

# UNIVERSITY OF MUMBAI



## Bachelor of Engineering

Civil Engineering (Second Year – Sem. III & IV)

Revised course (REV – 2016)

With Effect From Academic Year 2017 – 18

Under the

## FACULTY OF TECHNOLOGY

(As per Semester Choice Based Credit and Grading System)

**University of Mumbai**  
**Scheme of Instructions and Examination**  
**Second Year Engineering (Civil Engineering)**  
**(With effect from 2017 – 2018)**  
**(Semester – IV)**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CE-C401	Applied Mathematics–IV*	4	-	1	4	-	1	5
CE-C402	Surveying–II	3	3	-	3	1.5	-	4.5
CE-C403	Structural Analysis–I	4	2	-	4	1	-	5
CE-C404	Building Design & Drawing	2	3	-	2	1.5	-	3.5
CE-C405	Building Materials & Construction Technology	4	2	-	4	1	-	5
CE-C406	Fluid Mechanics–II	3	2	-	3	1	-	4
<b>Total</b>		<b>20</b>	<b>12</b>	<b>1</b>	<b>20</b>	<b>6</b>	<b>1</b>	<b>27</b>

Course Code	Course Name	Examination Scheme							Total
		Theory					TW	Oral & Practical	
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
CE-C401	Applied Mathematics-IV*	20	20	20	80	3	25	--	125
CE-C402	Surveying–II	20	20	20	80	3	50	25**	175
CE-C403	Structural Analysis–I	20	20	20	80	3	25	25	150
CE-C404	Building Design & Drawing	20	20	20	80	4	25	25@	150
CE-C405	Building Materials & Construction Technology	20	20	20	80	3	25	25	150
CE-C406	Fluid Mechanics–II	20	20	20	80	3	25	25	150
<b>Total</b>		--	--	<b>120</b>	<b>480</b>	--	<b>150</b>	--	<b>900</b>

\* Common with Mechanical/ Automobile/ Mechatronics

\*\* For the course 'Surveying-II (CE-C 402), the oral examination will be conducted in conjunction with practical/s/

@ For the course 'Building Design and Drawing (CE-C 404), the oral examination shall be conducted in conjunction with the sketching examination.

Semester IV		
Subject Code	Subject Name	Credits
CE-C 401	Applied Mathematics – IV*	05

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	--	01	04	--	01	05

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	--	--	125

### Rationale

The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.

### Objectives

- To inculcate an ability to relate engineering problems to mathematical context.
- To provide a solid foundation in mathematical fundamentals required to solve engineering problem.
- To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.

Detailed Syllabus		
Module	Sub-Modules/ Contents	Periods
I.	<b>1. Matrices</b>	11
	1.1 Brief revision of vectors over a real field, inner product, norm, Linear dependence and Independence and orthogonality of vectors.	

	1.2	Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and Eigen vectors of different types of matrices such as symmetric matrix, orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix.	
	1.3	Cayley Hamilton theorem (without proof) and its application	
	1.4	Similarity of matrices, Functions of a square matrix, Minimal polynomial and Derogatory matrix.	
	1.5	Quadratic forms: linear transformation of a quadratic form, congruence of a square matrix, reduction to canonical form under congruent transformations, orthogonal transformation, determining the nature of a quadratic form, Application of Eigen values and Eigen Vectors.	
	<b>2. Vector calculus</b>		<b>9</b>
<b>II.</b>	2.1	Brief revision of Scalar and vector point functions, Gradient, divergence and curl, Irrotational vectors, scalar potential, solenoidal vectors, Directional derivatives.	
	2.2	Line integrals, Circulation, Green's theorem (without proof) for plane regions and properties of line integrals.	
	2.3	Surface integrals, Stokes theorem(without proof)	
	2.4	Volume integrals, Gauss divergence theorem (without proof) related identities and deductions. (No verification problems on Stoke's Theorem and Gauss Divergence Theorem)	
	<b>3. Linear Programming</b>		<b>08</b>
<b>III.</b>	3.1	Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P.	
	3.2	Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P.	
	<b>4. Non Linear Programming</b>		<b>06</b>
<b>IV</b>	4.1	Unconstrained optimization, problems with equality constraints, Lagrange's Multiplier method	
	4.2	Problem with inequality constraints Kuhn-Tucker conditions.	
	<b>5. Probability Distributions</b>		<b>10</b>
<b>V.</b>	5.1	Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance.	
	5.2	Probability distributions: Binomial, Poisson, Normal and exponential Distributions.	

	<b>6. Sampling Theory</b>	<b>08</b>
<b>VI.</b>	6.1	Sampling distribution, Test of Hypothesis, Level of significance, critical region, One tailed and two tailed tests Interval Estimation of population parameters.
	6.2	Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples.
	6.3	Test of significance of small samples:-Student's t-distribution and its properties. Test for significance of the difference between sample mean and population mean, Test for significance of the difference between the means of two Samples, paired t-test.
	6.4	Chi square test, Test of goodness of fit and independence of attributes, Contingency table and Yate's correction.
	6.5	Analysis of Variance(F-Test): One way classification, Two-way classification (short-cut method)
	<b>Total</b>	<b>52</b>

### Contribution to Outcomes

Learner will be able to...

