IIT Palakkad

UG Curriculum 2022

BTech Civil Engineering

Applicable to all from 2022-23 Academic Year

21 April, 2022

The UG Curriculum and Sample Template for Civil Engineering

Program : **Bachelor of Technology**

Department : **Civil Engineering**

Year : **2022 Onwards**

The BTech CE programme aims to provide students with comprehensive knowledge in Civil Engineering and empower them as technically adept, socially responsible, ethical, and critical system thinkers. The curriculum is designed with basic science, mathematics, humanities, social sciences, and engineering courses, fundamental courses of civil engineering, and electives courses that cover a broad range of state-of-the-art topics. The total credit assigned to each category of courses is presented below.

Total Credits	
Institute Core (IC)	42
Program Major Core (PMC)	48
Program Major Elective (PME)	15
Humanities and Social Sciences Elective (HSE)	9
Sciences and Mathematics Elective (SME)	6
Open Elective (OE)	15
Project	9
Total	**144**

The professional major core courses cover fundamental courses in all streams of Civil Engineering and are presented in the proposed course plan below. In the proposed curriculum, many of the core courses include laboratory components to ensure effective learning of the concepts. The syllabi of the core courses are designed in such a way that it encourages the students to choose advanced courses from the pool of elective courses. The tentative list of elective courses are: Advanced Structural Analysis; Advanced Mechanics of Structures; Structural Dynamics; Advanced Design of Metal Structures; Advanced Concrete Technology; Airport and Railway Engineering; GIS and Remote Sensing; Geotechnical Investigations and Instrumentation; Ground Improvement; BIM for Construction Management; Finite Element Applications; Earthquake analysis and design of structure; Pavement Analysis and Design; Foundation Engineering; Geosynthetics and Reinforced Soil Structures; Irrigation Engineering; Solid Waste Management; Hazardous waste management; Construction Methods and Equipment; Project Management for Engineers; Optimization Techniques in Engineering; and Advanced Reinforced Concrete: Analysis and Design. The curriculum also ensures practice-oriented learning through different courses under the project category. This provides an opportunity for the students to start working on real-world problems from the 3rd year of their studies. Courses in the Open Elective category provide students the opportunity to learn interdisciplinary courses of their choice.

A course plan is proposed here to guide the students even though it is not mandatory in a credit-based system.

BTech Civil Engineering (Sample Template 2022 Batch Onwards)

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	I	PH1030	Physics	Institute Core	2-1-0-3
2		MA1011	Linear Algebra and Series	Institute Core	3-1-0-4
3		ME1130	Engineering Drawing	Institute Core	1-0-3-3
4		ID1010	Ecology and Environment	Institute Core	2-0-0-2
5		ID1050A	Engineering Design	Institute Core	1-0-3-3
6		ME1150	Mechanical Workshop	Institute Core	0-0-3-2
7		PH1130/ CY1140	Physics/Chemistry Lab	Institute Core	0-0-3-2
			Total		**19**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	II	MA1021	Multivariable Calculus	Institute Core	3-1-0-4
2		CY1040	Basic Chemistry for Engineers	Institute Core	2-1-0-3
3		HS1010	Technology and Society	Institute Core	2-0-0-2
4		CE1020	Engineering Mechanics	Institute Core	3-1-0-4
5		ID1110	Introduction to Programming	Institute Core	2-0-3-4
6		EE1110	Electrical Workshop	Institute Core	0-0-3-2
7		PH1130/ CY1140	Physics/Chemistry Lab	Institute Core	0-0-3-2
			Total		**21**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	III	CE2080A	Surveying Theory and Practice	PMC	2-0-2-3
2		CE2010	Strength of Materials	PMC	2-1-0-3
3		CE2030A	Introduction to Civil Engineering Materials	PMC	2-0-2-3
4		CE2150	Building Drawing and Modeling	PMC	0-0-2-1
5		BT2010	Life Sciences	Institute Core	2-0-0-2
6			Science and Mathematics Elective 1	SME	3
7			Humanities and Social Sciences Elective 1	HSE	3
8			Open Elective 1	OE	3
			Total		**21**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	IV	CE2020	Structural Analysis	PMC	2-1-2-4
2		CE2060	Soil Mechanics	PMC	3-0-2-4
3		CE2040	Hydraulic Engineering	PMC	3-0-2-4
4			Science and Mathematics Elective 2	SME	3
5			Humanities and Social Sciences Elective 2	HSE	3
6			Open Elective 2	OE	3
			Total		**21**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	V	CE3050A	Basic Reinforced Concrete Design	PMC	2-1-0-3
2		CE3070A	Geotechnical Engineering	PMC	3-0-0-3
3		CE3011	Transportation Planning and Traffic Engineering	PMC	2-0-2-3
4		CE3030	Environmental Engineering	PMC	3-0-2-4
5		CE3090A	Water Resources Engineering	PMC	3-0-0-3
6		CE3013	Construction Contracts and Estimation	PMC	2-0-0-2
7			Program Major Elective* (for Honours)	PME*	3
			Total		**18/21**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	VI	CE3012	Highway Engineering - Principles & Practices	PMC	2-0-2-3
2		CE3014	Construction Scheduling and Control	PMC	2-0-0-2
3		CE3040A	Basic Structural Steel Design	PMC	2-1-0-3
4			Program Major Elective 1	PME	3
5			Program Major Elective 2	PME	3
6			Open Elective -3/Project I	OE/Project	3
7			Program Major Elective* (for Honours)	PME*	3
			Total		**17/20**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	VII		Humanities and Social Sciences Elective 3	HSE	3
2			Program Major Elective 3	PME	3
3			Program Major Elective 4	PME	3

4			Project I/Open Elective 3	Project/OE	3
5			Open Elective 4/Project II	OE/Project	3
6			Program Major Elective* (for Honours)	PME*	3
			Total		**15/18**
Sl No.	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1	VIII		Project II/Open Elective 4	Project/OE	3
			Project III	Project	3
2			Program Major Elective-5	PME	3
3			Open Elective -5	OE	3
4			Program Major Elective* (for Honours)	PME*	3
			Total		**12/15**

