-2 Ph.D. Seminar courses of at least 2 credits each. Minimum number of courses will be 6 Ph.D. level courses and one Ph.D. seminar course *(minimum coursework of 20 credits).*

   * Ph.D. Seminar course can be taken either in Autumn or in Spring Semester or both as suggested by the Faculty Advisor/Thesis Supervisor.

Electrical Engineering courses for Electives-I to VI

(in addition to these courses, students can also take courses from other disciplines)

S. No.	Course Code	Course Title	Contact Hours (L-T-P-C)
1.	CE 612/ CE 412	Sustainable Construction	2-1-0-3
2.	CE 614/ CE 414	Design of Short and Medium Span Bridges	2-1-0-3
3.	CE 618/ CE 418	Disaster Management	2-1-0-3
4.	CE 634/ CE 434	Numerical Methods in Civil Engineering	2-1-0-3
5.	CE 635	Water and climate, sustainability and policies	2-1-0-3
6.	CE 444/ CE 644	Solid Waste Engineering and Management	2-0-2-3
7.	CE 674/ CE 474	Road Safety	2-0-2-3
8.	CE 684/ CE 484	Advanced Concrete Technology	2-0-2-3
9.	CE 694/ CE 494	Earthquake Engineering	2-1-0-3
10.	CE 696/ CE 496	Safety of Dams and Reservoirs	2-1-0-3

Course Code	**CE 601 (Till AY 2025-26)**
Title of the Course	**Mechanics of Advanced Composite Materials and Structures**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To understand the mechanics, analysis, and design of composite 2D structural elements.
Course Outcomes	1. To be able to apply shear deformation models for analysis of composite structures. 2. To be able to formulate geometrically nonlinear equilibrium equations of composite structural elements. 3. To be able to formulate nonlinear code for hygrothermal analysis of composite structural elements.
Course Content	1. Introduction of composites, constituent materials, constitutive relationships for varying stackings, 2. Nonlinear analysis of composite 2D structural elements, 3. Nonlinear hygrothermal analysis, 4. Shear deformation theories for composite structures, 5. Nonlinear numerical analysis of composite structures.
Suggested Books	Textbooks: 1. M. Mukhopadhyay: *Mechanics of Composite Materials andStructures*: Universities Press: 2005: ISBN: 9788173714771 2. R. M Jones: Mechanics of Composite Materials: CRC Press: 2018: ISBN: 9781498711067 3. J.N Reddy: Mechanics of Laminated Composite Plates and Shells: CRC Press: 2003: ISBN: 9780203502808. 4. A.N. Palazotto and S.T. Dennis: Nonlinear Analysis of Shell 5. Structures: AIAA Education Series: 1992: ISBN: 9781600860911. 6. Laszlo P. Kollar and George S. Springer: Mechanics of Composite Structures: Cambridge University Press: 2003: ISBN: 9781139439596. **Reference Books:** 1. Yi-Ming Fu: Nonlinear Analyses of Laminated Plates and Shells with Damage, WIT Press: 2013: ISBN: 9781845646905. 2. E. Carrera, F. A. Fazzolari, M. Cinefra: Thermal Stress Analysis of Composite Beams, Plates and Shells: Computational Modelling and Applications, Academic Press: 2015: ISBN: 9780124200937. 3. M. Amabili: Nonlinear Vibrations and Stability of Shells and Plates, Cambridge University Press: 2008: ISBN: 9781139469029. 4. F. Tornabene, M. Bacciocchi, Anisotropic Doubly Curved Shells Higher-Order Strong and Weak Formulations for Arbitrarily Shaped Shell Structures, Società Editrice Esculapio: 2019: ISBN: 9788835328995.

Course Code	**CE 601** (From AY 2026-27)
Title of the Course	Mechanics of Advanced Composite Materials and Structures
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To understand the mechanics, analysis, and design of composite 2D structural elements.
Course Outcomes	At the end of the course, the students will be able to: • Apply shear deformation models for analysis of composite structures. • Formulate geometrically nonlinear equilibrium equations of composite structural elements. • Formulate a nonlinear code for hygrothermal analysis of composite structural elements.
Course Content	**Introduction of Composites:** Classification and characteristics of composite materials, basic terminology, and constituent materials. **Constitutive relationships for varying stackings:** Behaviour of lamina stress-strain relationship, transformation of elastic constants, inter-laminar stresses, and shear deformation theories for composite structures. **Nonlinear Analysis:** Nonlinear analysis of composite 2D structural elements, Nonlinear hygrothermal analysis, Nonlinear numerical analysis of composite structures.
Suggested Books	**Textbooks:** 1. M. Mukhopadhyay, **Mechanics of Composite Materials and Structures**, Universities Press, 2005, ISBN: 9788173714771. 2. R.M. Jones, **Mechanics of Composite Materials**, CRC Press, 2018, ISBN: 9781498711067. 3. J.N. Reddy, **Mechanics of Laminated Composite Plates and Shells**, CRC Press, 2003, ISBN: 9780203502808. 4. L.P. Kollar and G.S. Springer, **Mechanics of Composite Structures**, Cambridge University Press, 2003, ISBN: 9781139439596. **Reference Books:** 5. Y.-M. Fu, **Nonlinear Analyses of Laminated Plates and Shells with Damage**, WIT Press, 2013, ISBN: 9781845646905. 6. E. Carrera, F.A. Fazzolari and M. Cinefra, **Thermal Stress Analysis of Composite Beams, Plates and Shells: Computational Modelling and Applications**, Academic Press, 2015, ISBN: 9780124200937.

Course Code	**CE 603 (From AY 2026-27)**
Title of the Course	Design of Steel-Concrete Composite Structures
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To develop an understanding of composite structures as applied to structural engineering.
Course Outcomes	At the end of the course, the students will be able to: • Select the appropriate steel concrete composite system. • Analyze the steel concrete composite systems. • Design the steel concrete composite systems
Course Content	**Composite Systems:** Materials, loadings, composite floor systems, composite building systems, methods of analysis. **Composite beams:** Components and systems, fundamentals of composite action, shear connection, design for flexure, serviceability, prestressed beams. **Composite Columns:** Types of composite compression members, behaviour of composite columns, and special considerations. **Lateral Resisting Systems:** Types of bracing, moment resisting frames, braced frames, shear-wall design, horizontal diaphragms, and joints. **Time-dependent effects:** Creep, shrinkage, thermal effects.
Suggested Books	**Textbooks:** 1. R.P. Jhonson and Y.C. Wang, **Composite Structures of Steel and Concrete: Beams, Slabs, Columns, and Frames for Buildings**, Wiley Blackwell, 2018, ISBN: 978-1-119-40138-4. 2. D.J. Ohelers and M.A. Bradford, **Elementary Behaviour of Composite Steel and Concrete Structural Members**, CRC Press, 2020, ISBN: 9780429213960. 3. R. Narayanan, **Steel-Concrete Composite Structures**, CRC Press, 1988, ISBN: 978-1482286366. **Reference Books:** 4. Eurocode 4, **EN 1994-1-1: Eurocode 4: Design of composite steel and concrete structures**, European Committee for Standardisation, 2004. 5. Q.Q. Liang, **Analysis and Design of Steel and Composite Structures**, CRC Press, 2014, ISBN: 9780415532204. 6. J.Y.R. Liew, M.X. Xiong and B.-L. Lai, **Design of Steel-Concrete Composite Structures Using High-Strength Materials**, Woodhead Publishing, 2021, ISBN: 978-0128234365.

Course Code	**CE 603 (Till AY 2025-26)**
Title of the Course	**Design of Steel-Concrete Composite Structures**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To develop an understanding of composite structures as appliedto structural engineering.
Course Outcomes	• To be able to select the appropriate steel concrete composite system. • To be able to analyse the steel concrete composite systems. • To be able to design the steel concrete composite systems
Course Content	1. Composite Systems: Materials, loadings, composite floor systems, composite building systems, methods of analysis. 2. Composite beams: Components and systems, fundamentals of composite action, shear connection, design for flexure, serviceability, prestressed beams. 3. Composite Columns: Types of composite compression members,behavior of composite columns, and special considerations. 4. Lateral Resisting Systems: Types of bracing, moment resisting frames, braced frames, shear-wall design, horizontal diaphragms,and joints. 5. Time-dependent effects: Creep, shrinkage, thermal effects.
Suggested Books	**Textbooks** 1. Jhonson RP, and Wang YC, *Composite Structures of Steel and Concrete: Beams, Slabs, Columns, and Frames for Buildings*, Wiley Blackwell, 2018, ISBN: 978-1-119-40138-4 2. Ohelers DJ and Bradford MA, *Elementary Behaviour of Composite Steel and Concrete Structural Members*, CRC Press, 2020, ISBN: 9780429213960 **Reference Books** 1. Eurocode 4, EN 1994-1-1: *Eurocode 4: Design of composite steeland concrete structures*, European Committee for Standardisation, 2004. 2. Liang QQ, *Analysis and Design of Steel and Composite Structures*, CRC Press, 2014, ISBN: 9780415532204

Course Code	**CE 605 (Till AY 2025-26)**
Title of the Course	**Condition monitoring and reliability assessment**
Course Category	Core
Credit Structure	L-T-P-Credits 3-0-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To formulate a reliability analysis problem and predict the risk and reliability of engineering systems
Course Outcomes	• To be able to formulate condition monitoring and reliability engineering problems. • To be able to solve the damage detection, and damage prognosis problems using various data-driven and statistical methods. • To be able to fir various distribution and perform life time data analysis.
Course Content	1. Reliability concepts, Sensing and data acquisition, Damage sensitive features, 2. Detection using machine learning techniques, Random variables, Common probability distribution, 3. Distribution selection, Lifetime data analysis, Monte Carlo simulation, Multivariate distributions and correlations, Reliabilityindex with a normal random variable, 4. Reliability of repairable system, Event tree analysis, Degradationmodeling, Bayesian modeling.
Suggested Books	Textbook: 1. Ang, A.H-S. and W.H. Tang. 2006. Probability Concepts in Engineering: Emphasis on Applications to Civil and EnvironmentalEngineering (2nd ed.). John Wiley & Sons, New York ***ISBN***: 978-0-471-72064-5, 2nd Edition. Reference book 2. Benjamin, J.R. and C.A. Cornell. 1970. Probability, Statistics, and Decision for Civil Engineers. Dover Publicaions, New York. ***ISBN***-13: 978-0486780726, Reprint 2014 3. Charles R. Farrar, Keith Worden, 2012, Structural Health Monitoring: A Machine Learning Perspective, John Wiley & Sons, New York. ***ISBN***-13: 978-1119994336, First Edition 4. Michael S. Hamada, Alyson Wilson, C. Shane Reese, HarryMartz, 2008, Springer, Mathematics. ***ISBN*** 13: 9780387779485, First Edition

Course Code	**CE 605 (From AY 2026-27)**
Title of the Course	Condition Monitoring and Reliability Assessment
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	To formulate a reliability analysis problem and predict the risk and reliability of engineering systems
Course Outcomes	At the end of the course, the students will be able to: • Formulate condition monitoring and reliability engineering problems. Solve the damage detection and damage prognosis problems using various data-driven and statistical methods. • Fit various distributions and perform lifetime data analysis.
Course Syllabus	**Introduction:** Reliability concepts, sensing and data acquisition, damage sensitive features. **Condition monitoring:** Detection using machine learning techniques, random variables, and common probability distributions. **Reliability assessment:** Distribution selection, lifetime data analysis, Monte Carlo simulation, multivariate distributions and correlations, reliability index with a normal random variable. **Advanced topics and applications:** Reliability of a repairable system, event tree analysis, degradation modelling, Bayesian modelling.
Suggested Books	**Textbooks:** 1. A.H-S. Ang and W.H. Tang, **Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering,** John Wiley & Sons, 2006, ISBN: 978-0-471-72064-5. 2. R. Ranganathan, **Reliability Analysis and Design of Structures**, Jaico Publishing House, 1999, ISBN: 8172248474. **Reference Books:** 3. J.R. Benjamin and C.A. Cornell, **Probability, Statistics, and Decision for Civil Engineers**, Dover Publications, 1970 (Reprint 2014), ISBN: 978-0486780726. 4. C.R. Farrar and K. Worden, **Structural Health Monitoring: A Machine Learning Perspective**, John Wiley & Sons, 2012, ISBN: 978-1119994336. 5. M.S. Hamada, A. Wilson, C.S. Reese and H. Martz, **Bayesian Reliability**, Springer, 2008, ISBN: 9780387779485.

Course Code	**CE 607 (Till AY 2025-26)**
Title of the Course	**Analysis and Design of Tall Buildings**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To introduce the analysis and design methods of high-rise buildings among the students
Course Outcomes	• Learning of Structural systems of various types of loadings • Experience of modelling and design of high-rise buildings • Knowledge of various structural analysis software (s)
Course Content	1. Structural schemes for multi-storied buildings, gravity, lateral loadson buildings, analysis of multi- storied frames, 2. Significance of symmetry and regularity in the plan, and regularityin elevation, 3. Analysis of torsion in buildings, 4. Design of buildings with shear walls and coupled shear walls, Design and detailing of various members and beam-column jointsfor ductility, 5. The capacity design principle. Performance-based designphilosophy, 6. Design of floor slabs, raft and pile foundations. Application of MS-Excel, ETABS, and SAFE software
Suggested Books	Textbooks 1. Structural Analysis and Design of Tall Buildings: Steel and Composite Construction by B.S. Taranath 2011, Edition: 1st Publisher: CRC Press Inc, ISBN: 978-1439850893 2. Illustrated Design of Reinforced Concrete Buildings by V.L. Shah&S.R..Karve 2017, Edition: 8th Publisher: Assorted Publications, ASIN: B074M9RFFG Reference Books 3. Tall Building Structures by Bryan S. Smith & Alex Coull 1991, Edition: 1st Publisher: John Wiley & Sons, ISBN: 978-0471512370 4. High Rise Building Structures by Wolfgang Schueller 1977, Edition:1st Publisher: John Wiley & Sons, ISBN: 978-0471015307

Course Code	**CE 607 (From AY 2026-27)**
Title of the Course	Analysis and Design of Tall Buildings
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To introduce the analysis and design methods of high-rise buildings among the students
Course Outcomes	At the end of the course, the students will be able to: • Learn the structural systems of various types of loadings. • Perform the modelling and design of high-rise buildings. • Gain knowledge of various structural analysis software (s).
Course Content	**Structural systems and frame analysis:** Structural schemes for multi-storied buildings, gravity, lateral loads on buildings, analysis of multi- storied frames. **Symmetry:** Significance of symmetry and regularity in the plan, regularity in elevation. **Torsion and shear:** Analysis of torsion in buildings, design of buildings with shear walls and coupled shear walls, design and detailing of various members and beam-column joints for ductility. **Design of structures:** Capacity design principle, performance-based design philosophy, design of floor slabs, raft and pile foundations, application of MS-Excel, ETABS, and SAFE software.
Suggested Books	**Textbooks:** 1. B.S. Taranath, **Structural Analysis and Design of Tall Buildings: Steel and Composite Construction**, CRC Press Inc., 2011, ISBN: 978-1439850893. 2. V.L. Shah and S.R. Karve, **Illustrated Design of Reinforced Concrete Buildings**, Structures Publications, 2021, ISBN: 978-8190371728. **Reference Books:** 3. B.S. Smith and A. Coull, **Tall Building Structures**, John Wiley & Sons, 1991, ISBN: 978-0471512370. 4. W. Schueller, **High Rise Building Structures**, John Wiley & Sons, 1977, ISBN: 978-0471015307. 5. M. Sarikisiab, **Designing Tall Buildings Structure as Architecture**, Routledge, 2016, ISBN: 9781138886711. 6. G. Marriage, **Tall: The Design and Construction of High-Rise Architecture**, Routledge, 2019, ISBN: 1138350761.

Course Code	**CE 616**
Title of the Course	**Finite Element Methods for Structural Engineering**
Credit Structure	L-T-P-Credits 2-1-2-4
Course Category	Core
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Scope of the course (Objectives)	The course introduces finite element-based computational solution strategies addressing different aspects of structural engineering.
Course Outcomes	• To be able to formulate the FE discretized equations from linear balance laws. • To be able to identify boundary conditions and develop computer programs for FE analysis. • To be able to apply to structures undergoing deformation under different loading conditions.
Course Syllabus	1. Introduction to Finite Element Method. 2. Continuum equations of solids, constitutive models for a wide range of material behavior, including finite elasticity. 3. Finite Element analysis of continuum equations solids. 4. Implementation of the resulting algorithms in computer programs. 5. Application of computer programs to problems in Structural Engineering.
Suggested Books	Textbooks: 1. J.N. Reddy, Introduction to the finite element method, 4th Edition, McGraw-Hill Education, 2019, ISBN: 9781259861901. 2. Y.C. Fung and Pin Tong, Classical and computational solid mechanics, World Scientific, 2001, ISBN: 9789810241247. Reference Books: 3. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann, 7th Edition, 2013, ISBN: 9781856176330. 4. E. B. Tadmor, R. E. Miller, R. E. Elliot, Continuum mechanics and thermodynamics, Cambridge University Press, 2012, ISBN: 9781107008267.

