

DEPARTMENT OF CIVIL ENGINEERING
Curriculum M.Tech. (Civil Engineering)
SPECIALIZATION: STRUCTURAL ENGINEERING

FIRST SEMESTER

Sl.No.	Subj. Code	Subjects	L-T-P	Credits
1.	CE 601	Material Technology	3-1-0	4
2.	CE 611	Advanced Structural Analysis	3-1-0	4
3.	CE 613	Analysis and Design of Plates & Shells	3-1-0	4
4.		Professional Elective-I	3-1-0	4
5.		Professional Elective- II	3-1-0	4
6.	CE 671	Structural Engineering Laboratory	0-0-3	2
7.	CE 681	Computational Laboratory	0-0-3	2
8.	CE 685	Seminar and Technical Writing-I	0-0-3	2
TOTAL				26

SECOND SEMESTER

Sl.No.	Sub. Code	Subjects	L-T-P	Credits
1.	CE 610	Structural Dynamics & Earthquake Engineering	3-1-0	4
2.	CE 612	Stability of Structures	3-1-0	4
3.		Professional Elective- III	3-1-0	4
4.		Professional Elective-IV	3-1-0	4
5.		Professional Elective-V	3-1-0	4
6.	CE 670	Structural Engineering Design Practice	0-0-3	2
7.	CE 680	Computational Laboratory-II	0-0-3	2
8.	CE 689	Seminar and Technical Writing-II	0-0-3	2
TOTAL				26

THIRD SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 691	Seminar & Technical Writing - III	0-0-3	2
2	CE 693	Summer Research/Industrial Project		4
3	CE 695	Research Project Work – I		8
4	CE 697	Research Project Review – I		8
TOTAL				22

FOURTH SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 692	Seminar & Technical Writing – IV	0-0-3	2
2	CE 694	Comprehensive Viva Voce	0-0-0	4
3	CE 696	Research Project Work – II		8
4	CE 698	Research Project Review – II	0-0-0	4
5	CE 699	Dissertation	0-0-0	8
TOTAL				26

SPECIALIZATION: GEO TECHNICAL ENGINEERING

FIRST SEMESTER

Sl.No.	Subj. Code	Subjects	L-T-P	Credits
1	CE 621	Advanced Soils Mechanics	3-1-0	4
2	CE 623	Soil-Structure Interaction	3-1-0	4
3	CE 625	Soil Exploration and Analysis of Foundations	3-1-0	4
4		Professional Elective-I	3-1-0	3
		Professional Elective-II	3-1-0	3
6	CE 673	Geotechnical Engineering Laboratory	0-0-3	2
7	CE 681	Computational Laboratory	0-0-3	2
8	CE 685	Seminar & Technical Writing-I	0-0-3	2
TOTAL				24

SECOND SEMESTER

Sl.No.	Subj. Code	Subjects	L-T-P	Credits
1.	CE 620	Ground Improvement Techniques	3-1-0	4
2.	CE 622	Stability Analysis of Slopes, Dams and Embankments	3-1-0	4
3.		Professional Elective-III	3-1-0	3
4.		Professional Elective -IV	3-1-0	4
5.		Professional Elective- V	3-1-0	3
6.	CE 672	Geotechnical Engineering Practice	0-0-3	2
7.	CE 682	Computer Aided Foundation Engineering Design	0-0-3	2
8.	CE 689	Seminar & Technical Writing-II	0-0-3	2
TOTAL				24

THIRD SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 691	Seminar & Technical Writing - III	0-0-3	2
2	CE 693	Summer Research/Industrial Project		4
3	CE 695	Research Project Work – I		8
4	CE 697	Research Project Review – I		8
TOTAL				22

FOURTH SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 692	Seminar & Technical Writing – IV	0-0-3	2
2	CE 694	Comprehensive Viva Voce	0-0-0	4
3	CE 696	Research Project Work – II		8
4	CE 698	Research Project Review – II	0-0-0	4
5	CE 699	Dissertation	0-0-0	8
TOTAL				26

SPECIALIZATION: TRANSPORTATION ENGINEERING

FIRST SEMESTER

Sl. No.	Subj. Code	Subjects	L-T-P	Credits
1	CE 641	Transportation Systems Planning	3-1-0	4
2	CE 643	Highway and Airport Pavement Materials	3-1-0	4
3		Professional Elective-I	3-1-0	4
4		Professional Elective-II	3-1-0	4
5		Professional Elective-III	3-1-0	4
6	CE 681	Computational Laboratory	0-0-3	2
7	CE 677	Transportation Engineering Laboratory	0-0-3	2
8	CE 685	Seminar & Technical Writing-I	0-0-3	2
TOTAL				

SECOND SEMESTER

Sl. No.	Subj. Code	Subjects	L-T-P	Credits
1.	CE 640	Analysis and Structural Design of Pavements	3-1-0	4
2.	CE 604	Finite Element Method	3-1-0	4
3		Professional Elective-III	3-1-0	4
4		Professional Elective-IV	3-1-0	4
5		Professional Elective-V	3-1-0	4
6.	CE 676	Transportation Engineering Design Practice	0-0-3	2
7.	CE 686	Traffic & Transportation Engineering Laboratory	0-0-3	2
8.	CE 689	Seminar & Technical Writing-II	0-0-3	2
Total Credits				22

THIRD SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 691	Seminar & Technical Writing - III	0-0-3	2
2	CE 693	Summer Research/Industrial Project		4
3	CE 695	Research Project Work – I		8
4	CE 697	Research Project Review – I		8
TOTAL				22

FOURTH SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 692	Seminar & Technical Writing – IV	0-0-3	2
2	CE 694	Comprehensive Viva Voce	0-0-0	4
3	CE 696	Research Project Work – II		8
4	CE 698	Research Project Review – II	0-0-0	4
5	CE 699	Dissertation	0-0-0	8
TOTAL				26

SPECIALISATION: WATER RESOURCES ENGINEERING**FIRST SEMESTER**

Sl.No	Subj. Code	Subjects	L-T-P	Credits
1	CE 653	Advanced Fluid Mechanics	3-1-0	4
2	CE 651	Hydrologic Element and Analysis	3-1-0	4
3	CE 655	Computational Fluid Dynamics	3-1-0	4
4		Professional Elective-I	3-1-0	4
5		Professional Elective-II	3-1-0	4
7	CE 675	Hydraulics and Hydrologic Engineering Laboratory	0-0-3	2
8	CE 681	Computational Laboratory	0-0-3	2
9	CE 685	Seminar and Technical Writing-1	0-0-3	2
TOTAL				26

SECOND SEMESTER

Sl.No	Subj. Code	Subjects	L-T-P	Credits
1	CE 650	Hydrology and Hydraulics of Surface and Sub-surface Water	3-1-0	4
2	CE 652	Open Channel Flow	3-1-0	4
3	CE 654	Water Resources management	3-1-0	4
4		Professional Elective-III	3-1-0	4
5		Professional Elective-1V	3-1-0	4
6	CE 684	Computer Application in Water Resources Engineering	0-0-3	2
7	CE 674	Water Resources Engineering Design Practice	0-0-3	2
8	CE 689	Seminar and Technical Writing-II	0-0-3	2
TOTAL				26

THIRD SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 691	Seminar & Technical Writing - III	0-0-3	2
2	CE 693	Summer Research/Industrial Project		4
3	CE 695	Research Project Work – I		8
4	CE 697	Research Project Review – I		8
TOTAL				22

FOURTH SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 692	Seminar & Technical Writing – IV	0-0-3	2
2	CE 694	Comprehensive Viva Voce	0-0-0	4
3	CE 696	Research Project Work – II		8
4	CE 698	Research Project Review – II	0-0-0	4
5	CE 699	Dissertation	0-0-0	8
TOTAL				26

SPECIALISATION : ENVIRONMENTAL ENGINEERING & MANAGEMENT

FIRST SEMESTER

Sl. No.	Subj. Code	Subjects	L-T-P	Credits
1	CE 624	Ground Water & Flow Through Porous Media	3-1-0	4
2	CE 631	Principles of Environmental Management	3-1-0	4
3	CE 633	Water and Wastewater Engineering	3-1-0	4
4		Professional Elective-I	3-1-0	4
5		Professional Elective- II	3-1-0	4
6	CE 679	Environmental Engineering Laboratory	0-0-3	2
7	CE 681	Computational Laboratory	0-0-3	2
8	CE 685	Seminar and Technical Writing -I	0-0-3	2
TOTAL				26

SECOND SEMESTER

Sl. No.	Subj. Code	Subjects	L-T-P	Credits
1	CE 630	Advanced Wastewater Treatment	3-1-0	4
2	CE 632	Advanced Air Quality Management	3-1-0	4
3		Professional Elective- III	3-1-0	4
4		Professional Elective-IV	3-1-0	4
5		Professional Elective-V	3-1-0	4
6	CE 678	Environmental Engineering Design Practice	0-0-3	2
7	CE 688	Remote Sensing & GIS Laboratory	0-0-3	2
8	CE 689	Seminar and Technical Writing -II	0-0-3	2
TOTAL				26

THIRD SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 691	Seminar & Technical Writing - III	0-0-3	2
2	CE 693	Summer Research/Industrial Project		4
3	CE 695	Research Project Work – I		8
4	CE 697	Research Project Review – I		8
TOTAL				22

FOURTH SEMESTER

Sl. No.	Sub. Code	Subject	L-T-P	Credits
1	CE 692	Seminar & Technical Writing – IV	0-0-3	2
2	CE 694	Comprehensive Viva Voce	0-0-0	4
3	CE 696	Research Project Work – II		8
4	CE 698	Research Project Review – II	0-0-0	4
5	CE 699	Dissertation	0-0-0	8
TOTAL				26

LIST OF PROFESSIONAL ELECTIVES

Sl.No.	Subj. Code	Subjects	L-T-P	Credits
1.	CE 602	Optimisation Methods & Its Application in Civil Engineering	3-1-0	4
2.	CE 604	Finite Element Method	3-1-0	4
3.	CE 614	Advanced Reinforced Concrete Design	3-1-0	4
4.	CE 615	Applied Elasticity and Plasticity	3-1-0	4
5.	CE 616	Advanced Steel Design	3-1-0	4
6.	CE617	Bridge Engineering	3-1-0	4
7.	CE 618	Pre-Stressed Concrete	3-1-0	4
8.	CE 619	Composite Structures	3-1-0	4
9.	CE 624	Ground Water & Flow through Porous Media	3-1-0	4
10.	CE 626	Rock Mechanics	3-1-0	4
11.	CE 627	Dynamics of Soils and Foundations	3-1-0	4
12.	CE 628	Earth Retaining Structures	3-1-0	4
13.	CE 629	Earthquake Geotechnical Engineering	3-1-0	4
14.	CE 634	Industrial Pollution Prevention & Clean Technologies	3-1-0	4
15.	CE 635	Environmental Impact & Risk Assessment	3-1-0	4
16.	CE 638	Environmental Legislation & Policy	3-1-0	4
17.	CE 642	Traffic Engineering & Traffic Flow Theory	3-1-0	4
18.	CE 644	Planning & Design of Airports	3-1-0	4
19.	CE 645	Geometric Design of Highways	3-1-0	4
20.	CE 646	Evaluation and Strengthening of Pavements	3-1-0	4
21.	CE 647	Transportation & Environment	3-1-0	4
22.	CE 648	Transportation Systems, Analysis & Modelling	3-1-0	4
23.	CE 649	Advanced Railway Engineering	3-1-0	4
24.	CE 656	Design of Hydraulic Systems	3-1-0	4
25.	CE 657	Hydraulic Structures & Hydro Power Engineering	3-1-0	4
26.	CE 658	Water Quality Modeling & Management	3-1-0	4
27.	CE 659	Fluvial Hydraulics	3-1-0	4
28.	CE 660	High Rise Structures	3-1-0	4
29.	CE 661	Strength & Deformation Behaviour of Soil	3-1-0	4
30.	CE 662	Environmental Geotechnics	3-1-0	4
31.	CE 663	Mass Transit Systems	3-1-0	4
32.	CE 664	Integrated River Basin Management	3-1-0	4
33.	CE 665	Ground Water Assessment & Development	3-1-0	4
34.	CE 668	Special Topic in Civil Engineering-I	3-1-0	4
35.	CE 669	Special Topic in Civil Engineering -II	3-1-0	4
36.	CE 687	Special Laboratory in Civil Engineering -I	0-0-3	2
37.	CE 690	Special Laboratory in Civil Engineering -II	0-0-3	2

LIST OF PROFESSIONAL ELECTIVES OFFERED BY OTHER DEPARTMENTS

1.	CH 643	Environmental Management System	3-1-0	4
2.	CH 645	Bioprocess Engineering	3-1-0	4
3.	CH 648	Advanced Environmental Biotechnology	3-1-0	4
4.	CH 668	Evolutionary Computation	3-1-0	4
5.	MA 551	Numeric Analysis	3-1-0	4
6.	EE 637	Soft Computing Techniques	3-1-0	4
7.	MA 524	Statistical Methods	3-1-0	4
8.	MA 630	Advanced Fluid Dynamics	3-1-0	4
9.	ME 611	Vibration Analysis & Diagnostics	3-1-0	4
10.	ME 614	Experimental Stress Analysis	3-1-0	4
11.	MM 646	Composite Materials	3-1-0	4
12.	MN 608	Tuneling	3-1-0	4
13.	MN 614	Rock Mechanics Application to Environmental Problems	3-1-0	4
14.	MN 618	Hazardous Waste Management	3-1-0	4
15.	CS 612	Software Engineering	3-1-0	4
16.	CS 637	Digital Signal Processing	3-1-0	4
17.	CR 651	Techniques of Materials Characterization	3-1-0	4

DEPARTMENT OF CIVIL ENGINEERING

M.Tech.

