NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

COURSE STRUCTURE AND SYLLABUS
FOR B.TECH IN CIVIL ENGINEERING

1st Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	HUL1101	Communicative English	2-0-0	2
2	MAL 1101	Engineering Mathematics I	3-1-0	4
3	CHL 1101	Engineering Chemistry	3-0-0	3
4	BEE 1101	Basic Electrical Engineering	3-0-0	3
5	MEL 1101	Engineering Mechanics	3-0-0	3
6	BEP 1101	Basic Electrical Engineering Laboratory	0-0-2	1
7	CHP 1101	Engineering Chemistry Laboratory	0-0-2	1
8	MEP 1101	Engineering Mechanics Laboratory	0-0-2	1
9	HUP1101	Language Laboratory	0-0-2	1
10	OBE 1101	Outcome Based Education	1-0-0	0
Total			15-1-8	19

2nd Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	HUL 1202	Social Sciences	2-0-0	2
2	MAL 1202	Engineering Mathematics II	3-1-0	4
3	PHL 1101	Engineering Physics	3-0-0	3
4	CSL 1201	Computing Fundamentals	3-0-0	3
5	MEL 1202	Engineering Drawing	0-0-4	2
6	CSP 1201	Computing Fundamentals Laboratory	0-0-3	1.5
7	PHP 1201	Engineering Physics Laboratory	0-0-2	1
8	MEP 1203	Workshop	0-0-3	1.5
9	ECL 1201	Basic Electronics Engineering	3-0-0	3
10	EAA1201	Extra Academic Activity		0
Total			14-1-12	21

3rd Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CEL1301	Mechanics of Solids	3-1-0	4
2	CEL1302	Surveying	3-0-0	3
3	CEL1303	Fluid Mechanics	3-1-0	4
4	HUL1301	Managerial economics	3-0-0	3
5	MAL1301	Mathematical methods	3-0-0	3
6	CEP1301	Strength of Materials laboratory	0-0-2	1
7	CEP1302	Surveying laboratory	0-0-2	1
8	CEP1303	Fluid Mechanics laboratory	0-0-2	1
Total			15-2-6	20

(Prof. K. Darunkumar Singh) (Prof. U. Kumar) (Dr. Lalsangzela Sailo) (Dr. H. Lalmingsanga)

(Mr. Ricky Lalthazuala) (Ms. Sanasam Vipej) (Ms. Esther Vanlalmawii)

4th Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CEL1401	Concrete technology and Building materials	3-0-0	3
2	CEL1402	Hydraulics and Hydraulic machines	3-1-0	4
3	CEL1403	Transportation engineering-I	3-0-0	3
4	CEL1404	Construction technology and Project management	3-0-0	3
5	MAL1401	Numerical methods and Probability theory	3-0-0	3
6	CEP1401	Concrete laboratory	0-0-2	1
7	CEP1402	Hydraulics laboratory	0-0-2	1
Total			15-1-4	18

5th Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CEL1501	Structural Analysis – I	3-1-0	4
2	CEL1502	Design of R.C. Structures	3-1-0	4
3	CEL1503	Water resource engineering	3-0-0	3
4	CEL1504	Environmental Engineering - I	3-0-0	3
5	CEL1505	Geotechnical Engineering – I	3-1-0	4
6	CEL1506	Engineering Geology	2-0-2	3
7	CEP1501	Geotechnical Laboratory	0-0-2	1
Total			17-3-4	22

6th Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CEL1601	Design of Steel Structures	3-1-0	4
2	CEL1602	Structural Analysis-II	3-1-0	4
3	CEL1603	Geotechnical Engineering – II	3-0-0	3
4	CEL1604	Transportation Engineering – II	3-0-0	3
5	CEL1605	Environmental Engineering - II	3-1-0	4
6	CEP1601	Transportation Laboratory	0-0-2	1
7	CEP1602	Environmental laboratory	0-0-2	1
Total			15-3-4	20

7th Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CED1701	Project - I	0-0-12	6
2	CEL1701	Bridge Engineering	3-0-0	3
3	CEL1702	Departmental Elective-I	3-0-0	3
4	CEL1703	Quantity Surveying and Public works	3-0-0	3
5	CEP1701	Industrial Training Viva	0-0-2	1
Total			9-0-14	16

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8th Semester

Sl. No.	Course code	Course name	L-T-P	Credit
1	CED1801	Project-II	0-0-18	9
2	CEL1802	Departmental Elective-II	3-0-0	3
3	CEL1804	Open elective	3-0-0	3
4	CEP1801	Grand Viva	0-0-2	1
		Total	6-0-20	16

Semester/Year	1st Year	3rd Sem	4th sem	5th sem	6th sem	7th sem	8th sem
Credit	40	20	18	22	20	16	16
Total							**152**

LIST OF ELECTIVES

DEPARTMENTAL ELECTIVE-I

1. CEL17XX-GROUND IMPROVEMENT TECHNIQUES
2. CEL17XX-TRAFFIC ENGINEERING
3. CEL17XX-STRUCTURAL DYNAMICS
4. CEL17XX-DESIGN OF HYDRAULICS STRUCTURES
5. CEL17XX-AIR AND NOISE POLLUTION

DEPARTMENTAL ELECTIVE-II

1. CEL18XX- GROUNDWATER
2. CEL18XX- PAVEMENT ENGINEERING
3. CEL18XX- EARTHQUAKE GEOTECHNICAL ENGINEERING
4. CEL18XX- AIRPORT PLANNING AND DESIGN
5. CEL18XX-DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

OPEN ELECTIVE

1. CEL18XX-FINITE ELEMENT METHOD
2. CEL18XX-SOLID WASTE MANAGEMENT
3. CEL18XX- INDUSTRIAL AND E-WASTE MANAGEMENT
4. CEL18XX-WASTE TO ENERGY CONVERSION
5. CEL18XX-GROUNDWATER AND SURFACE WATER POLLUTION

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COURSE SYLLABUS

CEL1301 MECHANICS OF SOLIDS **(3 - 1 -0)**

1. Course Description:

Strength of Materials introduces you to the concept of stress, strain and deformation of solid and state of stress. It will also introduce the elastic constants and mechanical properties. The concept of shear force and bending moment diagram is discussed. It also focuses on the concepts of bending stresses, shear stresses in beams and compressive stresses in columns and struts, thin and thick cylinder under internal and external pressure. The behaviour of structural elements under flexure, torsion is emphasized. Also, failure theories are briefly introduced at the end of the course.

2. Learning Outcome:

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

- Determine the strength parameters of the materials.
- Know more about the concepts of stress and strain.
- Determine shear force, bending moment, bending and shear stress distribution.
- Analyze the stresses of different compression members subjected to different load.
- Understand the concept of thin and thick cylinders.
- Analyze members subjected to torsion.
- Know the different failure theories.

3. Broad Course Outline:

- Stress and strain.
- Elastic constants and Mechanical properties
- Members in uniaxial state of stress
- Shear Force and Bending Moment Diagram
- Theory of simple bending
- Columns and struts
- Thin and thick cylinders
- Torsion of Circular Shafts
- Failure theories

4. Readings:

a) Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.
b) Beer and Johnston, Mechanics of Materials, McGraw Hill International Edition, 1995.
c) E. Popov, Engineering Mechanics of Solids, Prentice Hall of India Pvt. Ltd., 1998.
d) R. Subramanian, Strength of Materials, Oxford University Press, 2010.
e) L. S. Srinath, Advanced Mechanics of Solids, Tata Mc Graw Hill Publishing Company Limited, 2009.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Stress and Strain		
	Concept of stress, normal stress and shear stress, Cartesian components of stress at a point, Concept of strain, normal and shear strain, Poisson's ratio, Volumetric strain, Concept of strain energy, Principal stress and strain, Mohr's circle		
	Elastic constants and Mechanical properties		
	Hooke's law, Modulus of rigidity and bulk modulus-Relation between E, G and K, Proof stress, Stress-strain diagrams for brittle and ductile materials, Hardness and impact strength.		
	Members in uniaxial state of stress		
	Members in uniaxial state of stress: Uniform cross section and tapered bars subjected to uniaxial tension and compression, Composite bars.		
	Shear Force and Bending Moment Diagram		
	Types of supports-Types of determinate beams--Shear force and Bending moment diagrams-Principles of Superposition		
	Theory of simple bending		
	Assumptions-Theory of simple bending-Bending stresses in beams-Discussion of efficiency of various shapes of cross sections, Flexural shear stress distribution in various shapes of cross section of beams.		
	Columns and struts		
	Direct and Bending stresses- Euler's critical load for columns with ordinary end conditions - Slenderness ratio and effective length of a column - Rankine's Formula - IS Code formula - Critical load of eccentrically loaded columns.		
	Thin and Thick cylinder		
	Introduction, thin cylinders under internal pressure, difference between thick and thin cylinders, Lame's theory, thick cylinders under internal pressure and external pressure.		
	Torsion of Circular Shafts		
	Theory of pure torsion in solid and hollow circular shafts-Torsional shear stresses and angle for twist-transmission of power.		
	Failure theories		
	Maximum Principal Stress Theory, Maximum Principal Strain Theory, Maximum Shear Stress Theory, Total Energy Theory, Distortion energy theory		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1302 SURVEYING **(3 - 0 - 0)**

1. Course Description:

Surveying introduces you to basics of linear/angular measurement methods like chain surveying, compass surveying. It mainly focuses on the concepts of errors, accuracy and precision. Later it focuses on significance of plane table surveying in plan making. It focuses on measurements in vertical plane using leveling and contouring. It provides introduction to modern surveying equipments like Theodolite, Electronic Distance Measurement, Total Station, Remote sensing, GPS, Photogrammetry etc.

2. Learning Outcome:

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

- Carry out preliminary surveying in the field of civil engineering applications.
- Know more about the use of chain surveying and compass surveying.
- Know more about leveling and contouring and implement them in the field of surveying.
- Know the use of modern equipments (Theodolite, EDM, Total station) in curve setting, area and volume calculations
- Understand principles of GPS, GRS and GIS
- Apply this advanced surveying techniques in the field of civil engineering

3. Broad Course Outline:

- Introduction.
- Chain surveying.
- Compass surveying.
- Trigonometrical surveying.
- Plane table surveying.
- Leveling and contouring.
- Introduction to Advanced surveying equipments.

4. Readings:

a) B.C. Punmia, A. K. Jain, A. K. Jain, Surveying-I & II, Laxmi Publications,2005.
b) A. M. Chandra, Higher Surveying, New Age International Publishers, 2007.

c) A. M. Chandra, Plane Surveying, New Age International Publishers, 2007.
d) T. M. Lillesand and R. W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, 1994
e) G. Joseph, Fundamentals of Remote Sensing, Universities Press, 2003.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		
	Surveying objectives, plane surveying principles and classification, scales, linear measurements, instruments for surveying, preparation of map and plan, Errors, Accuracy and Precision		
	Chain surveying		
	Measurement of distance, chain surveying principles, selection of stations, offsets, locating building corners, field book, chain surveying instruments, conventional signs.		
	Compass surveying		
	Measurement of directions and angles, types of compass, meridians and bearings, local attraction, magnetic declination, traversing with a chain and compass, plotting of traverse.		
	Trigonometrical surveying		
	Base of the object accessible, base of an inclined object accessible, reduced level of the elevated points with inaccessible bases, instrument axes at different levels.		
	Plane table surveying		
	Principle and instruments used in plane table surveying, working operations, methods of plane table surveying.		
	Leveling and contouring		
	Instruments for leveling, principle and classification of leveling, bench marks, leveling staff, readings and booking of levels, field work in leveling, longitudinal section and cross section, plotting the profile, height (level) computations, contours, characteristics of contours, contours of natural features, methods of contouring, interpolation, contour gradient, contour maps.		
	Introduction to Advanced surveying equipments		
	Introduction to Theodolite, Total station, Remote sensing, GIS, GPS and GRS.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1303 FLUID MECHANICS (3 - 1 - 0)

1. Course Description:

Fluid Mechanics introduces you to the properties of fluids, and principle of conservation of mass & momentum and their applications. It focuses on the concepts of the fluid flow, kinematics of flow and dynamics of fluid flow. It emphasizes the important concepts of continuity equation, Bernoulli's equation and Momentum equation in problem solving. Lastly it focuses on the concepts of laminar and turbulent flows.

2. Learning Outcome:

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

- Determine the properties of fluid and fluid pressure and their measurement.
- Know more about the concepts of fluid flow and kinematics of flow and their applications.
- Know more about the dynamics of flow.
- Know the important equation like continuity equation and momentum equation.
- Compute the laminar and turbulent flow and its applications.

3. Broad Course Outline:

- Introduction.
- Principles of Fluid Statics.
- Description of fluid flow.
- Kinematics of Flow.
- Fluid Dynamics.
- Dimensional Analysis and Similitude.
- Boundary layer theory.
- Laminar and turbulent flow through pipes.