Course code	**CE 620**
Title of the course	**Climate Applications and Practices**
Course Category	Core
Credit Structure	L - T - P - Credits 2-0-2-3
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	NA
Scope of the course (Objectives)	This course aims to provide a basic understanding of climate variability and change through statistical analysis. The course also explores the applicability of climate models in impact assessment studies.
Course Outcomes	Environment and sustainability: Understanding the role of climate variability and change on various sectors. Design/development of solutions: Apply the climate change models for hydrologic risk and vulnerability estimation. Modern tool usage: Analyze climate change impacts through advanced modelling and AI/ML-based techniques.
Course Content	1. Spatio-temporal distributions of temperature and precipitation – Global and Indian scenarios 2. Koppen's classification of climates, Estimation of climate variability from atmospheric observations. 3. Global circulation models and their use in climate studies and hydrologic design 4. Climate change – detection and attribution, climate feedback mechanisms. 5. Statistical analysis and modelling of climate extremes – droughts, floods, heat and cold waves 6. Climate change impact assessment through empirical models, hydrologic models, water resources planning models, AI/ML-based models. 7. Concepts of Numerical Weather Prediction 8. Case studies of climate change projection under the Intergovernmental Panel on Climate Change (IPCC).
Suggested Books	**Textbooks:** 1. Neelin, J. D.: Climate change and climate modeling. Cambridge University Press: 2010: ISBN 9780511780363. 2. Jensen, J.R.: Remote Sensing of the Environment an Earth Resource Perspective (2nd Edition): Pearson Education India: Delhi: 2009. **Reference Books:** 3. Agha Kouchak, A., Easterling, D., Hsu, K., Schubert, S., & Sorooshian, S. (Eds.): Extremes in a changing climate: detection, analysis and uncertainty: Springer: Dordrecht: 2012: ISBN: 978-94-007-4478-3. 4. Abrahart, R., Kneale, P. E., and See, L. M.: Neural networks for hydrological modeling: CRC Press: 2004: ISBN 9789058096197. 5. Wilks, D. S.: Statistical methods in the atmospheric sciences (4th Edition): Elsevier: 2019: ISBN 9780128158234.

Course Code	**CE 602/ CE 402**
Title of the Course	**Water Resources Engineering**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Exposure of Hydrology
Objectives of the course	
Course Syllabus	Rainfall and runoff, hydrograph analysis, peaks flows. Reservoir planning and operation, run-of the river schemes, storage schemes. Dams and spillways, intakes, water-conductor systems, tunnels, surge-tanks, penstocks and anchor blocks. Hydro-electric power classification and investigations. Turbines, powerhouse, irrigation, crop requirements and yields, water planning. Weirs on permeable foundations. Canals layout, stable channels, and silt control, canal losses and water-logging.
Suggested Books	1. R.K. Linsley and J.L.H. Paulhus, **Water Resources Engineering**, McGraw Hill Book Co., 1992. 2. W.P. Creager and J.D. Justin, **Hydroelectric Handbook**, John Wiley, 1968. 3. Bharat Singh, **Fundamentals of Irrigation Engineering**, Nemchand Bros., Roorkee, 1957. 4. P.N. Modi, **Irrigation water Resources and Water Power Engineering**, Standard Book House, New Delhi, 1990.

Course Code	CE 606
Title of the Course	Finite Element Methods
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course enables the learners to understand the fundamentals and application of the Finite Element Method for the analysis of Structures.
Course Outcomes	By the end of this course, students will be able to: • Discretize the structures based on appropriate boundary conditions and geometry. • Develop shape functions and resulting stress, strain, displacement, force, and stiffness matrices. • Apply the finite element method for analysis of a wide range of structures or their elements.
Course Syllabus	**Introduction:** Overview of different methods, background of finite element method, general steps, weak formulation, Ritz method, weighted residual methods. **Discretisation and shape functions:** Principles of discretisation, initial and boundary value problems, displacement formulations for different elements, coordinate systems, interpolation functions, stress function, strain functions. **Stiffness Matrix:** Stress analysis, review of theory of elasticity, development of stiffness matrix from shape functions. **Finite Element Analysis:** Development of force and displacement matrix, assembly of element matrices, application of boundary conditions, methods of analysis, free-free matrix, post-analysis stress-strain determination, numerical integrations, convergence, h-method, p-method. **Application of FEM:** One-dimensional analysis of linear spring, truss, beam, plane frame, grid, torsion, two-dimensional analysis of plane stress analysis, plane strain analysis, axisymmetric analysis, thin and thick plates and shells, semi-analytical formulations, three-dimensional elements and their degenerated forms.
Suggested Books	**Textbooks:** 1. J.N. Reddy, **Introduction to The Finite Element Method**, McGraw-Hill, 2019, ISBN: 9781259861901. 2. P.N. Godbole, **Introduction to Finite Element**, I.K. International Publishing House Pvt. Ltd., 2013, ISBN: 9789382332206. 3. O.C. Zienkiewicz, R.L. Taylor, S. Govindjee, **The Finite Element Method: Its Basis and Fundamentals**, Butterworth-Heinemann, 2009, ISBN:9780443160455. 4. C.S. Krishnamoorthy, **Finite Element Analysis - Theory and Programming,** McGraw-Hill Education, 2017, ISBN: 9780074622100. **Reference Books:** 5. T.J.R. Hughes, **The Finite Element Method - Linear Static and Dynamic Finite Element Analysis,** Dover Publications, 2012,

	ISBN: 9780486135021. 6. G. Li, **Introduction to the Finite Element Method and Implementation with MATLAB,** Cambridge University Press, 2020, ISBN: 9781108471688.

Course Code	CE 609/ CE 409
Title of the Course	Advanced Traffic Engineering
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	The course is designed to provide an understanding of traffic engineering. Through his course, students will gain knowledge of traffic flow characteristics and analysis.
Course Outcomes	At the end of the course, the students will be able to: • Understand and explain the fundamental principles of road user behavior, traffic control systems, and traffic flow theory. • Conduct and analyze traffic studies, including volume, speed, delay, and capacity assessment for various traffic conditions. • Design and evaluate signalized and unsignalized intersections considering traffic demand, control principles, and level of service.
Course Syllabus	**Introduction to Traffic Engineering, Traffic stream characteristics:** Road user and vehicle characteristics, Fundamental parameters and relations, Traffic Stream Models, Modelling vehicle arrivals: distributions to model Headways and speed. **Traffic measurement procedures:** Measurement at a Point, Measurement over a Short Section, Measurement along a Length of Road, Traffic forecasting, and growth studies. **Microscopic traffic flow modelling:** Car Following Models: Linear and Non-linear models, Lane Changing Models, Microscopic Traffic Simulation. **Macroscopic and mesoscopic models:** Traffic Flow Modelling, Traffic Analysis and Management: Capacity and Level of Service concepts, Queuing models and applications. **Traffic intersection control:** Principles of Traffic Control and Traffic Signs, Road Markings and Channelization, design of unsignalized and signalised intersections.
Suggested Books	**Text Books:** 1. C.J. Khisty and B.K. Lall, **Transportation Engineering: An Introduction**, Pearson India, 2017. ISBN: 978-9332569706. 2. R.P. Roess, E.S. Prassas, and W.R. McShane, **Traffic Engineering**, Pearson College Div, 2010, ISBN: 978-0136135739. 3. P. Chakroborty, and A. Das, **Principles of Transportation Engineering**, PHI Learning Pvt. Ltd., 2017. ISBN: 978-8120353459. **Reference Books:**

	4. A. D. May, **Traffic Flow Fundamentals**, Prentice Hall, 1990. ISBN: 978-0139260728. 5. J. L. Pline, **Traffic Engineering Handbook**, Institute of Transportation Engineers, 2006. ISBN: 978-0935403329.

Course Code	**CE 610 / CE 410 (Till AY 2025-26)**
Title of the Course	**Offshore engineering**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	None
Objectives of the course	
Course Syllabus	Linear theory of waves, brief description of higher order wave theories, random waves, probability theories. Morison? equation, wave forces on fixed and floating structures and fluid structure interaction. Soil exploration beneath seabed, criteria of foundation design in offshore environment, pile behaviour under cyclic lateral loading, development of p-y curves. Analysis of piles and foundations of gravity platforms, soil liquefaction under cyclic stresses. Various types of offshore structures and evaluation of their environmental loads. Structural idealization and analysis of forces due to wind, waves and for linear static behaviour. Wave force on inclined members, analysis of joints in offshore structures, stress concentration and fatigue life prediction. Elementary aspects of dynamic analysis and response.
Suggested Books	1 T. Sarapkaya and M. Isaacson, **Mechanics of Wave Forces on Offshore Structures**, Van Nostrand, Reinhold Co., N.Y., 1981. 2 C.A. Brebbla and S. Walker, **Dynamic analysis of Offshore Structures**, Newnes Butterworth, London, 1979.

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Course Code	CE 610/ CE 410 (From AY 2026-27)
Title of the Course	Offshore Engineering
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	To introduce the concept of offshore engineering to the students
Course Outcomes	At the end of the course, the students will be able to: • Understand the theory of waves and its applications. • Analyse the offshore structures considering various loads.
Course Syllabus	**Wave theories and forces:** Linear theory of waves, brief description of higher order wave theories, random waves, probability theories, Morison equation, wave forces on fixed and floating structures, and fluid-structure interaction. **Foundation for offshore structures:** Soil exploration beneath the seabed, criteria of foundation design in offshore environment, pile behaviour under cyclic lateral loading, and development of p-y curves, Analysis of piles and foundations of gravity platforms, soil liquefaction under cyclic stresses. **Offshore structures and their analysis:** Various types of offshore structures and evaluation of their environmental loads, structural idealisation, analysis of forces due to wind, waves and for linear static behaviour, wave force on inclined members, analysis of joints in offshore structures, stress concentration and fatigue life prediction, elementary aspects of dynamic analysis and response.
Suggested Books	**Textbooks:** 1 T. Sarapkaya and M. Isaacson, **Mechanics of Wave Forces on Offshore Structures**, Van Nostrand, Reinhold Co., 1981, ISBN: 0442254024. 2 C.A. Brebbla and S. Walker, **Dynamic analysis of Offshore Structures**, Newnes Butterworth, 2013, ISBN: 978-1483163284. **Reference Books:** 3 P. Bar-Avi and H. Benaroya, **Nonlinear Dynamics of Compliant Offshore Structures**, CRC Press, ISBN: 978-1351428248. 4 M.F. Randolph and S. Gourvenec, **Offshore Geotechnical Engineering**, CRC Press, 2017, ISBN: 978-1351988919. 5 S. Nuhu, **Offshore Platform Structural Engineering: Marine Load Analysis and Deepwater Stability Systems**, Independent publishing, 2026, ISBN: 979-8251088434.

Course code	**CE 612/ CE 412 (Till AY 2025-26)**
Title of the course	**Sustainable Construction**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any	Basic understanding of Building Materials and Building Construction
Scope of the course	This course aims to expose the students to the environmental challenges associated with the construction industry, and their management through the use of sustainable construction practices. This course will cover the use of alternate/green materials and the benefits associated with it. Students will also be exposed to emerging concepts like Life Cycle Assessment, Circular Economy, and Building Information Modelling. It is expected by the end of this course students will be able to understand and appreciate the concept of Sustainability in Construction Practices.
Course Syllabus	Sustainability in Construction: Concept of sustainability in construction, Carbon footprint, Embodied energy, Resource Management, Zero waste, 3R concept in construction Waste Utilization in Construction: Circular Economy, Value addition, local materials, Supplementary Cementitious Materials, Blended Cements, Recycled Aggregates, Refuse Derived Fuel Building Products: Fly Ash Bricks, Hollow Blocks, Precast Walls, Products for modular construction Biomaterials: Bamboo, Straw Bale, Bio Cementing, Plant-based Natural Fibers, Durability of Bio-Based Building Materials Green Building Design: Introduction to Green Building, Low Energy/ Energy Efficient Building Units, Landscape Management, Building Information Modelling (BIM) Assessment Methods: Life Cycle Assessment (LCA), Leadership in Energy & Environmental Design (LEED), Green Rating for Integrated Habitat Assessment (GRIHA).
Suggested Books	1. C. J. Kibert, ***Sustainable Construction, Green Building Design and Delivery***, John Wiley & Sons, Inc, New Jersey, 2016, 9781119055174. 2. F. Dodds, L. Beg, K. Hardcastle, M. Campbell, R. Fairclough and T. Callanan, ***Eco-efficient construction and building materials,*** Woodhead Publishing India Private Limited, New Delhi, 2014,9780857097675 3. G. M. Sabnis, ***Green Building with Concrete, Sustainable Design and Construction,*** CRC Press, Florida, 2015, 9781498704113 4. BIS, ***Coarse and Fine Aggregate for Concrete,*** *Specification,* Bureau of Indian Standards, New Delhi, 2016

Course Code	**CE 614/ CE 414 (Till AY 2025-26)**
Title of the Course	**Design of Short and Medium Span Bridges**
Credit Structure	L-T-P- Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, ifany	Design of concrete structures and design of steel structures
Objectives of the course	To provide the students a thorough understanding on the analysis and design of different types of short and medium span bridges.
Course Syllabus	• Introduction-Definition, components of a bridge, classification of bridges, selection of site, and economical span. Standard specifications for road and railways bridges, width of carriage way, clearances, types of bridges and their suitability, Indian Road Congress (IRC) loading, Indian Railway Standard (IRS) Loads and permissible stresses. • Design of RCC and PSC slab culvert bridges. • Design of RCC and PSC T-beam bridges. • Design of single span steel truss bridges and plate girder bridges. • Design of bearings, pier and pier cap.
Suggested Books	**Text Books:** • D. J. Victor, **Essentials of Bridge Engineering**, 6th Edition,Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2008 • N. K. Raju, **Design of Bridges,** 3rd Edition, Oxford & IBHPublishing Co. Pvt. Ltd., New Delhi, 2006 • N. Rajgopal, **Bridge Superstructure,** Narosa Publishing House,New Delhi, 2006 • V. K. Raina, **Concrete bridge Practice, Analysis: Design and Economics**, TMH, 2002 **Reference Books:** • E. Ellobody, **Finite Element Analysis and Design of Steel and Steel–Concrete Composite Bridges**, Elsevier Science, 2014, • J. Romo, **High-speed Railway Bridges - Concept Design Guideline**, Wiley, 2023. • H. Xia, N. Zhang, W. Guo, **Dynamic Interaction of Train-Bridge Systems in High-Speed Railways - Theory and Applications**, Springer Berlin Heidelberg, 2017.

Course Code	**CE 614/ CE 414 (From AY 2026-27)**
Title of the Course	Design of Short and Medium Span Bridges
Credit Structure	L-T-P- Credits 2-1-0-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To provide the students a thorough understanding of the analysis and design of different types of short and medium span bridges.
Course Outcomes	At the end of the course, the students will be able to: • Analyze the behaviour of short and medium span bridges. • Design the short and medium span bridges as per IS and IRC Codes.
Course Syllabus	**Introduction to design of bridges:** Definition, components of a bridge, classification of bridges, selection of site, and economical span. **Design standards:** Standard specifications for road and railway bridges, width of carriage way, clearances, types of bridges and their suitability, Indian Road Congress (IRC) loading, Indian Railway Standard (IRS) Loads and permissible stresses. **Design of bridges:** Design of RCC and PSC slab culvert bridges, design of RCC and PSC T-beam bridges, design of single-span steel truss bridges and plate girder bridges, design of bearings, pier, and pier cap.
Suggested Books	**Text Books:** 1. D.J. Victor, **Essentials of Bridge Engineering,** Oxford & IBH Publishing Co. Pvt. Ltd., 2019, ISBN: 8120417178. 2. N.K. Raju, **Design of Bridges,** Oxford & IBH Publishing Co. Pvt. Ltd., 2006, ISBN: 8120412575. 3. N. Rajgopal, **Bridge Superstructure**, Alpha Science International Ltd., 2006, ISBN: 9781842652398. **Reference Books:** 4. E. Ellobody, **Finite Element Analysis and Design of Steel and Steel–Concrete Composite Bridges**, Elsevier Science, 2014, ISBN: 0124172474. 5. J. Romo, **High-speed Railway Bridges - Concept Design Guideline**, Wiley, 2023, ISBN: 3433033137. 6. H. Xia, N. Zhang and W. Guo, **Dynamic Interaction of Train-Bridge Systems in High-Speed Railways - Theory and Applications**, Springer Berlin Heidelberg, 2017, ISBN: 9783662548691.