- Solve the system of linear equations using matrix algebra with its specific rules.
- Illustrate basics of vector calculus.
- Apply the concept of probability distribution and sampling theory to engineering problems.
- Apply principles of vector calculus to the analysis of engineering problems.
- Identify, formulate and solve engineering problems.
- Illustrate basic theory of correlations and regression.

#### **Theory examination:**

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4 – 5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may before this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.

4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

### **Internal Assessment:**

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

### **Term Work Examination:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments (02) on entire syllabus	:	05 marks
Class Tutorials on entire syllabus (08)	:	15 marks
Attendance (Theory and Tutorial)	:	05 marks
<b>Total</b>	<b>:</b>	<b>25 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.  
 75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

### **General Instructions:**

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University rules for practical.
2. Students must be encouraged to write assignments in tutorial class only. Each student has to write at least 8 class tutorials on entire syllabus.

### **Recommended Books:**

1. Advanced Engineering Mathematics, *E Kreyszing*, Wiley Eastern Limited.
2. Higher Engineering Mathematics, *B. S. Grewal*, Khanna Publication.
3. Advanced Engineering Mathematics, *H. K. Dass*, S. Chand & co.
4. Vector Analysis by *Murray R. Spiegel*, Shaum Series.
5. Operations Research, *S.D. Sharma*, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, *S C Gupta & V K Kapoor*, S. Chand & Co

Semester IV		
Subject Code	Subject Name	Credits
CE-C 402	Surveying – II	4.5

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	03	-	03	1.5	-	4.5

Evaluation Scheme								
Theory				Term Work/ Practical/Oral			Total	
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR		OR
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	50	-	25	175

Rationale
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This is an advanced course which intended to teach students modern surveying instruments with their principles and uses in surveying along with curves and setting out of different civil engineering works. Students are exposed to the concept of Total Station, G.P.S., G.I.S. and remote sensing techniques. To make the students acquainted with the field problems, a 4-day survey camp is arranged to execute the Road project, Block contouring project, Tachometric project and Total Station Traversing at ideal locations.

Objectives
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- To understand operation of Total Station, EDM, Electronic Theodolite for desired accuracy in surveying.
- To learn how to establish survey control of determined accuracy using GPS, GIS and Remote sensing.
- To Study various types of curves by linear and angular methods.
- To prepare different layout from surveying data.
- To learn how to generate and manipulate field survey data and incorporate design data using specialized software's.

<b>Detailed Syllabus</b>			
<b>Module</b>	<b>Sub-Modules/ Contents</b>	<b>Periods</b>	
<b>I.</b>	<b>1. Curves-Horizontal</b>	<b>10</b>	
	1.1		Definitions of different terms, necessity of curves and types of curves
	1.2		Simple circular curves and compound curves, office and field work, linear methods of setting out curves,  Angular methods of setting out curves, two theodolites and Rankine deflection angle method.
	1.3		Reverse and transition curves, their properties and advantages, design of transition curves, shift, spiral angle. Composite curves office and field level. Setting out of curves by angular method, composite curves problems.
	1.4		Difficulties in setting out curves and solution for the same.
<b>II.</b>	<b>2. Curves-Vertical</b>	<b>3</b>	
	2.1		Sight distance on a vertical curve
	2.2		Tangent correction and chord gradient methods.
	2.3		Sight distance on a vertical curve
<b>III.</b>	<b>3. Setting out works</b>	<b>4</b>	
	3.1		General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite
	3.2		Setting out a foundation plans for building, sewer line, culvert, and use of laser for works;  Setting out centre line for tunnel, transfer of levels for underground works.
	3.3		Project/route survey for bridge, dam and canal;Checking verticality of high rise structures.
<b>IV.</b>	<b>4. Special Survey Instruments</b>	<b>6</b>	
	4.1		<b>Electronic Theodolite, Total Station:</b>  Principles, Types, Applications, Topographical Survey and Stake-out, Transferring data to and from other software's for further processing, advantages and limitations
	4.2		Introduction to Site square, Penta Graph, Auto-setLevel, Transit level, Special Compasses, BruntonUniversal Pocket Transit, Mountain Compass Transit



