Report of the Subcommittee to review the course number: MTH102

Title of the course: (Mathematics II) 3L-1T-0P-0A (11 credits)

Objective of the course: The course gives the student a foundation in linear algebra and ordinary differential equations.

Specialized Infrastructure requirement: Sufficiently sized room to handle large class size.

Instructional aspects: Tutorial sessions either at the end or beginning of the week.

Course content: See break-up below

Lecture-wise break-up: (please note that the duration of each lecture is 50 minutes)

S. No.	Topic: Linear Algebra	Suggested Number of Lectures
1	Matrices, System of linear equations, Gauss elimination method, Elementary matrices.	1
2	Elementary matrices, Invertible matrices Gauss-Jordon method for finding inverse of a matrix.	1
3	Determinants, Basic properties of determinants.	2
4	Cofactor expansion, Determinant method for finding inverse of a matrix, Cramer's Rule.	1
5	Vector space, Subspace, Examples.	1
6	Linear span, Linear independence and dependence, Examples.	1
7	Basis, Dimension, Extension of a basis of a subspace, Intersection and sum of two subspace, Examples.	2
8	Linear transformation, Kernel and Range of a linear map, Rank-Nullity Theorem.	1
9	Rank of a matrix, Row and column spaces, Solvability of system of linear equations, some applications	1
10	Inner product on $\mathbb{R}^n$, Cauchy-Schwartz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process.	1
11	Orthogonal projection, Orthogonal complement, Projection theorem, Fundamental subspaces.	1
12	Fundamental subspaces and their relations, An application (Least square solutions and least square fittings).	1

13	Eigen-values, Eigen- Vectors, Characterization of a diagonalizable matrix.	1
14	Diagonalization: Example, An application.	1
15	Diagonalization of a real symmetric matrix.	1
16	Representation of a real linear maps by matrices (optional)	1
	Topic: Ordinary differential equations	
17	Introduction to DE, Order of DE, First Order ODE $F(x, y, y') = 0$.	1
18	Concept of solution (general solution, singular solution, implicit solution etc.), Geometrical interpretations (direction fields, nullclines)	1
19	Separable form, Reduction to separable form, Exact equations, Integrating factors [of the form F(x) and F(y)].	1
20	Linear equations, Bernoulli equation, orthogonal trajectories.	1
21	Picard's existence and uniqueness theorem (without proof), Picard's iteration method.	1
22	Numerical methods: Euler's method, improved Euler's method.	1
23	Second order linear ODE: fundamental system and general solutions of homogeneous equations, Wronskian, reduction of order.	1
24	Characteristic equations: real distinct roots, complex roots, repeated roots.	1
25	Non-homogeneous equations: undetermined coefficients	1
26	Non-homogeneous equations: variation of parameters	1
27	Extension to higher order differential equations, Euler-Cauchy equation.	1
28	Power series solutions: ordinary points (Legendre equation).	1
29	Power series solutions: regular singular points (Bessel equation), Frobenius method, indicial equations.	1
30	Legendre polynomials and properties	1
31	Bessel functions and properties	1
32	Sturm comparison theorem, Sturm-Liouville boundary value problems, orthogonal functions.	1
33	Laplace transform: Laplace and inverse Laplace transforms, first shifting theorem, existence, transforms of derivative and integral	1
34	Laplace transform: Differentiation and integration of transforms, unit step function, second shifting theorem.	1
35	Laplace transform: Convolution and applications, initial value problems	1
	TOTAL	**37**

Suggested reference material:

(1) *Linear Algebra* – G. Strang, "Introduction to linear algebra", 4th Edition, Wellesley Cambridge Press.

(2) *Ordinary Differential Equations* – G.F. Simmons, "Differential equations with applications and historical notes", 2nd Edition.

Main differences suggested in this review:

(1) The course content has been changed. The new MTH102 covers the topics of linear algebra and ordinary differential equations.

(2) The contents are similar to that covered under similar topics in MTH102 and MTH203, earlier.

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