Options for Courses under Project Category (Project-based courses and BTech Project)

	Semester VI	**Semester VII**	**Semester VIII**
Option1	Project I (3 Credit)	Project II (3 Credit)	Project III (3 Credit)
Option2	Project I (3 Credit)	----	BTP (6 Credit)
Option3	-----	Project I (3 Credit)	BTP (6 Credit)
Option 4		BTP (6 Credit)	Project III (3 Credit)

Civil Engineering

Core course Syllabi

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	:	Surveying Theory and Practice
Course Code	:	CE2080A
Credit	:	2-0-2-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Prerequisite (if any)	:	NA
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Subhasis Mitra

Course Content:

S. No.	Topic	Lecture/Practical Hours
1	Introduction, Overview of plane surveying; precision, accuracy and errors	2 Lectures
2	Linear Measurements	2 Lectures/1 Practicals (3 hrs)
3	Direction: Meridian, Azimuths and Bearings, Angle measurement, Theodolites, Electronic theodolites.	3 Lectures/1 Practical (3 hrs)
4	Levelling: Concept and terminology, Differential levelling instruments, Field measurements, Contouring, Trigonometric levelling	4 Lectures/ 2 Practical (6 hrs)
5	Traverse; methods of adjustment	2 Lectures
6	Construction surveys: Setting out of buildings, Computation of areas. Earth work measurements: LS & CS, Computation of volumes, Prismoidal correction.	5 Lectures
7	Horizontal and vertical curves, Methods of Setting out.	3 Lectures
8	Introduction to geodetic surveying, Modern surveying techniques, Electronic Distance Measurement (EDM), Total Station, photogrammetry, Remote sensing.	4 Lectures / 1 Practical (3 hrs)
8	Laser scanning – Airborne, Mobile and Terrestrial; Introduction to geographic information systems (GIS); GNSS Surveying	3 Lectures/2 Practicals (6 hrs)

	Total	**28 Lectures/7 Practicals (21 hrs)**

List of Experiments

1. Chain and Compass Surveying
2. Theodolite
3. Levelling (Rise and Fall method)
4. Levelling (Height of Instrument method)
5. Total Station 1
6. Total Station 2
7. GIS and GPS

Learning Outcomes: At the end of the course, the students should be able to

(i) Explain the fundamentals of land surveying and various surveying techniques using traditional and modern instruments;

(ii) Identify and perform appropriate method of surveying based on project requirements, required accuracy and area under consideration;

(iii) Measure differences in elevation, prepare and use contour plots, set-out building and roadway/railway curves on ground and calculate volumes for earthwork.

(iv) Work as a member of a survey screw in completing an assigned field surveying task.

Text/Reference Books:

1. Arora, K. R. (2009, 2007). Surveying, Vol. I, Standard Book House, New Delhi. (ISBN-13: 9788189401238)
2. Arora, K. R. (2009, 2007). Surveying, Vol. II, Standard Book House, New Delhi. (ISBN-13: 9788189401245)
3. Punmia, B. C., Jain, A. K. and Jain, A. K. (2016). Surveying, Vol. I, Laxmi Publications (P) Ltd., New Delhi. (ISBN-13: 978-8170088530)
4. Punmia, B. C., Jain, A. K. and Jain, A. K. (2005). Surveying, Vol. II, Laxmi Publications (P) Ltd., New Delhi. (ISBN-13: 978-8170088837)

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised~~/MOOC~~)

Course Title	: Strength of Materials
Course Code	: CE2010
Credit	: 2-1-0-3 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE and ME
Prerequisite (if any)	: Engineering Mechanics
Date of proposal	:18-11-2021
Date of approval	:
Proposing faculty	: Dr Gokulnath C

Course Content:

Stress: General state of stress at a point, Normal and shear stresses, Equilibrium of stress, Plane stress transformation, Principal stresses, Maximum shear stresses, Mohr circle for plane stress **(6 L + 3T)**

Strain: Strain at a point, Normal and shear strains, Strain-displacement relation, Plane strain transformation, Principal strain, Maximum shear strain, Mohr circle for plane strain, Strain measure technique – Strain gauge, Strain rosettes **(5 L + 3T)**

Constitutive relation: Stress-stain relationship, Hooke's Law **(2L + 1T)**

Axial member: Saint-Venant's principle, Elastic deformation, Principle of superposition, Thermal stress and strains. **(2L + 1T)**

Torsional member: Torsional deformation of circular shaft, Angle of twist, Torsion formula, Max. torsional stress **(2L + 1T)**

Linear beam theory: Euler Bernoulli beam theory, Neutral axis, bending moment and shear force diagrams, Bending and Shear stress for the transversely loaded symmetric beams, Transverse shear in symmetric beams **(4L + 2T)**

Composite beams: Neutral axis, transformed beam section, Bending stress calculation **(1 L)**

Strain energy: Calculation of strain energy for axial, torsional and bending members **(1L + 1T)**

Buckling: Analysis of slender/long columns with various end conditions, Columns with imperfections **(2L + 1T)**

Thin and thick cylinder: Analysis of thin and thick cylinder for Circumferential and Longitudinal stress **(1L + 1T)**

Failure theories: Behaviour of ductile and brittle materials, Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, Maximum distortion energy theory **(1L + 1T)**

Learning Outcomes:

1. Understanding basics of stress, strain as well as stress-strain relationship for homogeneous isotropic materials
2. Applying above concept to calculate the stress and strain of the Axial loaded member, Flexural member, Torsional member with circular cross section, thin cylinder
3. Failure analysis of structural elements based on strength and stability criteria

Text/Reference Books:

1. Russell C. Hibbeler, Mechanics of Materials, 9th Edition, Pearson, ISBN:978-93-325-1860-5.
2. Gere and Timoshenko, Mechanics of Materials, CBS, 2 edition, ISBN-13: 978-8123908946.
3. E. G. Popov, Engineering Mechanics of Solids, Second Edition, Phi Learning, ISBN: 978-81-203-2107-6.
4. Beer, Johnston, Dewolf, Mazurek and Sanghi, Mechanics of Materials, McGraw Hill Education India Private Limited; Seventh edition, ISBN-13: 978-9339217624

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	**: Introduction to Civil Engineering Materials**
Course Code	: CE2030A
Credit	: 2-0-2-3 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE
Prerequisite (if any)	: Nil
Date of proposal	:
Date of approval	:
Proposing faculty	: Sunitha K Nayar

Course Content:

Introduction – Building components and materials used – case studies **(2 lectures)**

Materials engineering and concepts -Atomic Bonding, Structure of Solids, Movement of Atoms, Lattice Defects, Development of Microstructure, Response to Stress, Failure Theories **(5 lectures)**

Concrete – Concrete making materials – Ordinary Portland Cement, mineral admixtures, aggregates, water, chemical admixtures; Steps in construction – mix proportioning, batching, mixing, transporting and placing; Properties of concrete – fresh properties, mechanical properties; Introduction to durability concepts; Introduction to special concretes and applications **(8 lectures/10 laboratory hours)**

Metals – Production, metallurgy, properties, and type of steel and aluminum **(4 lectures /4 laboratory hours)**

Masonry – Stones, bricks, concrete blocks, failure mechanisms **(4 lectures /4 laboratory hours)**

Wood and wood products **(2 lectures/2 laboratory hours)**

Finishing and other non-structural materials **(1 lectures)**

Modern materials of construction – glass/polymers/composites etc **(2 lectures)**

Total **28 Lectures / 20 Laboratory hours**

List of Experiments:

1. Consistency, Setting time and Specific gravity of cement, Fineness of cement - sieve analysis, Blaine's air permeability test
2. Compressive strength of cement
3. Aggregate properties - sieve analysis, specific gravity and water absorption
4. Concrete fresh (slump test, air content and unit weight), hardened properties (compression, flexure, split tensile strength) testing
5. Stress-strain characteristics of steel
6. Stress - strain characteristics of aluminum

7. Bricks - Compressive strength, water absorption, Warpage, Efflorescence, dimensional tolerance
8. Concrete block - Compressive strength, water absorption, Efflorescence, dimensional tolerance
9. Timber - flexural strength, compressive strength (parallel/perpendicular to grain)
10. Tile - abrasion test, wet flexural strength and water absorption tests

Learning Outcomes:

- To be able to identify a suitable material for an application based on material properties and target performance
- To be able to systematically explore the characteristics of any new material and identify its usage
- To be able to make decisions regarding usage of building materials in construction projects based on requirements

Textbook:

- P. C. Varghese, "Building Materials", PHI Private Limited, New Delhi. ISBN-978-81-203-2848-8

References:

- Michael S. Mamlouk and John P. Zaniewski, "Materials for Civil and Construction Engineers," Addison Wesley Longman Inc., USA, 1999, ISBN 10: 0673981878 ISBN 13: 9780673981875
- William D. Callister, Jr., "Materials Science and Engineering – An Introduction," 3rd Ed., John Wiley and Sons, New York, 1994, ISBN 10: 0471581283ISBN 13: 9780471581284
- S. C. Rangwala, "Engineering Materials," Charotar Publishing House, Anand, 1993, ISBN-10:9380358954, ISBN-13: 978-9380358956

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	: Building Drawing and Modeling
Course Code	: CE2150
Credit	: 0-0-2-1 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE
Prerequisite (if any)	: Nil
Date of proposal	:
Date of approval	:
Proposing faculty	: Madhu Karthik M

Course Content:

Understanding conventional signs and symbols **(2P)**; plan, section and elevation of buildings **(2P)**; building planning and drawing using 2D CAD **(3P)**, three dimensional modeling of building using building information modeling packages **(4P)**.

Learning Outcomes:

1. Draw, read, check and review Civil Engineering building drawings

Text/Reference Books:

Balagopal T.S. Prabhu, K. Vincent Paul, C. Vijayan. Building design and Civil Engineering drawing Calicut, Kerala Spades Publishers and Distributors 2015.

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised~~/MOOC~~)

Course Title	: Structural Analysis
Course Code	: CE2020
Credit	: 2-1-2-4 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE
Prerequisite (if any)	: CE2010: Strength of Materials
Date of proposal	:
Date of approval	:
Proposing faculty	: Sanjukta Chakraborty

Course Content:

Analysis of statically determinate structures: Introduction to different types of structures (description of structural elements—tie rods, beams, columns and their combinations to form trusses, cables, arches, frames and surface structures); Stability, determinacy, indeterminacy of structures; Static and kinematic indeterminacies; Analysis of statically determinate plane trusses by method of joint and method of section; Analysis of statically determinate beam structure and plane frame structure; Review of Shear force and bending moment diagrams; Qualitative deflected shape; Fundamental of arches and funicular system concepts.

[10 Lectures/8 Laboratory]

Deflection of structures: Geometric methods (moment-area method, conjugate-beam method); Work-energy methods (Virtual work, Castigliano's theorem); Maxwell's reciprocal theorem, Maxwell Betti's theorem. **[14 Lectures/8 Laboratory]**

Analysis of statically indeterminate structures: Force methods (method of consistent deformations, method of least work) and displacement methods (slope-deflection method, moment-distribution method). Introduction matrix methods using displacement methods.