<b>V.</b>	<b>5. Modern Methods of Surveying</b>		<b>12</b>
	5.1	<b>Global Positioning System (GPS):</b> Basic principles, GPS segments, receivers, computations of coordinates, Applications in surveying	
	5.2	<b>Remote Sensing:</b>  Definition, basic concepts, electromagnetic radiation and spectrum, energy source and its characteristics, image acquisition and image interpretation.  Application of remote sensing.	
	5.3	<b>Global Information System (GIS):</b>  Geographical concepts and terminology, advantages, basic components ofGIS, data types, GIS analysis, Applications of GIS.	
	5.4	<b>Field Astronomy:</b>  Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.	
	5.5	<b>Aerial photogrammetry:</b>  Introduction, Principle, Uses, Aerial camera, Aerial photographs, Definitions, Scale of vertical and tilted photograph, Ground Co-ordinates, Displacements and errors, Ground control, Procedure of aerial survey, Photomaps and mosaics, Stereoscopes, Parallax bar	
5.6	<b>Hydrographic Survey:</b> Introduction, Organizations,  National and International Maritime Hydrography, Hydrographic survey Methods, Lead lines, sounding poles, and single-beam, echo sounders.		
<b>VI.</b>	<b>6. Cadastral Surveying</b>		<b>4</b>
	6.1	Interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property. Legal requirements relating to property boundary surveys in India	
	6.2	Role of revenue department in maintaining survey records, introduction to local survey terminologies like tehsildar, 7/12, utara, namuna8, etc. Introduction to Survey of India Department; Department of Registration and Stamps, Maharashtra	
<b>Total</b>			<b>39</b>

## Contribution to Outcomes

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

- Operate Total Station & GPS for desired accuracy in surveying and establish survey control of determined accuracy using Total Station, GPS, GIS and remote sensing.
- Set out various types of curves by linear and angular methods
- Compute setting out data from survey and design information.
- Generate and manipulate field survey data and incorporate design data using specialised software's.
- Appreciate the role of various governmental authorities in maintaining cadastral survey records.

### **Theory examination:**

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

### **Oral Examination:**

The oral examination shall be based on the entire syllabus, the projects performed and practicals conducted. It will include a practical exam (10 marks) before proceeding for viva (15 marks)

### **List of Practicals:**

1. To set out circular curve by linear methods.
2. To set out circular curve by angular methods.
3. Determination of horizontal and vertical distances, bearings and area using Total Station.
4. Determination of co-ordinates of a traverse, length of traverse lines using GPS
5. Post-processing of data obtained in Total Station & GPS practical using softwares like *TERRAMODEL*, *AutoCAD* etc. and print out the sheets
6. Analysis of survey projects conducted using computer by applying various softwares like MS excel, SurveyOS, surfit, QuikGrid, etc.
7. Setting out a simple foundation plan in the field.

### **Internal Assessment:**

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

### **Term work**

It shall consist of the following:

1. **Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, Profile levelling, cross-sectioning, at least one simple and one reverse curve, plotting of L section and Cross Section. (Two full imperial sheet including plan, L – section and any three typical Cross-sections, sample data computation for curves, cutting and filling required)
2. **Project II:** Block Contouring project using Auto level for minimum 100 × 80 m area and generating contours by MS Excel, etc. (minimum contour interval 0.2 meter)
3. **Project III:** Tachometric contouring project on hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours using software such as Autodesk land desktop, Auto civil, Foresight etc. (minimum contour interval 1 meter)
4. **Project IV:** Traversing using a total station (minimum 10 acres' area)
5. The account of practicals performed with aim, apparatus, observations, calculations, results and inferences
6. Field book submission on afore-mentioned practicals conducted on and off the field.
7. The assignments shall comprise of the minimum 5 problems covering the entire syllabus, theory questions on each chapter

### **Distribution of the Term Work Marks:**

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory and field work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments on entire syllabus	:	10 marks
Practical performance	:	15 marks
Project (04)	:	20 marks
Attendance (Theory and Tutorial)	:	05 marks
<b>Total</b>	<b>:</b>	<b>50 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

**Recommended Books:**

1. Surveying: *R. Agor*, Khanna Publishers, New Delhi
2. Surveying and Levelling: *N N. Basak*, Tata McGraw Hill, New Delhi.
3. Surveying and Levelling, Vol-I and II: *Kanetkar and Kulkarni*, Pune VidyarthiGriha, Pune.
4. Surveying, Vol-I, II & III: *Dr K.R. Arora*, Standard Book House.
5. Surveying and Levelling, (2Edition): *R. Subramanian*; Oxford Higher Education.
6. Surveying and levelling, Vol.-I, II & III: *Dr. B.C. Punmia*, Laxmi Publications.
7. Surveying and Levelling, Vol.-I& II:*S. K.Duggal*, Tata Mc-Graw Hill
8. Advanced Surveying, *R. Agor*, Khanna Publishers, New Delhi
9. Fundamentals of Surveying, *S.K. Roy*, Prentice Hall India, New Delhi
10. Remote Sensing and GIS, *B Bhatta*, Oxford University Press, New Delhi.
11. Remote sensing and Image interpretation, *T.M Lillesand, R.W Kiefer andJ.W Chipman*, 5th edition, John Wiley and Sons India
12. Concepts and Techniques of Geographic Information Systems, *Lo, C.P. &Yeung A.K.W.*, Prentice Hall of India, New Delhi, 2002
13. Remote Sensing and Geographical Information Systems. *Anji Reddy*, B.S.Publications, Hyderabad, 2001.