Course Code	**CE 618/ CE 418**
Title of the Course	**Disaster Management**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	None
Objectives of the course	To understand different types of disaster, their forecasting, prevention and mitigation methods. The course is intended to create scientific awareness amongst graduates.
Course Syllabus	Terminology-Disaster;Hazard;Vulnnerability;Risk;disaster management. Types, Causes and Consequences- Geological, hydro-meteorological, biological, technological, anthropogenic, climate change and urban disasters. Disaster management cycle- pre-disaster (risk assessment, mapping, zonation, prevention and mitigation, early warning, preparedness, awareness); during disaster (evacuation, communication, search and rescue, command system, relief and rehabilitation); post disaster (damage and needs assessment, restoration, recovery, reconstruction, hyogo framework). Disaster Management in India – Disaster profile, disaster management act, national policy, national guidelines, role of government, role of agencies. Applications of Science and Technology- GIS, GPS, RS; Early warnings and communication; Planning and development; disaster safe designs; Institutions In India.
Suggested Books	1. Coppola D P, 2007. ***Introduction to International Disaster Management***, Elsevier Science (B/H), London. 2. ***An overview on natural & man-made disasters and their reduction***, R K Bhandani, CSIR, New Delhi 3. ***Manual on natural disaster management in India***, M C Gupta, NIDM, New Delhi 4. ***Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration***, S L Goyal, Deep & Deep, New Delhi, 2006 5. ***Disasters in India Studies of grim reality***, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur 6. ***Natural Disasters***, David Alexander, Kluwer Academic London, 1999, 632 pages 7. ***High Power Committee Report***, 2001, J.C. Pant 8. ***World Disasters Report***, 2009. International Federation of Red Cross and Red Crescent, Switzerland 9. ***Encyclopedia of Disasters – Environmental Catastrophes and Human Tragedies***, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008 10. ***Disaster Management Act 2005***, Publisher by Govt. of India 11. ***Management of Natural Disasters in developing countries***, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages 12. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

Course code	**CE 621**
Title of the course	**Water Quality and Treatment**
Course Category	Core
Credit Structure	L - T - P - Credits 2-0-2-3
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	NA
Scope of the course (Objectives)	The course's goal is to increase student comprehension of the standards, requirements, effects, and treatment options related to water quality. It focuses on the causes and consequences of water contamination and the deterioration of water quality from a variety of sources. Also, it provides illustrations of each unit's procedures, their roles in the water-treatment process, and the fundamental tools that each procedure employs.
Course Outcomes	Engineering knowledge: Understanding the local, regional, and global water concerns will be made easier through this course, which will also increase students' knowledge of water quality. Environment and sustainability: Analyze pollution level and its impacts on water quality through laboratory practices. Design/development of solutions: The ability to choose, develop, and construct a suitable water treatment facility for a given locality and budget while adhering to set rules, specifications, and cost restrictions.
Course Content	**Theory** 1. Surface water quality, water quality in rivers and streams, water quality in lakes, impounded water bodies, groundwater quality, water quality standards, and drinking water safety in terms of microbiological and chemical quality. Case Studies 2. Water Purification Process in Natural Systems – Physical, chemical; biochemical processes; Response of streams to Bio-degradable organic waste. 3. Water Purification Process in Engineered Systems – Aeration; Solids Separation; Settling Operations; Coagulation; Softening; Filtration; Disinfection; Other water treatment Processes and Design Aspects. **Laboratory** 4. Water quality monitoring & Testing; Cation / anion analysis; Nitrate/nitrite/carbonate; TDS, TSS, TOC; Biological Oxygen Demand; Chemical Oxygen Demand; Residual chlorine analysis; Metal analysis; Instrumental methods of pollutant analysis; Characterization of sludge sample. 5. Isolation and purification of Microbes from water samples; Media preparation; Microscopy; Staining and detection of microbes; Direct and indirect methods for enumerating microbes; Multiple tube fermentation technique; Membrane filter technique.

Suggested Books	• Peavy, H.S., Rowe, D.R. and Tchobanoglous, G : Environmental Engineering : McGraw-Hill Book Company, New York, 696 : 1985 : 978-9351340263 • Rangwala, S.C., Rangwala, K.S. and Rangwala, P.S : Water Supply and Sanitary Engineering : *Charotar Publishing House, Anand, New Delhi 200-201 : 2009 : 978-81-85594-86-6* • Pepper, I. L., Gerba, C. P., Brendecke, J. W. : Environmental Microbiology- A Laboratory Manual : Academic Press Inc., San Diego, USA : 1995 : 9780080470511 • American Public Health Association : Standard Methods for the Examination of Water and Wastewater, 19thEdition : APHA/AWWA/WPCF Publishing, Washington, D.C. : 1995 : • Csuros, M. and Csuros, C. : Microbiological Examination of Water and Wastewater : Lewis Publishers, CRC Press, Boca Raton, Florida, USA : 1999 : 9780203747285 • Ramp, H.H., and Krist, H. : Laboratory Manual for the Examination of Water, Wastewater and Soil, VCH Publishers, Weinheim : 1988 : 978-3527284405

Course code	**CE 623**
Title of the course	**Glaciology**
Course Category	Program Elective
Credit Structure	L - T - P - Credits 2-1-0-1.5
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	NA
Scope of the course (Objectives)	The course's goal is to provide a more in-depth and quantitative understanding of glacial processes and the link between weather/climate and glaciers. The interplay of snow, ice, and climate, mass balance modeling, temperature in glaciers, glacier hydrology, and glacier dynamics are all covered in the course.
Course Outcomes	• Conduct investigations of complex problem • Demonstrate the knowledge and need for sustainable development.
Course Content	• Introduction: Glaciers, Cryosphere, snow, ice sheets and sea ice; and characteristics. • Glacier dynamics and Mass balance: Overview of glacier dynamics, ice flows, calving and glacier instabilities; glacier mass budget. Glacier mass balance gradient and glacier mass balance profile. • Glacial hazards: Glacier length and mass changes, ice avalanches, and surging glaciers • Glacier meteorology: Ice cores and paleoclimate, Melting glaciers and sea level rise, Permafrost and its features; Response to changing climate, Ice age theories, and Current issues and possible adaptations. • Energy balance over snow and glaciers: Interaction of solar radiations with atmosphere, snow and ice. • Snow and glacier hydrology

Suggested Books	**Text Books:** • Kurt Cuffey, W. S. B. Paterson: The Physics of Glaciers: ELSEVIER: USA: 2010: ISBN 9780123694614 • Shawn J. Marshall: The Cryosphere: Princeton University Press: Canada: 2011: ISBN 9780691145266 • David J. Drewry: Glacial Geologic Processes: E. Arnold: London: 1986: ISBN 0713163909 **Reference Books:** • Johannes Oerlemans: The Microclimate of Valley Glaciers: Utrecht Publishing & Archiving Services: Utrecht: 2009: ISBN 9879039353055

Course code	**CE 625**
Title of the course	**Water Supply & Distribution Systems**
Course Category	Program Elective
Credit Structure	2- 1- 0 – 1.5
Name of the Concerned Dept	Civil Engineering
Pre-requisite, if any	NA
Scope of the course (Objectives)	This course aims to impart knowledge regarding various elements of water supply & distribution systems, including components of the water distribution system, water intake structures, and water conveyance systems.
Course Outcomes	Appropriate understanding of the public health and safety, and the cultural, societal, and environmental considerations.
Course Syllabus	• Introduction: Water supply issues and concerns; Data collection for water supply scheme, its Components, Layout. • Water demand: Components; Fluctuations; Concept of Design period; Demand Forecasting. • Water intake structures: Surface water intakes; Groundwater intakes; Design considerations; Well interferences; well losses and efficiency • Conveyance System: Channels, pipes and valves used in conveyance; Testing of Materials; Pumps. • Water distribution: Water distribution networks; Analysis of water distribution; Water losses; Loss detection and control.
Suggested Books	**Textbooks:** • Davis, M.L: Water and Wastewater Engineering: Design Principles and Practice: McGraw Hill Education Publisher: New York, U.S.A: 2010: 9780071713849. • Punmia, B.C, Jain, A.K., Jain, A.K., Water Supply Engineering: Laxmi Publications: New Delhi: 2016: 978-8131807033. • Frank R. Spellman: Handbook of Water and Wastewater Treatment Plant Operations: CRC Press: Boca Raton: 2013: 9780429097317 **Reference Books:** • Gilbert M. Masters, Wendell P. Ela: Introduction to Environment Engineering and Science: Pearson New International Edition: Dallas, TX, U.S.A.: 2013: 978-1292025759

Course Code	**CE 628/ CE 428 (Till AY 2025-26)**
Title of the Course	**Theory of Plates and Shells**
Course Category	Departmental Elective
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To understand the basic concept, mathematical modeling,behavior and analysis of plate and shell structures.
Course Outcomes	• To be able to compute stresses and strains on thin plates and shells. • To be able to formulate the buckling loads of plates and shells. • To be able to formulation finite element code for solution of plate and shell equations.
Course Content	1. Thin plates and shells - Kirchoff theory, strains and stresses, constitutive relations, equilibrium equations, buckling, and numericalsolutions. 2. Thick plates and shells - Reissner-Mindlin-Naghadi theories, shear correction factors, equilibrium equations, buckling, and numerical solutions. 3. Membrane and bending theories; shallow shell theory; equilibrium equations for simple shell forms considering membrane. 4. Finite Element formulations of plate and shell elements.
Suggested Books	Textbooks: 1. S.P Timoshenko and S.W. Krieger: *Theory of Plates and Shells*, Tata McGraw-Hill Edition: 2010: 9780070701250 2. J.N Reddy: *Theory and Analysis of Elastic Plates and Shells*, CRCPress: 2006: 9780849384165 3. G.S Ramaswamy: *Design and Construction of Concrete Shell Roofs*, CBS Publishers and Distributors Pvt. Ltd: 2005: 9788123909905 4. Robert Millard Jones: *Buckling of Bars, Plates, and Shells*, Bull Ridge Publishing: 2006: ISBN: 9780978722302. Reference Books: 1. M. Reza Eslami: *Buckling and Postbuckling of Beams, Plates, and Shells*, Springer International Publishing: 2017: ISBN: 9783319623689. 2. E. Carrera, S. Brischetto, P. Nali: *Plates and Shells for Smart Structures - Classical and Advanced Theories for Modeling and Analysis*, Wiley: 2011: ISBN: 9781119951124. 3. M. S. Qatu: Vibration of Laminated Shells and Plates, Elsevier Science: 2004: ISBN: 9780080474762.

Course Code	**CE 628/ CE 428 (From AY 2026-27)**
Title of the Course	Theory of Plates and Shells
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To understand the basic concept, mathematical modelling, behaviour and analysis of plate and shell structures.
Course Outcomes	At the end of the course, the students will be able to: • Compute stresses and strains on thin plates and shells. • Formulate the buckling loads of plates and shells. • Formulate finite element code for the solution of plate and shell equations.
Course Content	**Thin plates and shells:** Kirchhoff theory, strains and stresses, constitutive relations, equilibrium equations, buckling, and numerical solutions. **Thick plates and shells:** Reissner-Mindlin-Naghadi theories, shear correction factors, equilibrium equations, buckling, and numerical solutions. **Membrane:** Membrane and bending theories, shallow shell theory, equilibrium equations for simple shell forms considering membrane. **Finite Element Analysis:** Finite element formulations of plate and shell elements.
Suggested Books	**Textbooks:** 1. S.P. Timoshenko and S.W. Krieger, **Theory of Plates and Shells**, Tata McGraw-Hill Edition, 2010, ISBN: 9780070701250. 2. J.N. Reddy, **Theory and Analysis of Elastic Plates and Shells**, CRC Press, 2006, ISBN: 9780849384165. 3. G.S. Ramaswamy, **Design and Construction of Concrete Shell Roofs**, CBS Publishers and Distributors Pvt. Ltd, 2005, ISBN: 9788123909905. 4. R.M. Jones, **Buckling of Bars, Plates, and Shells**, Bull Ridge Publishing, 2006, ISBN: 9780978722302. **Reference Books:** 5. M.R. Eslami, **Buckling and Postbuckling of Beams, Plates, and Shells**, Springer International Publishing, 2017, ISBN: 9783319623689. 6. E. Carrera, S. Brischetto and P. Nali, **Plates and Shells for Smart Structures - Classical and Advanced Theories for Modeling and Analysis**, Wiley, 2011, ISBN: 9781119951124. 7. M.S. Qatu, **Vibration of Laminated Shells and Plates**, Elsevier Science, 2004, ISBN: 9780080474762.

Course Code	**CE 632/ CE 432 (From AY 2026-27)**
Title of the Course	Plastic Analysis and Design
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	The course aims to expose the students to the concepts of Plastic analysis and design
Course Outcomes	At the end of the course, the students will be able to: • Learn basic concepts of plastic collapse and elastic-plastic state. • Learn the methods of analysis and design. • Apply the principles to planar and space structures.
Course Content	**Introduction:** Yield conditions and concepts of simple plastic collapse, collapse criterion, virtual work in elasto-plastic state, theorems of plastic collapse. **Methods of analysis and design:** Graphical method, method of combining mechanisms, computer-aided elasto-plastic analysis, interaction diagrams. **Applications to planar and space structures:** Multi-bay frames, multistoried frames, grids, arches, virendeel girders, deflection at collapse, incremental collapse, minimum weight analysis, variable repeated loads, shakedown analysis, combined stress problems.
Suggested Books	**Textbooks:** 1. J. Heyman, **Beams and Framed Structures,** Pergmon Press, Oxford, 2013, ISBN: 978-1483160580 2. B.G. Neal, **Plastic Methods of Structural Analysis**, Chapman and Hall, 1966, ISBN: 0412201208 3. M.R. Horne and B.G. Neal, **Plastic Theory of Structures: In SI/ Metric Units**, Pergamon Press, 2014, ISBN: 978-1483188454 **Reference Books:** 4. H.B. Harrison, **Structural Analysis and Design: Some Microcomputer Applications**, Pergman Press, 2014, ISBN: 978-1483299129 5. P.G. Hodge, **Plastic Analysis of Structures**, Krieger Pub. Co., 1981, ISBN: 0898741610 6. J.A. Konig, **Shakedown of Elastic-Plastic Structures**, Elsevier, 2012, ISBN: 978-0080983844

Course Code	**CE 632/ CE 432 (Till AY 2025-26)**
Title of the Course	**Plastic Analysis and Design**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	None
Objectives of the course	
Course Syllabus	Yield conditions and concepts of simple plastic collapse, collapse criterion, virtual work in elasto-plastic state, theorems of plastic collapse, methods of analysis and design. Graphical method, method of combining mechanisms, computer aided elasto-plastic analysis, interaction diagrams, applications to planar and space structures – multi-bay frames,, multistoried frames, grids, arches, virendeel girders, deflection at collapse, incremental collapse, minimum weight analysis, variable repeated loads, shakedown analysis, combined stress problems.
Suggested Books	1 J. Heyman, **Beams and Framed Structues**, Second ed., Pergmon Press, Oxford. 2 B.G. Neal, **Plastic Methods of Structural analysis**, Chapman and Hall. 3 M.R. Horne, **Plastic theory of structures**, 2nd Ed., Pergamon Press, 1979. 4 H.B. Harrison, **Structural analysis and Design**, 2ndf Ed., Pergman Press. 5 P.G. Hodge, (Jr.), **Plastic Analysis of Structures**, McGraw Hill. 6 J.A. Koing, **Shakedown of Elastic-Plastic Structures**, Elsevier, 1987. 7 A.A. Cyras, **Mathematical Models for the analysis and Optimization of Elasto Plastic Structures**, Ellis Horwood Ltd., 1983. 8 J. Baker and J. Heyman, **Plastic Design of Frames**, Cambridge University Press, 1969. 9 B.P.Parikh, J.H. Daniels and L. Lu, **Plastic Design of Multi-story frames Design aids**, Lehigh University, Bethlhem Pennsylvania.

॥ ज्ञानम् सर्वजनहिताय ॥

Course code	**CE 634/ CE 434**
Title of the course	**Numerical Methods in Civil Engineering**
Credit Structure	L - T - P - Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any	NA
Scope of the course	This course is designed for mainly engineering students to enhance their numerical techniques. In engineering, many complex problems do not have explicit analytical solutions, and in these cases, numerical techniques are extremely beneficial. In addition to providing basic numerical strategies, this course introduces some advanced concepts for solving non-linear differential and integral equations, which are expected to be helpful in B.Tech., M.Tech., and Ph.D. thesis works.
Course Syllabus	Computer applications in Civil Engineering, typical problem categories, techniques for linear problems, techniques for nonlinear problems. Iterative solutions for linear and non-linear systems. Algorithms in time domain using Runge - Kutta methods. Newmark B-method and finite-difference approaches, concept of stability of algorithm, propagation of errors in different algorithms. Numerical Differentiation, Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems. Numerical solutions of integral equations, Types of integral equations. Fredholm integral equations of the first and second kind. Fredholm_s Alternative theorem. Collocation and Galerkin methods for solving integral equations. Use of commercial software for Civil Engineering Problems.
Suggested Books	1. A. Jennujs, ***Matrix computations for Engineers and Scientists***, John Wiley & Sons, Rumford, ME, USA, 1977, 978-0471994213 2. S.D. Conte and C-de Boor, ***Elementary Numerical Analysis***, **An algorithmic approach**, McGraw Hill, New York, USA , 1980 , 978-0070662285 3. G. Dahlquist and Å. Bjorck, ***Numerical Methods***, Dover Books, NY, USA , 2003 , 978-0486428079 4. S.Guha and R. Srivastava, ***Numerical Methods,*** *O*xford University Press, 2010, 019-569348-5

॥ ज्ञानम् सर्वजनहिताय ॥

Course code	**CE 635**
Title of the course	**Water and climate, sustainability and policies**
Credit Structure	L - T - P - Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any	NA
Scope of the course	The course aims to provide an overview of global water and climate change including socioeconomic issues. The course will provide an introduction to the global challenges of achieving water security in the context of sustainable development and policies, illustrated through case studies. The course is designed for undergraduate and graduate students interested in water management and climate changes issues.
Course Syllabus	Review of climate change aspects, Introduction to ecosystem services, importance of water availability for crop water production, basic principles of irrigation under climate change, water- climate-energy nexus, importance of groundwater management, Drought-types and index used, significance and roles of sustainability, Sustainability of river and ground water resources, resilience of hydrologic systems, simulation and modeling through case studies, socio- economic consideration, adaptation, Review of water policies, Framework of water policies in consideration of supply and demand.
Suggested Books	1. E. Kolokytha, Soishi and R. S.V. Teegavarapu, ***Sustainable Water Resources Planning and Management Under Climate Change***, Springer, Heidelberg, 2016, 978-9811020513 2. S. Shrestha, M. S. Babel and V. P. Pandey, ***Climate Change and Water Resources***, CRC Press,Taylor and Francis Group, Boca Raton, 2014, 978-1466594661 3. C. F. Fung, A. Lopez and M. New, ***Modelling the Impact of Climate Change on Water Resources,*** Wiley-Blackwell, West Sussex, 2010, 978-1405196710

।। ज्ञानम् सर्वजनहिताय ।।

Course code	**CE 640**
Title of the course	**Industrial Wastewater Management**
Course Category	Departmental Elective
Credit Structure	L-T-P-Credits 2-0-0-2
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	NA
Scope of the course (Objectives)	This course aims to impart knowledge regarding various elements of industrial wastewater management including characteristics of industrial wastewaters, design of common effluent treatment plants and various advanced wastewater treatment techniques.
Course Outcomes	Design/development of solutions: Understanding the impact of professional engineering solutions in societal and environmental contexts and demonstrating the knowledge of and need for sustainable development.
Course Content	1. Physical, chemical and biological properties of industrial wastewater, Difference between industrial and municipal waste waters, Effects of industrial effluents on sewers and treatment plants. 2. Characteristics and composition of effluent and different methods of treatment & disposal of effluent for different industries: Steel, Petroleum Refineries, Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries. 3. Common Effluent Treatment Plants (CETPs)- Location, need, design, operation & maintenance problems and economical aspects. 4. Wastewater Treatment Methods: Nitrification and De-nitrification – Phosphorous removal – Heavy metal removal – Membrane Separation Process – Air Stripping and Absorption Processes –Adsorption –Special Treatment Methods – Disposal of Treated Waste. 5. Statistical analysis and modelling in wastewater treatment: Activated sludge, Adsorption Isotherm, biofilm models.
Suggested Books	**Textbooks:** 1. W. Wesley Eckenfelder: Industrial Wastewater Pollution Control: McGraw-Hill: New York: 1999: 978-0070393646. 2. Arceivala, S. J., Asolekar S. R.: Wastewater Treatment for Pollution Control: McGraw-Hill: Noida, India: 1998: 9780070620995 **Reference Books:** 1. Frank Woodard, Butterworth Heinemann: Industrial waste treatment Handbook: New Delhi, India: 2001: 9780080495392. 2. Water Environment Federation: Wastewater Treatment Process Modeling, MOP31: McGraw-Hill Education: New York: 2014: 9780071798426 Indian standards: IS: 2490 (1963), IS: 3306 (1065).