[18 Lectures/6 Laboratory]

List of Experiments:

Analysis of truss
Bending of beams
Three-hinged arch
Thin and thick-walled cylinder
Torsion Test
Deflection of frames
Continuous beam

Learning Outcomes:

1. Realization of stability, determinancy and indetreminancy of structural system
2. Understanding the force deformation behaviour of different structural systems
3. Learn the analysis of statically determinate and indeterminate structures

Text Books:

1. Kassimali, A. (2015). *Structural Analysis*. Delhi: Cengage Learning India Pvt. Ltd. ISBN: 9788131520444
2. Menon, D. (2008). *Structural Analysis*. New Delhi: Narosa Publishing House. ISBN: 9788173197505
3. Hibbeler, R.C. (2006). *Structural Analysis.* New Delhi: Pearson Education. ISBN: 9788131721414

Reference Books:

1. Wang, C-K. (1983). *Indeterminate Structural Analysis.* New Delhi: McGraw Hill Education. ISBN: 9780070702493

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New/Revised/MOOC)

Course Title	:	Soil Mechanics
Course Code	:	CE2060
Credit	:	3-0-2-4 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Prerequisite (if any)	:	Strength of Materials
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Sudheesh T. K., Divya P. V. and Rakesh J. Pillai

Course Content:

Soil Formation: Introduction to engineering geology, Soil types, Clay mineralogy **[3 Lectures]**

Basics of soil mechanics: Phase diagrams, Index properties, Grain size distribution, Soil Classification **[6 Lectures / 6 Laboratory hours]**

Flow of water through soil: Permeability of soils, Seepage analysis **[6 Lectures / 3 Laboratory hours]**

Effective stress principle: Applications, Seepage forces and quicksand condition, Capillarity in soils **[4 Lectures]**

Compaction: Compaction characteristics of soils, Relative density, Optimum moisture content and Maximum dry density, Field density determination **[2 Lectures / 3 Laboratory hours]**

Stress distribution in soils: Boussinesq's equation and applications, Newmark's Influence chart, Westergaard's equation **[3 Lectures]**

Consolidation of soils: Compressibility, Stress history and settlements, Terzaghi's one dimensional consolidation theory, Rate of settlement **[9 Lectures / 3 Laboratory hours]**

Shear Strength of soils: Coulomb's theory, Mohr's circle analysis, Mohr-Coulomb failure criterion, Shear strength parameters, Laboratory determination of shear strength **[9 Lectures/6 Laboratory hours]**

Total: 42 Lectures / 21 Laboratory hours

List of Experiments:

1. Specific gravity of soils

2. Grain size distribution of soil
3. Atterberg limits of fine grained soils
4. Coefficient of permeability of soils by constant head and falling head methods
5. Compaction characteristics of soil
6. Field density using core cutter and sand replacement methods
7. Determination of compression index and coefficient of consolidation
8. Unconfined compressive strength of soil
9. Shear strength parameters of soil [Direct shear test and Triaxial test (demonstration)]

Learning Outcomes: At the end of the course, the students should be able to

1. Identify and perform the appropriate method of determination of physical and engineering properties of soil and classify the soil for various civil engineering applications.
2. Apply engineering knowledge and judgment to calculate the seepage through the soil, to compute both geostatic and induced stresses due to different types of loading.
3. Estimate the amount and time required for settlement under a given load and to compact the soil based on soil conditions and project requirements.
4. Determine the shear strength parameters of different soils and estimate the soil strength for different field conditions.

Text/Reference Books:

Text Books:

1. Murthy, V. N. S. (2018). *Geotechnical Engineering Principles and Practices of Soil Mechanics and Foundation Engineering*, CBS, ISBN-13: 978-8123913629.
2. Ranjan, G. and Rao, A. S. R. (2000). *Basic and Applied Soil Mechanics,* New Age International (P) Ltd., New Delhi, ISBN: 8122412238
3. Arora K. R. (2008). *Soil Mechanics and Foundation Engineering*, 7th Edition, Standard Publishers Distributors, Delhi, ISBN: 9788180141126

Reference Books:

4. Holtz, R. D., Kovacs, W. D. and Sheahan, T. C. (2011). "An Introduction to Geotechnical Engineering." Prentice-Hall, Second Edition, ISBN - 13: 978-0134843940.
5. Knappet J and Craig, R. F. (2019). *Craig's Soil Mechanics*, CRC Press, ISBN: 9781138070066.
6. Das, B. M. (2014). *Principles of Geotechnical Engineering*, Cengage Learning, New Delhi, ISBN: 9788131526132.
7. Coduto, D. P., Kitch, W. A. and Yeung, M. R. (2018). *Geotechnical engineering: Principles and Practices*, Pearson India Education Services, ISBN 978-93-325-8742-7.
8. All Relevant Indian Standard (IS) codes and related International guidelines

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title :	Hydraulic Engineering
Course Code :	CE2040
Credit :	3-0-2-4 (L-T-P-C)
Category :	Core
Target Programme :	UG
Target Discipline :	CE
Prerequisite (if any) :	Engineering Mechanics
Date of proposal :	
Date of approval :	
Proposing faculty :	Athira P., and Sarmistha Singh

Course Content:

Fluid Mechanics: Fluid properties: properties involving mass and weight, concept of viscosity, stress tensor, constitutive equations for Newtonian fluid; Fluid Statics: pressure variation, manometry, force on an inclined plane, force on curved surface, buoyancy; Fluid Kinematics - Equations for acceleration, Continuity equation, Irrotational and rotational flow, Potential and stream functions; Fluid Dynamics: Eulerian vs. Lagrangian analysis, local and convective acceleration, steady and unsteady flow, one, two and three dimensional flows; Laminar and turbulent flows, Reynolds transport theorem and its application to conservation of mass, momentum and energy; pump and turbine heads and efficiency, Euler's and Bernoulli's equations; Dimensional analysis**:** need, dimensions, Ispens method; Similitude and Modelling: Model laws (Froude, Reynolds)

[22 Lectures/ 12 Laboratory]

Pipe flow: friction losses, minor losses, analysis of pipe networks; Pump-pipe analysis: types of pumps, pump characteristic curves, specific speed and selection of pump, operating point. Flow measurement in Pipes: Orifice meter, venturi meter, electromagnetic flow meters

[10 Lectures/ 6 Laboratory]

Open channel flow - channel and flow classifications, geometric elements, flow regimes – Reynolds and Froude numbers, energy equation, concept of specific energy, flow transitions, concepts of uniform and non-uniform flows, most efficient channels and channel design,

gradually varied flow and hydraulic jump; Flow measurements in open channels-weirs and notches; basics of unsteady flows.