4. Readings:

a) A.K. Jain, Fluid Mechanics, Khanna Publishers, Delhi, 2002.
b) R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications(P) Ltd. New Delhi, 2002.

c) Shames, Mechanics of Fluids, McGraw Hill Book Co.,2003.
d) Streeter V.L., Benjamin Wylie and Bedford, Fluid Mechanics, McGraw Hill Book Co., 1998

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		
	Properties of fluids, concept of continuum, viscosity, compressibility, ideal and real fluids, surface tension, cavitations.		
	Principles of Fluid Statics		
	Stress at a point, pressure, Pascal's law, Variation of pressure with elevation in compressible and incompressible fluids, hydrostatic law, Pressure measurement, piezometers and manometers, Hydrostatic forces exerted on submerged surfaces.		
	Description of fluid flow		
	With reference to translation, rotation and deformation, concept of continuum, control mass & control volume approach, Reynolds transport theorem. Steady flow and uniform flow.		
	Kinematics of Flow		
	Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocity potential function, potential flow, standard flow patterns, combination of flow patterns, flownet.		
	Fluid Dynamics		
	Forces exerted in a fluid flow, derivation of Continuity equation and Euler's equation, Bernoulli's equation and its applications, Momentum equation and its applications.		
	Dimensional Analysis and Similitude		
	Dimensional Homogeneity, Buckingam's π theorem, dimensionless numbers, similitude.		
	Boundary layer theory		
	Concepts of boundary layer flows, Laminar and Turbulent boundary layers, Integral momentum equation of boundary layer flows, Boundary layer separation and control, Drag and lift.		
	Laminar and turbulent flow through pipes		
	Laminar flow and its characteristics, Reynolds experiment, Laminar flow between parallel plates, Laminar flow through pipes, Hazen-Poiseuille equation, Turbulence, Reynolds turbulent stresses, Prandtl's mixing length theory, Velocity distribution in turbulent flow, Head loss in flow through pipes, Darcy Weisbach equation, major and minor losses.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEP1301 STRENGTH OF MATERIALS LABORATORY (0 - 0 - 2)

1. Course Description:

The lab session will includes experiments on

- Finding Young's Modulus, Torsional strength, hardness and tensile strength of given specimens.
- Finding Impact value and crushing value on coarse aggregates.
- Finding stiffness of open coiled and closed coiled springs.
- Finding physical properties of given coarse aggregate, fine aggregate and cement samples.

2. Learning Outcome:

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

- Evaluate Young's modulus
- Evaluate torsional strength, hardness and tensile strength of given specimen.
- Find stiffness of open coiled and close coiled springs.

3. Broad Course Outline:

- Test for flexural rigidity
- Torsion test
- Tensile test
- Hardness test
- Impact test
- Compression test
- Test on springs

CEP1302 SURVEYING LABORATORY (0 - 0 - 2)

1. Course Description:

The Lab sessions would include experiments on:

- Chain Surveying
- Chain Traverse
- Compass Surveying
- Compass surveying Traversion
- Plane Table Surveying – Radiation, intersection, Traverse, Resection Leveling.
- Theodolite surveying and traversing
- Curve setting
- EDM
- Total Station

2. Learning Outcome:

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

- use conventional surveying tools such as chain/tape, compass, plane table, level in the field of civil engineering applications such as structural plotting and highway profiling
- apply the procedures involved in field work and to work as a surveying team
- plan a survey appropriately with the skill to understand the surroundings
- take accurate measurements, field booking, plotting and adjustment of errors can be understood
- Plot traverses / sides of building and determine the location of points present on field on a piece of paper.
- Apply modern surveying techniques such as Theodolite, EDM and Total Station.

3. Broad Course Outline:

- Introduction & list of equipments
- Survey of an area by chain survey (closed traverse) & plotting.
- Compass Traversing.
- Radiation method, intersection methods by plane table survey.
- Traversing by plane table survey.
- Fly leveling (differential leveling).
- Grid Contouring.
- Indirect Contouring.
- Theodolite Surveying
- EDM, Total Station

CEP1303 FLUID MECHANICS LABORATORY (0 - 0 - 2)

1. Course Description:

The Lab sessions would include experiments on:

- Flow measurement in a pipe flow.
- Energy loss in pipe flow

2. Learning Outcome:

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

- Calibrate flow measuring devices used in pipes, tanks and channels.
- Measure discharge in pipes.
- Determine fluid and flow properties
- Characterize laminar and turbulent flows.

3. Broad Course Outline:

- Calibration of Venturimeter, Orifice meter (discharge measuring device in pipes).
- Calibration of Orifice and Mouthpiece (discharge measuring device in Tanks).
- Calibration of Triangular Notch and Rectangular notch (discharge measuring device in Channels).
- Measurement of Viscosity of water.
- Determination of Darcy Friction Factor, relative roughness for laminar and turbulent flows.
- Determination of minor losses.

CEL1401 CONCRETE TECHNOLOGY AND BUILDING MATERIALS (3 - 0 - 0)

1. Course Description:

Concrete Technology introduces you to the different materials for construction like bricks, wood products, steel and aluminuim, concrete and new materials such as fly ash, AAC bricks, geopolymer etc. The course focuses on concrete, its making materials and properties. Different tests available for determining strength of concrete is discussed. The course also emphasize on factors influencing properties of fresh and hardened concrete. Lastly, it focuses on the concepts of mix design of concrete. Some special types of concrete are also introduced at the end of the course.

2. Learning Outcome:

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

- Know more about the different materials for construction.
- Test all the concrete materials as per IS code.
- Determine the properties of fresh and hardened of concrete.
- Design the concrete mix using IS code method.
- Know about special types of concrete and their applications.

3. Broad Course Outline:

- Introduction to building materials
- Cement.
- Aggregates.

- Water and admixtures
- Fresh concrete.
- Hardened concrete.
- Durability.
- Concrete Mix design.
- Special concrete.

4. Readings:

a) M.S. Shetty, Concrete Technology, S Chand Co., Publishers, 2006.
b) M.L. Gambhir, Concrete Technology Theory and Practice, Tata McGraw Hill Publishers, 5th edition.
c) A.M. Neville, Properties of Concrete, Longman Publishers, 2004.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction to building materials		
	Brick and clay products, Timber and wood based products, steel and aluminium, Cement, new materials - fly ash, AAC brick, Geopolymer.		
	Cement		
	Cement, Different test on cement as per Indian standards, Bogue's compounds, Hydration of cement, Gel formation, pore & capillary water.		
	Aggregates		
	Fine and coarse aggregate, Tests on aggregates as per Indian standards, Bulking of sand, Sieve analysis – Grading.		
	Water and admixtures		
	Quality of water, Types of chemical and mineral admixtures		
	Fresh concrete		
	Properties of fresh concrete- Workability – different tests of workability- Factors influencing workability compaction, finishing, curing.		
	Hardened concrete		
	Tests on hardened concrete as per IS codes – Relationship between different strengths – factors influencing strength, NDT techniques.		
	Durability		
	Factors influencing durability – Chemical effects on concrete- Carbonation, Sulphate attack, Chloride attack.		
	Concrete Mix design		
	Different methods of mix design – factors affecting mix design – exercises.		
	Special concrete		
	Heavy density concrete, underwater concrete,		

	self-compacting concrete, light weight concrete, mass concrete.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1402 HYDRAULICS AND HYDRAULIC MACHINES (3 - 1 - 0)

1. Course Description:

Hydraulic and hydraulic structures introduce you to the flow through pipes and channels. Further it focuses mainly on the uniform and non-uniform flow, steady and unsteady flow. It focuses mainly on the impact of jet on different conditions of plate. It also focuses on measurements of flow in open channels. It gives introduction to sediment transport. Later it focuses on the classification of hydraulic machines like pumps and turbines.

2. Learning Outcome:

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

- Know the properties of flow through channels and pipes.
- calculate forces and work done by a jet on fixed or moving plate and curved plates
- Know more about the flow measurement in open channels.
- select the type of turbine required with reference to available head of water and discharge
- Determine the characteristics of hydraulic machines like centrifugal pump and reciprocating pump.

3. Broad Course Outline:

- Introduction to Free surface flows.
- Uniform flow in Open channels.
- Steady Gradually Varied Flow.
- Steady Rapidly Varied flow.
- Unsteady flow.
- Introduction to sediment transport
- Flow measurement in open channels.
- Principles of impingement of jets.
- Hydraulic Similitude
- Turbines.
- Centrifugal pump.
- Reciprocating pump.

4. Readings:

a) Bansal R.K., A text book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications(P) Ltd., New Delhi, 2002.
b) R.S. Khurmi, Text book of Hydraulics and Hydraulic Machine, S.Chand & Co., 2003.
c) C.S.P. Ojha, P.N. Chandramouli, R.Berndtsson, Fluid Mechanics and Machinery, Oxford University Press, 2010.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction to Free surface flows		
	Comparison between pipe and channel flows, classification of channels and basic equations of flow.		
	Uniform flow in Open channels		
	Specific energy, Critical flow, Channel transitions, Uniform flow formulae, best hydraulic sections.		
	Steady Gradually Varied Flow		
	Non uniform flow in open channels, gradually varied flow equation, Type of GVF profiles, Computation of GVF profiles.		
	Steady Rapidly Varied flow		
	Steady Rapidly Varied flow: Hydraulic jump in a horizontal rectangular channel, specific force, Computation of energy loss.		
	Unsteady flow		
	Celerity of gravity wave, Monoclonal rising wave, Positive and Negative surges, St. Venant's equations, Method of characteristics, Hydraulic routing.		
	Introduction to sediment transport		
	Incipient motion and Shield's theory		
	Flow measurement in open channels		
	Broad and sharp- crested weirs, free overall, and flow over spillways, sluice gates.		
	Principles of impingement of jets		
	Impact of jet on a stationary vertical plate, stationary inclined plate, and stationary curved plate, hinged plate, moving vertical and inclined plates, moving curved plate and on series of moving flat and curved vanes fixed on the periphery of circular rim.		
	Hydraulic similitude		
	Review of Dimensional analysis, Similarity laws, and Model studies.		
	Turbines		
	Classification, impulse turbines- Pelton wheel, Reaction turbines - Francis and Kaplan		

	Turbines, Governing of a Francis turbine - Performance of turbines - specific speed and their significance.		
Centrifugal pump			
	description and working , Head, discharge and efficiency of a centrifugal pump, pressure rise in the pump, minimum starting speed of a pump, cavitations , priming, multistage pumps, characteristic curves.		
Reciprocating pump			
	Description and working , types , discharge and slip, power required to drive the pump, Indicator diagram, Air vessel, work done against friction with and without air vessels.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1403 TRANSPORTATION ENGINEERING – I (3 - 0 - 0)

1. Course Description:

Transportation Engineering-I introduces you to planning of highway network, design of cross section elements, preparing final report and master plan. Further it emphasizes on the alignment geometric design of highway and the geometric design of highway plan. In the later part, it focuses on the traffic characteristics, management and control, and its regulations. Lastly it focuses on the concepts of railway engineering.

2. Learning Outcome:

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

- Carry out surveys involved in planning and highway alignment.
- Design cross section elements, sight distance, horizontal and vertical alignment.
- Implement traffic studies, traffic regulations and control, and intersection design.
- Know more about railway engineering and its characteristics.

3. Broad Course Outline:

- Highway Network Planning.
- Highway Alignment and Geometric Design.

- Traffic Engineering.
- Traffic Management and Control.
- Introduction to Railway Engineering.

4. Readings:

a) Kadiyali L.R. Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 2008.
b) Khanna, S.K. and C.E.G. Justo Highway Engineering, Nem Chand and Bros, Roorkee, India, 2001.
c) P. Chakraborty and A. Das, Principles of Transportation Engineering, Prentice Hall India
d) C. S. Papacotas and P. D. Prevedouros, Transportation Engineering and Planning, Hall India, 2001.
e) Ministry of Road Transport and Highways. Specifications for Road and Bridge Works, Fourth Edition, Indian Roads Congress, New Delhi, India, 2001.
f) IRC Codes of Practices.
g) S.C Saxena, S.P Arora, A textbook of Railway Engineering, Dhanpat Rai, 2001.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Highway Network Planning		
	Different modes of transportation, role of highway transportation, classification, network patterns, planning surveys, preparation of plans, final report, master plan, evaluation by saturation system, 20 year road development plans, salient features, determination of road lengths.		
	Highway Alignment and Geometric Design		
	Principles of highway alignment, requirements, controlling factors, engineering surveys, importance of geometric design, design controls and criteria, cross section elements, pavement surface characteristics, camber, carriageway, kerbs, road margins, formation, right of way, typical cross sections. Sight distance, stopping sight distance, overtaking sight distance, sight distance at intersections. Design of horizontal alignment, super elevation, transition curves. Design of vertical alignment, gradients, vertical curves.		
	Traffic Engineering		
	Traffic characteristics; components of traffic stream, flow-speed Density, measurement and analysis, q-k-v relationships, design hourly volume, concept of PCU, capacity		

	and level of service(LOS). Parking studies and accident studies. Design of intersections, at grade intersections, channelized and rotary. Introduction to grade separated intersections, cloverleaf interchange, trumpet interchange, flyovers.		
Traffic Management and Control			
	Traffic regulations, one-way streets, traffic signs, road markings, signals, warrants. Design of isolated fixed time signal, introduction to signal coordination.		
Introduction to Railway Engineering			
	Universal scenario and Indian railways, terminologies used in railways, track design, rails and their requirements, creep and wear in rails, rail joints, types of sleepers, requirement of ballast, track fastening, check rails and guard rails. Railway cross sections, various types of gradients.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1404 CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT (3 - 0 - 0)

1. Course Description:

Construction Technology and Project Management introduces you to the concepts of engineering economics, it focuses on the importance of Project Management, the role of a project manager. It focuses on the knowledge and processes involved in construction projects. Later it focuses on the different types of equipments used for construction. Lastly it mainly focuses on the finance in construction.

2. Learning Outcome:

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

- Able to make a correct decision.
- Know more about the role of a project manager.
- Emphasize the importance of project management.
- Take up a project on construction in a well-planned and systematic way.

- Know more about the different equipments for construction.
- Estimate the required finance in construction projects.
- Know more about entrepreneur and entrepreneurship.