SUMMARY OF COURSES

Sub discipline: Structural Engineering

CE 601	Material Technology	3-1-0	4
CE 604	Finite Element Method	3-1-0	4
CE 610	Structural Dynamics & Earthquake Engineering	3-1-0	4
CE 611	Advanced Structural Analysis	3-1-0	4
CE 612	Stability of Structures	3-1-0	4
CE 613	Analysis & Design of Plates & Shells	3-1-0	4
CE 614	Advanced Reinforced Concrete Design	3-1-0	4
CE 615	Applied Elasticity & Plasticity	3-1-0	4
CE 616	Advanced Steel Design	3-1-0	4
CE 617	Bridge Engineering	3-1-0	4
CE 618	Prestressed Concrete	3-1-0	4
CE 619	Composite Structures	3-1-0	4
CE 660	High Rise Structures	3-1-0	4

Sub discipline: Geotechnical Engineering

CE 602	Optimization Methods & Its Application In Civil Engineering	3-1-0	4
CE 620	Ground Improvement Techniques	3-1-0	4
CE 621	Advanced Soil Mechanics	3-1-0	4
CE 622	Stability Analysis of Slopes, Dams and Embankments	3-1-0	4
CE 623	Soil-Structure Interaction	3-1-0	4
CE 624	Ground Water & Flow through Porous Media	3-1-0	4
CE 625	Soil Exploration and Analysis of Foundations	3-1-0	4
CE 626	Rock Mechanics	3-1-0	4
CE 627	Dynamics of Soils and Foundations	3-1-0	4
CE 628	Earth Retaining Structures	3-1-0	4
CE 629	Earthquake Geotechnical Engineering	3-1-0	4
CE 661	Strength & Deformation Behaviour of Soil	3-1-0	4
CE 662	Environmental Geotechnics	3-1-0	4

Sub discipline: Environmental Engineering

CE 630	Advanced Wastewater Treatment	3-1-0	4
CE 631	Principles of Environmental Management	3-1-0	4
CE 632	Advanced Air Quality Management	3-1-0	4
CE 633	Water and Wastewater Engineering	3-1-0	4

CE 634	Industrial Pollution Prevention & Clean Technologies	3-1-0	4
CE 635	Environmental Impact & Risk Assessment	3-1-0	4
CE 638	Environmental Legislation & Policy	3-1-0	4

Sub discipline: Transportation Engineering

CE 640	Analysis & Structural Design of Pavements	3-1-0	4
CE 641	Transportation Systems Planning	3-1-0	4
CE 642	Traffic Engineering & Traffic Flow Theory	3-1-0	4
CE 643	Highway and Airport Pavement Materials	3-1-0	4
CE 644	Planning & Design of Airports	3-1-0	4
CE 645	Geometric Design of Highways	3-1-0	4
CE 646	Evaluation and Strengthening of Pavements	3-1-0	4
CE 647	Transportation & Environment	3-1-0	4
CE 648	Transportation Systems, Analysis & Modelling	3-1-0	4
CE 649	Advanced Railway Engineering	3-1-0	4
CE 663	Mass Transit Systems	3-1-0	4

Sub discipline: Water Resources Engineering

CE 650	Hydrology and Hydraulics of Surface and Sub-Surface Water	3-1-0	4
CE 651	Hydrologic Element and Analysis	3-1-0	4
CE 652	Open Channel Flow	3-1-0	4
CE 653	Advanced Fluid Mechanics	3-1-0	4
CE 654	Water Resources Management	3-1-0	4
CE 655	Computational Fluid Dynamics	3-1-0	4
CE 656	Design of Hydraulic Systems	3-1-0	4
CE 657	Hydraulic Structures & Hydro Power Engineering	3-1-0	4
CE 658	Water Quality Modeling & Management	3-1-0	4
CE 659	Fluvial Hydraulics	3-1-0	4
CE 664	Integrated River Basin Management	3-1-0	4
CE 665	Ground Water Assessment & Development	3-1-0	4

Sub discipline: Laboratory Courses

CE 670	Structural Engineering Design Practice	0-0-3	2
CE 671	Structural Engineering Laboratory	0-0-3	2
CE 672	Geotechnical Engineering Design Practice	0-0-3	2
CE 673	Geotechnical Engineering Laboratory	0-0-3	2
CE 674	Water Resources Engineering Design Practice	0-0-3	2
CE 675	Hydraulics and Hydrologic Engineering Laboratory	0-0-3	2
CE 676	Transportation Engineering Design Practice	0-0-3	2
CE 677	Transportation Engineering Laboratory	0-0-3	2
CE 678	Environmental Engineering Design Practice	0-0-3	2

CE 679	Environmental Engineering Laboratory	0-0-3	2
CE 680	Computational Laboratory-II	0-0-3	2
CE 681	Computational Laboratory		
CE 682	Computer Aided Foundation Engineering Design Practice	0-0-3	2
CE 684	Computer Application in Water Resources Engineering	0-0-3	2
CE 686	Traffic & Transportation Engineering Laboratory	0-0-3	2
CE 688	Remote Sensing & GIS Laboratory	0-0-3	2

Sub discipline: Project, Seminar and Special Courses

CE 668	Special Topic in Civil Engineering-I	3-1-0	4
CE 669	Special Topic in Civil Engineering -II	3-1-0	4
CE 685	Seminar & Technical Writing-I	0-0-3	2
CE 687	Special Laboratory in Civil Engineering -I	3-1-0	2
CE 689	Seminar & Technical Writing-II	0-0-3	2
CE 690	Special Laboratory in Civil Engineering -II	0-0-3	2
CE 691	Seminar & Technical Writing-III	0-0-3	2
CE 692	Seminar & Technical Writing – IV	0-0-3	2
CE 693	Summer Research/Industrial Project	0-0-6	4
CE 694	Comprehensive Viva Voce	0-0-0	4
CE 695	Research Project Work – I	0-0-0	8
CE 696	Research Project Work – II	0-0-0	8
CE 697	Research Project Review – I	0-0-0	8
CE 698	Research Project Review – II	0-0-0	8
CE 699	Dissertation	0-0-0	8

DEPARTMENT OF CIVIL ENGINEERING

DETAILED SYLLABI OF COURSES

CE 601	Material Technology	3-1-0	4
CE 602	Optimization Methods & Its Application In Civil Engineering	3-1-0	4
CE 604	Finite Element Method	3-1-0	4
CE 610	Structural Dynamics & Earthquake Engineering	3-1-0	4
CE 611	Advanced Structural Analysis	3-1-0	4
CE 612	Stability of Structures	3-1-0	4
CE 613	Analysis & Design of Plates & Shells	3-1-0	4
CE 614	Advanced Reinforced Concrete Design	3-1-0	4
CE 615	Applied Elasticity & Plasticity	3-1-0	4
CE 616	Advanced Steel Design	3-1-0	4
CE 617	Bridge Engineering	3-1-0	4
CE 618	Prestressed Concrete	3-1-0	4
CE 619	Composite Structures	3-1-0	4
CE 620	Ground Improvement Techniques	3-1-0	4
CE 621	Advanced Soil Mechanics	3-1-0	4
CE 622	Stability Analysis of Slopes, Dams and Embankments	3-1-0	4
CE 623	Soil-Structure Interaction	3-1-0	4
CE 624	Ground Water & Flow through Porous Media	3-1-0	4
CE 625	Soil Exploration and Analysis of Foundations	3-1-0	4
CE 626	Rock Mechanics	3-1-0	4
CE 627	Dynamics of Soils and Foundations	3-1-0	4
CE 628	Earth Retaining Structures	3-1-0	4
CE 629	Earthquake Geotechnical Engineering	3-1-0	4
CE 630	Advanced Wastewater Treatment	3-1-0	4
CE 631	Principles of Environmental Management	3-1-0	4
CE 632	Advanced Air Quality Management	3-1-0	4
CE 633	Water and Wastewater Engineering	3-1-0	4
CE 634	Industrial Pollution Prevention & Clean Technologies	3-1-0	4
CE 635	Environmental Impact & Risk Assessment	3-1-0	4
CE 638	Environmental Legislation & Policy	3-1-0	4
CE 640	Analysis & Structural Design of Pavements	3-1-0	4
CE 641	Transportation Systems Planning	3-1-0	4
CE 642	Traffic Engineering & Traffic Flow Theory	3-1-0	4
CE 643	Highway and Airport Pavement Materials	3-1-0	4
CE 644	Planning & Design of Airports	3-1-0	4
CE 645	Geometric Design of Highways	3-1-0	4
CE 646	Evaluation and Strengthening of Pavements	3-1-0	4
CE 647	Transportation & Environment	3-1-0	4
CE 648	Transportation Systems, Analysis & Modelling	3-1-0	4
CE 649	Advanced Railway Engineering	3-1-0	4
CE 650	Hydrology and Hydraulics of Surface and Sub-Surface Water	3-1-0	4
CE 651	Hydrologic Element and Analysis	3-1-0	4

CE 652	Open Channel Flow	3-1-0	4
CE 653	Advanced Fluid Mechanics	3-1-0	4
CE 654	Water Resources Management	3-1-0	4
CE 655	Computational Fluid Dynamics	3-1-0	4
CE 656	Design of Hydraulic Systems	3-1-0	4
CE 657	Hydraulic Structures & Hydro Power Engineering	3-1-0	4
CE 658	Water Quality Modeling & Management	3-1-0	4
CE 659	Fluvial Hydraulics	3-1-0	4
CE 660	High Rise Structures	3-1-0	4
CE 661	Strength & Deformation Behaviour of Soil	3-1-0	4
CE 662	Environmental Geotechnics	3-1-0	4
CE 663	Mass Transit Systems	3-1-0	4
CE 664	Integrated River Basin Management	3-1-0	4
CE 665	Ground Water Assessment & Development	3-1-0	4
CE 668	Special Topic in Civil Engineering-I	3-1-0	4
CE 669	Special Topic in Civil Engineering -II	3-1-0	4
CE 670	Structural Engineering Design Practice	0-0-3	2
CE 671	Structural Engineering Laboratory	0-0-3	2
CE 672	Geotechnical Engineering Design Practice	0-0-3	2
CE 673	Geotechnical Engineering Laboratory	0-0-3	2
CE 674	Water Resources Engineering Design Practice	0-0-3	2
CE 675	Hydraulics and Hydrologic Engineering Laboratory	0-0-3	2
CE 676	Transportation Engineering Design Practice	0-0-3	2
CE 677	Transportation Engineering Laboratory	0-0-3	2
CE 678	Environmental Engineering Design Practice	0-0-3	2
CE 679	Environmental Engineering Laboratory	0-0-3	2
CE 680	Computational Laboratory-II	0-0-3	2
CE 681	Computational Laboratory		
CE 682	Computer Aided Foundation Engineering Design Practice	0-0-3	2
CE 684	Computer Application in Water Resources Engineering	0-0-3	2
CE 685	Seminar & Technical Writing-I	0-0-3	2
CE 686	Traffic & Transportation Engineering Laboratory	0-0-3	2
CE 687	Special Laboratory in Civil Engineering -I	3-1-0	2
CE 688	Remote Sensing & GIS Laboratory	0-0-3	2
CE 689	Seminar & Technical Writing-II	0-0-3	2
CE 690	Special Laboratory in Civil Engineering -II	0-0-3	2
CE 691	Seminar & Technical Writing-III	0-0-3	2
CE 692	Seminar & Technical Writing – IV	0-0-3	2
CE 693	Summer Research/Industrial Project	0-0-6	4
CE 694	Comprehensive Viva Voce	0-0-0	4
CE 695	Research Project Work – I	0-0-0	8
CE 696	Research Project Work – II	0-0-0	8
CE 697	Research Project Review – I	0-0-0	8
CE 698	Research Project Review – II	0-0-0	8
CE 699	Dissertation	0-0-0	8

CE 601 MATERIAL TECHNOLOGY**4 Credits [3-1-0]**

Cement and Concrete: Portland cement: chemical composition, hydration of cement, structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration. Cements of different types. Factors affecting the strength of concrete. Elasticity, shrinkage and creep of concrete ; Durability of concrete: Permeability of concrete. Chemical attack of concrete, air-entrained concrete and thermal properties of concrete. The mechanical test of hardened concrete .Light weight and high density concrete. Mix design. Statistical quality control; Biaxial strength of concrete, Fibre reinforced concrete ; Metals: Behaviour of common constructional metals in tension and compression. True stress-strain curve for mild steel in simple tension. Theories of failure and yield surfaces ; Fatigue properties: Nature of fatigue failure, fatigue strength for completely reversed stresses, fatigue strength with super imposed static stress and factors influencing fatigue strength ; Temperature and Creep properties: Low temperature properties ,high temperature properties, creep-stress-time-temperature relations for simple tension, mechanics of creep in tension. Structure of materials and their imperfections. Deformation of crystals and theory of dislocations.