[10 Lectures/ 4 Laboratory]

Total 42 Lectures / 22 Laboratory

List of Experiments:

1. Demonstration of Bernoulli's principle
2. Calibration of Pressure gauge
3. Determination of critical Reynolds number using Osborne Reynolds Experiment setup
4. Characteristic curves of Centrifugal pumps
5. Determination of major and minor loss in pipe
6. Determination of hydrostatic pressure
7. Impact of jet
8. Determination of coefficients of discharge of weirs and notches
9. Determination of Metacentric Height of a floating body
10. Study of characteristics of Hydraulic Jump
11. Water hammer and surge tank

Learning Outcomes: The students should be able to

1. Understanding the basic concepts of fluid mechanics and apply the concepts to various civil engineering problems
2. Analyze fluid systems by conservation laws
3. Comprehend the physics of pipe and open channel flow systems and design them

Text/Reference Books:

1. Roberson, J.A., Crowe, C.T. Engineering Fluid Mechanics. 4th Ed., Jaico Publishing House, ISBN-13 : 978-8172247805
2. Frank M. White. Fluid Mechanics, 8th Edition, McGraw Hill Education (India) Pvt. Ltd., ISBN-13: 978-0073398273.
3. V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill, 1998. 2. ISBN-13: 978-0-07-062537-2.
4. Granger, R.A., Fluid Mechanics, CBS College Publishing, New York, 1985. ISBN 9780486135052
5. Subramanya, K., Flow in Open Channels. 4th Ed., McGraw Hill Education (India) Pvt. Ltd., ISBN-13 : 978-9332901339
6. Vent te Chow (2009), "Open Channel Hydraulics", McGraw-hill, New Delhi. ISBN 047462,145-3

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title	: Basic Reinforced Concrete Design
Course Code	: CE3050A
Credit	: 2-1-0-3 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE
Prerequisite (if any)	: Strength of Materials; Civil Engineering Materials
Date of proposal	:
Date of approval	:
Proposing faculty	: Madhu Karthik M

Course Content:

Introduction to reinforced concrete structures **(1L)**; basic concrete and reinforcing steel material properties, durability of concrete **(1L);** basic design concepts **(1L);** design of singly and double reinforced rectangular and flanged beams for flexure, shear and torsion **(8L+ 4T)**; design for bond and curtailment of bars **(4L+2T)**; design of simply supported and continuous one-way and two-way slabs **(3L+2T)**; design of short compression members for axial loads, and axial loads plus uniaxial and biaxial moments **(5L+3T)**; design of slender compression members; design of isolated footings for flexure, one-way and two-way shear, and bearing **(4L+2T)**; serviseability limit state – deflection and cracking **(2L)**.

Learning Outcomes:

1. Understand the properties of materials, and various design concepts
2. Analyze structural elements at ultimate loads
3. Design structural elements such as beams, slabs, columns, and footing.
4. Design structural elements for flexure, shear, torsion, and compression.

Text/Reference Books:

1. Pillai, S.U., and Menon, D. *Reinforced Concrete Design* 3rd Ed., Tata McGraw Hill Education Pvt. Ltd., 2011. ISBN: 9780070141100
2. Varghese, P.C. *Limit State Design of Reinforced Concrete* 2nd Ed., Phi Learning, 2009. ISBN: 9788120320390

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New/Revised/MOOC)

Course Title	:	Geotechnical Engineering
Course Code	:	CE3070A
Credit	:	3-0-0-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Prerequisite (if any)	:	Soil Mechanics
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Sudheesh T. K., Divya P. V. and Rakesh J. Pillai

Course Content:

Site Investigation and Subsoil Exploration: Purpose, Extent of investigation, Methods of investigation, Soil sampling, In-situ testing, Importance of code guidelines. **[6 Lectures]**

Earth pressure theories and Retaining walls: Rankine's and Coulomb's theory, Variations of earth pressure with depth, Types of retaining walls, Stability analysis **[8 Lectures]**

Flexible retaining structures: Sheet pile walls with and without anchors, Stability analysis, Cofferdams and their stability **[6 Lectures]**

Shallow Foundations: Bearing capacity theories, Correction factors, Effect of the water table, Settlement of footings, Construction requirements, Analysis of combined footing **[8 Lectures]**

Deep Foundations: Types of deep foundations, Construction methods of pile foundations, Methods of testing and evaluation of design load for pile foundations, Behaviour of pile foundations under lateral loads **[8 Lectures]**

Stability of Slopes: Types of failure, Methods of analysis, Effect of seepage on stability, Methods to improve slope stability **[6 Lectures]**

Total: 42 Lectures

Learning Outcomes: At the end of the course, the students should be able to

1. Explain the fundamentals of earth pressure theories, bearing capacity, slope stability, and soil dynamics;
2. Identify and perform the appropriate methods of site investigation and sampling techniques as well as in-situ testing based on the soil condition and project requirements;
3. Applying engineering knowledge and judgment to select the suitable type of foundation or retaining wall for the real-world scenarios and perform their analysis and design;
4. Perform the stability check for a given slope.

