Unit 1

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* Polar form:- $x = r\cos\theta$, $y = r\sin\theta$, $dx\,dy = r\,dr\,d\theta$

* Volume under $z = f(x,y)$ & above R

$$= \iint_R f(x,y)\,dx\,dy$$

* Ellipsoid :- $x = ar\cos\theta$, $y = br\sin\theta$, $dx\,dy = ab\,r\,dr\,d\theta$

* Cylindrical:- $x = r\cos\theta$ $y = r\sin\theta$ $z = z$

$$dx\,dy\,dz = r\,dr\,d\theta\,dz$$

* Spherical :- $x = r\sin\theta\cos\phi$, $y = r\sin\theta\cos\phi$, $z = r\cos\theta$

$$dx\,dy\,dz = r^2\sin\theta\,dr\,d\theta\,d\phi$$

* MOI = $I_x = \iiint_V (y^2+z^2)\,F(x,y,z)\,dV$

* Mass = $\iiint_V \rho(x,y,z)\,dV$

Unit - 2

→ Unit Normal = $\dfrac{\nabla\phi}{|\nabla\phi|}$

→ DD along $f(x) = \nabla\phi \cdot \dfrac{\nabla f}{|\nabla f|}$

→ Surface integral = $\iint_S F \cdot n\,ds$

$ds = \dfrac{dx\,dy}{|\hat{n} \cdot \hat{k}|}$ → $\hat{n}$ = unit normal to S

$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

~~$r = 2t\,\hat{i} + t^2\hat{j} + t^3\hat{k}$~~

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→ Greens theorem:-

$$\int_C M\,dx + N\,dy = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right) dx\,dy$$

in vector form $= \iint (\text{curl } \vec{F} \cdot \hat{k})\, dx\,dy$

* Area $= \frac{1}{2} \oint_C (x\,dy - y\,dx)$

→ Stoke's theorem:-

$$\int_C \vec{F} \cdot \vec{dr} = \iint_S \text{curl } \vec{F} \cdot \hat{n}\, ds$$

→ Gauss Divergence :-

$$\int_S \vec{F} \cdot \hat{n}\, ds = \iiint_V \text{div } \vec{F}\, dV$$

Unit - 3

* $\mathcal{L}\{f(t)\} = \int_0^\infty e^{-st} f(t)\,dt$
* $\mathcal{L}\{f(at)\} = \frac{1}{a} F\left(\frac{s}{a}\right)$
* $\mathcal{L}\{k\} = \frac{k}{s}$
* $\mathcal{L}\{e^{at}\} = \frac{1}{s-a}$
* $\mathcal{L}\{\sin at\} = \frac{a}{s^2+a^2}$
* $\mathcal{L}\{\cos at\} = \frac{s}{s^2+a^2}$
* $\mathcal{L}\{\sinh at\} = \frac{a}{s^2-a^2}$
* $\mathcal{L}\{\cosh at\} = \frac{s}{s^2-a^2}$
* $\mathcal{L}\{a^t\} = \frac{1}{s - \ln a}$

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* $\mathcal{L}\{t^n\} = \frac{\Gamma(n+1)}{s^{n+1}}$

* $\mathcal{L}\{\sin\sqrt{t}\} = \frac{1}{2s}\sqrt{\frac{\pi}{s}}\cdot e^{-1/4s}$

* $\mathcal{L}\{e^{at} f(t)\} = F(s-a)$

* $\mathcal{L}\{u(t)\} = \frac{1}{s}$

* $\mathcal{L}\{u(t-a)\} = \frac{e^{-as}}{s}$

* $\mathcal{L}\{f(t-a)u(t-a)\}$
$= e^{-as}F(s)$

* $\int e^{ax}\sin bx = \frac{e^{ax}}{a^2+b^2}[a\sin bx - b\cos bx]$

$\int e^{ax}\cos bx = \frac{e^{ax}}{a^2+b^2}[a\cos bx + b\sin bx]$

* $\mathcal{L}\{t^n f(t)\} = (-1)^n \frac{d^n}{ds^n}(F(s))$

* $\mathcal{L}\left\{\frac{f(t)}{t}\right\} = \int_s^\infty F(s)\,ds$

* $\mathcal{L}(f'(t)) = sF(s) - f(0)$

* $\mathcal{L}(f''(t)) = s^2F(s) - sf(0) - f'(0)$

* $\mathcal{L}\{\underbrace{\iint\int}_{n} f(t)\,\underbrace{dt\,dt\,dt}_{n}\} = \frac{F(s)}{s^n}$

* $\underset{\hookrightarrow \text{periodic}}{\mathcal{L}\{f(t)\}} = \frac{1}{1-e^{-sT}}\int_0^T e^{-st} f(t)\,dt$

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Unit 5

* $f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$

$a_0 = \frac{1}{l} \int_{-l}^{l} f(x)\, dx$ $\quad a_n = \frac{1}{l} \int_{-l}^{l} f(x) \cos nx\, dx$

$b_n = \frac{1}{l} \int_{-l}^{l} f(x) \sin nx\, dx$

* Nature	a_0	a_n
even	$\frac{2}{l} \int_0^l f(x)dx$	$\frac{2}{l} \int_0^l f(x) \cos\left(\frac{n\pi x}{l}\right) dx$
odd	0	0

	b_n	FS
odd	0	$\frac{a_0}{2} + \sum a_n \cos\left(\frac{n\pi x}{l}\right)$
even	$\frac{2}{l} \int_0^l f(x) \sin\left(\frac{n\pi x}{l}\right) dx$	$\sum b_n \sin\left(\frac{n\pi x}{l}\right)$

* $f(x)$ is discontinuous on a point

$$f(x) = \frac{1}{2}\left[f(x^-) + f(x^+)\right]$$

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* Complex form $= f(x) = \sum_{-\infty}^{\infty} c_n e^{\frac{in\pi x}{l}}$

$$C_n = \frac{1}{2l}\int_{-l}^{l} f(x)\, e^{-i\left(\frac{n\pi x}{l}\right)} dx$$

* Parseval's formula:-

$$\int_{-l}^{l} \left(f(x)\right)^2 dx = l\left[\frac{a_0^2}{2} + \sum_{n=1}^{\infty} (a_n^2 + b_n^2)\right]$$

(full series FS)

$$\int_{0}^{l} \left(f(x)\right)^2 dx = \frac{l}{2}\left[\frac{a_0^2}{2} + \sum_{n=1}^{\infty} a_n^2\right]$$

(Cosine series)

* Harmonic analysis

$$a_n = \frac{2}{N}\sum y \cos\left(\frac{n\pi x}{l}\right)$$

$$b_n = \frac{2}{N}\sum y \sin\left(\frac{n\pi x}{l}\right)$$

→ Amplitude of n^{th} harmonic $= \sqrt{a_n^2 + b_n^2}$

→ FS upto 1^{st} harmonic $= \frac{a_0}{2} + a_1\cos\theta + b_1\sin\theta$

$$\ldots\ldots = \frac{a_0}{2} + a_1\cos\theta + b_1\sin\theta + a_2\cos 2\theta + b_2\sin 2\theta$$

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