Essential Reading:

1. A.M. Neville, J.J. Brooks, *Concrete Technology*, Low Priced Edition, Pearson Education, 2004.
2. A J Martin, *Mechanical behavior of engineering materials*.

Supplementary Reading:

1. S P Timoshenko, *Strength of materials- Part II*
2. M. S. Shetty, *Concrete technology- Theory & Practice*, S.Chand & Company New Delhi, 2005

**CE 602 OPTIMIZATION METHODS IN ITS APPLICATION
IN CIVIL ENGINEERING****4 Credits [3-1-0]**

Introduction: Need for engineering optimal design, Optimum design formulation: Design variable, objective function and constraints ; Unconstrained optimization methods Single variable optimization methods: Region elimination method – Golden section search, Interval halving method; Gradient based method – Newton-Raphson, bisection and secant method. Multi variable optimization methods: Direct search method: Hooke-Jeeve pattern search, simplex reflection search, Powell's conjugate direction search. Gradient Based methods: Cauchy's steeped descent, Newton's method, Levenberg-Marquardt's method, Fletcher-Reeve method ; Constrained optimization methods Kuhn Tucker condition, Penalty function method, Augmented Lagrangian method, sequential unconstrained minimization, cutting plane method ; Introduction to Evolutionary algorithms: Need for evolutionary algorithms, Type of evolutionary methods, Introduction to Genetic algorithm (GA), Difference and similarities between GA and traditional methods. Basic operations of GA: reproduction, crossover, mutation and elitism. Binary coded and Real coded GA ; Application of Optimization techniques: Water resource planning management, Structural Optimization, Transportation planning and Management, Slope stability and optimal dimensioning of foundations. multi-objective optimization models.

Essential Reading:

1. J.S. Arora, *Introduction to Optimum Design*, Elsevier, 2nd Edition, 2004.
2. K. Deb, *Optimization for Engineering. Design: Algorithms & Examples*, Prentice Hall India, 2006

Supplementary Reading:

1. S.S. Rao, *Engineering Optimization: Theory & Practice*, New Age International (P) Ltd, 3rd Edition, 1996, Reprint : June, 2008
2. K. Deb, *Multi-Objective Optimization Using Evolutionary Algorithms*, John Wiley, 2003

CE 604 FINITE ELEMENT METHOD**4 Credits [3-1-0]**

Equations of Equilibrium, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method; Finite Element modeling of one and two dimensional problems. Isoparametric elements, four node, eight node elements. Numerical integration, order of integration; Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling.

Essential Reading:

1. R. D. Cook, *Concepts and Applications of Finite Element Analysis*, John Wiley, NewYork, 2004.
2. O. C. Zienkiewicz and R. L. Taylor, *Finite Element Method*, Butterworth Heinemann publication, 2000.

Supplementary Reading:

1. C.S. Krishnamoorthy, *Finite element methods*, Tata-Mc Graw Hill, Second Edition, New Delhi, 2002.
2. T. R. Chandupatla & A. D. Belegundu, *Introduction to Finite Elements in Engineering*, Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999
3. J. N. Reddy, *An introduction to Linear Finite Element Method*, Oxford University Press, Oxford, 2004.

CE 610 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING**4 Credits [3-1-0]**

Single degree of freedom system: Equation of motion, Damped and undamped free vibration, Response to harmonic, periodic, impulse load and general dynamic load, Duhamel's integral ; Multi-degrees of freedom system: Equation of motion, Free vibration analysis, Dynamic response and modal analysis ; Free and Forced vibration of distributed mass system: Beam ; Analysis of structural response to Earthquakes: Seismological background, Deterministic analysis of Earthquake.

Essential Reading:

1. R. W. Clough and J Penzien, *Dynamics of structures*, McGraw-Hill, Inc,
2. A K Chropra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, Prentice Hall of India

Supplementary Reading:

1. M. Paz, *Structural Dynamics - Theory and Computation*, Van Nostrand, 1985.
2. *IS: 1893 - 2002 Criteria for Earthquake Resistant Design of Structures.*
3. L. Meirovitch, *Elements of Vibration Analysis*, 2nd Ed., McGraw-Hill, 1986.

CE 611 ADVANCED STRUCTURAL ANALYSIS**4 Credits [3-1-0]**

Methods of structural analysis; flexibility and stiffness matrices; analysis of trusses, beams and frames.

Supplementary Reading:

1. W. Weaver Jr. and J.M Gere, *Matrix analysis of Frames and Structures*, CBS Pub and Distributors

CE 612 STABILITY OF STRUCTURES**4 Credits [3-1-0]**

Torsion of thin walled open sections, warping displacements under pure torsion,-Warping constants for rolled steel section. Strain energy in bending and torsion of members of thin walled open section including the effects of warping. Torsional buckling including the effects of Wagner's effect, flexural torsional buckling (with centroid and shear centres coincident) ; Lateral buckling of beams under pure bending central point load through centre of gravity of the section. Cantilever beams with point load at the free end, Application of Rayleigh-Ritz method ; Beam-columns on rigid supports-concentrated and continuous lateral loads with simply supported and built in-ends. Continuous beam with as axial loads. Application of trigonometric series. Inplane buckling of bars ; Approximate calculation of critical loads for bar structures by energy method- a bar on elastic foundation, a bar with intermediate compressive forces, bar under distributed axial loads, a bar with changes in cross section ; Effects of shearing force on the critical load. Buckling of built-up columns. In-elastic in-plane buckling of columns. Tangent and reduced modulus concept, Shanley's contribution, elastic critical loads for rigid frames and triangulated structures, stability functions. Bending of thin plate. Buckling of thin rectangular plates in compression, shear and bending.

Essential Reading:

1. S.P. Timoshenko and J. M. Gere, *Theory of Elastic Stability* , MC Graw Hill,
2. A. Kumar, *Stability of Structures*, Allied Publishers Ltd., New Delhi, 1998

Supplementary Reading:

1. M.R.Horns and W.Merchang, *The stability of frames*, Pergamon press, 1965.
2. M.Gregory , *Elastic Instability*, spon's Civil Engineering series,1967.
3. F.Bleich, *Buckling strength of Metal structures*,Mc Graw Hill Book co.,1952
4. T.V Galambos, *Structural members and frames*, Prentice-Hall INC, 1968

CE 613 ANALYSIS & DESIGN OF PLATES AND SHELLS**4 Credits [3-1-0]**

Pure Bending of Plates: Slope & curvature of slightly bent plates, Relations between bending moments and curvature in pure bending of plates, Strain energy in Pure bending of plates ; Symmetrical bending of Circular plates: Differential equation for symmetrical bending of laterally loaded circular plates, uniformly loaded circular plates, Circular plates with circular hole at center, circular plate concentrically loaded ; Small deflections of laterally loaded plates : Differential equation of the deflection surface, Boundary conditions, Simply supported rectangular plates under sinusoidal load, Navier solution for simply supported rectangular plates, Further applications of the Navier solution, Alternate solution for simply supported and uniformly loaded rectangular plates, Concentrated load on simply supported rectangular plates. Classification of shell structures, importance of membrane theory of shells, shells in the form of a surface of revolution and loaded un-symmetrically with respect to their axes, spherical dome, conical shells, cylindrical shells, Elliptic paraboloid, hyperbolic paraboloid and conoids ; General theory of cylindrical shells : Circular cylindrical shell loaded symmetrically with respect to its axis, particular cases of symmetrical deformations of circular cylindrical shells, cylindrical tanks of uniform wall thickness. Design of spherical domes with/without lanterns at top.

Essential Reading:

1. S. P. Timoshenko and Woinowsky-Kriegar, *Theory of plates and shells*, Mc Graw Hill International , New Delhi
2. G. S. Ramaswamy, *Design and construction of concrete shells Roofs*, CBS Publishers, Delhi

Supplementary Reading:

1. D. P. Billington, *Thin shell concrete structures*, Mc Graw Hill international, New York
2. W. T. Marshall, *Design of cylindrical shell roofs*, E& FN SPON, London

CE 614 ADVANCED REINFORCED CONCRETE DESIGN 4 Credits [3-1-0]

Estimation of crack width and deflection of reinforced concrete beams. Analysis and design of building frames subjected to wind load ; Earthquake forces and structural response. Ductile detailing of RCC frames. Design of beam-column joints ; Design of deep beam. Design of shear walls.

Essential Reading:

1. R. Park and T. Pauley, *Reinforced concrete structures*, John Wiley and sons
2. A. K. Jain, *Reinforced Concrete: Limit State design*, NemChand and Bros. 1999.

Supplementary Reading:

1. J. Krishna and OP Jain, *Plain and Reinforced Concrete*, Vol. I I, Roorkee, Nem Chand and Bros.
2. H. Nilson, D. Darwin and C. W. Dolar, *Design of Concrete structures*, Tata McGraw Hill
3. T. Paulay and M.J.N. Priestley , *Seismic Design of Reinforced Concrete and Masonry Buildings*, John Wiley & Sons Inc

CE 615 APPLIED ELASTICITY AND PLASTICITY 4 Credits [3-1-0]

Plane stress and plane strain problems. General stress and strain equations (Equilibrium and compatibility equations). Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility equations in polar coordinate. Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam. Effect of circular holes on stress distributions in plates. Stress and strain in three dimensions: Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatical bar by its own axis. Elementary problems of elasticity in three dimension. Torsion of non-circular prismatic bars. Saint Venant's theory. Various analogies. Torsion of hollow and thin section. Application of energy methods ; Introduction to the theory of plasticity, the yield criteria of metals, stress space representation of yield criteria. stress-strain relations plastic potential, flow rules and maximum work hypothesis. Two dimensional plastic flow problems. Incompressible two dimensional flow, stresses in plastic materials in condition of plane strain, equation of equilibrium the simplest slip-line fields.

Essential Reading:

1. S P Timoshenko and J N Goodier, *Theory of Elasticity*, Mc Graw Hill
2. W. Johnson and P B Meller, *Plasticity of Mechanical Engineers*

Supplementary Reading:

1. *Theory of plasticity*, Hoffman and Sachs

CE 616 ADVANCED STEEL DESIGN**4 Credits [3-1-0]**

Design for tension and compression members, connections, design of plate girders, crane girders and trusses. Multi-storyed buildings. Silos, bins and hoppers. Design of steel tanks and staging. Design of bridges, trusses, lateral bracings, sway brackens and stress reversals. Design of continuous beams and frames by plastic theory ; Use of reference books and relevant codes of practice are permitted in the examination.

Essential Reading :

1. K.Mukhanov, *Design of Metal structures*.
2. B Bresler, T Y Lin and J B Scalzi, *Design of Steel structures*.

Supplementary Reading :

1. P Dayaratnam, *Design of Steel Structures*

CE 617 BRIDGE ENGINEERING**4 Credits [3-1-0]**

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project. Site investigation and planning;. Scour - factors affecting and evaluation. Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures; Superstructure - analysis and design of right, skew and curved slabs. Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks. Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, Prestressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination).