3. Broad Course Outline:

- Introduction to Engineering Economics
- Project Management
- Construction Project
- Construction Equipment and Management
- Entrepreneur and Entrepreneurship

4. Readings:

a) F. Harris, R. MacCaffer and F. Edum-Fotwe, Modern Construction Management, Blackwell publishing, 2006.
b) C. J. Schexnayder and R. E. Mayo, Construction Management Fundamentals, McGraw Hill, New Delhi, 2003.
c) Peurifoy, Construction Planning, Equipment and Method, Tata McGraw Hill Educations, 2010.
d) B.C. Punmia and K.K. Khandelwal, Project Planning and Control with PERT and CPM, Motilal UK Books of India, 2002.
e) S.C. Sharma, Construction Equipment and Management, Khanna Publishers.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction to Engineering Economics		
	Engineering decision makers, Engineering and Economics, Problem solving and decision making, Intuition and analysis, economic models, demand and supply, interest rate, economic analysis of engineering projects, project feasibility reports, problems on above.		
	Project Management		
	Importance of Project Management, Role of Project manager.		
	Construction Project		
	Stakeholders in construction project, Different types of projects, similarities & dissimilarities in projects. Time, Scope & Money, Knowledge areas & Processes involved in construction projects, WBS of a major work, with examples, Planning, monitoring & executing, Planning, sequencing, scheduling, Bar Charts, Networks, CPM, PERT, Upgrading, Cash		

	flow diagram		
Construction Equipment and Management			
	Introduction, Management of construction, Materials management, equipments management in construction projects, earth moving equipments, hoisting equipments, factors for selecting equipment.		
Entrepreneur and Entrepreneurship			
	Concept of Entrepreneur, characteristics of an Entrepreneur, distinction between an Entrepreneur and a Manager, Functions of Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship, Role of Entrepreneurship in Economic Development.		

6. Evaluation plan:

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEP1401 CONCRETE LABORATORY **(0 - 0 - 2)**

1. Course Description:

The Lab sessions would include experiments on:

- Cement.
- Aggregates.
- Concrete.
- Non-destructive test equipments
- Mix design.

2. Learning Outcome:

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

- Conduct Quality Control tests on concrete making materials.
- Conduct Quality Control tests on fresh & hardened concrete.
- Design and test concrete mix.
- Conduct Non-destructive tests on concrete.

3. Broad Course Outline:

- Determination of Fineness and Specific Gravity of cement
- Determination of consistency of standard Cement Paste
- Determination of initial and Final Setting times of Cement
- Determination of Compressive Strength of Cement.
- Determination of Fineness modulus of Coarse and Fine Aggregates
- Determination of percentage of voids, Bulk density, Specific Gravity of coarse and Fine Aggregates.
- Workability Tests: Slump Cone Test, Compaction factor test, Vee-Bee consistometer Test
- Preparing and curing concrete specimens for tests & Determination of compressive strength of concrete cubes
- Experiments to demonstrate the use of non-destructive test equipment like rebound hammer, ultrasonic pulse velocity, permeability, corrosion and core cutter.
- Mix Design: IS Code method

CEP1402 HYDRAULICS LABORATORY (0 - 0 - 2)

1. Course Description:

The Lab sessions would include experiments on:

- Determination of Manning's and Chezy's coefficients.
- Energy loss in hydraulic jump.
- Velocity distributions.
- Pressure drag coefficient.
- Pumps and turbines.

2. Learning Outcome:

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

- Determine Manning's and Chezy's coefficients for smooth and rough channels.
- Determine Energy loss in Hydraulic jump.
- Test the performance of pumps and turbines.
- Compute drag coefficients.

3. Broad Course Outline:

- Determination of Manning's and Chezy's coefficients for smooth and rough channels by gradually varied flow method.
- Determination of Energy loss in Hydraulic jump.
- Determination Velocity distributions in open channels.
- Computation of pressure drag coefficient for flow past a cylinder in a subsonic wind tunnel.
- Performance Characteristics of single stage centrifugal pump, multi stage centrifugal pump,

- Submersible pumps, and varying speed centrifugal pump.
- Performance Characteristics of Pelton turbine, Francis turbine, and Kaplan turbine**.**

CEL1501 STRUCTURAL ANALYSIS-I (3 - 1 - 0)

1. Course Description:

Structural Analysis introduces you to different types of structures and loads on the structures. The different methods of analysis of determinate and indeterminate structures are also discussed. Analysis of trusses, arches and cables are discussed in detail. Later, it focuses on the Force method of analysis of indeterminate structures. Lastly, it emphasizes on the concepts of influence line diagrams.

2. Learning Outcome:

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

- Use various methods of analysis of determinate structures.
- Use force method of analysis of indeterminate structures.
- Apply the concept of ILD and moving loads on beams, frames and arches.

3. Broad Course Outline:

- Types of Structures and Loads
- Methods of Analysis
- Analysis of Trusses.
- Arches and Cables.
- Deflections.
- Analysis of Indeterminate structures by Force Method.
- Influence lines.

4. Readings:

a) C.S. Reddy, Basic structural Analysis, 3rd edition, McGraw Hill Education(India) Pvt. Ltd.
b) R. C. Hibbeler, Structural Analysis, 2nd Edition, Tata McGraw Hill, 2005.
c) G.Pandit and S.Gupta, Theory of Structures, Vol-1, Tata McGraw Hill, New Delhi, 1999.
d) T.S. Thandavamoorthy, Structural Analysis, Oxford University Press, 2011.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Types of Structures and Loads		
	Different types of structures, Loads on structural system.		
	Methods of Analysis		
	Static and kinematic indeterminacy,		

	Equilibrium equations, Compatibility requirements, Introduction to Force and Displacement methods of analysis.		
Analysis of Trusses			
	Analysis of plane truss, compound truss, complex truss, space truss.		
Arches and Cables			
	Arches and Suspension cables, Three hinged arches and Suspension cables		
Deflections			
	Deflection of beams, Various methods for calculation of Deflection: Moment area theorem, Conjugate beam method, Double Integration method, Energy methods: Principle of minimum potential energy, principle of virtual work, Castigliano's theorem.		
Analysis of Indeterminate Structures by Force Method			
	Reciprocal theorem, Force Method of Analysis of Beams, Frames and Trusses.		
Influence Lines			
	Influence lines for reaction bending moment and shear force diagrams for simply supported beams - stresses in members of statically determinate pin jointed plane frames due to moving loads, Muller-Breslau Principle with applications to determinate and indeterminate structures, Qualitative ILD for continuous beams, frames and arches.		

6. Evaluation plan:

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1502 DESIGN OF R.C. STRUCTURES (3 - 1 - 0)

1. Course Description:

Design of R.C. structures introduces you the concepts of working stress method and limit state method. The codal provisions of IS 456:200 used for design will be discussed. It focuses on the design of singly reinforced section with the three modes of failure-balanced, over-reinforced and under-reinforced. It focuses on the design of doubly reinforced section. Later

the concepts of shear and bond design of RC structures are studied. The design of RC flanged beams, slabs-one way and two way slab, continuous slabs and beams, columns and footings are studied in detail.

2. Learning Outcome:

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

- Apply the fundamental concepts of working stress method and limit state method.
- Use IS code of practice for the design of concrete elements.
- Know more about the concepts of bond.
- Design the beams, slab, column and footing.
- Draw various RC structural elements.

3. Broad Course Outline:

- Introduction.
- Design philosophies.
- Analysis and Design of Singly Reinforced Beams.
- Analysis and Design of Doubly Reinforced Beams.
- Analysis and Design of Flanged Beams.
- Shear and Bond design of RC.
- Design of RC Slabs.
- Design of Continuous Slab and Beams.
- Design of RC Columns.
- Design of RC Footings.
- Design for Serviceability.

4. Readings:

a) S. Unnikrishna Pillai, Devdas Menon, Reinforced Concrete Design, Tata McGraw Hill Education, 2003.
b) N. Subramanian, design of Reinforced Concrete Structures, Oxford University Press, 2013.
c) P.C. Varghese, Limit State Design of Reinforced Concrete, 2nd Edition, PHI, 2009.
d) IS 456:2000, IS 3370(Part-IV), BIS 2000.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction			
	Review of Concrete making materials-Structural concrete- Grades- properties of Concrete- Modulus of elasticity-flexural strength-Characteristic and Design values-Partial safety factor.		
Design philosophies			

	Objectives of RC design -Working stress method- comparison of design approaches. Limit State method- Assumptions- Stress-Strain behavior of Steel and Concrete- Stress block parameters		
Analysis and Design of Singly Reinforced Beams			
	Analysis of Singly Reinforced RC Section-Neutral axis-Balanced-Under Reinforced-Over Reinforced Sections- Moment of Resistance-Design parameters- Design examples.		
Analysis and Design of Doubly Reinforced Beams			
	Necessity of Doubly Reinforced sections-Analysis of Doubly Reinforced RC Section-Moment of Resistance- Design parameters-Design.		
Analysis and Design of Flanged Beams			
	Analysis of flanged RC section- Singly and Doubly reinforced-Effective flange width-Moment of Resistance- design examples.		
Shear and Bond design of RC			
	Shear forces in RC-Shear Resistance of RC-Truss analogy- design of Vertical stirrups-Bent-up bars- Limitation- Bond failure in RC- Check for bond resistance-Development length-Design for shear and bond.		
Design for Torsion			
	Equilibrium torsion and Compatibility torsion, General behavior of RC structures in Torsion, Design strength in Torsion, Design examples.		
Design of RC Slabs			
	Design of One and Two way slabs: Effect of edge conditions- Moment of resistance-Torsion reinforcement at corners- Design examples.		
Design of Continuous Slab and Beams			
	Effect of continuity- analysis of continuous beam/slab- Moment and shear coefficients for continuous beam/slab- Critical sections.		
Design of RC Columns			
	Design principles of RC columns- Assumptions-Rectangular and Circular columns- Helical reinforcement- Minimum eccentricity-Use of Interaction diagrams for Axial load and Moment.		
Design of RC Footings			
	RC footings-Minimum depth of footing- Safe bearing capacity- Design for Bending-Shear in One way and Shear in Two way- Transfer of load at base of column.		
Design for Serviceability			
	Concept of Serviceability- Deflection- Span to depth ratio- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1503 WATER RESOURCE ENGINEERING (3 - 0 - 0)

1. Course Description:

Water resource engineering focuses on the brief introduction on precipitation and characteristics of precipitation, rainfall runoff characteristics. Later it focuses on the measurement of stream flow and catchment characteristics. It focuses on the concepts of hydrograph, floods and flood routing. It also introduces basic irrigation systems, canal systems and its design. It also gives a brief introduction to dams.

2. Learning Outcome:

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

- Know more about the type and characteristic of precipitation and their measurement.
- Apply the concepts of rainfall runoff relationship for computing water and sediment yield from catchment.
- Estimate the peak discharge and learn concepts of flood and flood routing.
- Assess the irrigation needs of crops
- Know more about concept of canals, its design and dams.

3. Broad Course Outline:

- Introduction.
- Hydrograph Theory
- Floods and Flood routing
- Irrigation
- Canal systems
- Design of canal structures
- Introduction to dam

4. Readings:

a) K. Subramanya, Engineering Hydrology, Tata Mc Graw Hill Pub. Co., New Delhi, 2008

b) H. M. Raghunath, Hydrology: Principles, Analysis and Design, New Age International, 2006.
c) P. Jaya Rami Reddy, A Text Book of Hydrology, Laxmi Publications, 2011.
d) P. M. Modi, Irrigation Water Resources and Hydropower Engineering, Standard Publishing Company, New Delhi, 2000.
e) S. K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2006.
f) C. S Murthy, Water Resources Engineering, New Age International, 2002.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		
	Description of Hydrologic Cycle, Overview of application of hydrology in engineering. Forms and types of precipitation, basic concepts of weather systems, characteristics of precipitation in India, types of rain gauges, rain gauge network, intensity-duration-frequency analysis and depth-area duration analysis, measurement of infiltration, infiltration models		
	Hydrograph Theory		
	Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models, Runoff characteristics, flow duration curve and flow mass curve.		
	Floods and Flood Routing		
	Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Design flood, return period, flood frequency analysis, Gumbel's and log Pearson Type III methods, Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, and flood forecasting.		
	Irrigation		
	Necessity, Types of irrigation, Methods of supplying water, Assessment of irrigation water, Consumptive use and its determination, water requirement of various crops, Duty, Delta, Base period and crop period.		
	Canal Systems		
	Types of canals, Principles of design of stable irrigation canals, Silt theories, Tractive force theory, Design of lined canal, Design of longitudinal section, canal losses, Seepage theories, Principles of energy dissipation, Layout of a diversion head work.		
	Design of Canal Structures		

	Canal regulators, Types of canal falls, Design of Sarda type fall, Design of straight glacis fall, Types of cross drainage works, Design of canal fluming, Design of aqueduct/ syphon aqueduct.		
Introduction to Dam			
	Types of Dam, Details of Arch dam. Gravity Dam and Earthen Dam, Types of spillways, Design of Ogee spillway.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1504 ENVIRONMENTAL ENGINEERING – I (3 - 0 - 0)

1. Course Description:

Environmental Engineering-I introduces you to the Public Water Supply Scheme, water demand and population forecasting and then source of water supply-surface and sub surface. Later it focuses mainly on water quality requirement – physical, chemical and biological. Then the collection and conveyance of water will be highlighted. Later it focuses mainly on treatment of water as per requirement. Lastly it focuses on the distribution process, operation and maintenance of water supply.

2. Learning Outcome:

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

- Identify the source of water and water demand.
- Apply the water treatment concept and methods.
- Apply the concepts of collection and conveyance of water.
- Know more about the water treatment process.
- Apply water distribution processes and operation and maintenance of water supply.

3. Broad Course Outline:

- Introduction and scope.
- Source of Water.
- Water Quality.
- Collection and conveyance of water.
- Water Purification.
- Distribution System.

