

INITIAL
Syllabus

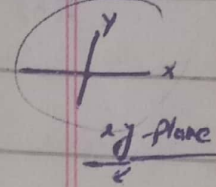
MTH201

Objective

ten 44-45

(END Term)

① Intersection of two straight line is _____
⇒ plane



② Plane is a _____ surface.

⇒ Two dimensional

③ straight line is special kind of _____
⇒ plane

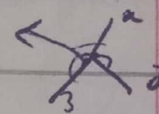
④ A n order triple corresponds to _____ in
three dimensional space. $(n, 0, 3)$

⇒ Three point

unique point, (not confirmed)

⑤ The angle which a line makes with
positive x, y, z are known as _____

⇒ Direction angles



⑥ What is Laplace transform of function $f(t)$ if $F(t) = t$?

$f(t)$ if $F(t) = t$?

$$\Rightarrow L\{t\} = \frac{t}{s}$$

Constant #

$$L\{a\} = \frac{a}{s}$$

$$L\{4\} = \frac{4}{s}$$

⑦ What is value $L\{e^{st}\}$ if L denot Laplace trans (t)

$$L\{e^{-at}\} = \frac{1}{s+a}$$

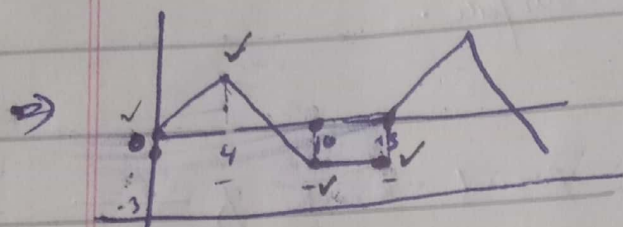
$$\Rightarrow L\{e^{st}\} = \frac{1}{s-s}$$

change sign

$$L\{e^{at}\} = \frac{1}{s-a}$$
$$L\{e^{4t}\} = \frac{1}{s-4}$$

8. Match the following periodic function with graph.

$$f(x) = \begin{cases} \frac{x}{4} & 0 < x < 4 \\ 7-x & 4 < x < 10 \\ -3 & 10 < x < 13 \end{cases}$$



$$\begin{matrix} 0 < x < 4 & \textcircled{1} \\ 4 < x < 10 & \textcircled{2} \\ 10 < x < 13 & \textcircled{3} \end{matrix} \Bigg\} \text{so}$$

9. Polar co-ordinate of point are $(-2, -3\pi/2)$.
which of following is another possible polar-co-ordinate representation of this point?

→ $(2, -\pi/2)$

∴ $(-r, \theta)$

$(r, \theta + \pi)$ (قسم زنی)

$(2, \frac{-3\pi}{2} + \pi) \Rightarrow (\frac{-3\pi + 2\pi}{2})$

$(2, -\pi/2)$ $(-\pi/2)$

10. function $f(x) = x^3 e^x$

→ Neither even nor odd

Point
→ $\boxed{\text{even} = f(x) = f(x)}$
 $f(x) = x^2 \Rightarrow f(-x) = x^2 = f(x)$

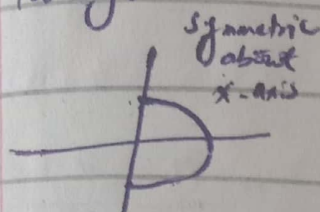
→ $\boxed{\text{odd} = f(x) = -f(x)}$
 $\begin{cases} f(x) = x^3 \\ f(-x) = (-x)^3 = -x^3 = -f(x) \end{cases}$

→ e^x $\begin{matrix} \text{not even} \\ \text{not odd} \end{matrix}$ $\boxed{\text{Neither}}$

→ $e^{(-x)^2} \rightarrow \boxed{\text{even}}$

$\begin{matrix} +r \\ EE = E \\ OE = O \\ ON \rightarrow N \\ EN \rightarrow N \end{matrix} \Bigg\} \text{Neither}$
 $\begin{matrix} +r \\ OO = E \\ EO = O \end{matrix} \Bigg\}$