**Web Materials:**

1. <http://nptel.ac.in/courses/105104100/1>
2. <http://www.surveyofindia.gov.in/>
3. <http://igrmaharashtra.gov.in/#>

Semester IV		
Subject Code	Subject Name	Credits
CE-C 403	Structural Analysis – I	5

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	-	01	04	-	01	05

Evaluation Scheme								
Theory				Term Work/ Practical/Oral			Total	
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR		OR
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale
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There are various types of the components of any civil engineering structures which are subjected to different types of loading or combination thereof. Most of the structures which are analyzed for finding its structural response which would form the basis for its structural design are indeterminate structure. Notwithstanding, the structural analysis of any civil engineering structural systems idealizing the same as the statically determinate one shall be the foundation of the analysis of the indeterminate structures. The knowledge gained in the subjects such as engineering mechanics and strength of materials in the preceding semesters where students have been exposed to the principles of engineering mechanics and subsequently, its application on the materials and solids to study its behavior under the action of loads and further to evaluate its strength properties, is extended in this subject for the analysis of various structural systems such as beams, frames, arches and suspension bridges.

Objectives
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- To analyze the statically determinate simple portal frame (both- rigid jointed and having an internal hinges).
- To study the methods and evaluating rotation and displacement parameters in respect of beams and frames using various methods.
- To analyze the three hinged arches; and cables, suspension bridges and three hinged stiffening girder.
- To study the buckling behavior of the axially and transversely loaded beam-columns and its analyses.
- To understand the concept and behavior of the beam and trusses under rolling loads and subsequently, to obtain the absolute maximum bending moment.
- To understand the concept of unsymmetrical bending and shear center and its application in solving the problems of structural mechanics.

<b>Detailed Syllabus</b>		
<b>Module</b>	<b>Sub- Modules/ Contents</b>	<b>Periods</b>
<b>I.</b>	<b>1. Axial force, shear force and bending moment</b>	<b>6</b>
	Concept of statically determinate structures; Axial force, shear force and bending moment diagrams for statically determinate frames with and without internal hinges.	
<b>I.</b>	<b>2. General theorems and its application to simple structures</b>	<b>3</b>
	General theorems and principles related to elastic structures, types of strain energy in elastic structures, complementary energy, principle of virtual work, Betti's and Maxwell's reciprocal theorems, Castigliano's first theorem, principle of superposition. Application of Energy Approach to evaluate deflection in simple structures such as simple beams, portal frame, bent and arch type structures, etc.	
<b>II.</b>	<b>3. Deflection of Statically Determinate Structures Using Geometrical Methods</b>	<b>7</b>
	Deflection of cantilever, simply supported and overhanging beams for different types of loadings Using-Integration Approach including Double Integration method and Macaulay's Method, Geometrical Methods including Moment area method and Conjugate beam method.	
<b>III.</b>	<b>4. Deflection of Statically Determinate Structures Using Methods Based on Energy Principle</b>	<b>9</b>
	4.1 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out slope and deflection in beams. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such structures.	
	4.2 Application of Unit Load Method (Virtual Work Method) for finding out deflection of rigid jointed frames. Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in such frames.	
	4.3 Application of Unit Load Method (Virtual Work Method/ Dummy Load Method) for finding out deflection in pin jointed frames (trusses). Application of Strain Energy Concept and Castigliano's Theorem for finding out deflection in trusses.	
<b>IV.</b>	<b>5. Rolling Load and Influence Lines for Statically Determinate Structures</b>	<b>8</b>
	Influence lines for cantilever, simply supported, overhanging beams and pin jointed truss including warren truss, criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under moving loads (UDL and Series of point loads) for simply supported girder.	

	<b>6. Three Hinged Elastic Arches</b>	<b>5</b>
	Determination of normal thrust, radial shear and bending moment for parabolic and circular (semi and segmental) three hinged arches, Influence lines for normal thrust, radial shear and bending moment for three hinged parabolic arch.	
<b>V.</b>	<b>7. Cables, Suspension bridges and Three Hinged Stiffening Girder</b>	<b>4</b>
	Simple suspension cable, different geometries of cables, minimum and maximum tension in the cable supported at same/different levels, anchor cable, suspension cable with three hinged stiffening girder.	
	<b>8. Columns and Struts</b>	<b>4</b>
	Columns and struts subjected to eccentric loads, Secant formula, Perry's formula, struts with initial curvature.	
<b>VI.</b>	<b>9. Unsymmetrical bending</b>	<b>3</b>
	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	<b>10. Shear Centre</b>	<b>3</b>
	Shear centre for thin walled sections such as channel, tee, angle section and I-section.	
	<b>Total</b>	<b>52</b>

### Contribution to Outcomes

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

- Understand the behavior of various statically determinate structures including compound structures having an internal hinge for various loadings.
- Analyze these structures to find out the internal forces such as axial force, shear force, bending moment, twisting moments, etc.
- Evaluate the displacements / deflections in beams and frames under the action of loads. They will be able to obtain the response of the beams under the action of moving loads.
- Analyze the structures such as arches and suspension bridges and study the behavior of eccentrically loaded columns.
- Analyze the section with respect to unsymmetrical bending and shear center.
- Demonstrate the ability to extend the knowledge gained in this subject in the subjects *Structural Analysis-II* and elective subjects such as *Advanced Structural Analysis* and *Advanced Structural Mechanics* in the higher years of their UG programme where they will be dealing with the indeterminate structures. The knowledge gained in this subject shall also be useful for application in the structural design in later years.