4. Readings:

a) Peavy H. S., Rowe D. R. and George Tchobanoglous, Environmental Engineering, McGraw-Hill International.
b) B.C. Punmia, Ashok Kumar Jain, Arun K Jain, Water Supply Engineering, Laxmi Publications, 2nd Edition.
c) Davis M. L and Cornwell D., Introduction to Environmental Engineering, A McGraw-Hill, Inc.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction and scope		
	Public Water Supply Scheme Objectives, Planning and Components, Water Demand, Population forecasting, design period, estimation of water demand for various uses, factors affecting consumption and fluctuation of water demand.		
	Source of Water		
	Surface source, types, selection, storage reservoir, yield and capacity estimation. Sub-surface water, types.		
	Water Quality		
	The hydrologic cycle and water quality parameters: physical, chemical and biological, water quality requirements and standards.		
	Collection and conveyance of water		
	Intakes, types of intakes, factors governing location of intakes, pumps, types of conduits, types of pipes.		
	Water Purification		
	Water treatment, operation involved in water treatment, Design and operation of Sedimentation tanks, Aeration, Coagulation and Flocculation, design and operation of Filtration units, Disinfection, Hardness Removal, Fluoride and Arsenic Removal, Household Water Treatment Systems, Miscellaneous Methods, Flow-sheets for treatment of surface and sub-surface waters.		
	Distribution System		
	Requirements, Classification, Analysis and Design of distribution systems, Detection and Prevention of wastage of water in distribution system.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1505 GEOTECHNICAL ENGINEERING-I (3 - 1 - 0)

1. Course Description:

Geotechnical Engineering - I introduces the importance of soil mechanics in domain of civil engineering. The course deals with the primary concepts of the composition, classification as well as physical and engineering characterization of soil. It focuses on the soil water interaction phenomena like capillarity, permeability, seepage, flow nets, generation of pore pressures, and effective stress characteristics. The course also highlights the stress-strain related behaviour of soils inclusive of stress distribution, compaction, consolidation and shear strength of soils. Various field and laboratory investigations related to estimate the shear strength parameters of soils are addressed in this course. Further, the course addresses the issues of slope stability and the associated mechanics of soil.

2. Learning Outcome:

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

- Characterize and classify soils
- Identify shear strength parameters from field and laboratory investigation
- Compute and analyze the consolidation characteristics of soil
- Understand the principles of compaction and its control
- Analyze stability of soil slopes

3. Broad Course Outline:

- Physical properties of soil
- Classification of Soils
- Soil Water
- Compaction of Soils
- Stress distribution in Soils.
- Consolidation
- Shear Strength
- Stability of Soil Slopes

4. Readings:

a) G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age International Pvt.Ltd, New Delhi, 2016.
b) V.N.S. Murthy , A textbook of Soil Mechanics and Foundation Engineering, CBS Publications, New Delhi. 2015.
c) B. M. Das, Principles of Geotechnical Engineering, Cengage Learning India Pvt. Ltd., New Delhi, 2017.
d) A. Singh, Soil Engineering: Vol-I Fundamentals and General Principles, CBS Publishers and Distributors, 2012.
e) K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers and Distributors, 2009.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Physical properties of soil		
	Soil formation- Development of soil mechanics- Importance of soil engineering- Major soil deposits of India, basic Definitions and Relationships: 3-phase soil system, volumetric relationships and weight volume relationships, determination of Index Properties: Water content, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg's limits and indices.		
	Classification of Soils		
	Classification of soil systems – Particle size classification, Textural classification, AASHTO classification, Unified soil classification and Indian soil classification- Field identification of soils.		
	Soil Water Interaction Phenomena		
	Types of soil water, Capillarity in soils, Permeability of soils, Darcy's law, Determination of permeability of soils, Permeability of stratified soils, Absolute coefficient of permeability, Factors affecting permeability- Effective stress principle- Effective stress under different field conditions. Seepage pressure-Quick sand condition. Seepage and Flownets (seepage velocity, exit gradient, uplift pressure), Seepage flow through earth dams, Piping failure.		
	Compaction of Soils		
	Definition and importance of compaction – Standard Proctor compaction test, Modified compaction test- Factors affecting compaction- Influence of compaction on soil properties – Field compaction and its control.		
	Stress distribution in Soils		
	Importance of estimation of stresses in soils –		

	Boussinesq's and Westergaard's theories for point loads, uniformly loaded circular and rectangular areas, pressure bulb, variation of vertical stress under point load along the vertical and horizontal planes – Newmark's influence chart.		
Consolidation			
	Types of compressibility and consolidation, Primary consolidation and secondary consolidation – Stress history of clay, normally consolidated soil, over consolidated soil and under consolidated soil- pre consolidation pressure and its determination- Estimation of consolidation settlements -Terzaghi's 1-D consolidation theory – Coefficient of consolidation and its determination using consolidometer.		
Shear Strength			
	Definition and use of shear strength - Source of shear strength- Normal and Shear stresses on a plane – Mohr's stress circle- Mohr-Coulomb failure theory- Measurement of shear strength, Drainage conditions -Direct shear test, Triaxial shear test, Unconfined compression test and vane shear test – Factors affecting shear strength of granular soils and cohesive soils.		
Slope Stability			
	Types of slopes – Types of slope failures – Slip circle Method--Method of slices, Bishop's method(original and simplified), Morgenstern method, Spencer method, Determination of centre of most critical slip circle – Taylor's stability charts and their use. Stabilization of soil slopes.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1506 ENGINEERING GEOLOGY **(2 - 0 - 2)**

1. Course Description

Engineering Geology deals with the study of earth formation. It will introduce you to different types of minerals, crystals and rocks found in the earth. The properties of these minerals and rocks will be studied in detail in the course for engineering purpose. Phenomena's occurring inside the earth that will lead to earthquake and landslide will be introduced. The study of soil using resistivity and seismic refraction methods will also be emphasized. Dams and tunnels which require proper soil investigation for construction are also discussed at the end of the course.

2. Learning Outcome

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

- Identify minerals, crystals, rocks
- Know the properties of different rocks and minerals
- Know the causes and effects of earthquake and landslide
- Perform sub surface investigation
- Perform geological investigation for dams and tunnel site.

3. Broad Course Outline

- General geology
- Mineralogy
- Petrology
- Structural geology
- Engineering properties of rock
- Ground water
- Earthquakes and landslides
- Subsurface Investigations
- Dams
- Tunnels

4. Readings

a) K.V.G.K. Gokhale, Principles of Engineering Geology, BS Publications, 2009.
b) David George Price, "Engineering Geology: Principles and Practice", Springer, 2009.
c) Parbin Singh., Engineering and General Geology, Katson Publishers, 2009.
d) N. Chenna Kesavulu, "Text book of Engineering Geology", Mac Millan Ltd., New Delhi, 2009.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
	General Geology		
	Branches and scope of geology, Importance of geology in Civil engineering. Earth surface features and internal structure, weathering of		

	rocks.		
Mineralogy			
	Definition of a crystal and mineral, physical properties in mineral identification, rock forming minerals and their identification – quartz and its varieties, feldspar, hornblende, olivine, mica, garnet, kyanite, calcite, talc, bauxite, corundum, gypsum, fluorite, apatite, beryl, barite, asbestos, magnetite, hematite.		
Petrology			
	Formation and classification of rocks – Igneous, Sedimentary and metamorphic rocks, their texture and structures, properties of granite, pegmatite, dolerite, gabbro, charnockite, basalt, sandstone, conglomerate, breccia, limestone, shale, laterite, schist, gneiss, quartzite, marble, khondalite and slate.		
Structural Geology			
	Outcrop, Strike and dip, types and classifications of folds, faults, joints, unconformities.		
Engineering properties of rocks			
	Drilling, Core recovery, RQD, Sample preparation, tests on rock samples - compression, tensile, shear and slake durability tests		
Ground Water			
	Water tables, aquifers, occurrence of ground water in different geological formations, springs, selection of a site for well sinking and ground water investigations.		
Earthquakes and Landslides			
	Causes and effects of earthquakes and landslides, Remedial measures to prevent damage for engineering structures.		
Subsurface Investigations			
	Soil Profile, Geophysical methods – Electrical Resistivity and Seismic refraction methods.		
Dams			
	Types of dams, Requirements of dam sites, preliminary and detailed geological investigations for a dam site, Case histories of dam failures and their causes. Geology of the major dam sites of India, Factors affecting the seepage and leakage of reservoir and the remedial measures.		
Tunnels			
	Purpose of tunneling, geological considerations for tunneling, geothermal step, over break, stand up time, and logging of tunnels.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEP1501 GEOTECHNICAL LABORATORY (0 - 0 - 2)

1. Course Description:

The Lab sessions would include experiments on different tests on soils to find out its properties.

2. Learning Outcome:

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

- Determine index properties of soils.
- Classify soils.
- Determine engineering properties of soils.

3. Broad Course Outline:

- Sieve analysis
- Consistency limits.
- Specific gravity.
- Permeability tests
- Unconfined compression test
- SPT test
- Direct shear test
- Core cutter and sand replacement
- Compaction test
- California bearing ratio test
- Vane shear test
- Triaxial test
- Consolidation test
- Plate load test

CEL1601 DESIGN OF STEEL STRUCTURES **(3 - 1 - 0)**

1. Course Description

Design of Steel Structures introduces you to the design guidelines followed by engineers and designers for building or designing steel structures. The main objective of the course is to learn to use IS 800:2007 code of practice for the design of different structural elements such as compression, tension and flexural members. It introduces you to different design philosophies used in design. The course also gives an idea of different types of connections used in steel structures.

2. Learning Outcome

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

- apply the IS code of practice for the design of steel structural elements
- design compression and tension members using simple and built-up sections
- calculate forces on various members of truss and design them
- Analyze and design welded and bolted connections.
- design welded connections for both axial and eccentric forces

3. Broad Course Outline

- Introduction
- Methods of Structural Design
- Design of Steel Connections
- Design of tension Members
- Design of Compression Members
- Design of Beams
- Design of Beam Columns
- Design of Column Splices and Column Base
- Design of Eccentric Connections
- Design of Plate Girder

4. Readings

a) Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.
b) L. S. Negi, Design of Steel Structures, Tata McGraw Hill, 2008.
c) S. S. Bhavikatti, Design of Steel Structures, I. K. Innternational Pvt. Ltd., 2009.
d) S K Duggal, Design of Steel Structures, Tata McGraw Hill Education, 2000.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
	Introduction		
	General, Types of Steel, Properties of steel, Structural steel sections.		
	Methods of Structural Design		
	Introduction, Design Philosophies, Working Stress method, Ultimate Stress method, Load and Resistant factor, Limit State Method,		

	Partial safety factor, Load, Load combinations, General aspects in the design.		
Introduction to Plastic Analysis			
	Introduction to plastic theory, Plastic moment, Plastic section modulus, Plastic hinge concept, Cross section classification.		
Design of Steel Connections			
	Riveted connections, Bolted connections, Assumptions, Failure of bolted joints , Strength of bolted joints, Design examples, Design of Welded connections, Butt weld-fillet weld, Design examples.		
Design of Tension Members			
	Modes of Failure of Tension member, Analysis of Tension members, Example, Design steps, Design examples, Lug angles.		
Design of Compression Members			
	Strength of Compression members, Design Compressive strength, Example on analysis of Compression members, Design of Angle struts, Design Examples, Built up Columns, Design of Lacing, Design of Battens, Design Examples, Design of Roof members.		
Design of Beams			
	General, Lateral Stability of Beams, Bending Strength of Beams, Plastic Section Modulus, Design Examples.		
Design of Beam Columns			
	Behavior of members under combined loading, Modes of Failures, Design Examples.		
Design of Column Splices and Column Base			
	Design of Column Splice-Design Examples- Design of Column Base- Slab Base- Gusseted Base- Design Examples.		
Design of Eccentric Connections			
	Design of Brackets- Type-1 and Type 2 – Moment Resistant connections - Design Examples.		
Design of Plate Girder			
	Design of Plate Girder: General- Components of Plate Girder- Optimum depth – Bending Strength – Shear Strength – Shear Buckling- Simple Post critical method- Tension Field method- Stiffeners-Bearing- Transverse stiffeners - Design Examples.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage

1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1602 STRUCTURAL ANALYSIS - II **(3 - 1 - 0)**

1. Course Description

The course is designed to understand the classical methods of analysis of framed structures for external loads. It also highlights the approximate methods of analysis. Analysis of multistory frames for lateral load is discussed in the course. It also focuses on Matrix method of structural analysis.

2. Learning Outcome

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

- apply the displacement method of analysis
- apply the approximate method of analysis
- analyze structures for lateral loads
- analyze indeterminate structures using matrix method of analysis

3. Broad Course Outline

- Classical method of analysis of framed structures
- Approximate methods of analysis
- Lateral load analysis
- Matrix Methods of Structural Analysis

4. Readings

a) Hibbeler. R. C, Structural Analysis, Pearson Prentice Hall, 2012.
b) L.S. Negi, Theory and Problems in Structural Analysis, Tata McGraw Hill Pub, 2008.
c) Wang C.K., Intermediate Structural Analaysis, Tata Mc Graw Hill Publishers, 2010.
d) W. Weaver and J. M. Gere, Matrix analysis of framed structures, CBS Publishers, 2nd edition, 2004.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
Classical method of Analysis of Framed Structures			
	Slope deflection method, Moment distribution method, effect of symmetry and anti-symmetry, sway correction		
Approximate methods of Analysis			
	Substitute frame methods for gravity load		

Lateral load analysis			
	Portal and Cantilever methods		
Matrix method of Structural Analysis			
	Local and global stiffness matrices, assembly, band storage, solution of resulting simultaneous algebraic equation, boundary conditions, applications to plane and space truss, analysis of plane frame, grid and three dimensional frame		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1603 GEOTECHNICAL ENGINEERING-II (3 - 0 - 0)

1. Course Description

The course intimates about the various exploratory and non-destructive field investigation techniques associated with the subsurface exploration and characterization. The course provides an explanation of the lateral earth pressure theories and their utility in the analysis and designing of rigid and flexible earth retention systems. It explains the concept of bearing capacity and estimation of the various types of bearing capacities including both stress and settlement considerations. Different aspects of foundations related to shallow foundations, pile foundation and well foundation are also discussed. The estimation of the settlement of various types of foundations are also explained. An introduction to the foundations in difficult conditions such as footings resting on slope, expansive and collapsible soils, are also provided. A preliminary idea about ground improvement, geosynthetic engineering and reinforced soil structure is included.