Course code	**CE 444/ CE 644**
Title of the course	**Solid Waste Engineering and Management**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Civil Engineering
Pre-requisite if any	NA
Scope of the course	This course aims to impart knowledge regarding various elements of waste management, including Municipal and Industrial sources highlighting the related engineering principles, processes, and treatment.
Course Outcomes	Understanding the impact of professional engineering solutions in societal and environmental contexts and demonstrating the knowledge of and need for sustainable development.
Course Syllabus	**Introduction to Solid Waste Management**: Definitions; Classification of Wastes; Different waste streams and their sources; Waste generation rates and its Quantification; Waste Composition; Solid waste management system in India. **Solid Waste Management Strategies & Technologies**: Concept of 3R's, Municipal Solid Waste Management functional system, Biological Treatment (Anaerobic digestion, Composting), Thermal Treatment (Pyrolysis, Incineration), Refused derived fuels, Sanitary Landfilling; Lifecycle Assessment approach in Solid Waste Management Systems. **Engineering Aspects of Solid Waste Management**: Concept of Circular Economy, Appropriate Waste Processing Technology Selection techniques, Sampling and Physico-chemical characterization of Solid Wastes; Design of Reactors/Engineering systems for treatment of Organic waste streams viz composting, biomethanation, RDF and Gasification, Kinetics of organic waste degradation, Site Selection for landfills, Design aspects of Sanitary Engineered landfills. **Legislations for Solid Waste Management**: Salient features of Indian Legislations on management and handling of different waste streams, Overview of various Government Initiatives including Swachh Bharat Mission, GOBAR-dhan (Galvanizing Organic Bio-Agro Resources) Scheme, Jal Shakti Abhiyaan, Waste to Energy. **Practical Demonstrations**: Real-time practical demonstration of solid waste sampling techniques, Characterization, and Treatment of solid waste. **Site Visits:** Case studies of different cities of India, Visiting Operational Waste to Energy plants/Biogas plants/Composting plants/ Waste Recycling plants/Sanitary Landfill sites.
Suggested books	**Textbooks:** • Tchobanoglous, G., Theisen, H., & Vigil, S. A.: Integrated Solid Waste Management: Engineering Principles and Management Issues: McGraw-Hill Education: New York, USA: 2019: 9781259848789 **Reference Books:** • Kumar, S.: Municipal Solid Waste Management in Developing Countries: CRC Press: New Delhi, India: 2020: ISBN-13: 978-0367574284.

Course code	**CE 646**
Title of the course	**Climate Hazards and Disaster Mitigation**
Course Category	Departmental Elective
Credit Structure	L - T - P - Credits 2-0-0-2
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	Nil
Scope of the course (Objectives)	This course provides an overview of the climate hazards such as floods, droughts, and temperature-related disasters, and studying their regional impacts for devising disaster mitigation plans to counter them.
Course Outcomes	Problem analysis: Identify the potential drivers of climate hazards and document their global and regional impacts. Conduct investigations of complex problems: Apply statistical techniques for analysis and modelling of climate hazards. Modern tool usage: Employing modern tools and techniques to devise region-specific disaster mitigation plans.
Course Content	Climate hazards and disasters; role of climate change and climate variability, climate hazard profile of India. Types of floods – pluvial, fluvial, coastal, glacial, and estuarine floods; flood frequency analysis; flood management; cyclones and tropical storms. Types of droughts – agricultural, meteorological, hydrological, and anthropogenic droughts; drought indices; drought severity and vulnerability. Heat and cold waves – definition, causes, detection, and impacts; urban heat island. Science meets policy; Disaster risk reduction under sustainable development goals (SDGs); economics of disasters; emergency and humanitarian response; The Disaster Management Act, 2005 (India).
Suggested Books	**Textbook:** Simonović, S. P.: Floods in a changing climate - Risk management: Cambridge University Press: New York: 2012: ISBN 9781139088404. Şen, Z.: Applied drought modeling, prediction, and mitigation: Elsevier: 2012: ISBN 978-0-12-802176-7. Manish Kumar Goyal, Anil Kumar Gupta, Akhilesh Gupta, Hydro-Meteorological Extremes and Disasters, Springer, 2022, Pages 1-300, ISBN: 978-981-19-0725-8 **Reference book:** Quevauviller, P. (Eds.).: Hydrometeorological hazards - Interfacing science and policy. John Wiley and Sons: Sussex: 2014: ISBN 978-1-118-62957-4. NIDM: Mapping climatic and biological disasters in India: National Institute of Disaster Management: New Delhi: 2021: ISBN: 978-81-955009-1-8.

Course Code	**CE 648/ CE 448 (Till AY 2025-26)**
Title of the Course	**Prestressed Concrete Design**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To study the effect of initial stresses in the concrete for structural engineering applications.
Course Outcomes	• Learning of initial stress effect into the concrete • Stress and strain behavior of Prestressed concrete • Design of prestressed structural elements
Course Content	1. Introduction of prestressing, Materials required Prestressing systems and methods of prestressing, Analysis of prestressed concrete sections, and prestress losses. 2. Prestressed concrete slabs, beams, tank, and pipes, Prediction of long-term deflections due to creep and shrinkage, use of relevant codes of practice, 3. Partial prestressing, Methods of achieving partial prestressing, Merits and demerits of partial prestressing.
Suggested Books	Textbook 1. Prestressed Concrete by N. Krishna Raju, 2018, Edition: 6th Publisher: McGraw Hill Education. ISBN: 978-9387886209 2. Design Of Prestressed Concrete by H. Nilson 1987, Edition: 2nd Publisher: John Wiley & Sons, ISBN: 978-0471830726 Reference Book 3. Design of Prestressed Concrete Structures by Tung-Yen Lin, 2010 Edition: 3rd, Publisher: John Wiley & Sons, ISBN: 978-9812531179

Course Code	**CE 648/ CE 448 (From AY 2026-27)**
Title of the Course	Prestressed Concrete Design
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To study the effect of initial stresses in the concrete for structural engineering applications.
Course Outcomes	At the end of the course, the students will be able to: • Learn the initial stress effect on the concrete. • Understand stress and strain behavior of prestressed concrete. • Design of prestressed structural elements.
Course Content	**Introduction:** Introduction of prestressing, advantages, materials required, prestressing systems, and methods of prestressing. **Analysis and design:** Analysis of prestressed concrete sections, prestress losses, prestressed concrete slabs, beams, tanks, and pipes, prediction of long-term deflections due to creep and shrinkage, use of relevant codes of practice. **Partial prestressing:** Partial prestressing, methods of achieving partial prestressing, merits and demerits of partial prestressing.
Suggested Books	**Textbooks:** 4. N.K. Raju and A. Laskar, **Prestressed Concrete,** McGraw-Hill Education, 2025, ISBN: 9364442032. 5. H. Nilson, **Design of Prestressed Concrete**, John Wiley & Sons, 1987, ISBN: 978-0471830726. 6. S.B. Singh, **Analysis and Design of Prestressed Concrete Structures**, Wiley, 2023, ISBN: 9354644155. **Reference Books:** 7. N.K. Raju, **Prestressed Concrete Problems and Solutions**, CBS Publishers, 2017, ISBN: 8123925425. 8. T.Y. Lin, **Design of Prestressed Concrete Structures**, John Wiley & Sons, 2010, ISBN: 978-9812531179. 9. F.K. Kong and R.H. Evans, **Reinforced and Prestressed Concrete**, CRC Press, 1987, ISBN: 041924560X.

Course Code	CE 650/CE 450
Title of the Course	Design of Long Span Bridges
Credit Structure	L-T- P-Credits 2-1-0-1.5 [3/2 half-semester]
Course Category	Flexi Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course provides an in-depth understanding of the design, analysis, construction, and maintenance of long-span bridges.
Course Outcomes	By the end of this course, students will be able to: • Select appropriate materials and structural systems for long-span bridges. • Analyse and design the bridges under gravity and lateral loads. • Assess dynamic loads due to wind and seismic actions and suitable control mechanisms. • Propose maintenance, retrofitting, and restoration strategies.
Course Syllabus	**Introduction:** Overview of long span bridges, design philosophy based on strength, serviceability, fatigue and aesthetics. **Dynamic loads:** Wind and seismic loads, aeroelastic effects, vibration control, aerodynamic shaping, ship/barge impacts, temperature and shrinkage effects. **Plate girder and composite deck bridges:** Dead and live loads, lateral loads and deflection control, shear connectors, design example. **Balanced cantilever bridges:** General arrangements and applications, support systems, distribution of shear, design example. **Cable-stayed bridges:** Components, pylon systems, stay arrangements, deck–tower interaction, dynamic behaviour, design example. **Maintenance and rehabilitation:** Primary functions, inspection strategies and necessary instruments, repair and rehabilitation techniques, restoration of the strength of concrete and prestressed bridges. **Case studies on the failure of long-span bridges**
Suggested Books	**Textbooks:** 1. X. Gongyi, and L. Daxing, **Design of Long Span Railway Suspension Bridges,** Springer Nature Singapore, 2025, ISBN: 9819983940. 2. F. Richard, **Bridge failures and lessons learnt: future-proofing to prevent disasters**, Ernst & Sohn (A Wiley Company), 2025, ISBN: 9781836085584 (e-book). 3. N.K. Raju, **Design of Bridges,** Oxford & IBH Publishing Co. Pvt. Ltd., 2019, ISBN: 8120417984. 4. V.K. Raina, **Concrete Bridge Practice: Analysis, Design and Economics**, Shroff Publishers, 2014, ISBN: 9351103560. **Reference Books:** 5. H. Svvensson, **Cable-Stayed Bridges-Forty Years of Experience Worldwide**, Ernst & Sohn (A Wiley Company), 2012, ISBN: 3433029923. 6. E. Ellobody, **Finite Element Analysis and Design of Steel and Steel–Concrete Composite Bridges**, Elsevier Science, 2014, ISBN:

	0124172470. 7. J. Romo, **High-speed Railway Bridges - Concept Design Guideline**, Wiley, 2023, ISBN: 3433033137. 8. H. Xia, N. Zhang and W. Guo, **Dynamic Interaction of Train Bridge Systems in High-Speed Railways - Theory and Applications**, Springer Berlin Heidelberg, 2017, ISBN: 3662548691.

Course Code	**CE 651 (From AY 2026-27)**
Title of the Course	Structural Engineering Lab
Credit Structure	L-T- P-Credits 0-0-6-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Objectives of the course	To develop an understanding in practical hands-on experience on the applications of Structural Engineering
Course Outcomes	By the end of the course, students will be able to: • Solve practical hands-on experiments in Structural Engineering. • Conduct practical experiments to gain hands-on experience on the applications of Structural Engineering.
Course Syllabus	Students will perform the following representative experiments: • To study the behaviour of trusses in terms of deflections. • To study the behaviour of bridge systems in terms of deflections and strains. • To learn the testing of large elements under a load frame. • To study the behaviour of materials under fatigue. • To study the behaviour of materials under impact. • To study structural elements under the different rates of loading, instrumentation for testing.
Suggested Books	**Reference Books:** 1. I.A. Karnovsky and O. Lebed, **Advanced Methods of Structural Analysis,** Springer, 2021, ISBN: 9783030443931. 2. S.P. Timoshenko and D.H. Young, **Elements of Strength of Materials**, East West Press, 2002, ISBN: 9788176710190. 3. J.W. Dally and W.F. Riley, **Experimental Stress Analysis**, McGraw-Hill Inc., 1978, ISBN: 978-0070152045.

।। ज्ञानम् सर्वजनहिताय ।।

Course Code	CE 652/CE 452
Title of the Course	Project Management
Credit Structure	L-T- P-Credits 2-1-0-1.5 [3/2 half-semester]
Course Category	Flexi Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course enables the learners to understand the fundamentals of project management and their application in construction-related projects.
Course Outcomes	By the end of this course, students will be able to: • Understand project life cycle, develop project schedules, and apply project management techniques. • Perform cost estimation and budgeting, including cost-benefit analysis. • Plan, allocate and manage construction resources. • Identify project risks and apply quality control methods. • Understand the fundamentals of construction contracts.
Course Syllabus	**Project Life Cycle and Planning:** Introduction to project management, phases of project cycle, work breakdown structure, development of project activity networks, Gantt charts, precedence diagram method, critical path method (CPM), program evaluation and review technique (PERT), schedule compression techniques, delay analysis and mitigation, line balance methods in scheduling, crashing of project schedules, earned value analysis (EVA). **Cost Estimation and Budgeting:** Overview of construction costs, time value of money, investment analysis, cost-benefit analysis, financial management principles and cash flow analysis. **Resource Management:** Resources in construction, resource planning and management, resource allocation and levelling. **Risk Management and Quality Control:** Identification and assessment of project risks, qualitative and quantitative risk analysis, project quality assurance and control systems, Lean construction.
Suggested Books	**Textbooks:** 1. K.K. Chitkara, **Construction Project Management: Planning, Scheduling and Controlling,** McGraw-Hill Education, 2019, ISBN: 9789353166274. 2. K.N. Jha, **Construction Project Management,** Pearson Education India, 2015, ISBN: 9789332542013. 3. P.S. Gahlot and B.M. Dhir, **Construction Management and Planning,** New Age International Publishers, 2014, ISBN: 9786520144431. **Reference Books:** 4. A.D. Marco, **Project Management for Facility Construction: A Guide for Engineers and Architects,** Springer, 2018, ISBN: 9783319754314. 5. S.K. Sears, G.A. Sears and R.H. Clough, **Construction Project Management,** Wiley, Hoboken, USA, 2015, ISBN: 978-1118745052.

Course Code	CE 654/ CE 454
Title of the Course	Precast and Prefabricated Construction
Credit Structure	L-T- P-Credits 2-1-0-1.5 [3/2 half-semester]
Course Category	Flexi Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course enables the learners to understand the fundamentals, on-site practices, and analysis methods for precast and prefabricated construction.
Course Outcomes	By the end of this course, students will be able to: • Understand the concept and different types of precast and prefabricated construction. • Appreciate the special considerations related to the materials, manufacturing, transportation, handling, erection, design, and analysis of precast and prefabricated construction.
Course Syllabus	**Introduction:** Comparison with traditional cast-in-situ methods, advantages of precast technology including quality control, speed, and sustainability, types of prefabrication, modular coordination and standardisation principles, emerging technologies and innovations. **Materials and Manufacturing:** Materials used in precast elements, design considerations for precast slabs, beams, columns, and walls, non-structural precast components. **Handling and Erection:** Handling techniques, and erection methods for different precast elements, installation sequencing and temporary supports. **Design and Analysis:** Load paths in precast concrete systems, limit state design concepts, handling and erection stresses, design of various precast elements for flexure, shear, and bearing capacity, connection design including bolted, welded, and grouted joints.
Suggested Books	**Textbooks:** 1. A. Steinle, H. Bachmann and M. Tillmann, **Precast Concrete Structures,** Wiley-VCH Verlag GmbH & Co. KGaA, 2019, ISBN: 9783433032251. 2. K.S. Elliott, **Precast Concrete Structures,** The Concrete Centre, 2016, ISBN: 9781498723992. 3. P. Meuser, **Prefabricated Housing: Construction and Design Manual,** DOM publishers, 2020, ISBN: 9783869220215. **Reference Books:** 4. M. Levitt, **Precast Concrete: Materials, Manufacture, Properties and Usage,** CRC Press, 2019, ISBN: 9780367864033. 5. A. Haddad and M. Noguchi (Eds.), **Prefabricated Construction for Sustainability and Mass Customization,** Intech Open, 2024, ISBN: 9781837692521.

