ENGINEERING MATHEMATICS - I

MAT 1151

Differential equations and applications:

- First order differential equations, Basic applications.
- Methods of solving first order differential equations
- Higher order differential equations: Solution of homogeneous and nonhomogeneous linear equations.
- Cauchy and Legendre's differential equations.
- Solution of system of differential equations

References: 'A short course in differential equations' by **Rainville E.D. and Bedient P.E**

'Advanced Engineering Mathematics' by **Kreyzig E**

'Higher Engineering Mathematics' by **B.S.Grewal**

MATRIX ALGEBRA:

- **Matrices**: Elementary column and row transformations, Inverse of a matrix by elementary row operations, Echelon form and rank of a matrix.
- **System of linear equations:** Consistency, Solution by Gauss elimination, Gauss Jordon, Gauss Jacobi and Gauss Seidel methods.
- **Eigen values and Eigen vectors:** Elementary properties, Computation of largest eigen value by power method.

References:

‘Higher Engineering Mathematics’ by **B.S.Grewal**

‘Introductory methods of Numerical analysis’ by **Sastry S S**

‘Advanced Engineering Mathematics’ by **Kreyzig E**

LINEAR ALGEBRA:

- Generalization of vector concept to higher dimensions, Generalized vector operations, Vector spaces and sub spaces, Linear independence and dependence, Basis.
- Gram- Schmidt process of orthogonalization.

References: ‘Linear Algebra’ by **G. Hadley**

`Elementary Linear Algebra – A Matrix Approach’ by Lawrence E Spence, Arnold J Insel, Stephen H Friedberg

NUMERICAL METHODS – I :

Interpolation:

- Finite differences and divided differences.
- Newton-Gregory and Lagrange’s interpolation formulae.
- Newton’s divided difference interpolation formula.
- Numerical differentiation.
- Numerical integration: Trapezoidal rule, Simpson’s one third rule and Simpson’s three eighth rule.

References: Introductory methods of Numerical analysis’ by **Sastry S.S**

‘Higher Engineering Mathematics’ by **B S Grewal**

NUMERICAL METHODS – II:

Solution of Algebraic and Transcendental equations:

- Bisection method, Method of false position, Iteration method, Newton-Raphson method.
- Solution of System of Non-linear equations using Newton-Raphson method.

Numerical solution of ordinary differential equations:

- Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta methods.

References: 'Introductory methods of Numerical analysis' by **Sastry S.S**

'Higher Engineering Mathematics' by **B S Grewal**

LIST OF FORMLAE

TRIGONOMERTY:

Fundamental Identities :

(i) $\cos^2\theta + \sin^2\theta = 1$

(ii) $1 + \tan^2\theta = \sec^2\theta$

(iii) $\cot^2\theta + 1 = \operatorname{cosec}^2\theta$

Addition and Subtraction formulae:

$$\sin(x \pm y) = \sin x . \cos y \pm \cos x . \sin y$$

$$cos(x \pm y) = cosx.cosy \mp sinx.siny$$

$$\tan(x \pm y) = \frac{tanx \pm tany}{1 \mp tanx.tany}$$

Transforming product into sum :

sin x. cos y = ½ [sin (x + y) + sin (x – y)]

cos x. sin y = ½ [sin (x + y) – sin (x – y)]

cos x. cos y = ½ [cos (x + y) + cos (x – y)]

sin x. sin y = ½ [cos (x – y) – cos (x + y)]

Transforming sum into product:

$$\sin C + \sin D = 2\sin\left(\frac{C+D}{2}\right) cos\left(\frac{C-D}{2}\right)$$

$$\sin C - \sin D = 2\cos\left(\frac{C+D}{2}\right) sin\left(\frac{C-D}{2}\right)$$

$$\cos C + \cos D = 2\cos\left(\frac{C+D}{2}\right) cos\left(\frac{C-D}{2}\right)$$

$$\cos C - cos\, D = -2\sin\left(\frac{C+D}{2}\right) sin\left(\frac{C-D}{2}\right)$$

Formulae for multiple angles:

$$\sin 2A = 2\sin A\cos A = \frac{2tanA}{1+\tan^2 A}$$

$$cos2A = \cos^2 A - \sin^2 A = 1 - 2\sin^2 A = 2\cos^2 A - 1 = \frac{1-\tan^2 A}{1+\tan^2 A}$$

$$\tan 2A = \frac{2\tan A}{1-\tan^2 A}$$

$$\sin 3A = 3\sin A - 4\sin^3 A$$

$$\cos 3A = 4\cos^3 A - 3cos\, A$$

$$tan3A = \frac{3tanA - \tan^3 A}{1-3\tan^2 A}$$

Differential Calculus:

Rules of differentiation:

1) $\frac{d}{dx}(uv) = u\frac{dv}{dx} + v\frac{du}{dx}$ (Product Rule)

2) $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$ (Quotient Rule)

3) $If\ u = f\,(z)\ and\ z = g\,(x)$, then $\frac{du}{dx} = \frac{du}{dz}.\frac{dz}{dx}$ (Chain Rule)

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

$$\frac{d}{dx}(e^x) = e^x$$

$$\frac{d}{dx}(a^x) = a^x log_e a$$

$$\frac{d}{dx}(\log_e x) = \frac{1}{x}$$

$$\frac{d}{dx}(\sin x) = cosx$$

$$\frac{d}{dx}(cosx\ ) = -sinx$$

$$\frac{d}{dx}(\tan x) = \sec^2 x$$

$$\frac{d}{dx}(sec\ x) = secx\ tanx$$

$$\frac{d}{dx}(\cot x) = -cosec^2 x$$

$$\frac{d}{dx}(\operatorname{cosec} x) = -cosecx\ cotx$$

$$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$$

$$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$$

$$\frac{d}{dx}(\cot^{-1} x) = -\frac{1}{1+x^2}$$

$$\frac{d}{dx}(\sec^{-1} x) = \frac{1}{x\sqrt{x^2-1}}$$

$$\frac{d}{dx}(\operatorname{cosec}^{-1} x) = -\frac{1}{x\sqrt{x^2-1}}$$

Integral Calculus:

$$\int x^n dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) + \mathrm{c}$$

$$\int \frac{1}{x} dx = \log_e x + \mathrm{c}$$

$$\int e^x dx = e^x + \mathrm{c}$$

$$\int a^x dx = \frac{a^x}{\log_e a} + \mathrm{c}$$

$$\int sinx\, dx = -cosx + \mathrm{c}$$

$$\int cosx\, dx = sinx + \mathrm{c}$$

$$\int tanx\, dx = -\log|cos\, x| + \mathrm{c}$$

$$\int cotx\, dx = \log|sinx| + \mathrm{c}$$

$$\int secx\, dx = \log|secx + tanx| + \mathrm{c}$$

$$\int cosecx\, dx = \log|cosecx - cotx| + \mathrm{c}$$

$$\int \sec^2 x\, dx = tanx + \mathrm{c}$$

$$\int \mathrm{cosec}^2\, x\, dx = -cotx + \mathrm{c}$$

$$\int \frac{dx}{a^2+x^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right) + c$$

$$\int \frac{dx}{\sqrt{a^2-x^2}} = \sin^{-1}\left(\frac{x}{a}\right) + c$$

$$\int \frac{dx}{a^2-x^2} = \frac{1}{2a} log \left| \frac{a+x}{a-x} \right| + c$$

$$\int \frac{dx}{\sqrt{a^2+x^2}} = log\left(x + \sqrt{a^2 + x^2}\right) + c$$

$$\int \frac{dx}{x^2-a^2} = \frac{1}{2a} log \left| \frac{x-a}{x+a} \right| + c$$

$$\int \frac{dx}{\sqrt{x^2-a^2}} = log\left(x + \sqrt{x^2 - a^2}\right) + c$$

$$\int \sqrt{a^2 + x^2}\,dx = \frac{x}{2}\sqrt{a^2 + x^2} + \frac{a^2}{2} log\left(x + \sqrt{a^2 + x^2}\right) + c$$

$$\int \sqrt{x^2 - a^2}\,dx = \frac{x}{2}\sqrt{x^2 - a^2} - \frac{a^2}{2} log\left(x + \sqrt{x^2 - a^2}\right) + c$$

$$\int \sqrt{a^2 - x^2}\,dx = \frac{x}{2}\sqrt{a^2 - x^2} + \frac{a^2}{2}\sin^{-1}\left(\frac{x}{a}\right) + c$$

$$\int e^{ax} sinbx\,dx = \frac{e^{ax}}{a^2+b^2}(asinbx - bcosbx) + c$$

$$\int e^{ax} cosbx\,dx = \frac{e^{ax}}{a^2+b^2}(acosbx + bsinbx) + c$$