

## ES 202 – Mathematics for Engineers

### Course outline

#### **Part 1 / Vector Calculus**

1. Vector and scalar fields, derivative of a vector function, partial derivative. Parametric representation of curves. Tangent vector, arc length.
2. Directional derivative and gradient of a scalar function.
3. Divergence and curl of a vector function. Conservative, solenoidal and irrotational fields.
4. Line integrals of vector functions. Work done by a force, path independence.
5. Surface and volume integrals. Integral theorems: Divergence theorem of Gauss, Stokes' theorem. Green's theorem in the plane.

#### **Part 2 / Fundamentals of Linear Algebra**

6. Introduction to vectors: Basic definitions, vector operations, vector spaces, subspaces, Euclidean space, linear independence, span, basis, dimension, inner product, norm of a vector, orthogonality, Gram-Schmidt orthogonalization process.
7. Matrices, matrix operations, transpose of a matrix, special matrices. Determinant of a matrix, properties of determinants. Submatrices, minors, cofactors, inverse of a matrix by adjoint (cofactor) method.
8. Elementary row and column operations, row echelon form of a matrix, rank of a matrix. System of linear algebraic equations. Homogeneous and non-homogeneous systems. Solution of a system of equations by matrix inversion method, Cramer's rule and Gaussian elimination method (GEM). Gauss-Jordan method, consistent and inconsistent systems, complete (general) solution. Determinant and inverse of a matrix by GEM.
9. Linear transformations. Matrix representation of linear transformations. Coordinate transformation, change of basis, direction cosine matrix, applications.
10. Algebraic characteristic value (eigenvalue) problems: basic definitions, eigenvalues and eigenvectors, modal matrix, equivalence and similarity transformations, diagonalization of a matrix, powers of a square matrix, Cayley-Hamilton theorem, quadratic forms, positive definiteness, diagonal form of quadratic forms.

#### **References**

- Kreyszig, E., Advanced Engineering Mathematics, John Wiley and Sons, 9<sup>th</sup> ed., Chps. 7, 8, 9, 10, 13.
- O'Neil, P.V., Advanced Engineering Mathematics, Wadsworth Publishing, 4<sup>th</sup> ed., Chps. 7, 8, 9, 12, 13.