Maths

$u(x,y) = x^2 + y^2 + 2y - \sin(x)\sinh y$

$u_x = 2x - \cancel{\sin y}\cos(x)\sinh y$

$\phi_1(z,0) = 2z$

$\cancel{\phi_2(z,0)}\ u_y = -2y + 2 - \sin x\cosh y$

$\phi_2(z,0) = 2 - \sin z$

$f'(z) = \phi_1 - i\phi_2$

$= 2z - i(2 + \sin z)$

$f'(z) = 2z - 2i + i\sin z$

$f(z) = \int (2z - 2i + i\sin z)\,dz$

$= z^2 - 2iz - i\cos z$ $\quad -i(-i\sinh)$

$= (x+iy)^2 - 2i(x+iy) - i\cos(x+iy)$

$= x^2 - y^2 + 2ixy - 2ix + 2y - i[\cos x\cos iy - \sin x\sin iy]$

$= x^2 - y^2 + 2ixy - 2ix + 2y - i\cos x\cosh y - \sin x\sinh y$

$f(z) = x^2 - y^2 - \sin x\sinh y + 2y + i[2xy - 2x - \cos x\cosh y]$

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A) $\mathcal{L}\{\sin^2 t \cos^3 t\}$

$$= \mathcal{L}\left\{\frac{1-\cos 2t}{2} \cdot \frac{1}{4}(3\cos t + \cos 3t)\right\}$$

$$= \frac{1}{8}\mathcal{L}\left\{(1-\cos 2t)(3\cos t + \cos 3t)\right\}$$

$$= \frac{1}{8}\mathcal{L}\left\{3\cos t + \cos 3t - 3\cos 2t \cdot \cos t - \cos 3t \cdot \cos 2t\right\}$$

$$= \frac{1}{8\times 2}\mathcal{L}\left\{6\cos t + 2\cos 3t - 3[\cos 3t + \cos t] - [\cos 5t + \cos t]\right\}$$

$$= \frac{1}{16}\mathcal{L}\left\{6\cos t + 2\cos 3t - 3\cos 3t - 3\cos t - \cos 5t - \cos t\right\}$$

$$= \frac{1}{16}\mathcal{L}\left\{2\cos t - \cos 3t - \cos 5t\right\}$$

$$= \frac{1}{16}\left[\frac{2s}{s^2+1} - \frac{s}{s^2+9} - \frac{s}{s^2+25}\right]$$

Information => Seat No:- 42213077
Sem :- III
Subject:- Maths

Signature :- S.D.Shetty

B)

$\bar{x} = 65 \quad \bar{y} = 65$

x	y	dx	dy	$dxdy$	dx^2	dy^2
61	64	-4	-1	4	16	1
63	62	-2	-3	6	4	9
65	65	0	0	0	0	0
67	70	2	5	10	4	25
69	72	4	7	28	16	49
		$\Sigma dx = 0$	$\Sigma dy = 8$	$\Sigma dxdy = 48$	$\Sigma dx^2 = 40$	$\Sigma dy^2 = 84$

$N = 5$

$$r = \frac{\Sigma dxdy - \frac{(\Sigma dx)(\Sigma dy)}{N}}{\sqrt{\Sigma dx^2 - \frac{(\Sigma dx)^2}{N}}\sqrt{\Sigma dy^2 - \frac{(\Sigma dy)^2}{N}}}$$

$$= \frac{48 - \frac{0 \times 8}{5}}{\sqrt{40-0} \times \sqrt{84 - \frac{64}{5}}} = \frac{48}{\sqrt{40}\sqrt{71.2}}$$

$$r = \frac{48}{53.36}$$

$$r = 0.8996$$

Information => Seat No :- 42213077

Sem :- III

Subject :- Maths

Signature :- S.D.Shetty

x	y	R_x	R_y	$d_i = R_x - R_y$	d_i^2
61	64	5	4	1	1
63	62	4	5	-1	1
65	65	3	3	0	0
67	70	2	2	0	0
69	72	1	1	0	0

$\Sigma d_i^2 = 2$

$n = 5$

$$R = 1 - \left[\frac{6 \Sigma d_i^2}{n^3 - n}\right]$$

$$= 1 - \frac{6(2)}{5^3 - 5}$$

$$= 1 - \frac{12}{120}$$

$$= \frac{9}{10}$$

$R = 0.9$

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Sem :- III
Signature :- S.D.Shetty
Subject :- Maths

c) $f(x) = x\sin x$

$f(x) = x\sin x$
$f(-x) = x\sin x$

$\therefore f(x) = \text{even}$

$b_n = 0 \ , \ L = \pi$

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

$$a_0 = \frac{2}{L} \int_0^L f(x)\, dx$$

$$= \frac{2}{\pi} \int_0^{\pi} x\sin x \, dx$$

$$= \frac{2}{\pi} \Big[x(-\cos x) - (-\sin x) \Big]_0^{\pi}$$

$$= \frac{2}{\pi} \Big[-x\cos x + \sin x \Big]_0^{\pi} = \frac{2}{\pi} \Big[+\pi \Big] = 2$$

Information => Seat No:- ~~48~~ 42213077
Sem :- III
Subject:- Maths

Signature:- S.D.Shetty

$$a_n = \frac{2}{l}\int_0^l f(x)\cos nx\,dx$$

$$= \frac{2}{\pi}\int_0^\pi x\sin x\cos nx\,dx$$

$$= \frac{2}{2\pi}\int_0^\pi 2x\sin x\cos nx\,dx$$

$$= \frac{1}{\pi}\int_0^\pi x[\sin(n+1)x + \sin(n-1)x]\,dx$$

$$= \frac{1}{\pi}\left[x\left[\frac{-\cos(n+1)x}{(n+1)} - \frac{\cos(n-1)x}{n-1}\right] - 1\left[\frac{-\sin(n+1)x}{(n+1)^2} - \frac{\sin(n-1)x}{(n-1)}\right]\right]_0^\pi$$

$$= \frac{1}{\pi}\left[\pi\left(\frac{-\cos(n+1)\pi}{n+1} - \frac{\cos(n-1)\pi}{n-1}\right)\right]$$

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

$$= (-1)^n\left[\frac{-1-1}{n^2-1}\right] = \left[\frac{-2(-1)^n}{n^2-1}\right] = a_n$$

Information => Seat No:- 42213077

Sem :- III

Subject :- Maths

Signature:- S D shetty

This method fails for $n=1$

$$= \frac{2}{\pi}\int_0^{\pi} x\sin 2x\,dx$$

$$= \frac{2}{\pi}\left[x\left(\frac{-\cos 2x}{2}\right)-(1)\left(\frac{-\sin 2x}{4}\right)\right]_0^{\pi}$$

$$= \frac{2}{\pi}\left[\frac{-\pi}{2}(1)\right]$$

$$f(x) = \frac{a_0}{2} + a_1\sin x + \sum_{n=2}^{\infty} a_n f(x)\cos nx\,dx$$

$$= \frac{2}{2} + (-1)\sin x + \sum \frac{(-2)(-1)^n}{n^2-1}\, x\sin x\cos nx\,dx$$

$$= 1 - \sin x + \sum_{n=2}^{\infty} \frac{(-2)(-1)^n}{n^2-1}\, x\sin x\cos nx\,dx$$

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Sem :- III
Subject :- Maths

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