B. Sc Honors (Mathematics)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VIII

ADVANCED MECHANICS			
Course Code	**21BSM81**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives: The course will enable the students to**:**

1. Provide basic concepts of statics in space
2. To learn the concepts of motion of rigid bodies.
3. Aims to provide the concept of kinematics and kinetics of fluid motion and motion in two dimensions**.**

Pedagogy (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need of Mathematics in Science Study and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning home work, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).

Module-1: Statics in space

Forces in three dimensions, reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Null points, lines and planes with respect to a system of forces. **(8 hours)**

Self study: conjugate forces and conjugate lines.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	**Chalk and talk method / Power Point Presentation**

Module-2: Motion of a Rigid body

Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moment of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body, Euler's equations of motion for a rigid body with fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical, Polar coordinates. **(8 hours)**

Self Study: Motion about a fixed axis, Compound pendulum.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Kinematics of Fluid Motion	
Lagrangian and Eulerian approaches, Material and connective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, Cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, boundary surface, Stream lines and path lines, Steady and unsteady flows, Velocity potential, rotational and irrotational motion. **(8 hours)** **Self-study:** Vorticity vector and vortex lines	
(RBT Levels: L1, L2 and L3)	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Kinetics of Fluid Motion	
Euler's equations of motions in Cartesian, Cylindrical polar and spherical polar coordinates, Bernoulli's equation, **Self-study:** Impulsive motion. **(8 hours)**	
(RBT Levels: L1, L2 and L3)	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Motion in two-dimensions
Stream function, Complex potential, Basic singularities, Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle. **Self study:** Milne-Thomson circle theorem. **(8 hours)**
(RBT Levels: L1, L2 and L3)

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

1. Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple
2. Learn about a null point, a null line, and a null plane with respect of a system of forces acting on a rigid body.
3. Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia.
4. Study the kinematics and kinetics of fluid motions and hence to derive Euler's and Bernoulli's equations.
5. Understand the concepts of sources, sinks, doublets and image system of these with regard to a line and a circle

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**
(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**
1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Books Recommended :

1. A.S.Ramsay (1960). *A Tratise on Hydromechanics. Part-II Hydrodynamics*. G.Bell & Sons
2. F.Chorlton (1967). *A Text book of Fluid dynamics*. CBS Publishers
3. Michel Rieutord (2015). *Fluid Dynamics An Introduction*. Springer
4. E.A. Milne (1965). *Vectorial Mechanics*, Methuen &Co.Limited, Londen

Web links and Video Lectures (e-Resources):

- https://www.researchgate.net
- http://arxiv.org

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Quiz
- Group assignment
- Seminars

B. Sc Honors (Mathematics)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VIII

Set Theory and Metric Spaces			
Course Code	**21BSM82**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The course will enable students to:

1. Provide an insight on theory of sets
2. Learn basic concepts of metric spaces
3. Understand the concepts of connected sets and compact spaces

Pedagogy (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need of Mathematics in Science Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning home work, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution of some exercises(post-lecture activity).

Module-1: Theory of Sets

Finite and infinite sets, countable and uncountable sets, cardinality of sets, Schroder-Brmsten theorem, cantor's theorem, Order relation in cardinal numbers, Arithmetic of cardinal numbers, Partially ordered set, Zom's lemma and axioms of choice, various set theoretic paradoxes

Self-study: Set Operations and properties

(RBT Levels: L1, L2 and L3) **8 hours**

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-2: Concepts in metric spaces

Definition and examples of metric spaces, Open spheres and Closed spheres, Neighborhoods, Open sets, Interior, Exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set.

Self-study: Subspace of a metric space.

(RBT Levels: L1, L2 and L3) **8 hours**

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Complete Metric Spaces and Continuous Functions	
Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, continuous and uniformly continuous functions, Homeomorphism. **Self-study:** Banach contraction principle.	
(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Compactness	
Compact spaces, Sequential compactness, Bolzano-Weierstrass property, Compactness and finite intersection property, Heine-Borel theorem, Totally bounded set, equivalence of compactness and sequential compactness. **Self study:** Continuous function on compact spaces.	
(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Connectedness	
Separated sets, Disconnected and connected sets, components, connected subsets of R, Continuous functions on connected sets **Self study:** Local connectedness and arc wise connectedness	
(RBT Levels: L1, L2 and L3)	**8 hours**

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

1. Learn basic facts about the cardinality of a set and various set theoretic paradoxes.
2. Recognize open and closed spheres and bounded sets.
3. Understand several standard concepts of metric spaces and their properties
4. Identify the continuity of a function defines on metric spaces and homomorphism

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Books Recommended :