**Theory examination:**

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

**Oral Examination:**

The oral Examination shall be based upon the entire syllabus and the term work consisting of the assignments.

**Internal Assessment:**

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

**Term Work:**

The term-work shall comprise of the neatly written report of the assignments. The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least four problems on each modules/ sub-modules contents thereof further.

**Distribution of Term-work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Assignments	:	20 Marks
Attendance	:	05 Marks
<b>Total</b>	<b>:</b>	<b>25 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks



### **Recommended Books:**

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: *S. B. Junnarkar and H.J. Shah*, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, *Vazirani and Ratwani*
4. Strength of Materials: *S. Ramamrutham*, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: *S. Ramamrutham*, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: *Hemant Patil, Yogesh Patil, Jignesh Patel*, Synergy Knowledgeware, Mumbai.
7. Strength of Materials: *Rajput*, S. Chand Publications, Delhi
8. Structural Analysis: *Bhavikatti*, Vikas publisher house Pvt, Ltd.
9. Structural Analysis: *DevdasMenon*, Narosa Publishing House.
10. Basic Structural Analysis: *K.U. Muthu, Azmi Ibrahim, M. Vijyanand, MagantiJanadharnand. I.K.* International Publishing House Pvt. Ltd.
11. Comprehensive Structural Analysis: Vol-I and II by *Vaidyanathan R. and Perumal R.*Laxmi Publications.
12. Elementary Structural Analysis: *Jindal*
13. Structural Analysis: *L.S. Negi and R.S. Jangid*, Tata Mc-Graw Hill India
14. Fundamentals of Structural Analysis: *Sujit Kumar Roy and SubrotaChakrabarty*, S. Chand Publications.
15. Structural Analysis: *T.S. Thandavamoorthy*, Oxford University Press.
16. Structural Analysis: *Manmohan Das, Bharghab Mohan*Pentice Hall International.

### **Reference Books:**

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norries and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet, C.M. Uang and A.M. Gilbert*, Tata McGraw Hill New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall.

Semester IV		
Subject Code	Subject Name	Credits
CE-C 404	Building Design and Drawing	3.5

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
02	03	-	02	1.5	-	3.5

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	25	-	25	150

Rationale
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Drawing is the language civil engineers communicate in. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives
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- To remember and recall the intricate details of building design and drawing.
- To gain an understanding of the basic concepts of building design and drawing.
- To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- To identify, analyse, research literature and solve complex building design and drawing problems.
- To design new solutions for complex building design and drawing problems.
- To effectively communicate ideas related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus		
Module	Sub- Modules/ Contents	Periods
<b>I.</b>	<b>1. Principles and Codes of Practices for Planning and Designing of Buildings (Residential and Public buildings)</b>	<b>9</b>
	1.1 Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings	
	1.2 Principles of planning for residential buildings	
	1.3 Classification of buildings: <b>Residential</b> –Bungalows, Apartments/Flats etc. <b>Public</b> – Education, Health, Offices/Commercial, Hotels, Hostels.	
	1.4 Study of building Bye – laws and documents / permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
	1.5 Study of sun path diagram, wind rose diagram and sun shading devices	
	1.6 Calculation of setback distances, carpet area, built-up area and floor space index (FSI)	
	1.7 Principles of planning for public buildings: i) Building for education: schools, colleges, institutions, libraries etc. ii) Buildings for health: hospitals, primary health centres etc. iii) Office buildings: banks, post offices, commercial complexes etc. iv) Building for public residence: hostels, boarding houses etc.	
<b>II.</b>	<b>2. Components and Services of a Building</b>	<b>5</b>
	2.1 Staircase (dog legged & open newel in details),	
	2.2 Foundations: stepped footing, isolated sloped footing and combined footing	
	2.3 Openings: doors and windows	
	2.4 Types of pitched roof and their suitability (plan and section)	
	2.5 Building services: Water supply, sanitary and electrical layouts	
<b>III.</b>	<b>3. Perspective Drawing</b>	<b>4</b>
	3.1 One-point perspective	
	3.2 Two-point perspective	
<b>IV.</b>	<b>4. Town Planning, Architectural Planning &amp; Built Environment</b>	<b>4</b>
	4.1 Objectives and principles (road systems, zoning, green belt etc.)	