Essential Reading:

1. V. K. Raina, *Concrete Bridges Practice – Analysis, Design and Economics*, Shroff Publications, New Delhi 2nd Ed. 2005.
2. Vazirani, Ratwani and Aswani, *Design of Concrete Bridges*, Khanna Publishers , 2nd Ed. 2008.

Supplementary Reading:

1. *IRC codes for Road bridges- IRS Sec –I , II, III*
2. *IRS Codes of Practice for Railway bridges*.
3. B. M. Das, *Principles of Foundation Engineering*, Thomson, Indian Edition, 2003.

CE 618 PRE-STRESSED CONCRETE**4 Credits [3-1-0]**

Different systems of prestressing, Characteristics of concrete and steel, Other suitable design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Comparison of design with respect to British, Australian and American code. Partial prestressing. Stress distribution in end-block of post tensioned section. Magnel's method, Guyen's method, Rowe's method and IS code method. Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members. Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia, Cap cable, Jaeques Muller's theorem. Prestressing of rigid frames. Composite construction of prestressed and in-situ concrete ; Design of special structures- Circular tanks, Pipes, Mast, and materials, Losses in prestress. Analysis of Railway sleepers.

Essential Reading :

1. Y. Guyen, *Prestressed concrete Vol-I & Vol.-II*, John Willey & Sons, New York-1960.
2. N. Krishnaraju, *Prestressed concrete*, Tata McGraw-Hill, New Delhi-2004.

Supplementary Reading :

1. T. Y. Lin and H. Burns Ned, *Design of Prestressed concrete structures*, John Willey & Sons, New York-1982.
2. S. K. Mallik and A. P. Gupta, *Prestressed concrete*, Oxford & IBH, New Delhi-1982.
3. E. W. Bennet, *Prestressed concrete theory & design*, Chapman & Hall, London-1962.

CE 619 COMPOSITE STRUCTURES**4 Credits [3-1-0]**

Introduction: definition, Classification and characteristics of Composite materials, advantages and limitations, Current Status and Future Prospects ; Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy; Characteristics and configurations of lamina, laminate, micromechanics and macromechanics. Constituent materials and properties ; Elastic behavior of unidirectional lamina: Anisotropic, separately orthotropic and transversely isotropic materials, stress-strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters ; Strength of unidirectional lamina: Macromechanical failure theories- Maximum stress theory, maximum strain theory, Deviatoric strain energy theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu) ; Elastic Behavior of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties ; Bending and vibration of laminated plates: Governing equations, Deflection of simply supported rectangular symmetric angle-ply, specially orthotropic, anti-symmetric cross-ply laminates ; Recent advances: Functionally graded materials, Smart materials.

Essential Reading:

1. R.M. Jones, *Mechanics of Composite materials*, Taylor and Francis, 1999.
2. I. M. Daniel and O. Ishai, *Engineering mechanics of Composite materials*, Oxford university press, 1999

Supplementary Reading :

1. P.K. Mallick, *Fiber-reinforced Composites*, Marcel Dekker Inc, 1988.
2. D. Hull and T. W. Clyne, *An introduction to composite materials*, Cambridge university press, Second Edition, 1996.
3. J.N. Reddy, *Mechanics of laminated composite plates and shells-Theory and Analysis*, CRC Press, Boca Raton, Second Edition, 2003.

CE 620 GROUND IMPROVEMENT TECHNIQUES**4 Credits [3-1-0]**

Introduction: Engineering properties of soft, weak and compressible deposits, Natural on land, off-shore and Man-made deposits. Role of ground improvement in foundation engineering, methods of ground improvement, Selection of suitable ground improvement techniques ; In-situ treatments methods: In-situ densification soils, Dynamic compaction and consolidation, Vibrofloatation, Sand pile compaction, Preloading with sand drains and fabric drains, Granular columns, Micro piles, Soil nailing, Ground Anchors, Lime piles, Injections, Thermal, Electrical and Chemical methods, Electro osmosis, Soil freezing ; Reinforced Soil: The Mechanism, Reinforcement materials, Reinforcement - Soil Interactions, Geosynthetics, Principles, Analysis and Design of Reinforced Retaining Structures, Embankments and

Slopes ; Ground Improvement Techniques for Geotechnical Earthquake Engineering, Case studies on ground improvement techniques.

Essential Reading:

1. R. M. Korner, *Design with Geosynthetics*, Prentice Hall, New Jersey, 3rd Edn. 2002
2. P. Purushothama Raj, *Ground Improvement Techniques*, Tata McGrawHill, New Delhi, 1995.

Supplementary Reading:

1. B. M. Das, *Principles of Foundation Engineering*, Thomson, Indian Edition, 2003.
2. G. V. Rao and G. V. S. Rao, *Text Book On Engineering with Geotextiles*, Tata McGraw Hill
3. T. S. Ingold and K. S. Miller, *Geotextile Hand Book*, Thomas Telford, London
4. N. V. Nayak, *Foundation Design Manual*, Dhanpat Rai and Sons, Delhi.

CE 621 ADVANCED SOIL MECHANICS

4 Credits [3-1-0]

Introduction: Origin of soil and its types, mineralogy and structure of clay minerals, X-ray and Differential Thermal Analysis; structure of coarse grained soil, behavior of granular and cohesive soils with respect to their water content ; Consolidation: Steady State flow, 2D and 3D seepage, transient flow; Compressibility and rate of consolidation, one, two, and three dimensional consolidation theories; Sand drains ; Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay ; Elastic and plastic analysis of soil:- Constitutive relationships of soil; failure theories. Limit analysis- Upper bound theorems, lower bound theorems, limit equilibrium methods ; Soil Stabilization: Classification of stabilizing agents and stabilization processes. Nature and surface characteristics of soil particles. Concepts of surface area and contact points. Inorganic stabilizing agents. Strength improvement characteristic of soft and sensitive clay, Marine clay and waste material.

Essential Reading :

1. B M Das, *Advanced Soil Mechanics*, Taylor and Francis
2. R F Scott, *Principles of Soil Mechanics*, Addison & Wesley.

Supplementary Reading :

1. R.O. Davis and A.P.S. Selvadurai, *Elasticity and Geomechanics*, Cambridge University Press, New York.
2. Mitchell, James K, *Fundamentals of Soil Behaviour*, John Wiley and Sons
3. D.M. Wood, *Soil Behaviour and Critical State Soil Mechanics*, University of Glasgow

**CE 622 STABILITY ANALYSIS OF SLOPES, EMBANKMENTS
AND DAMS**

4 Credits [3-1-0]

Landslide phenomenon: Types and causes of slope failures, Practical applications ; Stability analysis of infinite slopes with or without water pressures ; Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method ; Effect of seepage, submerged and sudden draw down conditions ; Design of slopes in cutting, Embankments and Earth dams ; Site Investigation: Reconnaissance, Preliminary and detailed investigation, Investigation for foundations ; Advances in stability analysis of slopes

Essential Reading :

1. L. W Abramson, T. S Lee, S Sharma and G M Boyce, *Slope Stability and Stabilization Methods*, Willey Interscience publications

2. B M Das, *Principles of Geotechnical Engineering*, Thomson Brooks/Cole

Supplementary Reading :

1. T W. Lambe and R V Whitman, *Soil Mechanics*, John Wiley & sons
2. V N S Murthy, *Principles of Soil Mechanics and Foundation Engineering*, UBS Publishers Private Ltd.

CE 623 SOIL-STRUCTURE INTERACTION

4 Credits [3-1-0]

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behavior ; Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions ; Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap ; Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts.

Essential Reading :

1. N.P. Kurien, *Design of Foundation Systems : Principles & Practices*, Narosa, New Delhi 1992,
2. E.S. Melerski, *Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation*, Taylor and Francis, 2006.

Supplementary Reading :

1. L.C. Reese, *Single piles and pile groups under lateral loading*, Taylor & Francis, 2000
2. G. Jones, *Analysis of Beams on Elastic foundation*, Thomas Telford, 1997.

CE 624 GROUND WATER AND FLOW THROUGH POROUS MEDIA

4 Credits [3-1-0]

Soil Water: Modes of occurrence of water in soils. Adsorbed water, capillary water, Capillary potential, Capillary tension and soil suction. Effective and Neutral pressures in soil ; Flow through porous Media: Darcy's law and measurement of permeability in laboratory and field. Steady State flow solutions of Laplace's equation, Plane problems, 3-dimensional problems, Partial cut-offs, uplift pressure, consolidation theory –one and three dimensional consolidation .Secondary consolidation ; Ground water Hydraulics: Water table in regular materials, Geophysical exploration for locating water table. Confined water, Equilibrium conditions, Non-equilibrium conditions, Water withdrawal from streams, Method of ground water imaging.

Essential Reading:

1. D.K.Todd, *Groundwater Hydrology*, John Wiley and Sons
2. H.M. Raghunath, *Ground Water*, Willy Eastern Ltd.

Supplementary Reading:

1. C.Fitts, *Ground Water Science*, Elsevier Publications, U. S. A.
2. P. P. Raj, *Geotechnical Engineering*, Tata McGraw-Hill
3. A. Jumikis, *Soil Mechanics*, East West Press Pvt Ltd.

CE 625 SOIL EXPLORATION AND ANALYSIS OF FOUNDATIONS

4 Credits [3-1-0]

Introduction: Planning of Geotechnical exploration, methods of boring, types of samples & sampling, field tests, Geophysical exploration ; standard penetration test, plate load test, cyclic plate load test, static and dynamic cone penetration test, pressure meter tests, dilatometer tests, in-situ permeability tests ; Presentation and processing of soil exploration data and its interpretation ; Shallow foundations: Bearing capacity of foundation based on in-situ tests. Bearing capacity for foundation on slope, mat foundations including floating raft, settlement calculations for footings on cohesive and cohesionless soil based on in-situ tests. Deep foundations: mechanics of load transfer in piles, load carrying capacity, pile load test, design of pile groups including settlement calculations ; well foundation- Design of well foundation based on bore log data ; Advanced topics on in-situ soil testing

Essential Reading :

1. B. M Das, *Principles of Foundation Engineering*, Thomson Brooks/Cole
2. J. E. Bowles, *Foundation Analysis and Design*, McGraw-Hill Book Company

Supplementary Reading :

1. N.P. Kurien, *Design of Foundation Systems : Principles & Practices*, Narosa, New Delhi 1992
2. G.Ranjan and A S R Rao, *Basic and Applied Soil Mechanics*, New Age international Publishers.
3. H. F. Winterkorn and H Y Fang, *Foundation Engineering Hand Book*, Galgotia Booksource

CE 626 ROCK MECHANICS

4 Credits [3-1-0]

Rock: Formation of rocks, Physical properties, Classification of rocks and rock masses, Static Elastic constants of rock ; Rock Testing: Laboratory and Field tests ; Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock ; Strength Behaviour: Compression, Tension and Shear, Stress-Strain relationships, Rheological behavior ; Strength/ Failure Criterion: Coulomb, Mohr, Griffith theory of brittle strength and other strength criteria. Stresses in rock near underground openings ; Application of rock mechanics in Civil Engineering: Rock tunneling, rock slope stability, bolting, blasting, grouting and rock foundation design.

Essential Reading:

1. W. Farmer, *Engineering Behavior of Rocks*, Chapman and Hall Ltd.
2. R. E. Goodman, *Introduction to Rock Mechanics*
3. P.R. Sheorey, *Empirical Rock Failure Criteria*, Balkema, Rotterdam, 1997

Supplementary Reading:

1. V.S. Vutukuri and R D Lama, *Hand Book on Mechanical Properties of Rocks*
2. B.P Verma, *Rock Mechanics for Engineers*

CE 627 DYNAMICS OF SOILS AND FOUNDATIONS

4 Credits [3-1-0]

Vibration of elementary systems, Analysis of systems with Single degree and multi-degree of freedom. Natural frequencies of continuous systems ; Elastic Constants of soil and their

experimental determination. Effect of vibration on soil properties ; Bearing capacity of dynamically loaded foundations ; Principles of Machine foundation design, Experimental and analytical determination of design parameters ; Design of foundations for turbines, vertical and horizontal reciprocating engines, forge hammers, Effect of machine foundation on adjoining structures, vibration isolation.