1. E.T. Copson (1988). *Metric spaces*. Cambridge University Press
2. P.R. Halmos (1974). *Naive Set Theor*y. Springer
3. P.K. Jain & Khalil Ahamad (2019), *Metric Spaces*. Narosa
4. S. Kumaresan (2011). *Topology of Metric spaces* (2nd edition), Narosa
5. Satish Shirali & Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
6. Micheal O;Searcoid (2009), Metric spaces. Springer-Verlag
7. G.F. Simmons (2004). Introduction to Topology and Modern analysis. McGraw-Hill

Web links and Video Lectures (e-Resources):

- http://www.umsl.edu
- http://www.waterstones.com

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Group assignment
- Seminars

B. Sc. Honors (Mathematics)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VIII

Advanced Mechanics & Set Theory Lab			
Course Code	21BMATL83	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:2:0	SEE Marks	50
Credits	02	Exam Hours	3 Hours

Course Description: This course will enable the students to gain hands-on experience in Mathematical tools to executive practical problems (Maxima/Scilab/MatLab/Mathematica/ Python).

Course Learning Objectives: This course will help the learner to

- Analyse the dynamics of a moving particle using various kinds of coordinate systems
- Understand the concepts of rotational and irrotational fluids
- Study the moments and torques.
- Understand the concepts of set and metric spaces.

List of Experiments:

Any Ten Experiments to be performed

Sl.NO	Experiments
1	Programs for finding the polar, cylindrical and spherical polar coordinates.
2	Programs for finding the velocity and acceleration of a particle
3	Programs for finding the resultant of a number of forces
4	Programs for finding the rotational and irrotational fluids
5	Programs for finding the kinetic energy of the rigid body
6	Programs for finding Moments and torques: Moment from magnitude and perpendicular distance, equilibrium of two moments
7	Programs for finding the streamlines and path lines
8	Programs for finding Projectiles
9	Programs on Euler's equations
10	Programs for finding stream functions and complex potentials
11	Programs for finding the length of a set
12	Programs for finding the distance between two sets

Course outcomes (Course Skill Set):

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

1. Apply the various kinds of coordinate systems to determine the velocity and acceleration of a particle.

2. Study the concepts of rotational and irrotational fluids
3. Study the moments and torques.
4. Determine the stream functions and complex potentials of a fluid flow.
5. Determine the distance between sets.

Assessment Details (both CIE and SEE)

Continuous Internal Evaluation (CIE): The CIE marks awarded in case of Practical shall be based on the weekly evaluation of laboratory journals/ reports after the conduction of every experiment and one practical test.

Semester End Evaluation (SEE): The practical examinations to be conducted as per the time table of University in a batch wise with strength of students not more than 10-15 per batch.

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Books:

1. A. S. Ramsay (1960). *A Treatise on Hydromechanics. Part-II Hydrodynamics*. G. Bell & Sons
2. F. Chorlton (1967). *A Textbook of Fluid Dynamics*. CBS Publishers
3. Michel Rieutord (2015). *Fluid Dynamics An Introduction*. Springer
4. E.A. Milne (1965). *Vectorial Mechanics*, Methuen & Co. Limited, London
5. E.T. Copson (1988). *Metric spaces*. Cambridge University Press
6. P.R. Halmos (1974). *Naive Set Theory*. Springer
7. P.K. Jain & Khalil Ahamad (2019), *Metric Spaces*. Narosa

Suggested Learning Resources:

http://vlabs.iitb.ac.in
http://math.fulletron.edu/mathews/numerical.html
http://www.my-mooc.com/en/categorie/mathematics
www.python.org

B. Sc. Honors (Mathematics)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VIII

Information Theory and Coding			
Course Code	**21BSM841**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	04	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: The course will enable students to:

1. Provide insight on the theory of Information theory
2. Learn different entropy functions and basic relation among different entropies
3. Study the concepts of coding and bounds of codes.

Pedagogy (General Instructions):

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Science Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning home work, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways
    - As an introduction to new topics (pre-lecture activity).
    - As a revision of topics (post-lecture activity).
    - As additional examples (post-lecture activity).
    - As an additional material of challenging topics (pre-and post-lecture activity).
    - As a model solution of some exercises (post-lecture activity).

Module-1: Concepts of Information Theory

Communication processes, a model of communication system, a quantitative measure of information, Binary unit of information, a measure of uncertainty, sources and binary sources, measure of information for two-dimensional discrete finite probability schemes.

Self-study: H function as a measure of uncertainty

(RBT Levels: L1, L2 and L3) **8 hours**

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-2: Entropy Functions

A sketch of communication network, Entropy, Basic relation among different entropies. A measure of mutual information, Interpretation of Shannon's fundamental inequalities; Redundancy, efficiency, and channel capacity; binary symmetric channel, Binary erasure channel, Uniqueness of the entropy function, Joint entropy and conditional entropy, Relative entropy and mutual information, Chain rule for entropy, Conditional relative entropy and conditional mutual information, The log sum inequality and its applications.