Text/Reference Books:

Text Books:

1. Murthy, V. N. S. (2018). *Geotechnical Engineering Principles and Practices of Soil Mechanics and Foundation Engineering*, CBS, ISBN-13: 978-8123913629.
2. Ranjan, G. and Rao, A. S. R. (2000). *Basic and Applied Soil Mechanics,* New Age International (P) Ltd., New Delhi, ISBN: 8122412238
3. Arora K. R. (2008). *Soil Mechanics and Foundation Engineering*, 7th Edition, Standard Publishers Distributors, Delhi, ISBN: 9788180141126

Reference Books:

4. Das, B. M. (2016). *Principles of Foundation Engineering*, Cengage Learning, New Delhi, ISBN-13: 9789386650955.
5. Knappet J and Craig, R. F. (2019). *Craig's Soil Mechanics*, CRC Press, ISBN: 9781138070066.
6. Das, B. M. (2014). *Principles of Geotechnical Engineering*, Cengage Learning, New Delhi, ISBN: 9788131526132.
7. Coduto, D. P. (2014), *Foundation Design: Principles and Practices*, Pearson Education Limited, ISBN-13: 978-1-292-04288-6.
8. Bowels, J. E. (2001), *Foundation Analysis and Design*, McGraw-Hill Education; 5th edition, ISBN-13: 978-0071188449
9. All Relevant Indian Standard (IS) codes and related International guidelines

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New/~~Revised/MOOC~~)

Course Title : Transportation Planning and Traffic Engineering

Course Code : CE3011

Credit : 2-0-2-3 (L-T-P-C)

Category : Core

Target Programme : UG

Target Discipline : CE

Prerequisite (if any) : -

Date of proposal :

Date of approval :

Proposing faculty : B. K. Bhavathrathan

Course Content:

Transportation System: The profession; system components; demand-supply interaction; modes of transportation; highway classification and hierarchy **(5L)**

Travel Demand Forecasting: travel demand modeling (TDM); the four-stage model; study area and zoning; data for TDM; trip generation; trip distribution; modal split; traffic assignment **(9L)**

Practical sessions : (i) Linear and logistic regression using software; **(6P)**
(ii) TDM software hands-on

Traffic Flow: Fundamental principles of traffic flow; capacity and LOS of traffic facilities: bidirectional roads; divided roads; urban roads; roundabouts; unsignalized intersections; signalized intersections **(7L)**

Practical sessions : (i) Traffic speed study;
(ii) traffic flow simulation;
(iii) analysis of an unsignalized intersection/roundabout **(9P)**

Intersection Control: General concepts; conflict points; types of intersection control; signal timing at isolated intersections; pre-timed signals; actuated signals **(7L)**

Practical sessions : (i) analysis of a signalized intersection;
(ii) signal design software hands-on **(6P)**

Learning Outcomes:

Upon the successful completion of this course, the students should be able to:

1. Appreciate the skill sets and techniques of transportation systems planning
2. Participate actively in transport demand forecasting exercises
3. Compute the capacity and LOS on traffic facilities
4. Design signal timings for simple intersections

Text/Reference Books:

1. Garber, Nicholas J., and Lester A. Hoel (2014). Traffic and highway engineering. Cengage Learning. ISBN :978-81-315-2943
2. Banks, James H (2001). Introduction to transportation engineering. McGraw-Hill. 978-00-724-31889
3. Papacostas, Constantinos S., and Panos D. Prevedouros (2000). Transportation engineering and planning. Prentice Hall. ISBN: 978-01-308-14197
4. Indian Highway Capacity Manual (2018). Council of Scientific and Industrial Research – Central Road Research Institute. ISBN: Not Applicable

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title : **Environmental Engineering**

Course Code : CE3030

(To be provided by the Academic Section, Level should be indicated by the proposer. Example: CE5XXX for a 5000 level course in Civil Engineering)

Credit : 3-0-2-4 (L-T-P-C)

(Weekly hours for L- lecture, T-Tutorial, P - Laboratory, C - total course credit)

Category : Core (Core/~~Elective~~)

Target Programme : UG (UG/~~PG~~)

Target Discipline : CE (CE, ~~CS, PHY, etc~~)

Prerequisite (if any) :

Date of proposal :

Date of approval :

Proposing faculty : Dr. Praveena Gangadharan

Course Content:

Water quality definition, characteristics, and perspectives. Physical water quality parameters: Suspended solids, turbidity, color, taste, odor, temperature, etc.	4 (L)
Determination of turbidity, pH, electrical conductivity, and solids	1 (P)
Chemical water quality parameters: Total dissolved solids, alkalinity, hardness, fluoride, metals, organics, nutrients.	4 (L)
Determination of acidity and alkalinity of water, hardness of water, dissolved oxygen content of water, biochemical oxygen demand, and chemical oxygen demand.	3 (P)
Biological water quality parameters: Pathogens and pathogen indicators. Essentials of water quality requirements and standards.	1 (L)
Water purification processes (including design problems): Aeration, solids separation, settling operations, coagulation, softening, filtration, and disinfection.	15 (L)
Determination of optimum coagulant dosage. Determination of residual chlorine and break point chlorination.	2 (P)
Wastewater treatment and disposal (including design problems): Primary treatment – screening, comminuting, grit removal. Primary sedimentation, Secondary treatment - activated sludge process and trickling filter	14 (L)
Sludge characteristics, sludge thickening, sludge digestion, and sludge disposal.	4 (L)
	[42 (L) & 6 (P)]

Learning Outcomes:

After successfully completing this course, the students will be able to:

1. Understand the significance of water quality and its physico-chemical and bacteriological characteristics.
2. Analyse the physico-chemical characteristics of water/wastewater.
3. Understand the primary objective of water and wastewater treatment processes and sanitation.
4. Design various water and wastewater treatment processes to achieve the desired water and effluent quality.