Essential Reading :

1. S. Saran, *Soil Dynamics and Machine Foundations*, Galgotia Publications Private Ltd.1999
2. N. S. V. Kameswara Rao, *Vibration Analysis and Foundation Dynamics*, Wiley New Delhi, 1998

Supplementary Reading :

1. B M Das, *Principles of Soil Dynamics*, Thomsons Engineering, 1992
2. K.G. Bhatia, *Foundations For Industrial Machines*, D-CAD Publishers , 2008
3. A Major, *Vibration Analysis and Design of Foundations for Machines and Turbines: Dynamical Problems in Civil Engineering*, Akademiai Kiado Budapest Collets Holding Ltd., 1962

CE 628 EARTH RETAINING STRUCTURES

4 Credits [3-1-0]

Earth Pressure: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine and Coulomb theories, Active, passive and pressure at rest ; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice. Assumption and conditions, point of application of passive earth pressures ; Bulkheads: Definition and assumptions, conditions of end supports and distribution of active earth pressure and bulkheads, bulkheads with free and fixed earth supports, equivalent beam method, Improvements suggested by Rowe, Tschebotarioff's method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates, Consideration of effects of ground water, seepage, surcharge loading together with possibility of shallow and deep sliding failures on retaining structure ; Sheet Pile wall: Free earth system, fixed earth system, Dead man ; Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits ; Arching and Open Cuts: Arching in soils, Braced excavations, Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays ; Reinforced earth retaining structures- Design of earth embankments and slopes ; Recent advances in Earth retaining structures.

Essential Reading:

1. B. M. Das, *Principles of Foundation Engineering*, Thomson, Indian Edition, 2003.
2. J. Bowel, *Foundation Engineering , Analysis and Design*. McGrwHill

Supplementary Reading:

1. P. Raj, *Geotechnical Engineering*, Tata McGraw Hill
2. R F Craig, *Soil Mechanics*, Chapman and Hall(ELBS)

CE 629 EARTHQUAKE GEOTECHNICAL ENGINEERING

4 Credits [3-1-0]

Earthquakes: Causes and characteristics (magnitude, intensity, accelarograms), response spectra, attenuation of ground motion. Estimation of seismic hazards (deterministic and

probabilistic) ; Introduction to vibratory motion: Waves in Elastic Medium; Dynamics of Discrete: Systems , Vibration of single and multiple degree of freedom systems. Free and forced vibrations (regular and irregular excitation) ; Dynamic properties of soils: Determination of site characteristics, local geology and soil condition, site investigation and soil test, Laboratory and in-situ tests; Site response to earthquake. Seismic Microzonation ; Liquefaction of soils: Fundamental concept of liquefaction, assessment of liquefaction susceptibility from SPT and CPT ; Seismic response of soil structure system, seismic bearing capacity of shallow foundation, design of pile foundation in liquefiable ground. Pseudo-static analysis and design of earth retaining structures and soil slopes. Estimation of earthquake-induced deformation.

Essential Reading :

1. S.L. Kramer, *Geotechnical Earthquake Engineering*, Pentice Hall, international series, Pearson Education (Singapore) Pvt. Ltd., 2004.
2. S.Saran, *Soil Dynamics and Machine Foundation*, Galgotia publications Pvt. Ltd., New Delhi 1999.

Supplementary Reading:

1. A. Ansal, *Recent Advances in Earthquake Geotechnical Engineering and Microzonation*, Springer, 2006.
2. I. Towhata, *Geotechnical Earthquake Engineering*, Springer , 2008.

CE 630

ADVANCED WASTE WATER TREATMENT

4 Credits [3-1-0]

Microbiological concepts; cells, classification and characteristics of living organisms, characterisation techniques, reproduction, metabolism, microbial growth kinetics and kinetics of biochemical operations; Modelling of suspended growth systems, techniques for evaluation of kinetic and stoichiometric parameters. Optimal selection of water and waste water treatment chain, Engineered systems, concepts and principles of carbon oxidation, nitrification, denitrification, methanogenesis. Biological nutrient removal ; Anaerobic treatment (process options, components of anaerobic reactions that influence process design); Attached growth reactors (process description, design and applications). Decentralised wastewater treatment systems; Low cost options, constructed wetlands. Reliability and cost effectiveness of wastewater systems.

Essential Reading:

1. M. J. Hammer, *Water and Wastewater Technology*, Prentice Hall, 6th edition, 2007.
2. G. Tchobanoglous, L. Franklin, Burton, H. D. Stensel, Metcalf & Eddy Inc., *Wastewater Engineering: Treatment and Reuse*, McGraw-Hill Higher Education; 4th edition, 2002.

Supplementary Reading:

1. G. M. Fair, J. C. Geyer, D. A. Okun, *Elements of Water Supply and Wastewater Disposal*, John Wiley and Sons Inc.,
2. J. McGhee, *Water Supply and Sewerage*, Terence, McGraw Hill Book Co..

CE 631

**PRINCIPLES OF ENVIRONMENTAL
MANAGEMENT**

4 Credits [3-1-0]

Environmental regulations and policies; Environmental protection laws and acts; Corporate and international charters and protocols; Environment Risk assessment; Industrial ecology,

Pollution prevention and Waste minimization; Sustainable development. Life cycle assessment; Environmental auditing; Eco-labelling of products; Performance indicators. Environmental management systems particularly IS 14000 series. Successful Case Studies.

Essential Reading:

1. R.Welford, *Corporate Environmental Management*, Earthscan Publications Limited, London, 2002.
2. D. Sayre, *Inside ISO 14000 : Competitive Advantage of Environmental Management*, St. Louis Press, Florida, 2000.

Supplementary Reading:

1. T.E. Graedel, and B.R.Allenby, *Industrial Ecology*, Englewood Cliffs: Prentice Hall, New Jersey, 1995.
2. A. Rosencranz, S. Divan and M.L. Noble, *Environmental Law and Policy in India : Cases, Materials and Statutes*, Tripathi Pvt. Ltd, Bombay, 1992.

CE 632

ADVANCED AIR QUALITY MANAGEMENT

4 Credits [3-1-0]

Air pollutants, Sources, Classifications, Effects, Atmospheric diffusion of pollutants and their analysis, Transport, transformation and deposition of air contaminants on a global scale, Air sampling and pollution measurement methods, principles and instruments; Particulate Pollutant Control: Settling chambers; Filtration; Impaction; Convective diffusion; Collection of particles; Electrostatic precipitation; Electrical migration velocity; Cyclones; Wet collectors; Efficiency and dimensions of particle control devices ; Aerosol Dynamics : Discrete and continuous aerosol size distributions; Thermodynamics of atmospheric aerosols; Homogeneous and heterogeneous nucleation; Coagulation and coagulation kernels; Condensation/evaporation, saturation vapour pressure corrections; Sedimentation and dry deposition; Chemical equilibria; Heterogeneous reactions in aerosol- and aqueous-phase; Aerosol-cloud interactions. Aerosols and Global Climate: Trends in anthropogenic emissions and troposphere composition; Solar and terrestrial radiation; Radiation scattering by aerosols and clouds ; Gaseous Pollutant Control: Gas absorption in tray and packed towers; Stage efficiency; Liquid/gas rates; Equilibrium number of stages/packed height; Absorption with/without chemical reaction; Removal of SO₂; Adsorption in fixed beds; Breakthrough; Wet scrubbers. Integrated air pollution control systems; Effect of process parameters on performance of control systems.

Essential Reading:

1. S.K. Friedlander, *Smoke, Dust and Haze: Fundamentals of Aerosol Dynamics*, Oxford University Press, New York, 2000.
2. Noel de Nevers, *Air Pollution Control Engg.*, McGraw-Hill Inc, 2000.

Supplementary Reading:

1. M.Z. Jacobson, *Fundamentals of Atmospheric Modelling*, Cambridge University Press, New York, 1999.
2. J.H.Seinfeld, and S.N.Pandis, *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, Wiley-Interscience, New York, 1998.
3. K.Willeke and P.A. Baron, *Aerosol Measurement: Principles, Techniques and Applications*, van Nostrand-Reinhold, New York, 1993.
4. C. S. Rao, *Environmental Pollution Control Engg*, Wiley Eastern Ltd, 1995.

CE 633

WATER AND WASTE WATER ENGINEERING

4 Credits [3-1-0]

Water Quality, Physical, chemical and biological parameters of water, Water Quality requirement. Potable water standards, In-stream standards, Wastewater Effluent standards.

Water quality indices. Water purification systems in natural systems ; physical processes, chemical processes and biological processes. Primary, Secondary and tertiary treatment. Unit operations, unit processes. Aeration and gas transfer Sedimentation, different types of settling, sedimentation tank design Coagulation and flocculation, coagulation processes, stability of colloids, destabilization of colloids, destabilization in water and wastewater treatment, transport of colloidal particles. Filtration: filtration processes, Hydraulics of flow through porous media, Rate control patterns and methods, Filter effluent quality parameters, Mathematical model for deep granular filters, slow sand filtration, rapid sand filtration, precoat filtration Adsorption, adsorption equilibria and adsorption isotherm, rates of adsorption, Sorption kinetics in batch reactors, continuous reactors, factors affecting adsorption Ion Exchange-processes, materials and reactions, methods of operation, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodialysis, Disinfection Water and Wastewater Treatment Processes.

Essential Reading:

1. G.Tchobanoglous, *Wastewater Engineering: Treatment and Reuse*, Tata-McGraw-Hill Science/Engineering, 2002.
2. MWH, *Water Treatment: Principles and Design*, Wiley, 2005.

Supplementary Reading:

1. *Manual on Sewerage and Sewage Treatment*, 2nd Edition, Ministry of Urban Development, New Delhi, 1993.
2. *Manual on Water Supply and Treatment*, 3rd Edition, Ministry of Urban Development, New Delhi, 1991.
3. T.M.Walski, J. Gessler, and J.W.Sjostorm, *Water Distribution Systems: Simulation and Sizing*, Lewis Publisher, Michigan, 1990.
4. H. S.Peavy, D. R.Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw Hill Book Company, Singapore, 1985.
5. L.D. Benefield, J.F. Judkins, and A.D. Parr, *Treatment Plant Hydraulics for Environmental Engineers*, Prentice-Hall Inc, New Jersey, 1984.

CE 634

INDUSTRIAL POLLUTION PREVENTION AND CLEAN TECHNOLOGIES

4 Credits [3-1-0]

Principles and techniques for industrial pollution prevention and waste minimization; Nature and characteristics of industrial wastes; Prevention versus control of industrial pollution; Source reduction tools and techniques: raw material substitution, toxic use reduction and elimination, process modification and procedural changes; Recycling and reuse; Opportunities and barriers to cleaner technologies; Pollution prevention economics ; Waste audits, emission inventories and waste management hierarchy for process industries; Material balance approach; Material and process mapping approach; Emission sources; Estimation of fugitive emissions; Environmental impact of VOCs; Energy and resource (material and water) audits for efficient usage and conservation. Unit operations in separation technology; Pollution prevention for unit operations: Boilers and Heat Exchangers; Storage tanks; Distillation columns; Application of separation technologies for pollution prevention; Process optimization for cleaner industrial processes: Flow sheet analysis: qualitative and quantitative approaches using mass exchange networks ; Thermodynamic constraints to waste minimization;Holistic and critical technology assessment; Environmental performance indicators; Concept of industrial ecology and symbiosis of eco-parks. Case studies on industrial applications of cleaner technologies in chemical, metallurgical, pulp and paper, textile, electroplating, leather, dairy, cement and other industries.

Essential Reading:

1. P.E. Bishop, *Pollution Prevention: Fundamentals and Practice*, McGraw Hill, 2000.

2. H. M. Freeman, *Industrial Pollution Prevention Handbook*, McGraw Hill, 1995.

Supplementary Reading:

1. D.T.Allen and K.S.Rosselot, *Pollution Prevention for Chemical Processes*, John Wiley, 1997.
2. D.T.Allen, N. Bakshani and K.S.Rosselot, *Pollution Prevention: Homework and Design Problems for Engineering Curricula*, American Institute for Pollution Prevention. Johansson, A., Clean Technology, Lewis Publishers, 1992.
3. L. Theodore and Y. C.McGuinn, *Pollution prevention*, Van Nostrand Reinhold, NewYork, 1992.

CE 635 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT 4 Credits [3-1-0]

Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA; Specialised areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties. Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation. Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment; Environmental management plan; Post project monitoring, EIA report and EIS; Review process. Case studies on project, regional and sectoral EIA. Risk assessment fundamentals and methodology, case studies.

Essential reading:

1. A.Chadwick, *Introduction to Environmental Impact Assessment*, Taylor & Francis, 2007.
2. Larry, W. Canter, *Environmental Impact Assessment*, McGraw Hill Inc. Singapore, 1996.

Supplementary Reading:

1. R.Therirvel, E. Wilson, S. Hompson, D. Heaney, D.Pritchard, *Strategic Environmental Assessment Earthscan*, London, 1992.
2. A.Gilpin, *Environmental Impact Assessment-Cutting edge for the 21st century*, CUP, London, 1994.
3. Paul, A Erickson, *A Practical Guide to Environmental Impact Assessment*, Academic Press, 1994.