Self-Study: Jensen's Inequality and its characterizations

(RBT Levels L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3:Concepts of Coding

Block codes, Hamming distance, maximum likelihood decoding, Levels of error handling, error correction, Error detection, erasure correction, Construction of finite fields, Linear codes, Matrix representation of linear codes.

Self-study: Hamming codes.

(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Bounds of Codes

Orthogonality relation, Encoding and decoding of linear codes, The singleton bound and maximum distance separable codes, The sphere-packing bound and perfect codes, The Gilbert-Varshamov bound.

Self-study: MacWilliams' identities

(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Cyclic Codes

Definitions and examples of cyclic codes, Generator polynomial and check polynomial, Generator matrix and check matrix, Bose-Chaudhuri-Hocquenghem (BCH) code as a cyclic code.

Self-study: Golay codes and RS codes.

(RBT Levels: L1, L2 and L3) **8 hours**

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

1. Study simple ideal statistical communicational models.
2. Understand the development of codes for transmission and detection of information
3. learn about the input and output of a signal via transmission channel
4. study detection and correction of errors during transmission
5. Represent a linear code by matrices-encoding and decoding

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Books Recommended: Reference Books

1. Robert B. Ash (2014). Information theory. Dover Publication
2. Thomas M. Cover & Joy A. Thomas (2013). Elements of Information Theory (second edition) Wiley India Pvt. Ltd
3. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th Edition). Cengage
4. Fazlollah M. Reza, (2003). An introduction to Information Theory. Dover Publication
5. Ron M. Roth (2007). Introduction to Coding Theory. Cambridge University Press.
6. Claude. F Shannon& Warren Weaver (!969). The Mathematical Theory of Communication. The University of Illinois Press

Web links and Video Lectures (e-Resources):

https://link.springer.com

https://www.tutorialspont.com

https://nptel.ac.in

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Quiz
- Group assignment
- Seminars

B. Sc Honors (Mathematics)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VIII

Mathematical Logic			
Course Code	**21BSM842**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

The course will enable the students to**:**

1. Provide basic concepts on Syntax of First-order Logic and Semantics of First-order Languages
2. To learn the propositional logics and Meta theorems
3. Study the Completeness Theorem and Model Theory

Pedagogy (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need of Mathematics in Science Study and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning home work, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre-and post-lecture activity).

Module-1: Syntax of First-order Logic	
Introduction to propositions, truth table, negation, conjunction and disjunction. Implications, bi-conditional propositions, converse, contrapositive and inverse propositions. First-order languages, Terms of a language, Formulas of a language, First- order theories. **Self-study:** Precedence of logical operators	
(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	**Chalk and talk method / Power Point Presentation**
Module-2: Semantics of First-order Languages	
Structures of first-order languages, Truth in a structure, Models and elementary classes, Embeddings and isomorphism. **Self-study:** Homogeneous structures	
(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Propositional Logics	
Syntax of propositional logic, Semantics of propositional logic, Compactness theorem for Propositional Logic, Proof in propositional logic, Meta theorems in Propositional logic. **Self-study**: Post-Tautology theorem.	
(R**BT Levels: L1, L2 and L3)**	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4: Completeness Theorem for first-order logic	
Proof in first-order logic, Meta theorems in first-order logic, Consistency and completeness. Proof of the completeness theorem, Interpretations in a theory. Extension by definitions, Some Meta theorems in Arithmetic. **Self study:** Applications of the completeness theorem	
(RBT Levels: L1, L2 and L3)	**8 hours**
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5: Model Theory	
Compactness theorem. Upward Lowenheim-Skolem theorem, Ultra products of Models, Prime and Atomic Models, Saturated Models. **Self-study:** Some applications in algebra.	
(RBT Levels: L1, L2 and L3)	**8 hours**

Course outcomes: After successfully completing the course, the students are familiar with:

1. The syntax and semantics of first-order logic
2. The completeness theorem of first-order logic
3. The compactness theorem and basic model theory
4. Lowenheim-Skolem theorem and its applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.

Books Recommended:

1. Shashi Mohan Srivastava (2013). *A Course on Mathematical Logic* (2nd edition).Springer.
2. Richard E. Hodel (2013). *An Introduction to Mathematical Logic.* Dover Publications.
3. Yu I. Manin (2010). *A Course in Mathematical Logic for Mathematicians* (2nd edition). Springer.
4. Elliott Mendelson (2015). *Introduction to Mathematical Logic* (6th edition). Chapman & Hall/CRC.
5. Herbert Enderson, A Mathematical Introduction to Logic (Second edition), Academic Press; 2nd edition (23 January 2001)

Web links and Video Lectures (e-Resources):

https://cfreer.org

https://www.springer.com

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Group assignment
- Seminars