B.E (OPEN TO ALL PROGRAMMES OF ENGINERRING)

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

(Effective from the academic year 2022-2023)

SEMESTER – VI

Advanced Linear Algebra

Course Code	21MAT655	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning Objectives: This course will enable students to:

1. To familiarize the important tools of linear algebra, that are essential in all branches of engineering.
2. To develop the knowledge/skills of linear transformation and decomposition techniques in a comprehensive manner.

Teaching-Learning Process (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 Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, 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 for some exercises (post-lecture activity).

Module – 1

Linear System of Equations: Consistent and inconsistent systems and its solution sets; LU-decomposition. Vector Spaces: Vector spaces; subspaces; Linearly independent and dependent vectors; Bases and dimension; coordinate vectors; computations concerning subspaces-Illustrative examples. **(8 Hours)**

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 2

Linear Transformations: Linear transformations; algebra of transformations; representation of transformations by matrices; linear functional; Non singular Linear transformations; inverse of a linear transformation; Problems on Rank-Nullity theorem. **(8 Hours)**

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 3	
Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and orthogonal projections; Gram-Schmidt orthogonalization process; QR- decomposition. **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning
Module – 4	
Introduction to Spectral Theory: Eigen values and eigenvectors; Diagonalization; quadratic Forms, constrained optimization; Singular value decomposition. **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning
Module – 5	
Engineering Applications: i) Graphs and Networks (Article No:10.1, P.No:452-461, Text No. 2). ii) Matrices in Engineering (Article No:10.2, P.No:462-473, Text No. 2). iii) Computer Graphics.(Article No:10.9, P.No:596-602, Ref No. 3). **(8 Hours)** **(RBT Levels: L1, L2 and L3)**	
Pedagogy	Chalk and Board, Problem based learning

Course Outcomes

- Analyze whether a system is consistent or inconsistent, its solution is unique or infinite and find bases and dimension of vector spaces required in network analysis.
- Linearly transform the system from one dimension to another in matrix form, required to analyze image processing problems.
- Compute orthogonal and orthonormal basis vectors required to analyze image and signal processing problems.
- Apply techniques of constrained optimization and singular value decomposition for problems arising in control system analysis, signals and systems.
- Apply linear algebraic tools to analyze problems in graphs and networks problems, computer graphics.

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.
The students have to answer 5 full questions, selecting one full question from each module. Marks scored out of 100 shall be reduced proportionally to 50 marks

Textbook/s:

1. David C. Lay, "Linear Algebra and its Applications", Cambridge University Press 3rd Edition, 2017.
2. Gilbert Strang, "Introduction to Linear Algebra", Wellesley-Cambridge Press 5 th Edition, 2016.

Reference Books:

1. Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications", Pearson Education (Asia) Pvt. Ltd 7 th Edition, 2003.
2. Kenneth Hoffman and Ray Kunze, "Linear Algebra", Pearson Education (Asia) Pte. Ltd, 2004. 2 nd Edition, 2004
3. Howard Anton and Chris Rorres, "Howard Anton and Chris Rorres", Elementary Linear Algebra - Applications Version Wiley, 2014 11thEdition, 2014.

Web links and Video Lectures (e-Resources):

http://www.class-central.com/subject/math(MOOCs)

http://academicearth.org/

http://www.bookstreet.in.

VTU EDUSAT PROGRAMME – 20

VTU e-Shikshana Program

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

- Quizzes
- Assignments
- Seminars