CE 638 ENVIRONMENTAL LEGISLATION AND POLICY 4 Credits [3-1-0]

Models of environmental management; Incentives; Context; Theories of corporate strategy and environmental policy; Environmental guidelines and charters; Auditing, Monitoring; Reporting, economics and accounting; Local economic development and environmental management; Role of government; National and International trends, changes in global perspective, International treaties. Legal provisions for environmental protection; various Acts, Rules and Regulations. Notifications issued under various Acts and Rules. Environmental standards, Criteria for standard setting. Public Liability Insurance Act and Acts relating to hazardous and toxic substances. Law and policies beyond environmentalism; Sustainability issues; Role of government and non-government organizations and citizens.

Essential Reading:

1. P.Portney and R.N. Stavins, *Public Policies for Environmental Protection*, RFF Press2000.

2. N.J. Vig and M.E. Kraft, *Environmental Policy: New Directions For the Twenty-First Century*, CQ Press, 2005
3. *EP Act*, Ministry of Environment & Forests, Govt of India. 2004.

Supplementary Reading:

1. P. Hawken, *Ecology and Commerce*, Harper Business, New York, 1993.
2. R. Welford, *Corporate Environmental Management*, Earthscan Publications Ltd., London, 1988.

CE 640 ANALYSIS AND STRUCTURAL DESIGN OF PAVEMENTS 4 Credits [3-1-0]

Theories of pavement design, Factors affecting pavement design ; Methods of flexible pavement design- applications of CBR, Burmister, Asphalt Institute, AASHTO and IRC methods. ; Load and temperature stresses in rigid pavements- Westergaard's, Bradburry's and Picket's concepts ; Design of rigid pavements by PCA, AASHTO and IRC methods ; Design of joints in rigid pavements ; Evaluation of pavement distress ; Design aspects of flexible and rigid overlays.

Essential Reading:

1. Yoder and Witzack, *Principles of Pavement Design*, John Willey and Sons, October 1975
2. Yang H. Huang, *Pavement Analysis and Design*, PH, 2nd Edition, 2004

Supplementary Reading:

1. *Relevant IRC, ASTM, AASHTO and other Codes*, Manuals and Specifications
2. D. Croney & P. Croney, *The Design and Performance of Road Pavements*, Mc Graw Hill Professional, 3rd Edition. 1998
3. Richard J Salter, *Highway design and construction*, Palgrave Macmillan, 1988

CE 641 TRANSPORTATION SYSTEMS PLANNING 4 credits [3-1-0]

Brief Description of urban and regional transportation systems, Definition of a system ; System analysis: scope and limitations, Transportation planning based upon system analysis, Survey and analysis of existing conditions, Models for trip generation, trip distribution, traffic assignment and modal split ; Analysis of future conditions, Plan synthesis and evaluation.

Essential Reading:

1. L.R. Kadiyalli, *Traffic Engineering and Transport Planning*, Khanna Publishers, 7th edition, 2008
2. C. S. Papacostas, P. D. Prevedouros, *Transportation Engineering and Planning*, PHI Publication, 3rd edition , 2002.

Supplementary Reading:

1. M.J. Bruton, *Introduction to Transportation Planning (Built Environment)*, Routledge, 1992.
2. J.D. Fricker and R. K. Whitford, *Fundamentals of Transportation Engineering: A Multimodal System Approach*, Pearson Education, PH, 2005
3. Ortuzar & Willumsen, *Modeling Transport*, John Wiley, 1990

CE 642 TRAFFIC ENGINEERING AND TRAFFIC FLOW THEORY 4 credits [3-1-0]

Traffic surveys: Speed, volume, delay, origin and destination, parking ; Traffic controls: Traffic signs, signals, road marking and other traffic control aids ; Traffic safety: Accidents, causes and prevention ; Traffic flow theory: Light hill and Witham's theory, the queuing theory and its application to traffic engineering problems, car flow theory ; Simulations of traffic: scanning technique

Essential Reading:

1. L.R. Kadiyalli, *Traffic Engineering and Transport Planning*, Khanna Publishers, 7th edition, 2008.
2. C.A.O'Flaherty, *Transport Planning and Traffic Engineering*, Arnold, 1997

Supplementary Reading:

1. R. P. Roess, E. S. Prassas, & W.R. Mc Shane, *Traffic Engineering*, Prentice Hall, 3rd Edition, 2004
2. May, *Traffic Flow Fundamentals*, Prentice Hall, 1989
3. F. L. Mannering, *Principles of Highway Engineering and Traffic Analysis*, 4th Edition, 2008, John Wiley.

CE 643 HIGHWAY AND AIRPORT PAVEMENT MATERIALS 4 credits [3-1-0]

Conventional aggregates and their evaluation, Bituminous binders- Properties, testing and applications; Bituminous mixes- Design, testing and evaluation; Materials for cement concrete and semi-rigid pavements, Design of mixes for stabilized roads ; Non-conventional and new pavement materials- their application and limitations.

Essential Reading:

1. Atkins & Harold, *Highway Materials, Soils, and Concretes*, Prentice Hall – Pearson, 4th Ed., 2003
2. Y. Richard Kim, *Modeling of Asphalt Concrete*, 2008, Mc Graw Hill Professional.

Supplementary Reading:

1. *Relevant IRC, ASTM, AASHTO and other Codes*, Manuals and Specifications
2. P.G. Lavin, *Asphalt Pavements*, Taylor and Francis, 1st Ed. 2007

CE 644 PLANNING AND DESIGN OF AIRPORTS 4 credits [3-1-0]

Classification of airports- ICAO standards ; Planning for airport- Airport components- Zoning laws ; Runways- orientation and geometric design- Runway patterns ; Taxiways- alignment- geometry and turning radius- exit taxiways ; Aprons- planning and design ; Design principles of critical, semi-critical, non-critical airport pavements- FAA and PCA methods ; Airport hangars- their planning and design criteria ; Airport landscaping, grading and drainage-general aspects ; Airport terminal and amenities ; Airport lighting and marking.

Essential Reading:

1. N.J. Ashford, P.H. Wright, *Airport Engineering*, 3rd Edition, 1992, John Wiley
2. R.M. Horonjeff, F.X. Mc Kelvey, W.J Sproule, *Seth Young, Planning and Design of Airports*, TMH International Publishers, Fifth Edition, 2009

Supplementary Reading:

1. Khanna, Arora and Jain, *Planning and Design of Airports*, Nemchand Bros., 2001
2. Wells, Alexander; Young, Seth, *Airport Planning & Management*, McGraw Hill, 5th Edition, July, 2009
3. De N. Richard, & Odoni, *Airport Systems: Planning, Design, and Management*, McGraw Hill Amedeo, 1st Edition, 2004.

CE 645 GEOMETRIC DESIGN OF HIGHWAYS 4 credits [3-1-0]

Highway capacities and speeds on rural and urban roads, Special aspects of horizontal and vertical alignments, Interrelationships between geometric elements in rural and urban roads, Variations in geometric standards between plains and hilly regions, Special curves, Design aspects of intersections and grade separations, Traffic rotaries, Flyovers and cloverleaf junctions.

Essential Reading:

1. C. S. Papacostas, P. D. Prevedouros, *Transportation Engineering and Planning*, PHI Publication, 3rd edition , 2002
2. L.R. Kadiyalli, *Traffic Engineering and Transport Planning*, Khanna Publishers, 7th edition, 2008.

Supplementary Reading:

1. P.H. Wright, K.K. Dixon, *Highway Engineering*, John Willey, 2004
2. C.J. Khisty and B. Lall, *Transportation Engineering*, PHI Publication, 3 ed., 2006 Relevant IRC and other Codes and specifications
3. J.G. Schoon, *Geometric Design Projects for Highways: An Introduction*, American Society of Civil Engineers (ASCE Press), 2nd Edition, 2002

CE 646 EVALUATION AND STRENGTHENING OF PAVEMENTS 4 credits [3-1-0]

Factors affecting pavement performance ; Failure and distresses- their nature ; Evaluation Techniques for monitoring the nature and magnitude of distress in flexible and rigid pavements- devices adopted ; Measurement of profile- tolerance standards in quality control- waves and deformations ; Measurements- rebound deflection- roughness index- effect of traffic, fuel, chemicals and environmental conditions ; Assessing structural strength of highway and airport pavements ; Serviceability, structural number and energy concepts- need for conditioning and strengthening ; Overlays- their types- general construction features, Design of overlays- over existing flexible and rigid Pavements- IRC, AASHTO and other methods- their comparison, Economics of overlays.

Essential Reading:

1. Yoder and Witzack, *Principles of Pavement Design*, John Willey and Sons.,1975
2. Yang, *Design of Functional Pavement*, Mc. Graw Hill,1972

Supplementary Reading:

1. *Relevant IRC and other Codes and Specifications.*
2. D. Croney & P. Croney, *The Design and Performance of Road Pavements*, McGraw Hill Professional, 3rd Edition, 1998.

CE 647 TRANSPORTATION AND ENVIRONMENT 4 credits [3-1-0]

The Road Environment: human factors in road user behavior, vehicle characteristics, driver, road and environment. Environmental Factors: impacts and mitigation measures of air quality, noise, severance, visual intrusion, impact on water quality, use of limited resources, impact on flora & fauna, vibration, dust ; Transport related pollution; Technology Vision-2020; Urban and non urban traffic noise sources, Noise pollution; Energy related aspects of different transport technologies. Traffic calming, Measures, Road transport related air pollution, sources of air pollution, effects of weather conditions, Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; Imitative measures; EIA requirements of Highways projects, Procedure; MOEF World Bank/EC/UK guidelines ; EIA practices in India.

Essential Reading:

1. K. Wark, C.F. Warner, & W.T. Davis, *Air Pollution: Its Origin and Control*, Prentice Hall. 3rd Ed. 1997.
2. R.W. Boubel, *Fundamentals of Air Pollution*, Academic Press, 4th Ed. 2007.

Supplementary Reading:

1. D. Vallero, *Fundamentals of Air Pollution*, Academic Press, 4th Ed. 2007.
2. L. Canter, *Environmental Impact Assessment*, McGraw-Hill International, 2nd Ed. 1995.

**CE 648 TRANSPORTATION SYSTEMS, ANALYSIS AND 4 credits [3-1-0]
MODELLING**

Systems modeling- definitions ; Transport models, Model building kit, Mathematical modeling and its calibration, Data collection and application of models ; Land use and transportation interaction ; Future forecasts using models ; Evaluation and analysis of transportation systems

Essential Reading:

1. P.H. Wright, N.J. Ashford, R.J. Stammer, *Transportation Engineering: Planning and Design*, 4th Edition, December 1997
2. *Principles of Highway Engineering and Traffic Analysis*, John Wiley & Sons, 3rd Ed., 2004.

Supplementary Reading:

1. M.D. Meyer and E.J. Miller, *Urban Transportation Planning. Urban Transportation Planning: A Decision-Oriented Approach*, 2nd edition, McGraw-Hill, 2001
2. B.G. Hutchinson, *Urban Transportation Planning*, Mc. Graw Hill, 1974

CE 649 ADVANCED RAILWAY ENGINEERING 4 credits [3-1-0]

Track and track stresses, Train resistances and hauling power of locomotives ; Railway track components: Important features, Railway curves, Superelevation, Gradients and grade compensation, Points and crossing and their design approaches. ; Construction and maintenance of railway track, Control of train movements; Signals and interlocking, Modernisation of railways and future trends; Track standards and track rehabilitation.

Essential Reading:

1. J.S. Mundrey, *Railway Track Engineering*, Tata McGraw Hill Co. Ltd., 3rd Edition, 2000.
2. M.M. Agarwal, *Railway Track Engineering*, Standard Publishers, 1st Ed. 2005.

Supplementary Reading:

1. S. Chandra and Aqarwal, *Railway Engineering*, Oxford University Press, 1st Ed. Feb 2008.
2. A.D. Kerr, *Fundamentals of Railway Track Engineering*, Simmons Boardman Pub Co (December 30, 2003)

**CE 650 HYDROLOGY AND HYDRAULICS OF SURFACE 4 credits [3-1-0]
AND SUB SURFACE WATER**

Hydraulics of alluvial rivers: regimes and morphology. Critical tractive force and resistance relations. Suspended, Bed and Total loads. Meandering, Braiding, Aggradation and Degradation. Routing of floods – reservoir and channel routing. Determination of reservoir capacity and height of dam. Sub-surface water flows. Aquifers and their properties. Estimation of ground water flows. Well hydraulics and quality of ground water.