2. Learning Outcome

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

- Carry out soil investigation for any civil engineering construction
- Analyze earth retaining structures for any kind of soil medium
- Estimate bearing capacity
- Design proper foundations for any kind of shallow foundation system
- Estimate pile and pile group capacity for any kind of soil including group efficiency and negative skin friction

3. Broad Course Outline

- Soil exploration

- Lateral earth pressure
- Bearing capacity of soil
- Settlement of foundation
- Shallow foundation
- Pile foundation
- Well foundation

4. Readings

a) Murthy V.N.S, A Textbook of Soil Mechanics and Foundation Engineering, CBS publications, Delhi, 2015.
b) G. Ranjan, A. S. R. Rao, Basic and applied soil mechanics, New age International Pvt. Ltd., Delhi, 2016.
c) J.E. Bowles, Foundation Analysis and Design, McGraw Hill Education, 2017.
d) B. M. Das, Principles of foundation engineering, Cengage Learning India Pvt. Ltd., New Delhi, 2017.
e) M. Tomlinson, Pile Design and Construction Practice, Taylor and Francis, 2018.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
Soil exploration			
	Introduction and different methods, Direct methods, Semi-direct and Indirect methods; Sampling in soils and rocks; subsurface exploration program, Preparation of bore logs and preparation of exploration report, SPT, CPT, PLT and VST, geophysical exploration techniques		
Lateral Earth Pressures			
	Lateral earth pressure theory, Different types of earth pressures, Rankine's active and passive earth pressures, pressure distribution diagram for lateral earth pressures against retaining walls for different conditions in cohesion less and cohesive soils, Coulomb's active and passive earth pressure theory, Culmann's graphical construction, Problem solving, Sheet pile wall and Braced cut.		
Bearing capacity of shallow foundation			
	Types of shallow foundations and choice, basic requirements, Significance of these foundations. Basic Definitions, Factors affecting bearing capacity, Estimation of Bearing capacity by different methods, Analytical methods and codal provisions, Terzaghi's and Meyerhof methods and calculations, Field measures, SPT, CPT and Plate load tests, Base bearing capacity analysis		
Settlement of shallow foundation			

	Settlement analysis, Types of foundation settlement, Components of settlements - their estimation, Allowable settlement values, Effects, Causes and remedial measures of total and differential settlements		
Pile foundations			
	Classification and uses, Load carrying capacity calculations by different methods, static methods, dynamic methods, in-situ penetration tests, piles load test; Negative skin friction; under reamed pile foundations; Pile groups, Necessity, Efficiency, Group capacity and settlements.		
Well foundations			
	Types of caissons and their construction; Different shapes of wells, component parts and forces; Estimation of bearing capacity; sinking of wells and remedial measures for tilts and shifts, Codal provisions.		
Introduction to Foundations in difficult conditions			
	Foundations on slopes, foundations on expansive and collapsible soil, Introduction to soil improvement, Introduction to Geosynthetic Engineering and Reinforced soil structures.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1604 TRANSPORTATION ENGINEERING – II (3 - 0 - 0)

1. Course Description

Transportation Engineering-II introduces you to pavement materials and various test performed on the pavement materials. Design of pavement using different methods is discussed in detail. It also gives an idea of different types of highway construction. It emphasize the causes of pavement failure and maintenance of highways. The course also introduces you to airport engineering and docks and harbor.

2. Learning Outcome

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

- Test the pavement materials to be used in design
- Design pavement
- Learn different types of highway construction
- Learn how to maintain pavement after construction
- Carry out surveys for airports and harbor

3. Broad Course Outline

- Pavement materials and Mix design
- Design of pavements
- Highway construction
- Highway maintenance
- Introduction to Airport engineering
- Docks and harbours

4. Readings

a) Kadiyali L.R. Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, India, 1997.
b) Khanna, S.K. and C.E.G. Justo Highway Engineering, Nem Chand and Bros, Roorkee, India, 2001.
c) IRC Codes of Practices
d) P. Chakraborty and A. Das, Principles of Transportation Engineering, Prentice Hall India
e) C. S. Papacotas and P. D. Prevedouros, Transportation Engineering and Planning, Hall India, 2001
f) Khanna S K and Arora M G, Airport Planning and Design, Nemchand and Bros., 1999.
g) Oza and Oza, Dock and Harbour Engineering, Charotar Publishing House, 2013.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
Pavement materials and Mix Design			
	Sub grade soil properties, CBR test, aggregates, desirable properties, tests, bituminous materials, bitumen and tar, tests. Bituminous mixes, requirements, design, Marshall Method.		
Design of Pavements			
	Types of pavement structures, functions of pavement components, design factors. Design of flexible pavements, methods, GI method, CBR method, IRC method, Burmister's method. Design of rigid pavements, design considerations, wheel load stresses, temperature stresses, frictional stresses, design of joints, IRC method of rigid pavement design.		
Highway construction			

	Types of highway construction, construction of earth roads, gravel roads, WBM roads. Bituminous pavements, types, surface dressing, penetration macadam, built up spray grout, bitumen bound macadam, bituminous carpet, bituminous concrete. Cement concrete pavements.		
Highway maintenance			
	Pavement failures, causes, failures in flexible pavements and rigid pavements. Maintenance of highways, routine maintenance, periodic maintenance, special repairs. Strengthening of existing pavements, evaluation, overlay design. Highway drainage, surface and sub-surface drainage.		
Introduction to Airport Engineering			
	Scenario in India, national and international agencies, aircraft characteristics, site selection, airport obstructions, runway orientation, geometric design of runway, taxiway, exit taxiway, apron, holding apron, runway configuration, visual aids.		
Docks and Harbours			
	Types, Layout and planning principles, breakwaters, docks, wharves and quays, Transit sheds, warehouses, navigation aids.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1605 ENVIRONMENTAL ENGINEERING – II (3 - 1 - 0)

1. Course Description

This course is designed to give you basics of sewage composition and its characteristics. It will give you a concept of sewers and its design. Primary and secondary treatment of sewage and the various stages of it are discussed here. The course will also introduce you to Solid waste and its disposal. The causes and effects of air pollution and noise pollution will also be emphasized at the end of the course.

2. Learning Outcome

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

- Determine sewage characteristics and design various sewage treatment plants
- Carry out municipal water and wastewater treatment system design and operation
- Manage hazardous wastes, risk assessment and treatment technologies
- Point out causes of air pollution and devise measures to control it
- Point out causes of noise pollution and devise measures to control it
- Carry out solid waste management

3. Broad Course Outline

- Introduction to Sanitary engineering
- Waste water flow estimation
- Sewage
- Treatment of sewage
- Hazardous waste and its disposal
- Solid waste management
- Air pollution-causes and effects
- Noise pollution-causes and effects

4. Readings

a) Peavy H. S., Rowe D. R. and George Tchobanoglous, Environmental Engineering, McGraw-Hill International
b) McGhee T. J, Water Supply and Sewerage, McGraw-Hill Inc.
c) Metcalf and Eddy, Waste Water Engineering, Collection, Treatment and Disposal, Tata McGraw Hill Inc, New York, 2005.
d) G. S. Birdie, J. S. Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, 1996.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
	Sanitary Engineering		
	Important terms, sewage treatment system and waste water management.		
	Waste water flow estimation		
	Dry Weather Flow and Storm Water, Variation of flow, Estimation of design discharge.		
	Sewage		
	Quality and quantity perspectives of sewage, Collection and Conveyance of Sewage Conservancy and sewage carriage system, comparison, Design of Sewer, factors affecting selection of materials for sewer constructions, materials for sewers, joints in sewers, shapes of sewers, maintenance, cleaning and ventilation of sewers.		

Treatment of sewage			
	Waste Water Treatment Flow diagram of conventional sewage treatment plant, Preliminary and primary treatment of sewage- screening, grit removal basin, tanks for removal of oil and grease, sedimentation, sedimentation added with coagulation. Secondary treatment of sewage- activated sludge process, sewage filtration, miscellaneous methods such as oxidation ditch, oxidation ponds, aerated lagoons, rotating biological contractors. Treatment and disposal of sludge, on site disposal method, advanced sewage treatment, treated effluent disposal and reuse.		
Toxic and Hazardous Waste			
	Equalization and neutralization, biological degradation, recycle and reuse of waste effluents, treatment of industrial wastes, Dairy, Tannery, Petrochemical, Fertilizer, textiles, Pulp and paper		
Solid waste, Air Pollution, Noise Pollution			
	Introduction to Solid waste, solid waste management, Air pollution effects, stack emission, automobile exhaust, control devices, Noise pollution.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEP1601 TRANSPORTATION LABORATORY (0 - 0 - 2)

1. Course Description

The Lab sessions would include extensive experiments on

- Volume studies
- Speed studies
- Parking survey
- Test on aggregates
- Test on bitumen
- Test on bituminous mixes
- Earthwork calculation

2. Learning Outcome

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

- Conduct traffic studies for estimating traffic flow characteristics
- Characterize the pavement materials
- Perform quality control test on pavements and pavement materials
- Estimate earthwork from longitudinal and cross section details
- Design grade intersections

3. Broad Course Outline

- Direction, duration and classification of traffic volume
- Speed studies
- Parking inventory and turnover studies and drivers characteristics
- Shape test, impact test, abrasion test, specific gravity test and water absorption test on aggregates
- Penetration test, ductility test, stripping test, softening point test, flash and fire point test, viscosity test on bitumen
- Marshall stability mix design
- Earthwork calculation

CEP1602 ENVIRONMENTAL LABORATORY (0 - 0 - 2)

1. Course Description:

The Lab sessions would include experiments on:

- Physical properties of water
- Chemical properties of water
- Break point chlorination test
- Determination of residual chlorine
- Determination of dissolved oxygen
- Determination of COD, BOD
- Jar test
- Total solids, Total dissolved solids and Settleable solids

2. Learning Outcome:

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

- Determine physical, chemical and biological characteristics of water and wastewater.
- Determine optimum dosage of coagulant.
- Determine break - point chlorination
- Assess the quality of water and wastewater.

3. Broad Course Outline:

- Determination of pH
- Determination of Conductivity
- Determination of Acidity of water
- Determination of Alkalinity of Water
- Determination of Chlorides
- Determination of Hardness of water
- Determination of Fluorides
- Determination of Available Chlorine in bleaching powder
- Conducting Break Point Chlorination Test
- Determination of Residual Chlorine
- Determination of Dissolved Oxygen
- Determination of Chemical Oxygen Demand
- Determination of Biochemical Oxygen Demand
- Conducting Jar test for determining optimum dosage of coagulant
- Determination of Total Solids, Total Dissolved Solids & Settelable Solids

CEL1701 BRIDGE ENGINEERING (3 - 0 - 0)

1. Course Description:

Bridge engineering focuses on certain features required for analysis and design of bridge such as structural configuration, loading standards and specifications (IRC, IRS and AASHTO guidelines). It mainly emphasizes on design of reinforced concrete bridges. Also, a brief introduction to steel bridges has been included.

2. Learning Outcome:

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

- Analyse and design RCC bridges.
- Understand the concept of prestressing.
- Plot the reinforcement details of RCC bridges.
- Understand the basic knowledge on design and analysis of steel bridges.

3. Broad Course Outline:

- Introduction.
- Reinforced concrete bridges.
- Introduction to pre stressing
- Abutment and piers.
- Steel bridges.

4. Readings:

a) D. J. Victor. - Essentials of bridge Engineering, Oxford and IBH Publishers, 2001.

b) V. K. Raina, Concrete Bridge Practice Analysis Design and Economics, Tata McGraw Hill, 2nd Ed, 1994.
c) N. Subramanian , Design of Steel Structures, Oxford University Press, New Delhi, 2008.
d) N. K. Raju, Prestressed Concrete, McGraw Hill Companies, 2007.
e) IRC 112: Code of Practice for Concrete Road Bridges, 2011.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		
	Types of bridges; structural configurations; bridge loading standards in India and other countries (IRC, IRS and AASHTO guidelines); Impact effect; Standard specifications for road and railway bridges; analysis of bridge deck.		
	Reinforced concrete bridges		
	Design of deck slab; T-beam bridge; balanced cantilever type; design and details of articulation		
	Introduction to pre stressing		
	Concept of pre stressing, design of pre stressing members.		
	Abutment and piers		
	Scour at abutment and piers; types of foundations; analysis for stresses and design		
	Steel bridges		
	Introduction to steel bridges, steel-concrete composite constructions, shear connectors and their design; types of bearings and layout.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

CEL1703 QUANTITY SURVEYING AND PUBLIC WORKS (3 - 0 - 0)

1. Course Description

Quantity surveying and public works will help you understand the importance of estimates under different conditions. It will help you know about the rate analysis and bill preparations. The

course emphasizes the idea of specification writing. It will also help you understand the valuation of land and buildings.

2. Learning Outcome

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

- Apply different types of estimates
- Carry out analysis of rates and bill preparation
- Demonstrate the concept of specification writing
- Handle contracts and tender
- Carry out valuation of assets

3. Broad Course Outline

- Introduction to estimates
- Analysis of rates
- Specifications
- Contracts
- Tenders
- Valuation

4. Readings

a) M. Chakraborti, Estimation, costing, specifications and valuation in civil engineering, National Halftone Co. Calcutta, 2005.
b) Rangawala, Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd., 2014.
c) B. N. Dutta, Estimation and costing in civil engineering: theory and practice, UBS Publishers Distributors Ltd, 2006.
d) G. S. Birdie, Estimation and costing in civil engineering, Dhanpat Rai Publishing Co. Ltd.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
	Introduction to estimates		
	Purpose of estimating; Different types of estimates - their function and preparation; Building estimates: Schedule of rates, Units of measurements, units of works; Road Estimates – Volume of earthwork, Different methods, Earthwork for hill roads; Railway and canal works – Estimates for a new track railway line; earthwork in canals.		
	Analysis of rates		
	Preparation for analysis of rates. Quantity of materials per unit rate of work, labour estimate.		