Text books/ Reference books:

1. Peavy, H. S., Rowe, D. R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York, 2013. ISBN: 9789351340263
2. Mackenzie Davis and David Cornwell, Introduction to Environmental Engineering, , Mc Graw-Hill Education, 2013. ISBN: 9780073401140
3. Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., & Tchobanoglous, G.MWH's water treatment: principles and design. John Wiley & Sons., 2012. ISBN:9781118103777
4. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment and Reuse, 5th Edition, Tata McGraw-Hill, New Delhi, 2013. ISBN:9780070495395
5. "Manual on Water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India. http://cpheeo.gov.in/cms/manual-on-water-supply-and-treatment.php
6. Manual on Sewerage and Sewage Treatment Systems - 2013, CPHEEO, Ministry of Urban Development, Government of India. (http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php)

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised~~/MOOC~~)

Course Title	:	Water Resources Engineering
Course Code	:	CE3090A
Credit	:	3-0-0-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Prerequisite (if any)	:	Hydraulics Engineering
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Subhasis Mitra, Athir P. and Sarmistha Singh

Course Content:

Introduction to Water Resources Engineering; applications and connections to field problems **[1 Lecture]**

Hydrologic cycle; Precipitation: forms, classification, variability, measurement, data analysis **[3 Lectures]**

Evapotranspiration process, factors affecting, field estimation, Penman-Monteith and other methods **[3 Lectures]**

Infiltration: factors affecting, field estimation, estimation by NRCS, Green-Ampt methods **[3 Lectures]**

Runoff: drainage basin characteristics; Rainfall runoff modelling (empirical and conceptual models); Runoff estimation by SCS-CN method; Peak runoff estimation; hydrograph; concepts, assumptions and limitations of unit hydrograph; derivation of unit hydrograph, flow duration curve **[6 Lectures]**

Hydrologic Analysis and Design: design flood estimation, frequency analysis, flood routing, storm drainage design
[7 Lecture]

Dams: types, dam/site selection; Reservoirs: safe yield, capacity design, reliability **[4 Lectures]**

Irrigation engineering: crop water requirements, irrigation water computation and yields, water planning **[3 Lectures]**

Role of economics in water resources planning, multipurpose projects, issues in water resources planning and development, risk analysis **[4 Lectures]**

Flood management: flood mitigation, flood damage analysis **[4 Lectures]**

Groundwater: occurrence, aquifers, hydraulics of wells, yield, artificial recharge **[4 Lectures]**

Learning Outcomes: In this course the students will:

1. Learn to describe the fundamental concepts of hydrology
2. Understand various methods of hydrologic analysis
3. Apply various hydrological analysis methods to design water supply projects, storm water drains, canal systems dams and reservoirs.

Text/Reference Books:

1. Chow, V. T., Maidment, D. R., and Mays L. W. (1988). Applied Hydrology. McGraw-Hill Inc., New York. ISBN-13 : 978-0070108103
2. James, L. D., and Lee, R. R. (1971). Economics of water resources planning. McGraw-Hill Book Inc., New York. ISBN-13 : 978-0070322639
3. Garg, S. K. (1991). Irrigation Engineering and Hydraulic Structures. Khanna Publishers, Delhi. ISBN-13 : 978-8174090478
4. Linsley, R. K., Franzini, J. B., Freyberg, D. L., and Tchobanoglous, G. (1992). "Water Resources Engineering", McGraw-Hill Inc., Singapore. ISBN-13 : 978-0070380103
5. Singh, V. P. (1991) "Elementary Hydrology". Prentice Hall, Englewood Cliffs, New Jersey. ISBN-13 : 978-0132493840

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	:	Construction Contracts and Estimation
Course Code	:	CE3013
Credit	:	2-0-0-2 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Pre/Co-requisite (if any):		Basic RC Design, Basic Steel Design
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Dr. Senthilkumar

Course Content:

General overview of construction contracts and their administration with special emphasis for construction projects. Introduction to Standard Forms of Contracts, Pricing Strategies, construction claims and disputes, issue resolution systems. Introduction to Covers strategies for avoiding litigations, dispute resolution techniques.

(18 Lectures)

Introduction to Construction Estimation and Costing, Quantity Takeoff for Earthwork, Concrete, Steel, Doors Windows, Equipment etc., Labor quantity, Rate Analysis, Bid Preparation; Introduction to Engineering Economics

(8 Lectures)

Learning Outcomes:

After successfully completing this course, the students will be able to:

Identify appropriate bidding, pricing strategies, project delivery methods and specifications.

Interpret various clauses in standard forms of contract and cover strategies to avoid litigations and disputes.

Prepare a BOQ and Cost estimation for various construction project items.

Perform a rate analysis and prepare BID

Text/Reference Books: (*Include ISBN Numbers*)

1. W. Hughes, and J. Murdoch. Construction Contracts: Law and Management, 5th Edition (2015). Taylor & Francis. ISBN 9781315695211
2. P. Keane, and A. Caletka. Delay Analysis in Construction Contracts, 2nd Edition, Wiley-Blackwell, ISBN: 978-1-118-63117-1
3. Dutta B.N. (2016), Estimating and Costing in Civil Engineering, 28th Edition, UBS Publishers' Distributors Ltd, ISBN: 9788174767707, 8174767703

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New)

Course Title	:	Highway Engineering - Principles & Practices
Course Code	:	CE3012
Credit	:	2-0-2-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Prerequisite (if any)	:	-
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Dr C V Veena Venudharan

Course Content:

1. ***Development & Planning:*** History of road development - Significance of planning - Engineering surveys for highway alignment - Classification of roads ***(4L)***
2. ***Geometric Alignment & Design:*** Factors influencing highway alignment – Cross-sectional elements of highway - Superelevation - Extra widening - Sight distances - Horizontal & Vertical alignment and design ***(8L)***
3. ***Materials:*** Construction materials - Soil - Aggregate - Asphalt - Asphalt Concrete - Properties - Tests & Specifications ***(6L)***

   Laboratory:

   Tests on aggregates: (i) Aggregate impact value, (ii) Aggregate crushing value, (iii) Flakiness & Elongation test, (iv) Sand equivalence, (v) LA abrasion test & (vi) Specific gravity ***(6P)***