Essential Reading:

1. H. Rouse, *Engineering Hydraulics* by John Wiley and sons
2. M.S. Stephenson, *River Engineering*, Prentice Hall, New Delhi.

Supplementary Reading:

1. H. Rouse, *Engineering Hydraulics*, John Wiley and Sons.

CE 651 HYDROLOGIC ELEMENTS AND ANALYSIS 4 credits [3-1-0]

Importance and application, water budget, catchments, hydraulics cycle and water budget. Hydrologic cycle. Measurement of rainfall, infiltration, evaporation and runoff. Hydrologic frequency analysis. Peak flow using frequency analysis and catchment area formulae. PMP, PMF and SPF. Unit hydrograph, Synthetic unit hydrograph, S-hydrograph and watershed dynamics simulation models. Flood hydrograph. Flood Routing, Reservoir routing and channel routing, Flood estimation and flood frequency studies. ; Erosion and sediment yield. Application of remotely sensed information in water resources engineering. hydrologic process; Measurements and networks for rainfall, stream flow. Statistical analysis of discrete Hydrologic data: Statistical analysis; Correlation & Regression analysis. ; Time series analysis and its applications. Synthetic data generation of hydrologic variables. Multivariate stream flow model. Models for long and short term forecasting; Depth duration and frequency analysis. Catchment characteristics; Mathematical models for deterministic, stochastic, conceptual and empirical models. Stochastic processes, stationary and non-stationary processes, discrete linear processes, Parameter estimation.

Essential Reading:

1. K.C. Patra, *Hydrology and Water resources Engineering*, by Narosa publishing house, New Delhi
2. K. Subramanya, *Engineering Hydrology*, Tata McGraw Hill Book Company

Supplementary Reading:

1. V. P. Singh, "*Elementary Hydrology*", Prentice Hall of India, Pvt. Ltd., New Delhi.
2. V.T. Chow, *Hand book of Applied Hydrology*, Mc Graw-Hill Publishing Company, New York.
3. M.A. Kohlar, J.L.H. Pauluhus, R.K. Linsely, *Hydrology for Engineers*, Tata Mc Graw Hill, New Delhi.

CE 652 OPEN CHANNEL FLOW 4 credits [3-1-0]

Energy and Momentum of flow; Critical flow; Channel Control and Transitions; Discharge measurement methods; Uniform flow and Flow resistance; Composite roughness and Compound channels; Gradually varied flow; Classifications and Computations of Free surface profiles; Spatially varied flow; Supercritical flows and Oblique flows. Rapidly varied flow; Hydraulic jump ; Unsteady flow in bounded systems, Quasi- steady flow, unsteady flow in open channel flow. Finite difference representation of depth dependent-discharge, Simulation of unsteady flow channels and ducts. Development of St. Venant equation of continuity and motion, Continuity and Dynamic equations of Unsteady flow; Wave propagation and Surge; Method of Characteristics; Dam-break problem; Density current; Flow in Channel bends.

Essential Reading:

1. V.T.Chow, *Open Channel Flow*, By McGraw- Hill Book Co.,
2. H. Chanson, *The Hydraulics of Open Channel Flow: An Introduction* by Elsevier

Supplementary Reading:

1. K. Subramanya, *Flow in Open Channel*, Tata Mc Graw hill, New Delhi
2. R.J. Garde and K.G. Rangaraju, *Mechanics of Sediment Transport and Alluvial Stream*.
3. K.G. R. Raju, *Flow Through Open Channels Problems*.

CE 653**ADVANCED FLUID MECHANICS****4 credits [3-1-0]**

Dynamic of Fluid Flow, One-Dimensional method, The Navier Stokes Equation, Limiting Case, applications ; Boundary Layer Theory for low and high Viscosity, Boundary Layer thickness, Prandtl's Equation, Momentum Integral Equation, Pressure Distribution in boundary layer. ; Dimension analysis and similarities, Buckingham π theorem, types of similarities, forces influencing hydraulic phenomenon, significance of dimensionless numbers, distorted model, and model proto type similarity law. ; Ideal Fluid Flow, Circulation and Vortices, Source and sink, combining flow field by super position, combined flow field for engineering importance. ; Doublet in rectilinear flow and Doublet with Circulation. Flow past a cylinder curved flow and with circulation and their different combinations ; Real-Fluid Flow: Viscous incompressible flow; Navier-Stokes equations, Laminar and Turbulent boundary layer, Turbulence and Coherent structure of flow; Reynolds stresses; Skin friction; Form drag and Lift.

Essential Reading:

1. K. Subramanya, *Theory and application of Fluid Mechanics*, Tata Mc Graw hill, New Delhi.
2. V.L. Streeter, *Fluid Mechanics*, 1971, New York, McGraw-Hill Book, New York.

Supplementary Reading:

1. J.F. Douglas, J.M. Gasiorek, J.A. Swaffield, *Fluid Mechanics*, Person Education.
2. S.K. Som and G. Biswas, *Introduction to Fluid Mechanics*, Tata McGraw Hill Book Company.
3. K.C. Patra, *Engineering Fluid Mechanics and Hydraulic Machines*, Narosa publishing house, New Delhi.

CE 654**WATER RESOURCES MANAGEMENT****4 credits [3-1-0]**

Managing our water resources, Erosion control and watershed development: their benefit towards conservation of national water wealth. Rain water harnessing and recharge of ground water: role of society and People's participation for sustainable water resource development. Mitigation strategies for flood damage: structural and non-structural measures.

Essential Reading:

1. A.S. Goodman, *Principles of Water Resources Planning*, Prentice Hall Inc., New Jersey, 1984.
2. L.D. James, and R.R. Lee, *Economics of Water Resources Planning*, Mc Graw Hill, 1971.

Supplementary Reading:

1. L. W. Meyer- *Water Resources Hand Book*, Mc Graw Hill
2. C.C. Warnic, *Hydropower Engineering*, Prentice Hall Inc., New Jersey, 1984

CE 655**COMPUTATIONAL FLUID DYNAMICS****4 credits [3-1-0]**

Introduction, overview of the numerical simulation of flood flows in river channels, governing equations in flood flows in river channels. Finite difference approach, Explicit finite difference schemes, Implicit finite difference schemes, significance of model boundary conditions, Hydraulic structures, hydraulic structures affect flow conditions within river channels and structures within numerical models, data requirements for numerical models of flood flows in river channels, Model calibration, understanding of the data checks necessary to ensure correct representation of the river geometry in a numerical model, calibrating numerical models of flood flows in river channels, Conveyance Estimation, prediction of conveyance within river channels, new Conveyance Estimation System (CES).

Essential Reading:

1. M.B. Abbot. *Computational Hydraulics*. (1979)
2. M.B. Abbott and D.R. Basco, *Computational Fluid Dynamics*. (1989).

Supplementary Reading:

1. C.B. Vreugdenhill, *Computational Hydraulics* (1989).
2. P.S. Huyakern and G. F. Pinder, *Computational Methods in sub-surface flows*, academic Press, 1983.

CE 656 DESIGN OF HYDRAULIC SYSTEMS 4 credits [3-1-0]

Objectives of hydraulic structures in Water resources systems, preliminary investigation and preparation of the reports, design of water storage structures ; (1)High dams-gravity dams(zonal method design), over flow and non over flow section.(2) Low dams- weirs, earthen dams, vented dams (Barrage), instrumentation and maintenance of dam structures. Collection and conveyance of water. Design of intakes, conveyance system of Irrigation, drinking and hydro power. Design of canal net work. Hydraulic design of pressure pipes, hydrostatic tests on pipes, design of distribution systems- pressure in distribution systems, nomo graphs, Hardy cross and numerical methods, computer added design (CAD).

Essential Reading:

1. Creager, Justin & Hinds, *Engineering for Dams*, Vols - I, II, III.
2. Varshney, *Hydraulic and Irrigation Structures*.

Supplementary Reading:

1. Varshney, *Hydraulic and Irrigation Structures*.

CE 657 HYDRAULIC STRUCTURE AND HYDRO POWER ENGINEERING 4 credits [3-1-0]

Advanced topics in design and construction of Gravity, earth and Rock-fill dams, Dynamic analysis of gravity dams under earthquake loading through computer package. Spillways and energy dissipaters, Gates, Sluices, galleries, Contraction joints, Seepage control measures, Principles of foundation treatment. Transients in water conductor systems. Design of hydropower installation components intake structures, water conductor systems, tunnels, surge-tanks, penstocks, valves and anchor-blocks. Types of powerhouse. Underground, Semi-Underground. Turbines and their foundations. Introduction to structural and geotechnical aspects of powerhouse design. CAD applications. Similitude and Models.

Essential Reading:

1. K.R. Arora, *Irrigation Water Power and Water Resources Engineering*.
2. Varshney, *Hydraulic and Irrigation Structures*.

Supplementary Reading:

H. Rouse, *Engineering Hydraulics*, John Wiley and Sons

**CE 658 WATER QUALITY MODELLING AND
MANAGEMENT**

4 credits [3-1-0]

Water quality description, various characteristics of water, water quality criteria and standards, elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transport mechanism-advection, diffusion, dispersion. River and streams, convective diffusion equation and its application. Estuaries, Estuarine hydraulics, Estuarine water quality models. Lakes and reservoirs, eutrophication. Contaminant transport in unsaturated flows, solute transport models for conservative species, solute transport in spatially variable soils. Contaminant transports in ground water advection, dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, bio degradation reaction. Water quality management, socio-economic aspects of water quality management, management alternatives for water quality control, waste load allocation process, lake quality management, ground water remediation.

Essential Reading:

1. Thomann and Muller, *Principles of surface water quality modeling and control*
2. Chapra, *Surface water quality modeling*

Supplementary Reading:

1. Schnoor, *Environmental Modelling*
2. Thomann, *Systems Analysis and Water Quality Management.*

CE 659 FLUVIAL HRDRAULICS

4 Credits [3-1-0]

Fluvial Hydraulics, Incipient Condition, Bed Load, Suspended Load, Sediment properties; Initiation of motion; Bed Load; Bed Forms; Bed Forms & Field Measurements Effective bed roughness; Armoring; Suspended Load; Total Load; Transport of Sediment due to unsteady flow; Meandering of rivers; Braided river; Local scour at different structures; Sediment sampling; Mathematical models of sediment transport. Methods of Computation & Computer Oriented Algorithms Transient Gradually Varied Flow, Saint Venant's Equation, Kinematics Wave Theory, Hydraulic Routing Through Channels, Overland Flow & Computer Oriented Algorithms.

Essential Reading:

1. M.S. Stephenson, *River Engineering*, Prentice Hall, N. Delhi.
2. S.N. Ghosh, *Flood control and Drainage Engineering*, Oxford and IBH Publishing Co.

Supplementary Reading:

1. D.W. Knight and A.Y. Shamseidin, *River Basin Modelling for flood risk management*, by Tayler and Francis Group, London
2. H. Chang, *Fluvial Processes in River Engineering*. Krieger Pub Co. 2001.

CE 660 HIGH RISE STRUCTURES

4 Credits [3-1-0]

Analysis of tall building frames, Lateral load analysis, multi bay frames, gravity loads, settlement of foundation. Analysis of shear walls - plane shear walls, infilled frames, coupled frames, frames with shear walls. Principle of three dimensional analysis of tall buildings; Perforated cores, pure torsion in thin tubes, bending and warping of perforated cores. Analysis of floor system in tall buildings, Vierendal girders, diagrid floors. Elastic and inelastic stability of frames and shear walls. Analysis of thermal stresses.

Essential Reading:

1. B S Smith & A Coull, *Tall Building Structures:* - John Wiley & Sons.
2. W. Schueller, *High Rise Building Structures:* John Wiley & Sons.

CE 661 STRENGTH AND DEFORMATION BEHAVIOUR 4 Credits [3-1-0]
OF SOIL

Introduction: Physico-Chemical aspects, Failure theories, Yield criteria, Elastic and Plastic analysis of soil, Mohr's diagram. ; Stresses in Soil: Description of state of stress and strain at a point, stress distribution problems in elastic half space. Boussinesqu, Westergard Mindlin and Kelvin problems. Distribution of contact pressure. Analysis of Elastic settlement. ; Soil Plasticity. ; Shear Strength of Soils: Experimental determination of shear strength, Types of tests based on drainage conditions and their practical significance, Skempton's and Henkel's pore water pressure coefficients, Stress path, Shear strength of unsaturated soils, Row's stress dilatancy theory. Constitutive Models: Constitutive Models in Soil Mechanics: Isotropic Elastic, Anisotropic Plasticity and Viscous Models. Representing Soil Behaviour using these Models. ; Advances in Constitutive models.