Course Code	CE 656/ CE 456
Title of the Course	Elastic Stability
Credit Structure	L-T- P-Credits 2-1-0-1.5 [3/2 half-semester]
Course Category	Flexi Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	To understand different states of structural stability and solution approaches for the critical loads of structural members.
Course Outcomes	By the end of this course, students will be able to: • Compute bifurcation points on the equilibrium path and calculate buckling loads of beams, columns, trusses, and plates. • To be able to solve stability equations using different numerical approaches.
Course Syllabus	**Introduction:** Definition, bifurcation of equilibrium, post-buckling behaviour. **Stability analysis:** Stability analysis of beam, column, truss and plates. **Approximate methods:** Rayleigh, Timoshenko, and Ritz methods. **Non-linear stability:** Numerical approaches to solve the non-linear stability problems.
Suggested Books	**Textbooks:** 1. N.G.R. Iyengar, **Elastic Stability of Structural Elements**, Macmillan India, 2007, ISBN: 9780230631861. 2. S.P. Timoshenko and J.M. Gere, **Theory of Elastic Stability**, Dover Publications, 2012, ISBN: 9780486134802. 3. A. Kumar, **Stability of Structures: McGraw-Hill Education**, 1998, ISBN: 978-0074515167. **Reference Books:** 4. D. Bushnell, **Computerized Buckling Analysis of Shells, Springer Netherlands**, 2012, ISBN: 9789400950634. 5. S. Jerath, **Structural Stability Theory and Practice Buckling of Columns, Beams, Plates, and Shells**, Wiley, 2020, ISBN: 9781119694496. 6. M. Pignataro, N. Rizzi and A. Luongo, **Stability, Bifurcation and Postcritical Behaviour of Elastic Structures**, Elsevier Science, 2013, ISBN: 9781483290836. 7. G. Simitses and D.H. Hodges, **Fundamentals of Structural Stability**, Elsevier Science, 2006, ISBN: 9780750678759.

Course Code	CE 658/ CE 458
Title of the Course	Time-series Analysis
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course enables the learners to model and analyze civil engineering data such as traffic flow, hydrological records, wind loads, and structural vibration signals, using statistical models to identify patterns, dependencies, and long-term trends.
Course Outcomes	By the end of this course, students will be able to: • Learn to identify and analyze the fundamental components of time series data, including trend, seasonality, and noise. • Apply statistical models to time series data, such as AR, MA, and ARMA, for univariate and multivariate analysis. • Learn to forecast future trends and values by applying various forecasting methods and understanding their strengths and limitations for different civil engineering applications.
Course Syllabus	**Fundamental Concepts:** Basics of stochastic processes, autocorrelation functions, and linear difference equations. **Stationary Time Series Models:** Autoregressive (AR), moving average (MA), and mixed autoregressive moving average (ARMA) models. **Non-stationary Time Series Models:** Non-stationarity in the mean, autoregressive integrated moving average (ARIMA) models, change point models. **Seasonal Models:** Seasonal ARIMA models, multiplicative seasonal ARMA models, and nonstationary seasonal ARIMA models. **Forecasting:** Minimum mean square error forecasts. **Parameters estimation:** Method of Moments, Least Squares Estimation, and Maximum Likelihood Method.
Suggested Books	**Textbooks:** 1. J.D. Cryer and K.-S. Chan, **Time series analysis: with applications in R**, Springer, 2008, ISBN: 978-0-387-75958-6. 2. P.S. Cowpertwait and A.V. Metcalfe, **Introductory time series with R**, Springer Science & Business Media, 2009, ISBN: 978-0-387-88697-8. 3. G.E.P. Box, G.M. Jenkins, G.C. Reinsel and G.M. Ljung, **Time Series Analysis: Forecasting and Control**, Wiley, 2015, ISBN: 1118675029. 4. P.J. Brockwell and R.A. Davis, **Time Series: Theory and Methods, 2nd Ed.**, Springer-Verlag, 2009, ISBN: 978-0-387-97429-3. **Reference Books:** 5. R.H. Shumway and D.S. Stoffer, **Time series analysis and its applications: with R examples**, Springer New York, 2006, ISBN: 978-1-4419-7864-6. 6. G. Kirchgassner and J. Wolters, **Introduction to Modern Time Series Analysis**, Springer, 2012, ISBN: 978-3-642-33435-1.

Course Code	**CE 660/ CE 460**
Title of the Course	AI/ML Applications in Civil Engineering
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course introduces Artificial Intelligence (AI) and Machine Learning (ML) techniques from a practical, civil-engineering-centric perspective.
Course Outcomes	By the end of the course, students will be able to: • Understand and apply basic AI/ML methods within civil engineering domains. • Use modern tools like LLMs, CNNs, and PINNs for engineering design, prediction, and decision-making. • Evaluate model performance and interpret results in the context of civil infrastructure. • Develop data-driven solutions for real-world problems using Python and ML libraries.

Course Syllabus	**Introduction to AI/ML and Tools:** Motivation, definitions, scope, AI/ML vs traditional simulation methods, supervised & unsupervised learning, regression, classification, clustering, dimensionality reduction, performance metrics. Tools: Python, scikit-learn, pandas, matplotlib.
	Pattern Recognition, Forecasting and Image-Based Analysis: Identification, detection, or labelling of materials, defects, or risks. Time-series or regression-based predictions for physical systems.
	Risk Assessment and Safety Monitoring: Identifying hazards, anomalies, or safety-critical events.
	Applications in Civil Engineering using AI/ML methods: Such as pattern recognition for crack and surface defect detection, safety issue detection, load and displacement prediction, flood forecasting, traffic volume prediction, and others.
	Emerging AI in Civil Engineering: Cutting-edge AI methods such as physics-Informed neural networks (PINNs), large language models (LLMs), vision-language models (VLMs), graph neural networks (GNNs), responsible AI, ethical, interpretable, and safe use of AI/ML in civil infrastructure.
	
	List of representative experiments:
	• Crack detection on the concrete surface.
	• Damage prediction in bridges using dynamic data of sensors such as accelerometers.
	• Digital twin of a model truss bridge and real-time monitoring.
	• Object detection and tracking on roads.
	  ○ Detecting stationary objects such as road signs.
	  ○ Detecting dynamics objects and tracking such as vehicles, pedestrian and stray animals.
	• Land use detection and forecasting from satellite imagery.

Suggested Books	**Textbooks:** 1. I. Goodfellow, Y. Bengio and A. Courville, **Deep learning**, MIT Press, 2016, ISBN: 0262035618. 2. A. Kaveh, **Applications of Artificial Neural Networks and Machine Learning in Civil Engineering**, Springer, 2024, ISBN: 978-3-031-66050-4. 3. L. Zhang, Y. Pan, X. Wu and M.J. Skibniewski, **Artificial Intelligence in Construction Engineering and Management**, Springer, 2021, ISBN: 978-981-16-2841-2. **Reference Books:** 4. M.Z. Naser, **Leveraging Artificial Intelligence in Engineering, Management, and Safety of Infrastructure**, CRC Press, 2022, ISBN: 9780367823467. 5. A. Géron, **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**, O'Reilly, 2022, ISBN: 9355421982.

Course Code	**CE 662/ CE 462 (Till AY 2025-26)**
Title of the Course	**Structural Dynamics**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	None
Objectives of the course	
Course Syllabus	SDOF System - Equation of Motion; Generalized SDOF system; Free Vibration; Harmonic Load; Periodic Load; Impulse Load; General Loads (Time and Frequency Domain analysis); Introduction of Nonlinear analysis; Seismic analysis. MDOF Systems - Systems - Property matrices; Undamped Free Vibration; Mode Superposition Techniques ; Practical Free-Vibration Analysis; Buildings; Seismic analysis; Code Provision.
Suggested Books	1. R.W. Clough, J. Penzlen, **Dynamics of Structures (2nd Ed.)**, McGraw Hill, 2nd ed. 1993. 2. M. Paz, **Structural Dynamics: Theory and Computation**, Van Nostrand, 1985. 3. IS: 1893-1984, **Criteria for Earthquake Resistant Design of Structures**.

Course Code	**CE 662/ CE 462 (AY 2026-27)**
Title of the Course	Structural Dynamics
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite,if any (for the students)	Nil
Course Objective	The course aims to expose the students to the analysis of dynamic forces.
Course Outcomes	At the end of the course, the students will be able to: • Evaluate the dynamic forces. • Analyze the structures subjected to dynamic loads.
Course Syllabus	**Single Degree of Freedom (SDOF) System:** Equation of motion, generalized SDOF system, free vibration, harmonic load, periodic load, impulse load, general loads (time and frequency domain analysis), introduction of nonlinear analysis, seismic analysis. **Multiple Degree of Freedom (MDOF) System:** Property matrices, undamped free vibration, mode superposition techniques, practical free-vibration analysis, buildings, seismic analysis, and code provision.
Suggested Books	**Textbooks:** 1. A.K. Chopra, **Dynamics of Structures**, Pearson Education, 2020, ISBN: 9353945259. 2. A.K. Jain, **Dynamics of Structures with Earthquake Engineering**, Pearson Education, 2023, ISBN: 9357059350. 3. J. Biggs, **Introduction to Structural Dynamics**, McGraw-Hill, 2013, ISBN: 9332902550. **Reference Books:** 4. IS: 1893, **Criteria for Earthquake Resistant Design of Structures**, Bureau of Indian Standards, 2016. 5. M. Paz and W. Leigh, **Structural Dynamics: Theory and Computation**, Springer-Verlag New York Inc., 2004, ISBN: 1402076673. 6. R.W. Clough and J. Penzlen, **Dynamics of Structures**, McGraw-Hill, 1975, ISBN: 9353945259.

Course Code	**CE 664/ CE 464 (Till AY 2025-26)**
Title of the Course	**Advanced Solid Mechanics**
Course Category	**Core**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Scope of the course (Objectives)	To provide fundamental and advanced structures with reference to applications. Concepts of mechanics.
Course Outcomes	To be able to derive generalized balance laws using tensorial notations. To be able to incorporate different material behaviors in the continuum equations. To be able to solve using analytical techniques and interpretation of the results.
Course Syllabus	Introduction to tensors and indicial notation, Divergence theorem. Elementary measures of strain. Deformation gradient, Polar decomposition, Cauchy-Green, and Lagrangian strain tensors. Mass, momentum, and energy balance. Constitutive relation for small deformation, St. Venant-Kirchoff materials. Hyperelastic and viscoelastic solids, uniaxial stretch, pure bending of a beam, torsion of a structural member. Exact solutions for bending and stretching of a rectangular elastic block. Linearized elasticity: bending and torsion.
Suggested Books	Text Books: 1. L. E. Malvern (1969), Introduction to the mechanics of a continuous medium, Prentice Hall Inc. Englewood Cliffs, N J., ISBN: 0134876032. 2. C. S. Jog (2015), Continuum Mechanics, Vol. 1, Cambridge University Press, ISBN: 9781316134054. Reference Books: 3. M. E. Gurtin (1982), Introduction to continuum mechanics, Vol. 158, 1st Edition, Academic Press, ISBN: 9780123097507. 4. A. E. Green and W. Zerna (1968), Theoretical elasticity, 2nd Edition, Dover Publications, ISBN: 9780486670768.

Course Code	**CE 664/ CE 464 (From AY 2026-27)**
Title of the Course	Advanced Solid Mechanics
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	To understand the advanced concepts of stress and strain analysis, strain tensors, applications of various strain energy theorems, and stress concentration.
Course Outcomes	At the end of the course, the students will be able to: • Derive generalized balance laws using tensorial notations. • Incorporate different material behaviors in the continuum equations. • Solve using analytical techniques and interpretation of the results.
Course Syllabus	**Introduction to strain tensors:** Introduction to tensors and indicial notation, divergence theorem, elementary measures of strain, deformation gradient, polar decomposition, Cauchy-Green, and Lagrangian strain tensors, mass, momentum, and energy balance. **Stress-strain relations:** Constitutive relation for small deformation, St. Venant-Kirchhoff materials, hyper-elastic and visco-elastic solids. **Analysis of simplified loadings:** Uniaxial stretch, pure bending of a beam, torsion of a structural member. **Advanced analysis of solids:** Exact solutions for bending and stretching of a rectangular elastic block, Linearised elasticity - bending and torsion.
Suggested Books	**Textbooks:** 1. L.E. Malvern, **Introduction to the mechanics of a continuous medium**, Prentice Hall Inc., 1969, ISBN: 0134876032. 2. C.S. Jog, **Continuum Mechanics, Vol. 1**, Cambridge University Press, 2015, ISBN: 9781316134054. **Reference Books:** 3. M.E. Gurtin, **Introduction to continuum mechanics, Vol. 158,** Academic Press, 1982, ISBN: 9780123097507. 4. A.E. Green and W. Zerna, **Theoretical elasticity,** Dover Publications, 1968, ISBN: 9780486670768. 5. S.P. Timoshenko and J.M. Gere, **Theory of Elastic Stability**, Dover Publications, 2012, ISBN: 9780486134802.

Course Code	CE 668/ CE 468
Title of the Course	Bayesian Inference and Reliability
Credit Structure	L-T- P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course enables learners to understand the fundamentals of Bayesian inference and apply them to reliability analysis of engineering systems.
Course Outcomes	By the end of this course, students will be able to: • Understand the fundamentals of Bayesian thinking. • Apply Bayesian inference to one-parameter and multiparameter models. • Integrate Bayesian approaches into reliability engineering practice to support decision-making.
Course Syllabus	**Introduction to Bayesian Thinking:** Bayesian reasoning, Bayes rule, discrete prior, continuous prior, conjugate prior, posterior distribution, point estimation, and comparing Bayesian and frequentist interval estimates, prediction. **Bayesian Inference of One Parameter Model:** Binomial model, exponential model, Poisson model, and normal model with known mean and unknown variance. **Multiparameter Models:** Normal data with both parameters unknown, multinomial model, posterior simulation, Markov chain Monte Carlo (MCMC) simulation, noninformative and informative prior. **Bayesian Reliability:** Defining reliability, examples of reliability data: Bernoulli success/failure data, failure count data, lifetime data, degradation data, censoring, Bayesian reliability analysis, exponential failure times, Weibull failure times, lognormal failure times, gamma failure times, inverse Gaussian failure times, normal failure times. **Case Studies in Civil Engineering:** Structural health monitoring of infrastructure such as bridges, dams, nuclear facilities, foundations, and slopes; flood forecasting and drought prediction; Bayesian updating using field and inspection data.
Suggested Books	**Textbooks:** 1. P.D. Hoff, **A first course in Bayesian statistical methods**, Springer, 2009, ISBN: 978-0-387-92299-7. 2. M.S. Hamada, A. Wilson, C.S. Reese and H. Martz, **Bayesian Reliability**, Springer, 2008, ISBN: 9780387779485. 3. K.-V. Yuen, **Bayesian methods for structural dynamics and civil engineering,** John Wiley & Sons, 2010, ISBN: 978-0-470-82454-2. **Reference Books:** 4. A.H-S. Ang and W.H. Tang, **Probability concepts in engineering: emphasis on applications to civil and environmental engineering**, John Wiley & Sons, 2006, ISBN: 978-0-471-72064-5. 5. J. Albert, **Bayesian computation with R**, Springer, 2009, ISBN: 978-0-387-92297-3. 6. H.F. Martz and R.A. Waller, **Bayesian Reliability Analysis**, Wiley–Blackwell, 1982, ISBN: 0471864250.

Course Code	CE 670
Title of the Course	Computational Lab
Credit Structure	L-T- P-Credits 0-0-4-2
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any (for the students)	Nil
Course Objective	This course introduces students to computational tools for solving structural engineering problems.
Course Outcomes	By the end of the course, students will be able to: • Analyze different civil engineering structures using software. • Write custom programs for numerical analysis of structural engineering applications.
Course Syllabus	Students will perform the following representative experiments: • Introduction to numerical methods and programming for solving indeterminate structures. • Writing code for the Matrix method of analysis of structures. • FEM analysis of one-dimensional, two-dimensional and three-dimensional structures using commercially available software. • Analyse two-dimensional building frames using commercially available software. • Analyse three-dimensional building frames using commercially available software. • Analysis of bridge structures using commercially available software.
Suggested Books	**Reference Books:** 1. S. Rajasekran, and G. Sankrasubramnian, **Computational structural mechanics**, PHI Learning Pvt. Ltd., 2015, ISBN: 9788120317345. 2. Q. Kong, T. Siauw, and A. Bayen, **Python programming and numerical methods: A guide for engineers and scientists**, Academic Press, 2020, ISBN: 9780128195499. 3. S. Nagar, **Beginning Julia Programming**, Springer, 2017, ISBN: 978-1-4842-3170-8.