Specifications			
	Necessity, types of specifications, specifications for different civil engineering materials.		
Contracts			
	Essentials of contracts, types of engineering contracts – advantages and disadvantages.		
Valuation			
	Purpose, difference between value and cost, qualifications and functions of a valuer, scrap & salvage value, sinking fund, capitalized value.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

DEPARTMENTAL ELECTIVE-I

GROUND IMPROVEMENT TECHNIQUES **(3 - 0 - 0)**

1. **Course Description:**

Ground improvement techniques introduce the necessity and principles of ground improvement and different ground improvement techniques. Further, it emphasizes on soil stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen. In the later part, it focuses on grouting and reinforced earth structures. Lastly, it introduces Geo-synthetic materials and its applications.

2. **Learning Outcome:**

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

- Have information about the necessity and principles of ground improvement.
- Understand the different techniques for ground improvement.
- Explain and analyze the stabilization of soil with different materials.
- Have better knowledge on geo-synthetic materials.

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3. **Broad course outline:**

- Introduction to Ground Improvement.
- Ground Modification Techniques.
- Soil Stabilization and soil reinforcement.
- Introduction to Geo- synthetics and their applications.

4. **Readings:**

a) P. Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi, 1999.
b) M.R. Hausmann, Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990.
c) S.K. Shukla, Geosynthetics and their applications, Thomas Telford, 2002.
d) R.M. Koerner, designing with Geosynthetics, Prentice hall, 2006.
e) C. V. J. Varma, A.R.G. Rao and G. V. Rao, Engineering with Geosynthetics, Tata McGraw Hill, 1994.
f) S. Saran, Reinforced Soil and its Engineering Applications, IK Publishing House, New Delhi, 2011.

5. **Session Plan:**

No of Sessions	Topics covered	Readings	Date
	General principles of Ground improvement		
	Introduction, Necessity and objectives for ground improvement, Introduction to ground improvement techniques		
	Ground Modification Techniques		
	Mechanical modification, Principles of mechanical modifications, Methods of compaction, Shallow		

	compaction, Deep compaction techniques, Vibro-floatation, Blasting, Dynamic consolidation, Pre-compression and compaction piles, Hydraulic modification, Methods of dewatering, Physical and chemical modification.		
Soil Stabilization and Soil Reinforcement			
	Stabilisation with admixtures - cement, lime, calcium chloride, fly ash and bitumen; Grouting, Grouting materials and methods, Reinforced earth technology, Concept of soil reinforcement, Reinforcing materials, Backfill criteria, Design of reinforcement for internal stability, Applications of reinforced earth structures (reinforced embankments, Pavement subgrades and foundations), Soil nailing and Earth anchors.		
Introduction to Geosynthetics			
	Geo-Synthetics- Types, category, materials; Functions and Property characterization, Testing methods, Field Applications, Case studies.		
Analysis and Design Project			
	Software based numerical analysis and design of projects related to reinforced earth structures. Software such as PLAXIS 2D and 3D, Geo-Studio to be used for the project.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		**100**

TRAFFIC ENGINEERING **(3 - 0 - 0)**

1. Course Description:

Traffic engineering focuses on certain features of elements of traffic engineering, issues for traffic engineers, road users, vehicles and modelling concepts. Also, it emphasizes on the traffic stream characteristics and design.

2. Learning Outcome:

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

- Understand the elements of traffic engineering.
- Learn certain parameters required for traffic studies.

3. Broad Course Outline:

- Introduction.
- Traffic stream characteristics.
- Traffic studies.
- Traffic design.
- Statistical application in traffic engineering
- Traffic flow theory.

4. Readings:

f) William R. Mcshane and Roger P. Roess, "Traffic Engineering", Pearson (4th Edition), 2013.

g) Kadiyali, L.R., "Traffic Engineering and Transport Planning", Khanna Publishers, 2012.

h) C A O'Flaherty, Ed , "Transport Planning and Traffic Engineering", Butterworth Heinemann, Elsevier, Burlington, MA, 2006.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		
	Elements of traffic engineering, issues for traffic engineers; road users, vehicles, highways and control devices, modelling concepts.		
	Traffic Stream Characteristics		
	Traffic stream parameters, Time Space diagram, relationship among q,k,u, Macroscopic Fundamental Diagrams (MFD).		
	Traffic Studies		
	Traffic volume studies, speed, travel time and delay studies, parking studies, RSI Survey, WTP Survey, accident data collection, pedestrian studies.		
	Traffic Design		
	Capacity analysis concepts – urban streets and rural highways, design of parking facilities, street design.		
	Statistical application in Traffic Engineering		
	Overview of probability functions and statistics, normal distribution and application, confidence bounds, sample size, binomial distribution, poisson distribution, Hypothesis testing.		
	Traffic Flow Theory		
	Models of Uninterrupted Flow, Queuing Theory, Shock Wave Theory.		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

STRUCTURAL DYNAMICS (3 - 0 - 0)

1. Course Description

This course introduces the basic concepts of dynamic loading and response of structure to such loads, and then uses these concepts to illustrate applications in practical structures. The course introduces dynamics of simple structures and develops fundamental knowledge of vibration analysis of multi degree of freedom structures and continuous structures.

2. Learning Outcome

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

- understand fundamental theory of dynamic equation of motion
- formulate equations of motion for systems excited by harmonic, impulse and arbitrary loadings
- analyse response of structure by time domain and frequency domain methods.

3. Broad Course Outline

- Dynamics of single DOF systems
- Earthquake response of SDOF systems
- Numerical evaluation of Dynamic response of SDOF systems
- Dynamics of multi DOF system
- Dynamics of continuous systems

4. Readings

a) M. Paz, Structural dynamics, CBS Publishers 1987.
b) A. K. Chopra, Dynamics of structures: Theory and applications to earthquake engineering, PHI Ltd., 1997.
c) R.W. Clough and J. Penzien, Dynamics of Structures, Second edition, McGraw Hill international edition, 1993.
d) K. Rao, Vibration analysis and foundation dynamics, Wheeler, 1998.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
	SDOF systems		
	Equations of motion, Free vibration, damping, Forced vibrations under harmonic, impulse and general loadings, Response spectrum		
	Numerical evaluation of Dynamic response of SDOF systems		
	Time domain analysis: Frequency domain analysis: basic methodology		
	MDOF systems		
	Dynamic properties, modal damping, classical damping, modal superposition methods, Response history for earthquake excitation using modal analysis, Response spectrum analysis for peak response		
	Generalised SDOF system		
	Basic concepts, mass-spring system, lumped mass systems, systems with distributed mass and elasticity, Rayleigh's method		
	Dynamics of Continuous systems		
	Equations of motion for axial and flexural vibration of a beam, free vibration analysis, froced vibration analysis		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

DESIGN OF HYDRAULICS STRUCTURES (3 - 0 - 0)

1. Course Description:

Design of hydraulic structures introduces the design strategy of water related structures. It mainly focuses on the design procedure for different conditions of load and other factors. The basic concept behind this subject is to give stability of the structure against hydraulic force and design steps that should be followed accordingly.

2. Learning Outcome:

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

- Know about various forces acting on hydraulic structures.
- Calculate forces and their impacts.
- Know about the fundamentals of stable condition.
- Hydraulic structures have to be designed according to stability criteria.
- Understand the design of dams and channel systems.
- Understand the different types of cross drainage works.

3. Broad Course Outline:

- Introduction of hydraulic structures.
- River engineering.
- Design of dams.
- Diversion headworks.
- Spillway design.
- Cross drainage structures.
- River training works.

4. Readings:

a) S.K. Garg, Irrigation Engineering & Hydraulic Structures, Khanna Publishers, Delhi, 1995.
b) N.N Basak, Irrigation Engineering, Tata McGrawHill Publishing Co. New Delhi, 1999.
c) P.N. Modi, Irrigation Water Resources & Water Power Engg, Standard Book House, 2008.
d) B.C. Punmia and P.B.B. Lal, Irrigation& Water Power Engineering, Standard Book House, 2nd Edition,1990.
e) Bharat Singh, Fundamentals of Irrigation Engineering, Nem Chand & Bros, Roorkee,1975.
f) K.R. Arora, Irrigation Water Power & Water Resources Engineering, Standard Publishers Distributors, Delhi, 2002.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction of hydraulic structures			
	Types and functions of hydraulic structures, Consideration for their selection.		
Introduction to River Engineering			
	Meandering of river, River training works, Bank protection works, Spurs, Guide banks, Artificial cut off.		
Design of dams			
	Introduction to dam with their classifications, Factors affecting location and type of dams, Design of gravity arch dam, Rock fill dams, Forces on a dam, Hydraulic design criteria of dams, Stability analysis, Causes of failure, Prevention of seepage.		
Diversion headworks			
	Diversion headworks, Components and functions, Selection of site, Canal head structures, Canal regulatory structures, Design of guide banks, Groynes or spurs.		

Spillway Design			
	Types and selection of spillway, Design of Ogee spillway, Energy dissipation, Weirs and elementary profile, Weirs on pervious foundations, Type of weirs on pervious foundations, Cause of failure, Bligh's creep theory, Khosla's theory, Complete design of a vertical drop weir.		
Cross Drainage structures			
	Types of cross drainage structures - Super passage, Aqueducts, Design of cross drainage structures, Water way and headway of the stream, Head loss through cross drainage structures, Design of transitions for canal waterway, Uplift pressure on culvert floor.		
River Training Works			
	Objectives and methods of river control, Classification and designing of river training works, Design of guide banks, Groynes or spurs and their design, Approach embankments and afflux embankments, Pitched Islands, Artificial cut-offs, Design considerations,.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		**100**

AIR AND NOISE POLLUTION **(3 - 0 - 0)**

1. Course Description:

Air and Noise Pollution helps you to provide general understanding of air quality and its impact on the environment. The fundamentals of meteorology and stability of atmosphere gives some knowledge about the atmospheric condition, and to study the fate and transport of air pollutants and its measurement techniques. It also focuses on the different control methods and principles for gaseous pollutants. It also discusses about small scale pollution such as indoor air pollution.

2. Learning Outcome:

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

- Identify the types and sources of air pollutants.
- Predict the effects of air pollutants on human health and the environment.
- Choose appropriate technologies for removal of particulates and gaseous pollutants.
- Measure pollutant concentration in indoor environment.
- Suggest control techniques for indoor air pollution.

- Effects of noise pollution with its permissible limits and regulations..

3. Broad Course Outline:

- Introduction to air pollution.
- Air pollutants and its effects.
- Indoor air pollution.
- Dispersion of pollutants.
- Control of pollutants from source.
- Introduction to noise pollution.

4. Readings:

a) M.L. Davis and D.A. Cornwell, Introduction to Environmental Engineering, Tata McGraw Hill Education Pvt. Ltd,. New Delhi, 2010.

b) H.S. Peavy and D.R. Rowe, Environmental Engineering, McGraw Hill Book Company, 1995.

c) M.N. Rao and H.V.N. Rao, Air Pollution, Tata McGraw Hill, New Delhi,2007.

d) D. Anjaneyulu, Air Pollution and Control Technologies, Allied Publishers, Mumbai, 2002.

e) W.L. Heumannn, Industrial Air Pollution Control Systems, McGraw Hill, New York, 1997.

f) C.S. Rao, Environmental Pollution Control Engineering, New Age International, NewDelhi, 2006.

g) S.K. Garg, Sewage Disposal and Air Pollution Engineering – Environmental Engineering (Vol. II), Khanna Publishers,1999.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction to Air pollution			
	Types of air pollution- Natural and man-made air pollution, Severe example of air pollution- Bhopal gas tragedy, Delhi air pollution, great smog of London, Smog in Los Angeles.		
Air pollutants and its effects			
	Sources of air pollutants and their classification, Standards and Guidelines for Air Quality Parameter, Effects of air pollutants on human health and property, Reactions of pollutants in the atmosphere and their effects- Smoke, smog, Green house effect, acid rain, ozone hole, etc.; Vehicular emissions, Motor fuel combustion.		
Indoor air pollution			
	Indoor air pollution, Indoor air pollutants and their		

	effects, Indoor air pollution from outdoor sources.		
Dispersion of pollutants			
	Atmospheric diffusion of pollutants, Transport, transformation and deposition of air contaminants; Plume behaviour and atmospheric diffusion theories, Plume height determination, Gaussian dispersion models.		
Control of pollutants from source			
	Control principles of pollutants, Description of control technologies - Gravitation, centrifugal, filtration, scrubbing, electrostatic precipitation; Control of gaseous air pollutants- absorption, adsorption, condensation, incineration and filtration;Automobile emission control.		
Introduction to Noise pollution			
	Sound characteristics, Permissible limits of noise pollution, Impacts or effects of noise pollution, Measurement of noise and its control, Noise standards and criteria, Noise pollution measurement in ambient air and industrial complex.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		**100**

DEPARTMENTAL ELECTIVE-II

GROUNDWATER **(3 - 0 - 0)**

1. Course Description:

Ground water introduces identification of various strata in ground by surface and subsurface investigation. It also introduces the occurrence and movement of ground water. Basic concepts behind well hydraulics and fetching of ground water from different types of well are also discussed. Later, it focuses on cause and effects of variation in the level of ground water including ground water recharge.