Essential Reading:

1. A.P.S. Selvadurai, *Plasticity & Geomechanics*, Cambridge University Press, 2002
2. W.F. Chen, *Limit Analysis & Soil Plasticity*, Elsevier Scientific, 1975.

Supplementary Reading:

1. C. S. Desai and J. T. Christian, *Numerical Methods in Geotechnical Engineering*, McGraw Hill, New York.
2. R. F. Scott, *Principles of Soil Mechanics*, Addison & Wesley

CE 662 ENVIRONMENTAL GEOTECHNICS 4 Credits [3-1-0]

Introduction: Forms of waste, engineering properties (determination and typical values), subsurface contamination. ; Selection of waste disposal sites: Site selection – selection criteria and rating; Solid waste disposal: Ash Disposal facilities- Dry disposal, waste disposal, Design of ash containment system, Stability of ash dykes; Contaminant transport through porous media: mechanisms- advective and dispersion; Municipal and hazardous waste landfill: Types- Dry cell, wet cell, bioreactor, Design- clay liners, geosynthetic clay liners for waste containment, cover and gas collection system. ; Remediation: Principle-planning, source control, soil washing, bioremediation.

Essential Readings:

1. K. R. Reddy and H D Sharma, "*Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies*", John Willey, 2004.
2. R N. Yong, "*Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation*", Thomson Telford, 2000.

Suggested Readings:

1. L N Reddy and H.I. Inyang, "*Geoenvironmental Engineering: Principles and Applications*", Marcel Dek, 2000

CE 663 MASS TRANSIT SYSTEMS 4 credits [3-1-0]

Mass Transit concepts- Trip interchanges and assignments ; Urban transportation problems, Modes of mass transit- their planning, construction and operation, Case studies of existing mass transit systems ; Technical and economic evaluation of mass transit projects

Essential Readings:

1. C. S. Papacostas, P. D. Prevedouros, *Transportation Engineering and Planning*, PHI Publication, 3rd edition, 2002

2. S. Grava, *Urban Transportation Systems*, Mc. Graw Hill Professional, 1st Ed. 2002

Supplementary Readings:

1. J.D. Fricker, & R.K. Whitford, *Fundamentals of Transportation Engineering*, Pearson, PH, 2004
2. V.R. Vuchic, *Urban Transit Systems and Technology*, John Wiley & Sons, February 2007
3. C.A. O'Flaherty, *Transport Planning and Traffic Engineering*, Arnold, 1997
4. J. E. Anderson, *Transit Systems Theory*, Lexinton Books, USA

CE 664 INTEGRATED RIVER BASIN MANAGEMENT 4 credits [3-1-0]

Necessary conditions of river basin development, Heceristic approach, sequential approach, components of river basin development, conjunctive use of surface water and ground water, planning design and development of regional ground water system in a river basin. Inverse modeling in regional GW system. Role of Industries, NGO and VO in river basin developments, socio-economic factors rehabilitation, concept of sustainable development, some typical case studies.

Essential Reading:

1. D.W. Knight and A.Y. Shamseidin, *River Basin Modelling for flood risk management*, by Tayler and Francis Group, London.
2. H. Chang, *Fluvial Processes in River Engineering*. Krieger Pub Co. 2001.

Supplementary Reading:

1. M. S. Stephenson, *River Engineering*, Prentice Hall, New Delhi.
2. S.N. Ghosh, *Flood control and Drainage Engineering*, Oxford and IBH Publishing Co.

CE 665 GROUND WATER ASSESSMENT AND DEVELOPMENT 4 credits [3-1-0]

Importance of GW, available water on earth, Hydrologic cycle, types of aquifer, storage coefficients, ground water basins, Darcy's law, permeability, well hydraulics, pumping test, water wells, test holes and well loss, Methods of Drilling of deep wells, cable tool drilling method, rotary method, pumps. ; Surface investigation of ground water, remote sensing, geo-physical exploration, electrical resistivity method, seismic refraction method, gravity and magnetic methods, water witching, sub surface investigation of ground water: test drilling, geologic logging, geophysical logging, resistivity logging, artificial recharge of ground water, conjunctive use of water.

Essential Reading:

1. *Ground Water Manuals, A water resources technical Publications*, Scientific Publishers, Jodhpur
2. L. Harvil and F. G. Bell, *Ground Water Resources and Development*, Butterworths, London.

Supplementary Reading:

1. H.M. Raghunath, *Ground Water*, New Age International Pvt. Ltd.
2. F. W. Schwartz & H. Zhang, *Fundamental of Ground Water*, John Willey & Sons.

CE 668 SPECIAL TOPIC IN CIVIL ENGINEERING - I 4 credits [3-1-0]

CE 669 **SPECIAL TOPIC IN CIVIL ENGINEERING – II** **4 credits [3-1-0]**

CE 670 **STRUCTURAL ENGINEERING DESIGN PRACTICE** **2 Credits [0-0-3]**

1. Analysis and design of Multi-storey building frames using STAAD. Pro. SAP
2. Analysis and design of Elevated Water Tank using STAAD-Pro., SAP
3. Analysis and design of bridge decks and other structures using STAAD-Pro., SAP
4. Analysis and design of steel trusses using STAAD-Pro., SAP
5. Dynamic response of structures using PULSE software.

CE 671 **STRUCTURAL ENGINEERING LABORATORY** **2 credits [0-0-3]**

1. Mix design of concrete of different grades & using admixtures.
2. Tensile and Flexural strength of concrete of different grades.
3. Tensile strength of different types of steel rebars, rolled steel sections.
4. Testing of simply supported RCC beams for flexural failure
5. Testing of simply supported RCC beams for shear failure
6. Testing of RCC column
7. Non-destructive testing of concrete including rebound hammer and ultrasonic pulse method.
8. Permeability of concrete
9. Vibration analysis of beams and plates
10. Buckling load of struts.

Essential Reading:

1. A.M. Neville & J.J. Brooks, *Concrete Technology*, Pearson Education, Delhi, 2004.
2. A.R. Santhakumar, *Concrete Technology*, Oxford University Press, 2007, New Delhi

Supplementary Reading:

1. *Structural Engineering laboratory manual.*
2. *Relevant BIS Codes of practice for mix design, rebar testing, concrete design etc.*

CE 672 **GEOTECHNICAL ENGINEERING PRACTICE** **2 Credits [0-0-3]**

Standard Penetration test
Field vane shear test
Cone penetration tests
Plate load test
Pile load tests
Non destructive testing of piles
Pressure meter test
Geophysical Exploration
Field Visit

CE 673 **GEOTECHNICAL ENGINEERING LABORATORY** **2 Credits [0-0-3]**

Standard and Modified Proctor Compaction Test
Permeability of fine grained soil
Direct Shear Test
Triaxial Shear Test (CU, CD, UU)
C.B.R (Unsoaked& soaked)
Consolidation Test
Mechanical properties of geosynthetics/ geogrid

CE 674 **WATER RESOURCES ENGINEERING DESIGN** **2 credits [0-0-3]**

DESIGN

Computing average unit hydrographs, Flood routing, estimation and design of flood, computation of yields series. ; Design of earth and gravity dams.

CE 675 HYDRAULIC AND HYDROLOGIC 2 credits [0-0-3]
ENGINEERING LABORATORY

Measurement of velocity profile in straight and meandering open channel; Experiments on velocity distribution and Boundary shear in rough and smooth channels, Discharge measurement by weir; Measurement of Shear stress using Preston Tube and from velocity distribution obtained from Acoustics Doppler Velocity meter (ADV). Measurement of rainfall, evaporation, infiltration, laboratory and field tests.

CE 676 TRANSPORTATION ENGINEERING DESIGN 2 credits [0-0-3]
PRACTICE

Soil-Cement / Soil-lime Mix Design
Blending of aggregates
Design and blending of sub-base material
Characterisation of Aggregate and Bituminous materials
Viscoelastic Characteristics of bituminous and modified binders
Modified Marshall test for bituminous mixes
Repeated Load Testing of pavement materials
Use of softwares for Pavement Analysis and Design

CE 677 TRANSPORTATION ENGINEERING 2 credits [0-0-3]
LABORATORY

Penetration Ratio and Penetration Viscosity Number of Bituminous binders
10% Fines Test for aggregates
Moisture sensitivity test for bitumen adhesion
Viscosity-Temperature relationships for Bituminous binders
Rheological properties of Bituminous binders
Design of Bituminous mixes

CE 678 ENVIRONMENTAL ENGINEERING DESIGN 2credits [0-0-3]
PRACTICE

1. Design of Water Supply Systems: Selection of site for the source of water supply. Design of units for sedimentation, cogulation, flocculation, granular media filtration, disinfection, water softening, advanced tertiary treatment, design of city water supply pumping and distribution systems.
2. Design of Wastewater Treatment Units: Screening chamber, septic tank and soak pits, activated sludge process and filtration units.
3. Design of air pollution control units: Design of stacks and chimneys, design fo air pollution control equipments.

CE 679 ENVIRONMENTAL ENGINEERING LABORATORY 2 credits [0-0-3]

1. Complete physical, chemical, and bacteriological analysis of water
2. Complete physical, chemical, and bacteriological analysis of wastewater
3. Ambient air quality analysis (NO_x, SO₂, PM₁₀, SPM)
4. Ambient Noise Quality Analysis
5. Solid waste Analysis
6. Ambient Noise Quality Monitoring

CE 680 COMPUTATIONAL LABORATORY - II 2 credits [0-0-3]

Development of Finite Element Programming for analysis of beams, trusses, frames. ; Analysis of plates and shells using commercial softwares.

CE 681 COMPUTATIONAL LABORATORY 2 credits [3-1-0]

Computer programming in C⁺⁺. ; Development of computer programs to solve problems related to civil engineering using matrix method.

CE 682 COMPUTER AIDED FOUNDATION ENGINEERING DESIGN PRACTICE 2 credits [0-0-3]

Computer aided design of:
Design of footing for compression, bending and uplift,
Design of sheet pile, bracing
Design of Pile foundation
Design of Retaining wall
Design of Well foundation
Design of slopes and embankments
Design of foundation subjected to dynamic load.
Design of reinforced earth works

CE 684 COMPUTER APPLICATION IN WATER RESOURCES ENGINEERING 2 credits [0-0-3]

The numerical simulation of flood flows in river channels, governing equations in flood flows in river channels. Finite difference approach, explicit finite difference schemes, implicit finite difference schemes, significance of model boundary conditions, computer application for velocity distribution, boundary shear study and conveyance estimation to open channel flow and prediction of conveyance within river channels.

CE 685 SEMINAR & TECHNICAL WRITING-I 2 credits [0-0-3]

CE 686 TRAFFIC & TRANSPORTATION ENGINEERING LABORATORY 2 credits [0-0-3]

Traffic volume studies
Spot speed studies
Accident and Parking studies
Design of Traffic rotaries and Intersections
Traffic simulation modeling
Road safety audit

Use of software for geometric design and alignment of highways

CE 687	SPECIAL LABORATORY IN CIVIL ENGINEERING-I	2 credits [0-0-3]
CE 688	REMOTE SENSING AND GIS LABORATORY	2credits [0-0-3]
	<ol style="list-style-type: none">1. Review of target Recognition Concepts.2. Non Photographic Imagery3. Introduction to Digital Image Analysis4. Image Exploration5. Image Corretion/ Recrification6. Unsupervised Classification7. Supervised Classification8. Verification	
CE 689	SEMINAR & TECHNICAL WRITING-II	2 credits [0-0-3]
CE 690	SPECIAL LABORATORY IN CIVIL ENGINEERING-II	2 credits [0-0-3]
CE 691	SEMINAR & TECHNICAL WRITING-III	2 credits [0-0-3]
CE 692	SEMINAR & TECHNICAL WRITING-IV	2 credits [0-0-3]
CE 693	SUMMER RESEARCH/INDUSTRIAL PROJECT	4 credits [0-0-0]
CE 694	COMPREHENSIVE VIVA VOCE	4 credits [0-0-0]
CE 695	RESEARCH PROJECT WORK-I	8 credits [0-0-0]
CE 696	RESEARCH PROJECT WORK-II	8 credits [0-0-0]
CE 697	RESEARCH PROJECT REVIEW-I	8 credits [0-0-0]
CE 698	RESEARCH PROJECT WORK-II	8 credits [0-0-0]
CE 699	DISSERTATION	8 credits [0-0-0]