	4.2	Master plan and slum rehabilitation	
	4.3	Architectural Planning: introduction and principles	
	4.4	Built Environment: introduction and principles	
<b>V.</b>	<b>5. Green Buildings</b>		<b>2</b>
	5.1	Introduction and overview	
	5.2	Certification methods (LEED and TERI)	
<b>VI.</b>	<b>6. Computer Aided Drawing (CAD)</b>		<b>2</b>
	6.1	Advantages of CAD	
	6.2	Overview of any one of the CAD software's prevailing in the market (AutoCAD, Revit, 3D Max etc.)	
<b>Total</b>			<b>26</b>

### Contribution to Outcomes

- Students will be able to list down the types of structures and its various components (for eg. doors, windows, staircase, foundations etc.)
- Students will be able to explain various concepts pertaining to building design and drawing (for eg, principles of planning, architectural planning, green buildings etc.)
- Students will be able to apply principles of planning, architectural planning and building bye laws while designing and preparing building drawings.
- Students will be able to calculate and analyze various technical details of a building (for eg. carpet area, FSI etc.) from its drawings.
- Students will be able to design various components of buildings (for eg. staircases etc.) as well as buildings as a whole, given the requirements of the building owner and local D.C. laws.
- Students will be able to prepare drawings (for eg. plans, elevation, perspective views etc.) of the designed components of buildings as well as buildings as a whole.

#### Theory Examination:

1. Question paper will consist of total 6 questions; each carrying 20 marks.
2. Only 4 questions (out of 6) need to be attempted.
3. Question no. 1 will be compulsory and based on the drawing work of any one building, may be residential or public building..
4. Any 3 out of the remaining 5 questions need to be attempted.
5. In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

## **Practical Examination (Oral and Sketching)**

Practical examination will consist of sketching and oral examination based on the entire syllabus.

### **Internal Assessment:**

There will be two class tests (to be referred to as an 'Internal Assessment') to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

### **Term Work**

#### **Reports:**

1. Summary of Development Control (D.C.) rules of student's own or nearest city
2. Summary of documents required from commencement to completion of the building by the concerned local body i.e. Municipal Corporation or nearest Municipality.
3. One-day site visit could be arranged for students to visit any one public building near the college like commercial complex, library, Bank etc. They need to study in detail of that building take the measurements of that building should submit as a site report with detailed drawing according to some suitable scale. This will become a part of Term Work.

#### **Drawings:**

1. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a **residential building (bungalow or apartment)** to be constructed as a (G+1) R.C.C. framed structure
2. Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, site plan, schedule of opening and construction notes of a **public building (school or hostel or hospital or bank)** be constructed as a (G+1) R.C.C. framed structure
3. Roof plan, foundation plan (with section of a typical foundation), plan and section of staircase, one typical door and one typical window of either one of the two above drawings
4. One point and two-point perspective
5. CAD sheet of either one of the first two drawings

#### **Distribution of Term-work Marks:**

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of term-work warrants the satisfactory the appropriate completion of the assignments the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Drawing Sheets	:	10 Marks
Report of the Drawing	:	05 Marks
Report on the Site Visit	:	05 Marks
Attendance	:	05 Marks
<b>Total</b>	<b>:</b>	<b>25 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

### **Recommended Books:**

1. Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S. Y. Patki* (Tata McGraw-Hill Education)
2. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)
3. Planning and Designing Buildings by *Y. S. Sane* (Modern Publication House, Pune)
4. Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C. V. Vijayan* (SPADES Publication, Calicut)
5. Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

### **References:**

1. IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2. National Building Code of India – 2005 (NBC 2005)
3. Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (<https://mmrda.maharashtra.gov.in/documents/10180/7761832/5.pdf/e09991a2-b29e-4e04-a33e-a40aca6e2689?version=1.1>)
4. Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (<https://www.nmmc.gov.in/development-control-regulations>)
5. Development Plan and Control Regulation for 27 villages of Kalyan and Ambernath tehsils of Thane district, Maharashtra (<https://mmrda.maharashtra.gov.in>)

Semester IV		
Subject Code	Subject Name	Credits
CE-C 405	Building Materials and Construction Technology	5

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
04	02	-	04	01	-	05

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale
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Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This subject provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing. This subject is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building construction system so that student can effectively plan and execute building construction work.

Objectives
------------

- To study the manufacturing process, properties, and use of different types of building materials like cement, lime, mortar, concrete, stone, brick, timber, including materials such as paints and varnishes used for treatment of the surfaces so as to achieve good knowledge about the building materials.
- To enable the students to identify various components of building masonry, roof and floor, staircase etc., their functions and methods of construction so as to achieve good knowledge about building construction.
- To study the properties such as workability, durability and porosity of fresh and hardened concrete.
- To understand the concept and optimization of mix design for different environmental conditions.