Course Code	**CE 674/ CE 474**
Title of the Course	**Road Safety**
Credit Structure	L-T-P-Credit 2-0-2-3
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any (for the students)	None
Course Objective	The course is designed to provide an overview on road safety of engineering and behavioural aspects. Through his course students will gain basic understanding of the road environment, road safety issues, role of human errors (road users) and the application of this knowledge, knowledge concerning the causes, analysis and consequences of accidents, road safety measures and audit.
Course Syllabus	*Introduction to Road Safety Engineering:* accidents, causes of crash, characteristics and type of road crashes, road safety issues, road safety scenario of India, factors contributing to road accidents, contribution and consequences of speeding; *Driver Cognition and Automotive User-Experience:* situation awareness, distracted driving, fatigue, stress, in-vehicle and out-vehicle information processing, human-machine collaborations for automated driving, road rage & aggressive driving, aging & driving, emergency Response Support, drugs & alcohol; *Accident Data Collection & Management; Crash Investigation & Analysis; Accident Remedial Schemes:* process, detailed site analysis, measuring the effectiveness of accident remedial schemes; *Road Safety Measures and Culture:* road alignments, road sign and pavements markings, street lighting and traffic signal, pedestrian facilities, training, education, awareness of traffic rules, rehabilitation, law-enforcement; Road Safety Audit (RSA).
Suggested Books	1. B. E. Porter (2011). ***Handbook of Traffic Psychology***, Elsevier Science Academic Press. ISBN: 9780123819857, 0123819857. 2. D. Shinar (2017). ***Traffic Safety and Human Behavior***, Emerald Publishing Limited. ISBN: 9781786352217, 1786352214. 3. E. Rune, H. Alena, V. Truls (2009) ***The Handbook of Road Safety Measures*** by Emerald Group Publishing, 2nd Edition. 4. Highway safety manual (2010). American Association of State Highway and Transportation Officials: Washington, DC, USA. 5. IRC:SP:88 (2010). Manual on road Safety Audit, Indian Roads Congress New Delhi, India: IRC. 6. M. Belcher, P. Steve, P. Cook (2008). ***Practical Road Safety Auditing*** by Thomas Telford Publishing. 7. M. O. Haque (2008). ***Road Safety: Data Collection, Analysis, Monitoring, And Countermeasure Evaluations With Cases***, University Press of America. 8. Walsh, I. D. (2011). ***ICE manual of highway design and management***. ICE Publishing

Course Code	**CE 684/ CE 484 (Till AY 2025-26)**
Title of the Course	**Advanced Concrete Technology**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any	Basic knowledge of Building Materials and Concrete
Scope of the course	This course aims to develop the understanding of properties, advances and findings in the field of multifunctional concretes, focusing on the principles, design and fabrication, test and characterization, performance and mechanism, and their applications in infrastructures. It's designed to discuss the challenges in the development and application of multifunctional concretes, providing useful theory, ideas and principles.
Course Syllabus	**Durability of Concrete:** Early-age and the long-term performance of concrete, including issues such as its ability to be placed and compacted, properties and performance characteristics, structural movements, strength development, fire resistance and durability performance. **Testing, Quality Assurance, Repair and Maintenance of Concrete:** Quality concepts and quality control of concretes, and test methods used both in laboratories and on site for measuring physical and chemical properties of concrete in fresh and hardened states. **Multifunctional Concrete Production:** Types of concretes that can be used for different applications. Concepts for self-compacting concrete, functionally graded concrete, self-healing concrete, 3-D printed concrete, high performance concrete, fibre reinforced concrete, geopolymer concrete.
Suggested Books	1. Zongjin Li, ***Advanced Concrete Technology*****,** John Wiley and Sons, 2011, 9780470437438 2. Mark Alexander, Arnon Bentur and Sidney Mindess, ***Durability of Concrete: Design and Construction***, CRC Press, 2011, 9781138746749 3. John Newman and B S Choo ***Advanced Concrete Technology 4*****,** Butterworth-Heinemann, 2003, 9780080489995

Course Code	**CE 684/CE 484 (Till AY 2026-27)**
Title of the Course	Advanced Concrete Technology
Credit Structure	L-T-P-Credits 2-0-2-3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Course Objective	To understand the properties of concrete, its characterization and discuss the multifunctionality of concrete.
Course Outcomes	At the end of the course, the students will be able to: • Understand the properties, advances, and findings in the field of multifunctional concretes. • Discuss the characterization, performance, and testing of concrete. • Discuss the challenges in the development and application of multifunctional concretes, providing useful theory, ideas and principles.
Course Syllabus	**Durability of Concrete:** Early-age and the long-term performance of concrete, including issues such as its ability to be placed and compacted, properties and performance characteristics, structural movements, strength development, fire resistance and durability performance. Testing, Quality Assurance, Repair, and Maintenance of Concrete: Quality concepts and quality control of concretes, and test methods used both in laboratories and on-site for measuring physical and chemical properties of concrete in fresh and hardened states. **Multifunctional Concrete Production:** Types of concretes that can be used for different applications. Concepts for self-compacting concrete, functionally graded concrete, self-healing concrete, 3-D printed concrete, high-performance concrete, fiber-reinforced concrete, geopolymer concrete. List of representative experiments: • To design concrete mix proportions that achieve the target mechanical, fresh, and durability properties as per specified standards while ensuring optimum material utilization (Mix design). • To determine the filling ability and horizontal free flow characteristics of fresh self-compacting concrete in the absence of obstructions (Slump Flow test). • To assess the flowability and viscosity of self-compacting concrete by measuring the flow time through a narrow opening (V-Funnel test). • To evaluate the passing ability of self-compacting concrete through congested reinforcement and its resistance to blocking (L-Box test). • To determine the passing ability of SCC through reinforcing bars and evaluate blocking/segregation tendency (J-Ring test). • To assess the filling ability and passing ability of SCC when flowing through reinforcement barriers (U-Box test). • To determine the elastic deformation characteristics and stiffness of concrete under compressive loading. • To estimate the surface hardness and approximate compressive strength of hardened concrete non-destructively.

	• To assess the quality, homogeneity, and internal integrity of concrete by measuring ultrasonic pulse travel velocity. • To determine the in-situ compressive strength, density, and internal quality of hardened concrete by extracting cylindrical core specimens from an existing concrete element for laboratory testing. • To determine the rheological behaviour of fresh cementitious material by measuring viscosity variation with changing shear rate with time (Shear ramp test). • To evaluate time-dependent rheological stability and viscosity of fresh material under constant shear (Constant shear rate test). • To characterize the viscoelastic properties and structural stability of fresh cementitious paste under oscillatory loading (Amplitude and frequency sweep test).
Suggested Books	**Textbooks:** 1. M.L. Gambhir and S. Chaudhary, **Concrete Technology: Theory and Practice**, McGraw-Hill, 2025, ISBN: 9364446968. 2. Z. Li, **Advanced Concrete Technology,** John Wiley and Sons, 2011, ISBN: 9780470437438. 3. M. Alexander, A. Bentur and S. Mindess, **Durability of Concrete: Design and Construction**, CRC Press, 2011, ISBN: 9781138746749. 4. J. Newman and B.S. Choo, **Advanced Concrete Technology**, Butterworth-Heinemann, 2003, ISBN: 9780080489995. **Reference Books:** 5. P.K. Mehta and P.J.M. Monteiro, Concrete: Microstructure Properties and Materials, McGraw-Hill, 2017, ISBN: 933920476X. 6. A.M. Neville, **Properties of Concrete**, Pearson, 2012, ISBN: 8131791076.

Course code	**CE 694/ CE 494**
Title of the course	**Earthquake Engineering**
Credit Structure	L - T - P - Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any	Basic Knowledge of Structural Dynamics and Soil Mechanics
Scope of the course	This course introduces the fundamental concepts of earthquake engineering.
Course Syllabus	Importance of Earthquake Engineering, Fundamentals of Earthquake Engineering, Introduction to geotechnical earthquake engineering, Damaging Effects of Earthquakes, Earthquake Ground Motions, Seismic hazard analysis: probabilistic seismic hazard analysis (PSHA) and deterministic seismic hazard analysis (DSHA), Seismic Regions of the World, Earthquake Genesis, Characterization of Strong Ground Motions, Seismic Vulnerability Assessment of Building, Geotechnical Earthquake Engineering.
Suggested Books	1. R. Villaverde, ***Fundamental Concepts of Earthquake Engineering,*** Taylor & Francis, New York, 2009, 978-1-4200-6495-7 2. S. L. Kramer, ***Geotechnical Earthquake Engineering,*** Prentice Hall, United States of America, 1996, 978-0133749434 3. Sucuoğlu, Halûk, Akkar, Sinan, ***Basic Earthquake Engineering,*** Springer, Switzerland, 2014, 978-3-319-01026-7 4. M. Beer, I. A. Kougioumtzoglou, E. Patelli, I. Siu-Kui Au, ***Encyclopedia of Earthquake Engineering,*** Springer, Brazil, 2015 : 978-3-642-35345-1

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Course code	**CE 496/ CE 696**
Title of the course	**Safety of Dams and Reservoirs**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any	Basic knowledge of water resources engineering
Scope of the course	The non-availability of water in the right place at the right time has lead the civilization to store surplus water in man-made reservoirs by constructing dams-large barriers in the flow path of rivers. Historically, these reservoirs have been used to supply water for drinking purposes, agriculture, and to generate hydroelectricity. Although vital assets, the management of such large water resources systems remains challenging. Dam failures pose significant threats to life, environment, and the local economy. Such failures may result from multiple reasons, large-magnitude floods being the most common and perhaps the least predictable. Over the last few decades, studies have found increasing trends in the frequency and magnitude of floods over the globe. The situation is expected to exacerbate with the changing climate over the next few decades. The aim of the course is to provide basic knowledge to manage and safeguard dams and reservoirs. This course provides introductory technical aspects of planning, design, operation, and maintenance of dams and reservoirs. In addition, topics covering risk management under a changing climate are introduced.
Course Syllabus	Introduction to planning, design, operation and maintenance of dams and reservoirs. Types of dams; causes of dam failures, flood failures and overtopping, backwater flooding, breaching, slope failure, internal erosion and shear stress in foundations. Principles of design of dams: Design flood, probable maximum floods, geologic and seismological considerations, stability analyses, environmental considerations. Uncertainty, risk, reliability, and resilience analyses of dams and reservoirs. Operation of dams: Modelling dam and reservoir systems. Rule curves and forecast-based policies, a brief introduction to optimization models. Design and operational challenges under a non-stationarity climate. Maintenance of dams: Silt and scouring, monitoring and instrumentation; Repair, rehabilitation, and removal of dams.
Suggested Books	• D. P. Loucks, E. V. Beek, ***Water Resources Systems Planning and Management: An introduction to methods, models, and applications***, Springer International Publishing, Gewerbestrasse, Switzerland, 2017, 978-3-319-44232-7 • A. Pepper, ***Maintaining the Safety of our Dams and Reservoirs***, ICE Publishing, London, United Kingdom, 2014, 9780727760340.

	• Committee on the Safety of Existing Dams Water Science and Technology Board Commission on Engineering and Technical Systems National Research Council, ***Safety of Existing Dams: Evaluation and Improvement***, Washington, D.C., USA, 1983, 978-0-309-03387-9

Course Code	**CE 633/CE 433**
Title of the Course	Advanced Soil Mechanics
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	Nil
Scope of the Course (Objectives)	To enable the learners to understand the fundamental behavior of soils.
Course Outcomes	By the end of this course, students will be able to: • Understand soil formation, classification, and how clay minerals affect soil behavior. • Apply principles of stress, shear strength, and permeability in geotechnical designs. • Analyze soil consolidation and settlement using theoretical models and stress paths.
	Advanced soil mechanics and stress principles: Phase relationships and index properties; stress–strain behavior of soils; effective stress principle and its mathematical formulation; pore water pressure, capillarity, and suction. **Shear strength and critical state mechanics:** Mohr–Coulomb failure theory; shear strength parameters; stress transformation and Mohr's circles; stress paths; fundamentals of critical state soil mechanics. **Flow through soils:** Darcy's law; permeability and seepage; governing equations for steady-state flow; flow nets; seepage forces; filter design criteria. **Compaction and consolidation mechanics:** Compaction characteristics; transient flow; one-dimensional consolidation theory; primary and secondary consolidation; settlement estimation and corrections. **Stress Paths and Settlement Analysis:** Stress path method for settlement computation; loading–unloading behavior; application to foundation settlement problems.
Suggested Books	**Text Books:** 1. M. Budhu, **Soil Mechanics Fundamentals,** John Wiley & Sons Inc., 2015, ISBN: 9781118655586. 2. G. Ranjan and A.S.R. Rao, **Basic and Applied Soil Mechanics,** New Age International Publishers, 2008, ISBN: 9788122422235. 3. J.K. Mitchell and K. Soga, **Fundamentals of Soil Behaviour,** John Wiley & Sons Inc., 2005, ISBN: 9780471463012. 4. B.M. Das and S. Khaled, **Principles of Geotechnical Engineering,** Cengage Learning, 2014, ISBN: 9781285738367. **Reference Books:**

	5. K. Terzaghi, R.B. Peck and G. Mesri, **Soil Mechanics in Engineering Practice,** John Wiley & Sons Inc., 1996, ISBN: 9780471086587. 6. J.A. Knappett and R.F. Craig, **Craig's Soil Mechanics,** Spon Press (Taylor & Francis), 2012, ISBN: 9780415506656.

Course Code	CE 639/CE 439
Title of the Course	Environmental Geotechnics
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Scope of the Course (Objectives)	To understand the importance of the parameters and mechanisms governing the interaction of contaminants with geomaterials (soils and rock mass), their long-term degradation under undesirable concentrations and elevated temperatures, and environmentally sound geotechnical solutions.
Course Outcomes	By the end of this course, students will be able to: • Understand interdisciplinary issues at the interface of environment and geotechnical engineering. • Analyze contaminant transport, thermal, hydraulic, and mechanical behavior of soils in environmental contexts. • Develop sustainable and environmentally sound solutions for geo-environmental challenges such as waste containment and remediation.
Course Syllabus	**Regulations and waste characterization:** Overview of environmental regulations for solid and hazardous waste disposal; hazardous waste classification; characterization of municipal, industrial, and **heavy-metal-contaminated** wastes. **Principles of environmental geotechnology:** Soil–environment interactions; fundamentals of soil behavior under environmental loading; introduction to conceptual and mathematical models in geoenvironmental engineering. **Soil Behavior under environmental conditions:** Soil–water–air interaction; shrink–swell and cracking behavior; effects of temperature and chemical contaminants, including **heavy metals**; chemo-mechanical soil response. **Transport phenomena in soils:** Hydraulic conductivity; diffusion and advection; coupled flow and mass transport; contaminant transport models including **advection–dispersion model, Fick's diffusion model,** and **retardation and sorption models** for heavy metals. **Thermal, electrical, and radiation effects:** Thermal and electrical properties of soils; heat transfer models; electrokinetic transport concepts; radiation-induced changes in geomaterials. **Geoenvironmental applications:** Soil liners, covers, and barrier systems; landfill design concepts; remediation techniques for contaminated soils, including **heavy-metal remediation**; sustainable geoenvironmental engineering practices.
Suggested Books	**Text Books:**

	1. H.Y. Fang and R.C. **Chaney, Introduction to Environmental Geotechnology,** CRC Press, 2016, ISBN: 9781315374734 2. D.S. Hari, and R.R. Krishna, **Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies**, Wiley, 2004, ISBN: 978-0-471-21599-8 3. J.B. Dixon and S.B. Weed, **Minerals in Soil Environments**, Soil Science Society of America, Inc. (SSSA), 1989, ISBN:9780891187875. **Reference Books:** 4. Y.B. Acar, and D.E. Daniel, **Geoenvironmental 2000: Characterization, Containment, Remediation & Performance in Environmental Geotechnics**, ASCE, ISBN: 0784400741 5. I.S. Oweis and R.P. Khera, **Geotechnology of Waste Management**, PSW Publishing Company, 1990, ISBN: 0-408-00969-1 6. J.F. Rees, **Contaminated Land Treatment Technologies**, Elsevier Applied Science, 1992, ISBN: 978-1-85166-943-1

Course code	CE 637/CE 437
Title of the Course	Foundation Engineering and Design
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre-requisite, if any	Nil
Scope of the Course (Objectives)	To provide advanced knowledge on foundation design, execution, and retrofitting.
Course Outcomes	By the end of this course, students will be able to: • Understand foundation classification and selection, including bearing capacity and settlement analysis of shallow foundations. • Learn design and construction aspects of deep foundations, including piles, piers, and caissons, and their application on various soil types. • Gain knowledge of foundation field testing, groundwater management, and legal considerations in foundation engineering.
Course Syllabus	**Introduction to Foundations:** Classification of foundations; choice of foundations; bearing capacity and settlement analysis of shallow foundations such as footings and rafts. **Deep Foundations:** Piles, piers, and caissons; foundations on expansive soils, laterites, fills, and rock; design and construction aspects of deep foundations. **Construction Aspects and Retrofitting:** Construction aspects of foundations; shoring and underpinning methods; retrofitting of foundations. **Groundwater and Drainage:** Groundwater lowering and drainage methods; soil-structure interaction considerations. **Field Testing and Legal Aspects:** Field tests in foundation engineering; instrumentation for monitoring foundations; legal and regulatory considerations in foundation engineering practice.
Suggested Books	**Text Books:** 1. N.P. Kurian, **Design of Foundation Systems – Principles and Practices**, 2014, Narosa Publishing House, ISBN: 9788173194962. 2. N.P. Kurian, **Modern Foundations – Introduction to Advanced Techniques,** Tata McGraw-Hill Publishing Company Ltd., 1984, ISBN: 9780074517863. 3. R.B. Peck, W.E. Hanson and T.H. Thornburn, **Foundation Engineering,** Wiley Eastern Ltd., 1980, ISBN: 9780471671769. **Reference Books:** 4. W.C. Teng, **Foundation Design,** Prentice-Hall of India Pvt. Ltd., 1965, ISBN: 9788120302584.

	5. M.J. Tomlinson, **Foundation Design and Construction**, Longman Group Ltd., 1986, ISBN: 9780582020745. 6. N.V. Nayak, **Foundation Design Manual for Practising Engineers and Civil Engineering Students,** Dhanpat Rai and Sons, 1985, ISBN: 9788189928537. 7. H.F. Winterkorn and H.Y. Fang, **Foundation Engineering Handbook,** Van Nostrand Reinhold Company, 1975, ISBN: 9780442233121.