2. Learning Outcome:

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

- To know different types of aquifers.
- Understand the surface and subsurface investigation corresponding to well hydraulics.
- Give fundamental and basic knowledge of ground water level variation including its causes and effects.
- To understand the methods and procedure of ground water recharge.
- To find out the causes and impacts due to ground and surface water pollution.

3. Broad course outline:

- Introduction to ground water.
- Aquifers.
- Well hydraulics.
- Drilling methodology of various types of wells.
- Ground water level fluctuations and its effects.
- Design and maintenance of wells.
- Groundwater recharge.
- Ground water pollution.

4. Readings:

a) S.K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi, 1996.
b) K. Subramanya, Engineering Hydrology, Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi,1990.
c) D.K. Todd.,Groundwater Hydrology, John Wiley and Sons, New York, 2005.
d) H.M. Raghunath, Hydrology, Principles, Analysis and Design, New Age International (P) Ltd, New Delhi, 2000.
e) K.C. Patra, Hydrology and Water Resources Engg.,Narosa Publishing house, New Delhi, 2001.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction to ground water			

	Occurrence of ground water, Water balance equation, Surface and sub-surface investigation, Groundwater basins.		
Aquifers			
	Origin and geological formations of aquifers, Classification of aquifers, Distribution of ground water, Formation of springs.		
Well Hydraulics			
	Steady flow to a well, Non equilibrium Thiem's equation, Thiem's method of solution, Multiple well systems, Partially penetrating wells.		
Drilling Methodology of various types of wells			
	Methods of drilling and constructing deep and shallow wells, Types- Down the hole hammer method, Direct circulation hydraulic rotary, Yield test of well.		
Ground water level fluctuations and its effects			
	Fluctuation due to miscellaneous causes- evapo-transpiration, tides, external loads and earthquake forces; Seasonal and secular variations on ground water table, Effect of irrigation, Stream flow and rainfall on groundwater level fluctuation.		
Design and maintenance of wells			
	Well design, its construction and maintenance procedures.		
Groundwater Recharge			
	Recharge through sewage pits, shafts, wells, water spreading, etc.		
Ground water pollution			
	Sources of ground water pollution - municipal, domestic, agricultural and industrial; Tank and pipeline leakage, Septic tank and cesspools, Activity due to mining, Pollution due to release of minerals from parent rock.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal Examination	20
3	End semester examination	50
Total		**100**

PAVEMENT ENGINEERING **(3 - 0 - 0)**

1. Course Description:

Pavement engineering introduces the construction strategy about highway engineering and related studies. It focuses mainly on the improvement techniques on various types of pavement construction. Various improvement steps including maintenance are also included in it.

2. Learning Outcome:

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

- Understand the importance of transportation, characteristics of road transport, highway planning, alignment and surveys.
- Know about the pavement materials and design.
- Understand the pavement construction, distresses in pavements and maintenance options.
- Learn the characteristics, properties and testing procedures of aggregate and bitumen.

3. Broad Course Outline:

- Introduction to highway and their classification.
- Highway survey.
- Stresses in pavements.
- Pavement construction materials and their properties.
- Highway drainage.
- Strengthening of pavement.

4. Readings:

a) Chakroborti and Das, Principles of Transportation Engineering, Prentice Hall India LearningPrivate Limited,2003.

b) Y.H, Huang, Pavement Analysis and Design, Pearson education, 2008.

c) S.K. Khanna & C.E.G. Justo Highway Engineering, Nem Chand & Bros,2001.

d) H. M. Atkins, Highway Materials, soil and concrete, Prentice Hall, 2003.

e) MORTH, Specifications for Road and Bridge works, 5th revision, Ministry of Road, Transport and Highway, 2013.

f) Guidelines for Design of Flexible Pavements IRC:37-2012.

g) Guidelines for Design of Rigid Pavements IRC:58-2011.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction to Highway and their classification			
	History of road development, Road planning in India,		

	Classification of roads, Network patterns, Modes of transportation, their importance and limitations.		
Highway survey			
	Surveys and investigations, Project estimates, Highway – planning, surveys and alignments.		
Pavement construction materials and their properties			
	Pavement components and their functions, Factors influencing the design of pavements, Sub grade soil investigation and properties, Desirable properties of subgrade soil, Road aggregates and bituminous materials, Bituminous Binders, Penetration Grade, Emulsions, Cut backs and Modified Binders		
Stresses in Pavements			
	Stresses in flexible pavements, Layered system concepts, Westergaard's theory and assumptions, Stresses due to curling, Stresses and deflections due to loading, Frictional stresses, Warping stresses, Combined stresses, Tyre pressure, Contact pressure, ESWL, EWLF and EAL concepts, Vehicle damage factors, Boussinesq's equations, Burmister's two layer and three layer theories, Considerations in rigid pavement analysis.		
Design of Pavement Construction			
	Design of flexible and rigid pavements as per IRC, Testing of aggregates, binders and mixes; IRC specifications for materials, Construction of low-cost roads- WBM, WMM, C.C. roads; Tools, Equipments and plants, Highways in hilly region and waterlogged areas, Resilient modulus and modulus of sub-grade reaction, Dynamic modulus, Flow time and flow number of bituminous mixes, Distresses in flexible and rigid pavements, Use of geo-synthetics in pavements.		
Highway Drainage			
	Surface and sub-surface drainage, Various techniques of surface and sub-surface drainage.		
Strengthening of pavement			
	Evaluation and strengthening of existing pavements, design of Overlays, Pavement management system, Salient features of hilly roads.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		**100**

EARTHQUAKE GEOTECHNICAL ENGINEERING **(3 - 0 - 0)**

1. Course Description:

This course elucidates the basics of earthquake seismology including the cause of earthquakes, plate tectonics, earthquake fault sources, theory of vibrations, propagation of seismic waves, and quantification of earthquake in terms of the intensity and magnitude of earthquake. The course will emphasize on the earthquake ground motions and their characteristics and measurement methodologies. The application of the codal provisions to estimate design earthquakes and design spectra for development of site specific studies will be provided. A broad understanding on liquefaction and its evaluation and hazard assessment will be provided. Finally, influence on earthquake induced forced on the seismic design of shallow and deep foundations, foundations in liquefiable soils, and seismic design of retaining walls and slope stability will be addressed.

2. Learning Outcome:

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

- Analyze and discuss different types of seismic waves and risks.
- Compare and contrast alternative solutions to earthquake problems.
- Select techniques and methodologies appropriate to seismic hazards.
- Suggest possible solutions to reduce earthquake problems.

3. Broad course outline:

- Introduction
- Inertia And Theory Of Vibrations
- Wave propagation
- Liquefaction And Its Evaluation
- Seismic Slope Stability And Retention systems

4. Readings:

a) S. L. Kramer Geotechnical Earthquake Engineering, Pearson Education India, 2003
b) K. Kumar, Basic Geotechnical Earthquake Engineering, New Age International Pvt Ltd, 2017
c) B. M. Das, Principles of Soil Dynamics, Cl-Engineering, 2016.
d) R. Day, Geotechnical Earthquake Engineering Handbook, McGraw Hill Education, 2012.
e) B. B. Prasad, Advanced Soil Dynamics and Earthquake Engineering, PHI, 2010.
f) I. Towhata, Geotechnical Earthquake Engineering, Springer, 2010.
g) T. Kokusho, Earthquake Geotechnical Case Histories for Performance-Based Design: ISSMGE TC4 2005-2009, CRC Press, 2009.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction		

	Introduction, cause and strength of earthquake, seismic waves, seismic risks and seismic hazards: Mitigation of seismic hazards, seismology and earthquakes, strong ground motion, seismic hazard analysis; Engineering problems involving soil dynamics.		
Inertia And Theory Of Vibrations			
	Engineering problems involving soil dynamics; Role of inertia; Theory of Vibrations: Single and two-degrees of freedom systems, vibration measuring instruments, Vibration absorption and isolation techniques. Measurement of small strain and large strain dynamic soil properties: Field and Laboratory tests. Selection of design values.		
Wave propagation			
	Theory of dynamics and seismic response, the nature and attenuation of ground motion. Wave propagation in unbounded media: in semi-infinite bodies, in layered soils and attenuation of stress waves; Determination of site characteristics, local geology and soil condition, site investigation and soil test, Determination of design earthquake, response spectra and accelerograms as design earthquake, criteria for earthquake resistant design.		
Liquefaction And Its Evaluation			
	Liquefaction: evaluation of liquefaction hazards, effects of liquefaction; Site response to earthquake, liquefaction of saturated cohesion-less soils, seismic response of soil structure system, shallow foundation, pile foundation, foundation in liquefiable ground. A seismic design of earth retaining structures.		
Seismic Slope Stability And Retention systems			
	Seismic slope stability analysis, Seismic bearing capacity and earth pressures, Soil improvement for remediation of seismic hazards, Codal provisions, Case studies.		

6. Evaluation Plan:

Sl No.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal Examination	20
3	End semester examination	50
Total		**100**

AIRPORT PLANNING AND DESIGN **(3 - 0 - 0)**

1. Course Description:

Airport planning and design introduces you the concepts of the basic concepts of airport planning and construction. To make the students conversant with the types of runway pavements and their design. To make them learn the importance of orientation of runways, Air traffic control devices and airport drainage system.

2. Learning Outcome:

Following the successful completion of this course, the students will be able to:

- The student will be able to describe and understand the historical federal involvement in airports and airport planning.
- The student will be able to identify and define the different kinds of airports and airport planning.
- The student will be able to understand and analyze key airport issues.
- Understand the multiple complexities of successful planning, data collection and analysis of airport planning and design.

3. Broad Course Outline:

- Introduction to Airport Engineering
- Airport Characteristics
- Airport Survey
- Air traffic control
- Runway Orientation
- Airport Characteristics, Planning And Design

4. Readings:

a) S. K. Khanna, M.G. Arora, and S.S. Jain, Airport Planning and Design, Nem Chand &Bros. Roorkee, India, 1999.
b) A. Odoni and D. R. Neufville, Airport Systems: Planning, Design and Management, McGraw Hill. 2002.
c) S. C. Rangwala, Airport Engineering by Charotar Publishing House.2008.
d) N. J. Ashford, H.P.M. Stanton and C. A. Moore, Airport Operations, 2nd Edition, McGraw Hill. 1997.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction to Airport Engineering		
	Air transport- structure and organization Classification of airports airfield components, Air traffic Zones and approach areas. Context of Airport system planning, Development of Airport Planning process, Ultimate		

	consumers, Airline decision, other Airport operations.		
Airport Characteristics			
	Holding aprons; runway lighting and markings; passenger terminal area; runway pavement design; airport drainage, roles of International Civil Aviation Organisations (ICAO)		
Airport Survey			
	Runway length and width, sight distances, longitudinal and transverse, runway intersections, taxiways, clearances, aprons, numbering, holding apron. Planning and design of the terminal area: Operational concepts, space relationships and area requirements, noise control, vehicular traffic and parking at airports. Air traffic control and aids: Runways and taxiways markings.		
Air traffic control			
	Elements; major components and functions of the National airspace system, models for capacity and delay, space time concept		
Runway Orientation			
	Windrose diagram, Basic runway length, Corrections for elevation, temperature and gradient, Airfield/ airport capacity; runway design		
Airport Characteristics, Planning And Design			
	The planning terminal system; design considerations and visual aids, Components Size, turning radius, speed, airport characteristics. Capacity and delay: Factors affecting capacity, determination of runway capacity related to delay, gate capacity, and taxiway capacity design		

6. Evaluation plan:

Sl no.	Type of evaluation	Weight age
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

DESIGN OF EARTHQUAKE RESISTANT STRUCTURES (3 - 0 - 0)

1. Course Description:

Design of earthquake resistant structures introduces the importance of incorporating seismic design in design of structures. Various concepts related to ground motion and its related hazards are introduced at the beginning of the course. It also focuses on how seismic load on buildings can be estimated for ductility considerations required for design of RC structures. Later, the course details the design of earthquake resistant structures and ductile detailing as per IS 13920:2016.

2. Learning Outcome:

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

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- Understand the concepts of ground motion.
- Understand concepts of structural dynamics and its importance in earthquake engineering.
- Know the importance of ductility and its implementation in earthquake resistant structures.
- Design the earthquake resistant buildings.

3. Broad course outline:

- Introduction to Engineering Seismology
- Characteristics of strong ground motions
- Estimation of Seismic load in buildings.
- Earthquake resistant design and ductile detailing.

4. Readings:

a) A.K.Chopra, Dynamics of structures, Prentice Hall, 1995.
b) I.S. 1893-2002, Criteria for earthquake resistance design of structures.
c) I.S. 13920: 2016, ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces, BIS, New Delhi.
d) I.S. 15988; 2013, Seismic Evaluation and Strengthening of Existing Reinforced Concrete Buildings, BIS, New Delhi.
e) Pankaj Agrawal and Manish Shrikhande, Earthquake resistant design of structures, PHI 2006 .
f) T. Paulayand M.S.N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1992.
g) D.J. Dowrick, Earthquake Resistant Design for Engineers and Architects, John Wiley and Sons, 1987.

5. Session Plan:

No of Sessions	Topics covered	Readings	Date
Introduction to Engineering Seismology			
	Structure of earth, faults, plate tectonics, seismic waves, intensity scale, magnitude scale, Richter magnitude, Seismic Moment and Moment Magnitude.		
Characteristics of Strong Ground Motions			
	Strong Motion, Accelerographs, Accelerograms, Characteristics, Side effects, Definitions, Seismic Hazards, Seismic Vulnerability, Seismic Risks.		
Estimation of Seismic Load in Buildings			
	Provisions of IS 1893, 2016: Design Response Spectrum; Irregularities in buildings; Equivalent static method, Response Spectrum Method.		
Earthquake Resistant Design and Ductile Detailing			
	Introduction to Earthquake Resistant Design: Role of Ductility, Beam Column connection design, Joint shear, Strong column weak beam criterions; Ductile Detailing and Shear wall design as per IS		

	13920, 2016, Introduction to Seismic Evaluation and retrofitting of buildings: Provisions of IS 15988, 2013.		