Detailed Syllabus		
Module	Sub-Modules/ Contents	Periods
I.	<b>Introduction</b> Classification of materials, building materials symbols and requirements of building materials and products: functional, aesthetical and economical	4
II.	<b>Manufacturing Process and Properties of Basic Construction Materials.</b>	11
	2.1 Rocks (Stone) quarrying, milling and surface finishing, preservative treatments. <b>Aggregate</b> -Properties of coarse and fine aggregates and their influence on properties of concrete, properties of crushed aggregates.	
	2.2 <b>Structural clay products</b> -bricks, roofing tiles, ceramic tiles, raw materials and manufacturing process.	
	2.3 Concrete blocks, flooring tiles, paver blocks -raw materials and manufacturing process.	
	2.4 <b>Binder material:</b> lime, cement: Manufacturing process and physical properties, plaster of Paris -properties and uses.	
	2.5 <b>Mortar</b> -ingredients, preparation and uses. 2.6 Damp -proofing and water proofing materials	
III.	3.1 <b>Concrete</b> Grades of concrete, Manufacturing process, Properties of fresh and hardened concrete. Durability – Factors affecting durability, Relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test.	09
	3.2 <b>Admixtures:</b> Plasticizers, Super-plasticizers, Retarders, Accelerators, Mineral admixtures and other admixtures, test on admixtures, chemistry and compatibility with concrete.	
	4.1 <b>Glass:</b> Types and uses. Introduction to glass fibre reinforced plastic.	
IV.	4.2 <b>Timber:</b> Varieties, defects in timber, preservative treatments and wood composites.	04
	5.1 <b>Concrete mix design</b> Types of mix, Mix design for compressive strength by I.S. method, Mix design for flexural strength, Method of determining compressive strength of accelerated - cured concrete test specimens as per IS:9013-2004 (revised code)	
V.		



	5.2	<b>Ready mix concrete:</b> Advantages of RMC, components of RMC plant, distribution and transport, handling and placing, mix design of RMC, Mass Concrete, Vacuum Concrete and Concreting Equipments	
<b>VI.</b>	6.1	<b>Masonry Construction and Masonry Finishes:</b> Classification and bonding of stone, brick and concrete blocks Masonry finishes -pointing, plastering and painting	<b>14</b>
	6.2	<b>Formwork</b> Materials used, design considerations, shuttering, centering and staging, scaffolding. Types of form work: Slip form work, Cantilever and other modern form work	
	6.3	<b>Floor and roof</b> Different types and its suitability. Type of roofs, wooden and steel trusses and roof covering Different types of cladding.	
<b>Total</b>			<b>52</b>

<b>Contribution to Outcomes</b>
---------------------------------

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

- Identify and list the various building materials, their properties and symbols.
- Identify the properties of ingredients of concrete, interpret and design concrete mix for various grades.
- Explain and interpret manufacturing process of basic construction materials and understand various masonry construction and finishes.
- Perform tests on various materials.

**Theory examination:**

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

**Oral Examination:**

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practicals conducted by the students and a detail report of the industrial/ site visit.

**Internal Assessment:**

There will be two class tests (to be referred to as an 'Internal Assessment) to be conducted in the semester. The first internal assessment (IA) will be conducted in the mid of the semester based on the 40% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA) will be conducted at the end of the semester and it will be based on next 40% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively.

**List of Practicals (*Any Eight to be performed*):**

1. Physical properties of cement: Fineness, consistency, setting time, Soundness, Compressive strength.
2. Water absorption and compressive strength test of bricks.
3. Water absorption and transverse load test on tiles.
4. Compression test on timber (Parallel/ perpendicular to the grains).
5. Effect of w/c ratio on workability, (slump cone, compaction factor, V-B test, flow table) and strength of concrete
6. Effect of w/c ratio on strength of concrete,
7. Study of admixtures and their effect on workability and strength of concrete
8. Secant modulus of elasticity of concrete and indirect tensile test on concrete
9. Nondestructive testing of concrete- some applications (hammer, ultrasonic)
10. Mix design in laboratory.

**Site Visit/ Industrial Visit:**

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall study various aspects of the plant along with various operations. A visit may also be arranged to the site involving repairs and rehabilitation of concrete structures. The visit to any site where construction is going on may be arranged and the students may be made aware of the various construction activities. They shall prepare a report of the visit which shall include all above points. The same shall be evaluated by the concerned teacher.

**Term Work:**

The term work shall consist of:

- Report of minimum **08** experiments.
- Assignments, including at least **20** sketches on A2 size drawing sheets covering entire syllabus.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of experiments and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

### **Distribution of the Term Work Marks:**

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report of the Experiments	:	10 Marks
Assignments	:	05 Marks
Sketches	:	05 Marks
Attendance	:	05 Marks
<b>Total</b>	<b>:</b>	<b>25 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75%– 80%: 03 Marks; 81%– 90%: 04 Marks 91% onwards: 05 Marks

### **Recommended Books:**

1. Building Construction: *S. P. Bindra and S. P. Arora*, Dhanpat Rai and Sons, Delhi.
2. Engineering Materials: *S.R. Rangwala*, Charotar Publications.
3. Building Construction: *Rangwala*, Charotar Publications, Anand (Gujrat).
4. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
5. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
6. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman.
7. Concrete mix proportioning-guidelines (IS 10262:2009).
8. Concrete Technology: *A. R. Shanthakumar*, Oxford University Press.
9. Engineering Materials: *S.R. Rangwala*, Charotar Publications.
10. Materials of Construction: *D. N. Ghose*, Tata McGraw Hill, Delhi.
11. Architectural Materials science: *D. Anapetor*, Mir Publishers.
12. Introduction to Engineering Materials: *B. K. Agrawal*, Tata McGraw Hill NewDelhi.
13. Engineering Materials: *P. Surendra Singh*, Vani Education Books New Delhi.
14. Building Materials (Products, Properties and Systems): *M.L. Gambhir and NehaJamwal*, Mc-Graw Hill Publications.
15. Specifications for different materials, BIS Publications, New Delhi
16. Properties of concrete: Neville, Isaac Pitman, London.
17. Relevant I.S. codes: Bureau of Indian standard.