Course Code	CE 641/CE 441
Title of the Course	Ground Improvement Techniques
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Scope of the Course (Objectives)	To provide students with knowledge of identifying issues related to weak, unstable, or compressible soil deposits and practical applications of ground improvement to ensure stable foundations for buildings, highways, embankments, and other infrastructure projects.
Course Outcomes	By the end of this course, students will be able to: • Understand the behavior of soft, weak soils under environmental and site conditions. • Apply appropriate ground improvement techniques for geotechnical problems. • Design sustainable ground improvement solutions using case studies and emerging technologies.
Course Syllabus	**Introduction and Fundamentals:** Nature of problematic soils: soft, weak, and compressible deposits; Need for ground improvement; Factors affecting ground performance (moisture, seepage, vegetation, temperature, vibrations, mining subsidence, construction operations). **Mechanical Methods:** Dynamic compaction; Preloading and surcharge; Vertical drains and vacuum consolidation; Vibro-floatation; Stone columns; Soil replacement; Sand cushion techniques; Controlled low-strength (CNS) layer. **Chemical and Thermal Methods:** Lime and cement stabilization; Fly ash and waste utilization; Grouting techniques (permeation, compaction, jet grouting); Thermal stabilization; Electrical stabilization methods. **Reinforcement and Drainage Methods:** Soil nailing; Anchors; Use of geosynthetics (geotextiles, geogrids, geocells); Excavation support methods; Horizontal and vertical moisture barriers; Surface and subsurface drainage; Pre-wetting. **Emerging Techniques and Case Histories:** Innovative ground improvement and soil reclamation techniques including nanotechnology, microbial geotechnology, and sustainable ground improvement methods; performance evaluation through case studies, reclamation projects, and lessons learned.
Suggested Books	**Text Books:** 1. M.R. Hausmann, **Engineering Principles of Ground Modification,** McGraw-Hill International Editions, 1990, ISBN: 0070272794.

	2. P.P. Xanthakos, L.W. Abramson, and D.A. Bruce, **Ground Control and Improvement,** John Wiley & Sons, 1994, ISBN: 9780471552314. 3. M.P. Moseley and K. Kirsch (2004), **Ground Improvement,** CRC Press, 2004, ISBN: 9780429095917. **Reference Books:** 4. R. Yonekura, M. Terashi, and M. Shibazaki, **Grouting and Deep Mixing,** A.A. Balkema, 1996, ISBN: 9054108179.

Course Code	CE 657
Title of the Course	Advanced Soil Mechanics Laboratory
Credit Structure	L – T – P – Credits 0 – 0 – 3 – 1.5
Course Category	Core
Name of the Concerned Department	Department of Civil Engineering
Pre–requisite, if any	Nil
Objectives	To acquire hands-on experience in measuring and interpreting various phenomena for advanced soil mechanics.
Course Outcomes	By the end of this course, students will be able to: • Understand basic soil properties, classification, and the role of clay minerals in governing mechanical behavior. • Analysis of consolidation phenomena, settlement predictions, and stress-strain relationships. • To understand drained/undrained soil strength through triaxial (conventional, stress-path) and direct shear tests. • Determine soil-water interaction characteristics.
Course Syllabus	Students will perform the following representative experiments: • To determine the one-dimensional consolidation characteristics and compressibility parameters of soils using the Oedometer (Consolidation) Test. • To evaluate soil strength and deformation behavior under independent principal stresses using the 3D / True Triaxial Compression Test. • To measure shear strength parameters of soils under different drainage conditions through Conventional Triaxial Tests (UU, CU, CD). • To investigate soil response under controlled stress paths using the Stress-Path Triaxial Test. • To assess cyclic strength, stiffness degradation, and frequency effects using the Cyclic / Multi-frequency Triaxial Test. • To determine small-strain shear modulus and damping characteristics using the Resonant Column Test. • To evaluate peak and residual shear strength of soils using Small- and Large-scale Direct Shear Tests. • To study volume change behavior and permeability variation of soils under applied stress conditions. • To measure in-situ stress conditions and determine the coefficient of earth pressure at rest (K_0) under laboratory conditions. • To evaluate small-strain shear modulus and damping properties using the Cyclic Simple Shear Test.
Suggested Books	**Reference Books** 1. K.H. Head and R.J. Epps, **Manual of Soil Laboratory Testing**, Whittles Publishing, 2014, ISBN: 9781849950541. 2. T.W. Lambe and R.V. Whitman, **Soil Mechanics**, John Wiley & Sons, 2012, ISBN: 9780471511922.

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Course Code	CE 659
Title of the Course	Geotechnical Modelling and Simulation Laboratory
Credit Structure	L – T – P – Credits 0 – 0 – 3 – 1.5
Course Category	Core
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Scope of the Course (Objectives)	To train students in using computational tools and numerical methods for solving geotechnical engineering problems.
Course Outcomes	By the end of this course, students will be able to: • Use commercial/geotechnical software for slope stability, seepage, and settlement analysis. • Apply finite element/finite difference methods in geotechnics. • Validate computational results with theoretical solutions.
Course Syllabus	Students will perform the following representative experiments: • To introduce geotechnical software tools and develop numerical models through proper geometry, meshing, boundary conditions, and material assignment. • To evaluate slope stability using Limit Equilibrium Methods under various loading and groundwater conditions. • To analyze slope stability using Finite Element / Finite Difference methods with advanced software/tools. • To simulate seepage behavior through earth dams and embankments and evaluate flow patterns and exit gradients. • To determine groundwater flow and pore pressure distribution within soil masses. • To study stress–strain behavior of soils using appropriate constitutive models. • To assess the settlement behavior of shallow foundations under static loading. • To evaluate load–settlement and load–displacement behavior of pile foundations. • To perform parametric studies on soil properties (c, φ, E) and assess their influence on numerical response. • To analyze excavation behavior and performance of earth retaining structures. • To model ground improvement techniques such as stone columns and geosynthetic reinforcement. • To evaluate the dynamic and seismic response of soil deposits under earthquake loading.
Suggested Books	Reference Books:

Course Code	CE 659
	1. C.S. Desai and J.T. Christian, **Numerical Methods in Geotechnical Engineering**, McGraw-Hill Publishers, 1977, ISBN: 0070165424. 2. D.M. Potts and L. Zdravkovic, **Finite Element Analysis in Geotechnical Engineering: Part I – Theory and Part II – Applications**, Thomas Telford Publishers, 1999, ISBN: 0727727532.

Course Code	CE 617/CE 417
Title of the Course	Pavement Materials
Credit Structure	L - T - P – Credits 2 - 1 - 0 - 3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Scope of the Course (Objectives)	To provide students with an understanding of fundamentals (historical, theoretical, experimental) related to the characterization of materials used in pavement construction.
Course Outcomes	At the end of the course, the students will be able to: • Understand the laboratory testing of soils, aggregates, and bitumen, and design bituminous mixtures using Marshall and Superpave methods. • Assess performance of bituminous mixes through advanced testing techniques and develop pavement quality concrete (PQC) mixes for highway construction. • Evaluate sustainable materials such as RAP, fly ash, and slags for their application and performance in pavement construction.
Course Syllabus	**Aggregate and Soil Characterisation:** Characterisation of soil and aggregates including quarrying, crushing, stacking, and gradation procedures. Basic material properties determination for pavement construction materials. Quality assessment measures for aggregate production and handling. **Bitumen and Binder Characterisation:** Characterisation of bitumen emphasizing viscosity grading and its importance. Properties of bitumen emulsions, modified bitumen, and their applications. Performance grading of bitumen and rheology assessment following ASTM standards. **Bituminous Mixture Design:** Bituminous mixture design using Marshall and Superpave methods. Fundamentals of mix design optimization for durability and performance. Selection criteria for binder content and aggregate gradation. **Performance Characterisation of Bituminous Mixes:** Performance characterisation of bituminous mixtures: resilient modulus, dynamic modulus, and creep properties. Advanced evaluation: 4-point bending fatigue assessment and Hamburg wheel tracking rutting analysis. Correlation of laboratory performance with field behavior. **Concrete and Sustainable Materials:** Pavement Quality Concrete (PQC) mixture design and characterisation of joint filler/sealant materials. Admixtures for bituminous and cement concrete applications. Alternate materials, including Reclaimed Asphalt Pavement (RAP), fly-ash, slags, and marginal materials for sustainable construction.
Suggested Books	**Text Books** : 1. R.B. Mallick and T.E.I. Korchi, **Pavement Engineering: Principles and Practice,** CRC Press, 2009, ISBN 9781439870358.

	2. Y.H. Huang, **Pavement Analysis and Design** (2nd Ed.), Pearson Prentice Hall, 2004, ISBN 9780131424739. **Reference Books:** 3. R.N. Hunter, A. Self, J. Read and E. Hobson, **The Shell Bitumen Handbook,** ICE Publishing, 2015, ISBN 9780727758378. 4. P.S. Kandhal, **Bituminous Road Construction in India**, PHI Learning, 2016, ISBN 9788120352582.

Course Code	CE 643/CE 443
Title of the Course	Reinforced Earth Structures
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Nil
Scope of the Course (Objectives)	To provide students with an understanding of the principles and mechanisms of soil reinforcement and apply various reinforcement techniques to geotechnical structures for designing practical soil reinforcement solutions.
Course Outcomes	By the end of this course, students will be able to: • Understand the fundamentals of reinforced earth and soil-reinforcement interaction mechanisms. • Classify and evaluate different soil reinforcement techniques and their engineering properties. • Apply and design reinforced soil systems for slopes, retaining walls, embankments, and foundations.
Course Syllabus	**Introduction to Reinforced Earth Concepts:** Principles of soil reinforcement; history and development of reinforced soil technology. **Reinforcing Methods and Materials:** Sand drains; soil nailing; geotextiles; geogrids; geocells; geosynthetic materials; engineering properties of reinforcement. **Mechanics of Soil–Reinforcement Interaction:** Stress transfer mechanisms; load–deformation compatibility; interface shear behavior; pull-out resistance; factors affecting soil–reinforcement performance. **Analysis and Design:** Design principles for reinforced slopes, embankments, retaining walls, and shallow/deep foundations; limit equilibrium and numerical methods; codes and guidelines. **Applications, Case Studies, and Projects:** Practical use of reinforced earth structures in highways, railways, embankments, foundations, and earth-retaining systems; field performance; lessons from case histories.
Suggested Books	**Text Books:** 1. C.J.F.P. Jones, **Earth Reinforcement and Soil Structures,** Thomas Telford Limited, 1996, ISBN: 0727725254 2. M.R. Hausmann, **Engineering Principles of Ground Modification,** McGraw-Hill, 1990, ISBN: 9780070276307. 3. S. Saran, **Reinforced Soil and Its Engineering Applications**, I.K. International, 2006, ISBN: 9788188237590. **Reference Books**:

	4. R.M. Koerner, **Designing with Geosynthetics (Vols. 1 & 2, 6th Ed.),** Xlibris Corporation, 2012, ISBN: 9781462882907. 5. R.A. Jewell, **Soil Reinforcement with Geotextiles,** CIRIA & Thomas Telford, 1996, ISBN: 9780727725187. 6. N.W.M. John, **Geotextiles,** Blackie & Son Ltd., 1987, ISBN: 9780216927716.

Course Code	CE 645/CE 445
Title of the Course	Unsaturated Soil Mechanics
Credit Structure	L - T - P – Credits 2 - 1 - 0 - 3
Course Category	Elective
Name of the Concerned Department	Civil Engineering
Pre–requisite, if any	Basics of Geotechnical Engineering
Scope of the Course (Objectives)	To provide students with an understanding of the principles of unsaturated soil mechanics and soil–water interaction behavior, and apply unsaturated soil concepts to geotechnical problems.
Course Outcomes	By the end of this course, students will be able to: • Understand suction, stress state variables, and soil–water behavior in unsaturated soils. • Analyze SWCCs, flow characteristics, and shear strength using extended effective stress concepts. • Apply unsaturated soil mechanics to the design and analysis of slopes, pavements, and landfills.
Course Syllabus	**Fundamentals of Unsaturated Soil Mechanics:** In-situ stress state component profiles; suction and potential of soil-water systems; transient suction and moisture profiles. **Soil Suction Principles and Measurement:** Components of suction (matric, osmotic, total); principles of suction measurement; capillarity; methods of controlling suction (axis translation, osmotic, vapor equilibrium). **Stress and Shear Strength in Unsaturated Soils:** Stress state variables; material variables; extended effective stress concepts; suction stress tensor; shear strength of unsaturated soils; extended Mohr–Coulomb criterion; shear strength parameters and pore pressure response. **Flow and Transport in Unsaturated Soils:** Soil-water characteristic curve (SWCC); hysteresis in SWCC; permeability and hydraulic conductivity functions; direct and indirect measurement methods; unsaturated flow equations and applications. **Applications in Geotechnical and Geo-Environmental Engineering:** Pavement performance; landfill liners and covers; slope stability analysis; role of unsaturated soils in forensic geotechnics.
Suggested Books	**Text Books:** 1. N. Lu and W.J. Likos, **Unsaturated Soil Mechanics**, John Wiley & Sons, Hoboken, 2004, ISBN: 9780471447313. 2. D.G. Fredlund, H. Rahardjo, and M.D. Fredlund, **Unsaturated Soil Mechanics in Engineering Practice**, John Wiley & Sons, 2012, ISBN: 9781118133590.

	3. C.W.W. Ng and B. Menzies, **Advanced Unsaturated Soil Mechanics and Engineering**, Taylor & Francis, 2007, ISBN: 9780415396308. **Reference Books:** 4. A.W. Bishop and D.J. Henkel , **The Measurement of Soil Properties in the Triaxial Test,** Edward Arnold Publishers, 1962, ISBN: 9780470172766. 5. R. Salgado, **The Engineering of Foundations: Soil–Structure Interaction and Unsaturated Soil Behavior,** Cambridge University Press, 2022, ISBN: 9781108489518.

Course Code	CE 647/CE 447
Title of the Course	Computational Geotechnics
Credit Structure	L - T - P - Credits 2 - 1 - 0 - 3
Course Category	Elective
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any	Basics of soil mechanics
Scope of the Course (Objectives)	To introduce students to computational methods and numerical techniques in geotechnical engineering.
Course Outcomes	By the end of this course, students will be able to: • Apply computational methods to model soil behavior and geotechnical problems. • Use finite element (FEM) and finite difference (FDM) methods for solving soil-structure interaction and geomechanics problems. • Evaluate soil constitutive models and numerical simulation outcomes for practical geotechnical applications.
Course Syllabus	**Numerical and Constitutive Modeling:** Fundamentals of numerical modeling, constitutive models for soils and rocks, continuum vs. discrete element modeling. **Stress–Strain Concepts:** Principal stresses and strains; octahedral stresses and strains; stress–strain relationships in geomechanics. **Finite Element Method (FEM) in Geotechnics:** FEM fundamentals, discretization of continua, analysis of plane strain and axisymmetric problems, treatment of boundary conditions. **Discrete Element Method (DEM):** Computational geotechnics for the granular, discontinuous, or particle-scale nature of soils and geomaterials **Soil Failure and Flow Rules:** Failure criteria for soils; associated and non-associated flow rules; material non-linearity in FEM. **Finite Difference Method (FDM):** Fundamentals of FDM; application to consolidation, slope stability, and other geotechnical problems. **Soil–Structure Interaction (SSI) Modeling:** Simulation of shallow/deep foundations, retaining structures, and excavation support using FEM/FDM. **Practical Applications and Case Studies:** Numerical modeling of consolidation, bearing capacity, slope stability, dynamic loading, and earthquake-related geotechnical problems.
Suggested Books	**Text Books:** 1. C.S. Desai and J.T. Christian, **Numerical Methods in Geotechnical Engineering**, McGraw-Hill Publishers, 1977, ISBN: 0070165424. 2. R.O. Davis and A.P.S. Selvadurai, **Plasticity and Geomechanics**, Cambridge University Press, 2002, ISBN: 0521818303. **Reference Books:**

	3. D.M. Potts and L. Zdravkovic, **Finite Element Analysis in Geotechnical Engineering: Theory and application**, Thomas Telford Publishers, 1999, ISBN: 0727728121 4. O.C. Zienkiewicz, A.H.C. Chan, M. Pastor, and B.A. Schrefler, **Computational Geomechanics: With Special Reference to Earthquake Engineering**, John Wiley & Sons, 1999, ISBN: 0471982857.

Course Code	CE 611/CE 411
Title of the Course	Transportation Planning
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	Through this course, the student will learn the fundamentals of transportation planning and the processes to plan a roadway transportation network.
Course Outcomes	At the end of the course, the students will be able to: • Explain the principles of transportation planning and system design. • Analyse multimodal transportation systems and related infrastructure. • Conduct trip analysis and apply travel demand forecasting techniques. • Evaluate the interaction between land use and transportation systems.
Course Syllabus	**Fundamentals of Transportation Planning:** Fundamentals of transportation system planning and the transportation system planning process. Characteristics of travel demand and transportation system components. Introduction to demand theory and supply theory in transportation systems. **Urban Travel Demand Forecasting – I**: Steps of urban travel demand forecasting: trip generation models and techniques. Trip distribution methods, including gravity and growth factor models. Basics of urban transportation networks and their role in planning. **Urban Travel Demand Forecasting – II**: Modal split analysis and trip assignment procedures (all-or-nothing, capacity-restrained). Introduction to tour-based and activity-based travel demand models. Integration of land use-transport interaction models. **Advanced Transportation Models**: Basics of activity-based models and their applications in urban planning. Urban mass transportation systems planning and operations. Goods movement characteristics, freight modeling, and logistics considerations. **Emerging Trends in Transportation Planning**: Comprehensive land use-transport models and scenario analysis. Sustainable transportation planning principles. Policy integration for multimodal transport systems and future demand forecasting techniques.
Suggested Books	**Text Books:** 1. J. de D. Ortuzar, and L. G. Willumsen, **Modelling Transport**, Wiley, 2024. ISBN: 978-1119282358 2. P. Chakroborty, and A. Das, **Principles of Transportation Engineering**, PHI Learning Pvt. Ltd., 2017. ISBN: 978-8120353459.