6. Evaluation plan:

Sl. no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		**100**

OPEN ELECTIVE

FINITE ELEMENT METHOD **(3 - 0 - 0)**

1. Course Description

The finite element method is a powerful tool for numerical solution of wide range of engineering problems. The course introduces the concept of finite element modelling approach for various problems encountered in civil, mechanical and aerospace applications.

2. Learning Outcome

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

- understand concepts of variational methods and weighted residual methods in finite element method
- understand and use various shape functions in finite element formulation
- understand global, local and natural coordinates
- understand formulation of one-dimensional and two-dimensional problems
- apply finite element method solutions to structural problems

3. Broad Course Outline

- Fundamental concepts
- One-dimensional problems
- Two-dimensional problems
- Beams and Frames

4. Readings

a) T. P. Chandrupatla, A. D. Belegundu, Introduction to Finite elements in Engineering, PHI Learning Pvt. Ltd., 2014.
b) J. N. Reddy, An introduction to the finite element method, Mc Graw Hill Education, 2016.
c) R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley & Sons, 4th Ed, 2002.
d) K.J. Bathe, Finite Element Procedures, Prentice Hall of India Pvt. Ltd., 2002.

5. Session Plan

No of Sessions	Topics covered	Readings	Date
Fundamental concepts			
	Stresses and equilibrium, Boundary conditions, Strain-displacement relations, Stress-strain relations, temperature effects, Method of weighted residuals: Method of least squares, Rayleigh-Ritz method, Galerkin's method.		
One-dimensional problems			

	Finite element modeling, Coordinates and shape functions, Potential energy approach, Galerkin approach, Global stiffness matrix, Treatment of boundary conditions, Quadratic shape functions, Plane trusses-local and global coordinate systems, element stiffness matrix, stress calculations		
Two-dimensional problems			
	Constant strain triangle, The Four-Node Quadrilateral, Isoparametric elements, Numerical integration, plane stress, plane strain and axisymmetric problems		
Beams and Frames			
	Finite element formulation, Euler-Bernoulli beam element, Load vector, Boundary considerations		

6. Evaluation plan

Sl no.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

SOLID WASTE MANAGEMENT **(3 - 0 - 0)**

1. Course Description:

It describes the understanding between people and the environment and also develops the ability to communicate harmful environmental impacts of solid waste generation. It also develops an understanding of how important it is to dispose solid wastes generated and look for the best possible treatment methods to reduce and recycle the wastes.

2. Learning Outcome:

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

- understand the impacts of solid waste generation on human beings, animals and plants.
- Compare and contrast alternative solutions to solid waste generation problems.
- Select techniques and appropriate methodologies for management of municipal solid waste.
- Suggest possible solutions to specific environmental problems.

3. Broad course outline:

- Introduction to solid waste management
- Processing of solid waste

- Disposal methods of solid waste
- Treatment of solid waste
- Environmental Impact Assessment

4. Readings:

a) N. S. Varandani, Environmental Engineering: Principles and Practices, Pearson, 2017.

b) Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, Environmental Engineering, Mc Graw Hill, 2015.

c) Mateo Roberts, Waste Management, Larsen and Keller Education, 2017.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction to Solid Waste management			
	Introduction, Important Definitions, Sources and Types of Solid Waste: Residential, commercial and industrial wastes, waste generation, sampling and analysis, Development of solid waste management (SWM) program, issues in solid waste management, integrated solid waste management, legislations and regulations.		
Processing of solid waste			
	Collection and Transport: Source separation, handling, storage, collection services, analysis of collection system, route optimization, transfer and transport; Processing and Material Separation Techniques: Receiving Area, Conveyors, Shredders, manual separation, screening, air classification, magnetic and eddy current separation techniques.		
Disposal methods of solid waste			
	Disposal of Solid Waste: Natural attenuation and containment landfills, Siting, Design and construction of landfills, gas, leachate, storm-water movement and control, closure of landfills, environmental monitoring, incineration, pyrolysis and gasification.		
Treatment of solid waste			
	Transformation of Solid Waste: Biological Processes: Composting and anaerobic Digestion, Reuse and Recycling possibilities, Waste to Energy Conversion: Emission control and ash management.		
Environmental Impact Assessment			
	EIA of landfills and other treatment methods. Case Studies: Overview of solid waste management practices in India.		

6. Evaluation Plan:

Sl No.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal Examination	20
3	End semester examination	50
Total		**100**

INDUSTRIAL AND E-WASTE MANAGEMENT **(3 - 0 - 0)**

1. Course Description:

It imparts knowledge regarding concept of industrial and electronic wastes and the harmful impacts of these wastes on the environment, human beings, animals and plants. It also emphasizes on waste management strategies and programs., the environmental regulations and hazardous treatment methods.

2. Learning Outcome:

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

- Analyze and characterize hazardous wastes from municipal solid waste.
- Carry out alternative solutions to management of electronic and industrial wastes.
- Select techniques and methodologies for better treatment of hazardous wastes.
- Suggest possible solutions to handle risk assessment, on-site and off-site emergency preparedness planning.

3. Broad course outline:

- Concept of Industrial System
- Waste management strategies and programs
- LCA and Case studies on Industrial Waste
- Environmental Regulations and Management Plans
- Hazardous waste treatment

4. Readings:

a) Zander Ellis, Industrial Waste Management, Larsen and Keller Education, 2017.

b) Majeti Narasimha Vara Prasad Meththika Vithanage, Electronic Waste Management and Treatment Technology 1st Edition, Butterworth-Heinemann, 2019.

c) Klaus Hieronymi, Ramzy Kahhat, Eric Williams, E-Waste Management: From Waste to Resource, Routledge, 2012.

d) R E Hester, R M Harrison, Electronic Waste Management (Issues in Environmental Science and Technology), Royal Society of Chemistry, 2008.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Concept of Industrial System			
	Industrial waste types and characteristics; levels of environmental pollution due to industrial wastes; health issues due to industrial wastes; ecological and human health risk assessment due to industrial wastes; waste characterization methods;		
Waste management strategies and programs			
	Treatment methods-conventional and recent trends (for air, water, soil media); Prevention versus control of industrial pollution; hierarchy of priorities for industrial waste management; comparison of real-life industrial waste management practices (ex: superfund remedial sites, etc.)		
LCA and Case studies on Industrial Waste			
	Life Cycle Analysis with example; Case studies/process and pollution generation from Dairy, Tannery, Pulp and paper, Iron and Steel, Metal plating, Thermal power plants, Chlor-Alkali, Aluminum industry etc.		
Environmental Regulations and Management Plans			
	Green technologies, zero waste discharge units, Environmental audit: Definitions and concepts, examples; Environmental regulations; Introduction to ISO and ISO 14000 series of standards for environmental management, Preparation and implementation of environmental management plans.		
Hazardous waste treatment			
	Hazardous waste treatment and disposal practices, stabilization and solidification, incineration, land filling, deep-well injection, underground disposal, encapsulation; site remediation. Hazardous waste management rules, classification of hazardous wastes, storage and handling requirements, risk assessment, on-site and off-site emergency preparedness planning.		

6. Evaluation Plan:

Sl No.	Type of evaluation	Weightage
1	Mid semester examination	30
2	Internal Examination	20
3	End semester examination	50
Total		**100**

WASTE TO ENERGY CONVERSION **(3 - 0 - 0)**

1. Course Description:

Waste to energy introduces you the concepts of Interrelationship between energy, ecology and environment, Environmental issues related to harnessing and utilization of various sources of energy and Related environmental degradation. It also develops an understanding of how natural resources and the environment affect quality of life and life cycle analysis for energy resource sustainable development.

2. Learning Outcome:

Following the successful completion of this course, the students will be able to:

- Access the socio-economic impact of biomass energy.
- Formulate protocol to convert biological waste into energy.
- Awareness on the energy crisis and environmental concerns and on the importance of energy efficiency, conservation and management.
- Able to identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.

3. Broad Course Outline:

- Introduction to Waste to energy
- Biological conversion
- Waste Energy Heat Recovery
- Energy Resource
- Energy Generation
- Life Cycle Analysis (LCA)

4. Readings:

a) B. Sorenson, Renewable Energy, Elsevier 2010.
b) S. Rao, B. B Parulekar , Energy Technology: Non-conventional, Renewable and Conventional, Khanna Pub. 2005.
c) J. A. Fay, D. S. Golomb. Energy and Environment, Oxford University Press 2002.
d) G.C. Young, "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.
e) F. Cherubini, S. Bargigli, and S. Ulgiati Life cycle assessment (LCA) of waste management strategies: Landfilling, sorting plant and incineration. Energy, 2009.
f) R.C. Brown and C. Stevens, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 2011.
g) S. Capareda, Introduction to biomass energy conversion, CRC Press 2013.
h) G. Lorenzini and C. Biserni, Solar Thermal and Biomass Energy, WIT Press 2012.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
Introduction to Waste to energy			

	Agricultural residues and wastes including animal wastes; industrial wastes; municipal solid wastes; Incinerators, gasifiers and digestors; Social, economic and ecological implications of waste energy		
Biological conversion			
	Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Chemical kinetics and mathematical modeling of biomethanation process; Economics of biogas plant with their environmental and social impacts; waste energy recovery		
Waste Energy Heat Recovery			
	Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste energy heat recovery devices, Commercial waste energy recovery systems, Case study		
Energy Resource			
	Sources of energy, sustainable energy, biomass as an alternative energy resource, Biomass classification and its use, biomass as fuel production and cleaner production, Bioconversion of substrates into alcohol: Production of methanol & ethanol, organic acids, solvents, amino acids, antibiotics etc		
Energy Generation			
	Production from waste plastics, organic wastes through anaerobic digestion and fermentation, introduction to microbial fuel cells; Energy production from wastes through fermentation and transesterification; Cultivation of algal biomass from wastewater and energy production from algae.		
Life Cycle Analysis (LCA)			
	Current costs, efficiencies and emissions & water for each phase, extraction, transport, processing, distribution, use		

6. Evaluation plan:

Sl no.	Type of evaluation	Weight age
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100

GROUNDWATER AND SURFACE WATER POLLUTION (3 - 0 - 0)

1. Course Description:

Groundwater and surface water pollution introduces you to the concepts of an in-depth examination of the physical, chemical, and biological processes affecting the fate and transport of inorganic and organic contaminants in groundwater and surface water. The course will provide better understanding

of the various interactions and mechanics of surface water pollution. Lastly it provides the various environmental control techniques and strategies so as to obtain water use objectives through a control program.

2. Learning Outcome:

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

- Get educated on Ground water and surface water contamination and its application.
- Awareness of the processes affecting fate and transport of contaminants in groundwater.
- Develop knowledge on water quality models.
- Understand the concept and behaviour of point and nonpoint source pollution.

3. Broad Course Outline:

- Introduction to groundwater pollution
- Groundwater quality
- Transport modelling
- Surface Water quality
- Sources and Effects of Water Pollution
- Engineered Water Quality Control Measures

4. Readings:

a) R. J. Charbeneau, Ground water Hydraulics and Pollutant transport, Prentice Hall, Upper Saddle River, 2009.
b) K. D. Todd, Ground water Hydrology, Second edition, John Wiley and Sons, New York, 2010.
c) A. Freeze, R and J. A. Cherry, Ground Water, Prentice Hall,Inc., 2009.
d) S. C. Chapra, Surface Water Quality Modeling, McGraw-Hill Companies, Inc., New Delhi, 2008.
e) V. Novotny, Water Quality: Diffuse Pollution and Watershed Management, Second Edition, John Wiley and Sons, New York, 2003.
f) W.W. Eckenfelder Jr. Industrial Water Pollution Control, 3d ed., McGraw-Hill, 2000.
g) M. M. Das, M. Saikia, Watershed Management, PHI Learning, Delhi, 2012.
h) K. N. Brooks, K. N. Ffolliott and J.A. Magner, Hydrology and the Management of Watersheds, Fourth Edition, Wiley-Blackwell, New York, 2012.

5. Session Plan:

No of Sessions	Topics Covered	Readings	Date
	Introduction to groundwater pollution		
	Sources and types of Ground water pollution; movement and attenuation of pollutants in aquifers; solute transport models; modelling of saltwater intrusion; management of groundwater pollution.		
	Groundwater quality		
	Water quality models, Landfills, Surface impoundment's, Waste disposal Injection wells Septic systems, Radioactive contamination, other sources of contaminates, Data-		

	collection methods, acquisition of soil and ground water quality		
Transport modelling			
	Historical development; Mass balance equation; Dissolved oxygen in Rivers and estuaries; Lake Water Quality Models; Models for Nitrogen, Bacteria, Phosphate and toxicants; MOC Modelling; Case studies		
Surface Water quality			
	Sources and Effects of Water Pollution; History of Water Pollution; Toxic Metals and Other Inorganic Pollutants; Organic Pollutants; Nutrients; Microorganisms; Thermal Effects		
Sources and Effects of Water Pollution			
	Atmospheric Deposition of Surface Water Pollutants; Irrigation-Induced Contamination and Other Non-Point Source Water Pollutants; Water Quality Surveillance. Water Quality Monitoring and Modelling		
Engineered Water Quality Control Measures			
	Sources of Water Supplies; Water Transmission; Physical and Chemical Treatment Processes for Water Supply; Wastewater Characteristics; Wastewater Collection Facilities; Wastewater Pre-treatment; Primary, Secondary and Tertiary Treatment Technologies; Statutory and Regulatory Approaches to Water Quality Management		

6. Evaluation plan:

Sl no.	Type of evaluation	Weight age
1	Mid semester examination	30
2	Internal evaluation	20
3	End semester examination	50
Total		100