Semester IV		
Subject Code	Subject Name	Credits
CE-C 406	Fluid Mechanics–II	4

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	02	-	03	01	-	04

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	25	-	25	150

Rationale
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The course introduces the fluid flow science, problems and their applications in varied conditions. The study dealt with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives
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- To understand the Pipe flow problems, losses incurred during transmission of power through pipe and nozzle.
- To study Hardy cross method and water hammer phenomenon
- To study and analyze the pipe network which will help to design water supply schemes.
- To study laminar, turbulent flows and its significance.
- To study compressible flow and understand boundary layer theory.

<b>Detailed Syllabus</b>		
<b>Module</b>	<b>Sub-module /Content</b>	<b>Periods</b>
<b>I</b>	<b>1. Flow through pipes</b>	<b>10</b>
	<b>1.1</b> Flow through pipes Loss of head through pipes, Darcy-Weisbach equation, minor and major losses. Hydraulic gradient line and energy gradient line, pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flow through branched pipes, three reservoir problem, siphon.	
	<b>1.2</b> Pipe network and water hammer Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures.	
<b>II</b>	<b>2. Flow through nozzles:</b>	<b>04</b>
	Power transmitted through nozzle, condition for maximum power transmitted, diameter of nozzle for maximum transmission of power.	
<b>III</b>	<b>3. Compressible flow</b>	<b>05</b>
	Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties	
<b>IV</b>	<b>4. Boundary layer theory</b>	<b>07</b>
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerged body, drag and lift, terminal velocity of body.	
<b>V</b>	<b>5. Laminar Flow:</b>	<b>05</b>
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving. kinetic energy correction factor, and momentum correction factor. Dash pot mechanism.	
<b>VI</b>	<b>6. Turbulent Flow:</b>	<b>08</b>
	Causes of turbulence, shear stress in turbulent flow, Prandtl's mixing length Theory, Hydro dynamically smooth and rough pipes, velocity distribution in smooth and rough pipes, Karman-Prandtl velocity distribution equation, Resistance to flow in smooth and rough pipes, resistance equation and Moody's diagram.	
<b>Total</b>		<b>39</b>

<b>Contribution to Outcomes</b>
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- On completion of this course the student will be able to:
- Interpret different pipe fittings and evaluate the fluid velocity considering major and minor losses.
- Solve pipe network problems by Hardy cross method.
- Distinguish the types of compressible flow and understand concept of boundary layer theory.
- Evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation for laminar flow in a pipe.
- Establish Prandtl's mixing theory and solve turbulent flow problems.

**Theory examination:**

1. The question paper will comprise of six questions; each carrying 20 marks.
2. The first question will be compulsory and will have short questions having weightage of 4-5marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus and may be . For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. Remaining questions will be mixed in nature (e.g. Suppose Q.2 has part (a) from module II then part (b) will be from any module other than module II).
5. The students will have to attempt any three questions out of remaining five questions.
6. Total four questions need to be attempted.

**Oral Examination:**

The oral examination shall be based on the entire syllabus and the report of the experiments conducted by the students including assignments.

**List of Practicals** (Any ix experiments to be performed):

1. Reynold's Experiment
2. Determination of viscosity of fluid
3. Friction loss through pipes
4. Minor losses through pipes
5. Laminar flow through pipes
6. Velocity distribution in circular pipes
7. Turbulent flow through pipe
8. Water Hammer phenomenon

**Term Work:**

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise.

### **Distribution of the Term Work Marks:**

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Report on Experiments	:	10 marks
Assignments	:	10 Marks
Attendance	:	05 Marks
<b>Total</b>	<b>:</b>	<b>25 marks</b>

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to.

75% – 80%: 03 Marks; 81% – 90%: 04 Marks 91% onwards: 05 Marks

### **Recommended Books:**

1. Hydraulics and Fluid mechanics: *Dr P.M. Modi and Dr. S.M. Seth*, Standard book House, Delhi.
2. Theory and Application of Fluid Mechanics: *K. Subramanya*, Tata McGraw hill publishing company.
3. Fluid Mechanics: *Dr. A.K Jain*, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: *Dr. D.S. Kumar, F.K. Kataria*.
5. Fluid Mechanics and Hydraulics: *Dr. S. K. Ukarande*, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN 97893 8116 2538.
6. Fluid Mechanics: *R.K. Bansal*Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: *C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli*. Oxford Higher Education.

### **Reference Books:**

1. Fluid Mechanics: *Frank M. White*, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: *Streeter White Bedford*, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: *R.L. Daugherty, J. B. Franzini, E.J., Finnemore*, Tata McGraw Hill New Delhi.
4. Hydraulics: *James F. Cruise, Vijay P. Singh and Mohsen M. Sherif*, CENGAGE Learning India Pvt. Ltd., Delhi.