   Tests on asphalt: (i) Penetration, (ii) Softening point, (iii) Ductility test, (iv) Capillary viscometer, (v) Rotational viscosity, & (vi) Flash & fire point ***(6P)***

   Tests on asphalt concrete: (i) Marshall mix design, & Marshall stability & flow ***(6P)***
4. ***Structural Design:*** Pavement components & their role - Design principles - Stresses in pavements - Design practice for flexible & rigid pavements (IRC methods) ***(6L)***

   Laboratory:

   Software demo: (i) IITPAVE and (ii) IITRIGID ***(6P)***
5. ***Construction & Maintenance:*** Pavement construction practices - Quality control measures - Construction machineries - Pavement Distresses - Types of maintenance - Functional & structural evaluation ***(4L)***

Learning Outcomes:

Upon the successful completion of this course, the students should be able to:

1. Understand highway planning and associated surveys

2. Identify the various geometric alignment features and their importance
3. Understand about highway materials and their associated properties
4. Determine the material properties from laboratory evaluation
5. Design rigid and flexible pavement using IRC methods
6. Understand the highway construction and maintenance practices

Text/Reference Books:

1) L. R. Kadiyali (2019). Highway Engineering. Khanna Publishing. ISBN: 978-9386173133
2) Papagiannakis, A. T., & Masad, E. A. (2008). Pavement design and materials. John Wiley & Sons. ISBN: 978-0471214618
3) Huang, Y. H. (2008). Pavement analysis and design. 2nd Edition. Pearson. ISBN: 978-8131721247
4) Mallick, R. B., and El-Korchi, T. (2017). Pavement engineering: principles and practice. CRC Press. ISBN: 978-1498758802
5) S. K. Khanna, C. E. G. Justo, and A. Veeraraghavan. (2013). Highway Materials and Pavement Testing. Nem Chand & Bros. ISBN: 978-8185240589
6) S. K. Khanna, C. E. G. Justo, and A. Veeraraghavan. (1990). Highway Engineering. 10th Edition. Nem Chand & Bros. ISBN: 978-8185240930

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	:	Construction Scheduling and Control
Course Code	:	CE3014
Credit	:	2-0-0-2 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	CE
Pre/ Co- requisite (if any)	:	Basic RC Design, Basic Steel Design
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Dr. Senthilkumar

Course Content:

Introduction to Construction Industry and Process, Time Management, Work Breakdown Structure (WBS), Gantt Charts, Duration Estimation, Network Representation & Analysis **(10 Lectures)**

Time-Cost Trade-off (Crashing), Resource Scheduling, Precedence Diagramming Method (PDM), Project Monitoring & Control, Project Monitoring & Control (Earned Value Concepts) **(10 Lectures)**

Uncertainty in Project Schedules (PERT), Introduction to Digital Tools on Planning and Control Applications; Introduction to Lean Constructions **(6 Lectures)**

Learning Outcomes:

After successfully completing this course, the students will be able to:

Identify the construction processes and practices for the construction of various building and infrastructure projects.

Perform scheduling for construction projects using scheduling techniques for project management that includes bar chart, network diagrams, CPM and PERT.

Exercise time cost tradeoff and estimate resource requirement and its management.

Deploy appropriate monitoring techniques such as earned value analysis etc.,

Use the digital techniques and tools necessary for construction practices

Text/Reference Books: (*Include ISBN Numbers*)

1. Construction Project Scheduling and Control, Wiley; 4th edition (2019), ISBN-10 : 0470505338, ISBN-13 : 978-0470505335
2. Project Management, Planning and Control (Sixth Edition) Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards, by Albert Lester, ISBN: 978-0-08-098324-0, Publisher: Butterworth-Heinemann; 6 edition (November 18, 2013)

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (~~New~~/Revised/~~MOOC~~)

Course Title	: Basic Structural Steel Design
Course Code	: CE3040A
Credit	: 2-1-0-3 (L-T-P-C)
Category	: Core
Target Programme	: UG
Target Discipline	: CE
Prerequisite (if any)	: Strength of Materials
Date of proposal	:
Date of approval	:
Proposing faculty	: M.V. Anil Kumar

Course Content:

Structural Steel Material Properties **(1 lecture);** Steel Structural Systems **(1 lecture);** Introduction to design philosophies; Loads and load combinations; **(2 lectures+1Tutorial);** Introduction to buckling of compression members and plates, member classification **(2 lectures);** Review of plastic analysis **(2 lectures+1 tutorial);** Rivets, Bolts and Welds **(3 lectures + 1 Tutorials**); Design of tension members; Single leg connected tension member; **(3 lectures + 1 Tutorial);** Design of compression members, Single leg connected compression member, Laced and battened columns **(6 lectures+2 Tutorials**); Lateral-torsional buckling; Design of beams; **(6 lectures+1 Tutorials)** ; Beam-columns **(2 lectures+1 Tutorial);** Bolted and Welded Connections **(3 lectures + 2 tutorial).** Introduction to earthquake resistant design **(2 lecture)**

Learning Outcomes:

1. Understand the structural steel drawings
2. Analyse and design bolted and welded connections
3. Design steel members subjected to tension, compression, bending and combined action.

Text/Reference Books:

1. Teaching Resources for Structural Steel Design, Vol 1& 2, INSDAG, Calcutta (http://www.steel-insdag.org/TM_Contents.asp)
2. Subramanian, N. “Design of steel structures: limit states method” Publisher: New Delhi Oxford University Press 2016, ISBN: 9780199460915
3. Raz, Sarwar Alam, “Structural design in steel” Publisher: New Delhi New Age International Publishers 2019, ISBN: 9789386418210

IS codes

i. IS 800: 2007 Code of practice for general construction in steel

ii. SP 6 (1): 1964 ISI handbook for Structural Engineers Part (1)-Structural steel sections

iii. IS:2062 :2011 Hot rolled medium and high tensile strength steel specification

iv. IS 875 (Part 1-5) Code of practice for design loads for building and structures