	3. C. S. Papacostas, and P. D. Prevedouros, **Transportation Engineering and Planning**, Prentice Hall, 2001. ISBN: 978-0130814197 **Reference Books:** 4. R. Thomas, **Traffic Assignment Techniques**, Avebury Technical, 1991. ISBN: 978-0566090622 5. E. Taniguchi, R. G. Thompson, T. Yamada, and R. Van Duin, **City Logistics - Network Modelling and Intelligent Transport Systems**, Elsevier, 2001. ISBN: 978-0080439037

Course Code	CE 613
Title of the Course	Computational Traffic Studio
Credit Structure	L-T-P-Credits 0-0-3-1.5
Course Category	Core
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	To provide students with practical knowledge, analytical skills, and experience in traffic engineering studies. The primary goals include developing the ability to assess and solve traffic-related problems, use relevant tools and technologies, and apply theoretical concepts to real-world scenarios.
Course Outcomes	At the end of the course, the students will be able to: • Collect, analyze, and interpret traffic data for volume, speed, delay, and capacity evaluation of transportation facilities. • Apply traffic simulation tools such as VISSIM to analyze and assess traffic operations. • Present study results and gain practical understanding of real-world traffic conditions through experiments and field visits.
Course Syllabus	List of Experiments (Representative) • To determine spot speed using radar speed gun/enoscope and speed distribution analysis • To measure travel time and delay studies in urban corridors • To study the driver testing unit and reaction time measurement • To determine driver vision characteristics using the vision screen tester • To conduct an origin-destination survey using the license plate method • To study the moving observer method for OD (Origin-Destination) data collection • To determine acceleration-deceleration characteristics of vehicles • To conduct a parking survey and determine accumulation characteristics • To determine intersection turning movement volume count • To measure saturation flow rate at signalized intersections • To measure delay at signalized and unsignalized intersections • To study gap acceptance behavior at uncontrolled intersections • To collect and analyze instrumented vehicle speed-flow data • To conduct a comprehensive traffic volume and classification count • To develop a traffic flow simulation model for intersection analysis • To analyze the transportation network using simulation software
Suggested Books	**Reference Books** 1. J. de D. Ortuzar, and L. G. Willumsen, **Modelling Transport**, Wiley, 2024. ISBN: 978-1119282358 2. T. R. Currin, **Traffic Engineering-A Manual for Data Collection and Analysis**, Cengage Learning, 2012. ISBN: 978-1111578619 3. L. R. Kadiyali, **Traffic Engineering and Transport Planning**, Khanna Publishers, 2024. ISBN: 978-8174092205

	4. J. L. Pline, **Traffic Engineering Handbook**, Institute of Transportation Engineers, 2016. ISBN: 978-1118762301 5. M. Slinn, P. Matthews, and P. Guest, **Traffic Engineering Design-Principles and Practice**, Elsevier, 2005. ISBN: 978-0340676479 6. R.P. Roess, E.S. Prassas, and W.R. McShane, **Traffic Engineering**, Pearson College Div, 2010, ISBN: 978-0136135739. 7. C. J. Khisty, and B. K. Lall, **Transportation Engineering: An Introduction**, Prentice-Hall India, 2020. ISBN: 978-9332569706

Course Code	CE 615/CE 415
Title of the Course	Geometric Design of Roads
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Core
Name of the Concerned Discipline	Civil Engineering
Pre-requisite, if any (for the students)	NIL
Scope of the course (Objectives)	To provide students with in-depth knowledge of highway design principles, focusing on safety, efficiency, and sustainability. It equips students with advanced design and analysis skills, the use of modern tools, and an understanding of regulatory standards.
Course Outcomes	At the end of the course, the students will be able to: • Design safe and efficient highways using advanced design tools and modern methodologies. • Apply and interpret relevant regulatory standards and guidelines in highway design and development. • Evaluate economic and technical factors to propose innovative solutions for complex highway design challenges.
Course Syllabus	**Geometric Design Fundamentals:** Geometric design provisions for transportation facilities as per AASHTO, IRC, and other guidelines. Controls governing geometric design, route layout, and selection. Elements of design, including sight distances and basic alignment principles. **Horizontal and Vertical Alignment:** Horizontal alignment: transition curves, superelevation, and side friction. Vertical alignment: grades, crest curves, and sag curves. Design considerations for rural highways, urban streets, and hill roads. **Cross-Sectional Elements and Intersections:** Highway cross-sectional elements and their design standards. At-grade intersections: sight distance considerations and design principles. Channelisation, mini-roundabouts, and roundabout layout. **Interchange and Special Facilities Design:** Interchanges: major and minor types, entrance/exit ramps, acceleration/deceleration lanes. Bicycle and pedestrian facility design principles. Parking layout, terminal design, and special facility considerations. **Design Application Projects:** Integration of geometric design elements for complex facilities. Practical design considerations for safety and efficiency. Introduction to highway design methodologies, best practices, and geometric design software.
Suggested Books	**Text Books:** 1. P. H. Wright, and K. K. Dixon, **Highway Engineering**, John Wiley & Sons, 2004. ISBN: 9780471264613 2. M. Rogers, and B. Enright, **Highway Engineering**, Wiley, 2023. ISBN: 9781119883302 **Reference Books:** 3. R. L. Brockenbrough, and K. J. Boedecker, **Highway Engineering Handbook**, McGraw-Hill, 1996. ISBN: 9780070087774

	4. J. L. Pline, **Traffic Engineering Handbook**, Institute of Transportation Engineers, 2016. ISBN: 9781118762301

Course Code	CE 655
Title of the Course	Pavement Materials Characterization Lab
Credit Structure	L-T-P-Credits 0-0-3-1.5
Course Category	Core
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NA
Scope of the course (Objectives)	To provide hands-on experience with standard laboratory procedures for testing pavement materials. To enhance understanding of material characterization, mix design, and performance testing for pavement construction. To develop skills in interpreting experimental results and applying them to real-world pavement engineering scenarios.
Course Outcome	At the end of the course, the students will be able to: • Perform laboratory testing and mix design of pavement materials to characterize their engineering properties and performance. • Demonstrate understanding of material characterization, interpret experimental results, and analyze their relevance to pavement performance. • Apply laboratory findings to practical pavement engineering applications, including material selection and real-world design.
Course Syllabus	**List of Experiments** (Representative) • To determine the viscosity grade of bituminous material • To study the temperature and aging susceptibility of bitumen • To determine the specific gravity and water content of bituminous material • To conduct emulsion stability tests and identify applications • To test modified bitumen rheology using DSR and elastic recovery • To determine polymer content in polymer-modified bitumen • To conduct the Marshall Stability and Flow test for bituminous mix design • To determine the Indirect Tension strength of bituminous mixtures • To measure the resilient modulus of bituminous mixtures • To determine the dynamic modulus of asphalt concrete • To conduct a creep test on bituminous mixtures • To study fatigue characteristics of bituminous mixtures • To determine rutting resistance using the Hamburg wheel-tracking test • To characterize Reclaimed Asphalt Pavement (RAP) properties • To determine binder content and aggregate gradation in RAP
Suggested Books	**Reference Books:**

	1. P. S. Kandhal, A. Veeraragavan, and R. Choudhary, **Bituminous Road Construction in India**, PHI Learning Pvt. Ltd., 2023. ISBN: 9789395302072 2. R. B. Mallick, and T. El-Korchi, **Sustainable Pavement Engineering: Principles and Practice**, CRC Press, 2017. ISBN: 9781498758828 3. R. N. Hunter, A. Self, J. Read, and E. Hobson, **The Shell Bitumen Handbook**, ICE Publishing, 2015. ISBN: 9780727758378 4. F. L. Roberts, P. S. Kandhal, E. R. Brown, D. Y. Lee, and T. W. Kennedy, **Hot Mix Asphalt Materials, Mixture Design, and Construction**, NAPA Research and Education Foundation, 1996. ISBN: 9780911403346

Course Code	CE 619/CE 419
Title of the Course	Urban Freight and Logistics Planning
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NA
Scope of the course (Objectives)	This course introduces the principles of freight and logistics systems with emphasis on urban freight planning and management. It covers freight demand, distribution networks, warehousing, terminals, city logistics, and policy measures, as well as freight demand modelling, data-driven analysis, and sustainable management strategies. Students will develop the ability to analyse, design, and evaluate efficient and sustainable freight systems in both Indian and global contexts.
Course Outcome	At the end of the course, the students will be able to: • Explain fundamentals of logistics and freight transportation systems, including demand modeling techniques for forecasting goods movement. • Analyze urban freight planning practices and evaluate policies, with emphasis on the Indian context. • Propose strategies to enhance efficiency and sustainability in freight transportation systems.
Course Syllabus	Introduction to Freight Systems: Introduction to freight and logistics systems concepts. Three-layer freight structure: global, regional, and local levels. Freight transport industry structure, including maritime, air, road, and rail freight, with emerging trends and the role of logistics service providers. Freight Demand and Modelling: Factors affecting freight demand, freight generation, and trip generation models. Inter-regional freight demand modelling techniques. Applications of GPS, Bluetooth, and big data in freight analysis, including international best practices. Freight Distribution and Logistics Networks: Freight distribution structures and logistics network planning. Distribution centres, urban consolidation centres, and warehousing: types, location, design, and operations. Warehouse management systems, inventory theory, economic order quantity (EOQ), and demand forecasting. Urban Freight Planning and Management: Importance of urban freight, stakeholders, movement characteristics, and logistics sprawl. City logistics, urban freight consolidation, vehicle access, loading/unloading operations, and low-emission zones. Off-hour delivery schemes, ITS applications, freight emission modelling, and sustainable urban logistics. Freight Policy, Case Studies and Projects: Objectives, scope of freight policies, and freight quality partnerships (FQPs). Planning measures and case studies from Indian and international city logistics experiences. Humanitarian logistics, disaster relief networks, and relief network models for efficient disaster management.
Suggested Books	**Text Books:**

	1. R. H. Ballou, **Business Logistics/Supply Chain Management**, Pearson Education, 2007. ISBN: 978-8131705841 2. S. Chopra, and P. Meindl, **Supply Chain Management: Strategy, Planning, and Operation**, Pearson, 2024. ISBN: 978-0137502702 3. M. S. Daskin, **Network and Discrete Location: Models, Algorithms, and Applications**, Wiley, 2013. ISBN: 978-0470905364 **Reference Books:** 4. J.P. Rodrigue, **The Geography of Transport Systems,** Routledge, 2024. ISBN: 978-1032712895 5. E. Taniguchi, R. G. Thompson, and T. Yamada, **City Logistics: Mapping the Future**, CRC Press, 2014. ISBN: 978-1482208894 6. A. Rushton, P. Croucher, and P. Baker, **The Handbook of Logistics and Distribution Management**, Kogan Page, 2021. ISBN: 978-1789668687

Course Code	CE 627/CE 427
Title of the Course	Transport Economics
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	The course will equip students with the tools to assess the economic feasibility and impact of transportation projects.
Course Outcomes	At the end of the course, the students will be able to: • Upon completing the course, students will be able to conduct economic evaluations of transportation projects using cost-benefit analysis. • Calculate key performance indicators like NPV and IRR, assess risks and uncertainties, and incorporate environmental and social impacts. • Make informed decisions on project selection and prioritization.
Course Syllabus	**Transport Economics Fundamentals:** Basic components of transport systems and their role as economic activity. Application of economic theories to analyze transportation demand characteristics. Introduction to congestion analysis and demand elasticities. **Congestion and Pricing Analysis:** Evaluation of congestion pricing mechanisms and their economic impacts. Analysis of transport supply characteristics and regulatory frameworks. Transport supply-demand equilibrium concepts and policy implications. **Cost and Pricing Strategies:** Comprehensive analysis of transport costs and pricing strategies. Cost-benefit evaluation methodologies for transportation infrastructure. Strategic pricing models for different transport modes. **Project Appraisal Techniques:** Appraisal and evaluation techniques for transportation projects. Economic feasibility assessment and multi-criteria analysis methods. Risk assessment and sensitivity analysis in transport project evaluation. **Funding and Financing Options:** Transportation project funding mechanisms and public-private partnerships. Financing options include bonds, tolling, and value capture. Financial structuring and sustainability of transport investments.
Suggested Books	**Text Books:** 1. K. Button, **Transport Economics**, Edward Elgar Publishing, 2022. ISBN: 9781786435682 2. D. Hensher, **Transport Economics**, Routledge, 2012. ISBN: 9780415599702

	3. B.E. Prentice, and D. Prokop, **Concepts of Transportation Economics**, World Scientific Publishing, 2016. ISBN: 9789814656160 **Reference Books:** 4. P.S. McCarthy, **Transportation Economics: Theory and Practice**, Blackwell Publishing, 2001. ISBN: 9780631221807 **5.** J. Cowie, and S. Ison, **The Routledge Handbook of Transport Economics**, Routledge, 2017. ISBN: 9781138847491

Course Code	CE 6XX/CE 4XX
Title of the Course	Transportation System Analysis
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	Through this course, the student will learn the fundamentals of sustainable transportation systems and techniques to analyse them in a collective approach that considers social acceptability, economic viability, and environmental friendliness.
Course Outcomes	At the end of the course, the students will be able to: • Explain fundamental concepts of transportation system analysis and evaluate their sustainability across environmental, social, and economic dimensions. • Analyze interdependent components of transportation systems and apply system-based approaches to identify planning and operational challenges. • Propose sustainable strategies to enhance overall transportation system performance and resilience.
Course Syllabus	**Introduction to System Analysis:** Introduction to transportation system analysis fundamentals. Overview of transportation technologies and their system integration. Basic concepts of system components and interrelationships. **Alternative Generation and Evaluation:** Generation of alternatives in transportation system planning. Performance evaluation of systems and development of performance functions. Criteria for assessing system effectiveness and efficiency. **Operational Planning Analysis:** Operational planning and detailed analysis of system components. Performance metrics for individual transportation elements. Integration of operational requirements with system design. **Network Analysis Fundamentals:** Transportation network analysis techniques and methodologies. Minimum path algorithms and their applications in networks. Basic network flow concepts and optimization principles. **Advanced Optimization Techniques:** Optimization techniques for transportation networks. Operations research methods specific to transportation systems. Comprehensive analysis and solution strategies for complex network problems.
Suggested Books	**Text Books** 1. M.L. Manheim, **Fundamentals of Transportation Systems Analysis**, The MIT Press, 1979. ISBN: 978-0262131292 2. A. Kanafani, **Transportation Demand Analysis**, McGraw Hill, 1983. ISBN: 978-0070332713 3. C.J. Khisty, and B.K. Lall, **Transportation Engineering - An Introduction**, Prentice Hall, 2016. ISBN: 978-9332569706 **Reference Books**

	4. P.A. Steenbrink, **Optimization of Transport Networks**, John Wiley & Sons, 1974. ISBN: 978-0471820987 5. K.G. Goulias**, Transportation Systems Planning: Methods and Applications**, CRC Press, 2003. ISBN: 978-0849302732

Course Code	CE 631/CE 431
Title of the Course	Airport Planning and Design
Credit Structure	L-T-P-Credits 2-1-0-3
Course Category	Elective
Name of the Concerned Discipline	Civil Engineering
Pre–requisite, if any (for the students)	NIL
Scope of the course (Objectives)	This course aims to provide students with a comprehensive understanding of the planning and design of airport systems. It covers the essential aspects of designing and laying out airport facilities, including runways, taxiways, aprons, terminals, and ground transportation systems, ensuring efficient operations while prioritizing safety and security.
Course Outcomes	At the end of the course, the students will be able to: • Design airport components emphasizing operational efficiency, safety, traffic forecasting, and capacity analysis. • Plan for future growth and expansion while integrating sustainable practices and addressing real-world design challenges. • Evaluate cost, environmental impact, and technological considerations in comprehensive airport planning and design.
Course Syllabus	**Air Transport Fundamentals:** Air transport structure, organization, and industry overview. Forecasting air travel demand using trend forecasts and analytical methods. Air freight demand characteristics and market analysis. **Airport System Planning:** Airport system characteristics and aircraft performance considerations. Airport capacity analysis and configuration strategies. Airport master planning: site selection, layout planning, and basic airfield configuration. **Runway and Taxiway Design:** Runway orientation, length determination per ICAO specifications, and geometric design. Taxiway and apron geometric design principles. Structural design of runway and taxiway pavements for load-bearing capacity; design considerations for complex terrain. **Airport Facilities and Terminals:** Passenger terminal functions, flow analysis for passengers and baggage. Parking configurations, apron facilities, and air cargo terminal operations. Airport lighting systems and airfield pavement drainage design. **Airport Access and Environmental Considerations in Design Projects:** Airport access problems and connectivity solutions. Environmental impact assessment of airport operations. Sustainable airport development and mitigation strategies for noise, emissions, and land use impacts.
Suggested Books	**Text Books** 1. R. Horonjeff, F.X. McKelvey, W.J. Sproule, and S.B. Young, **Planning and Design of Airports**, McGraw-Hill Professional Publishing, 2010. ISBN: 978-0071446419

	2. S. Young, and A. Wells, **Airport Planning and Management**, McGraw-Hill Education, 2019. ISBN: 978-1260143324 **Reference Books** 3. N.J. Ashford, S. Mumayiz, and P.H. Wright, **Airport Engineering: Planning, Design, and Development of 21st Century Airports**, John Wiley & Sons, 2011. ISBN: 978-0470398555

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