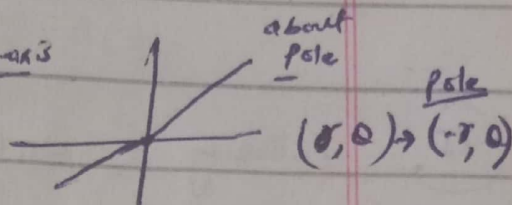
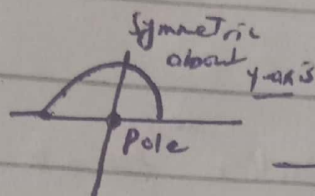
① If the ~~direction~~ of the curve, in polar coordinates, remain unchanged after replacing (r, θ) by $(-r, \theta)$ then the curve is said to be symmetric about origin.



$$(r, \theta) \rightarrow (r, \pi - \theta)$$

about y-axis

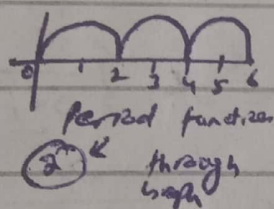
⇒ Pole



$$\begin{cases} (r, \theta) \rightarrow (r, -\theta) \\ \text{Symmetric about initial line} \end{cases}$$

② what is amplitude of periodic function defined by $f(x) = \sin \frac{x}{3}$

⇒ 1



Amplitude

$$y = A \sin nx$$

③ Is the function $f(x, y)$ continuous at origin.

If not, why?

$$f(x, y) = \frac{xy}{x^2 + y^2}$$

$$\lim_{(x, y) \rightarrow (0, 0)} \frac{xy}{x^2 + y^2}$$

⇒ $\lim_{(x, y) \rightarrow (0, 0)} f(x, y)$ limit does not exist

(+)

(14) sign of line integral is reserved when

→ Direction of path of integration is reversed.

$$\int_a^b f(x) dx \quad \text{and} \quad -\int_b^a f(x) dx$$

→ sign changed, limit change

(15) Following is wallis ^{sine} formula when n is even and $n \geq 2$?

$$\Rightarrow \int_0^{\pi/2} \sin^n x dx = \frac{\sqrt{\pi}}{2} \frac{(n-1)(n-3)(n-5) \dots 5 \cdot 3 \cdot 1}{n(n-2)(n-4) \dots 6 \cdot 4 \cdot 2}$$

→ if n is even $\frac{\pi}{2}$
 → if n is odd $\frac{\pi}{2}$

odd $\rightarrow \frac{n-1}{n} \cdot \frac{n-3}{n-2} \cdot \frac{n-5}{n-4} \dots$
 even $\rightarrow \frac{n-1}{n} \cdot \frac{n-3}{n-2} \cdot \frac{n-5}{n-4} \dots$

(16) What is Laplace inverse transform $\frac{1}{s+1}$

$$\Rightarrow L^{-1}\left\{\frac{1}{s+1}\right\} = e^{-t}$$

$e^{-t} = L^{-1}\left\{\frac{1}{s+1}\right\}$

$L\{e^{-at}\} = \frac{1}{s+a}$
 $L^{-1}\left\{\frac{1}{s+a}\right\} = e^{-at}$

→ ve sign + sing
 limit $t = 0$ to ∞

(17) What is Laplace Inverse transform $\frac{5}{s^2+25}$

$$\Rightarrow L^{-1}\left\{\frac{5}{s^2+25}\right\} = \sin 5t$$

$L\{\sin at\} = \frac{a}{s^2+a^2}$
 $L\{\cos at\} = \frac{s}{s^2+a^2}$
 $L\{\sinh at\} = \frac{a}{s^2-a^2}$
 $L\{\cosh at\} = \frac{s}{s^2-a^2}$

what is parametric equation that following vector eq

$$r(t) = (2t-1)\underline{i} - 3\sqrt{t}\underline{j} + \sin 3t\underline{k}$$

$$x = 2t-1 \quad y = -3\sqrt{t} \quad z = \sin 3t$$

or $\vec{r} = x\underline{i} + y\underline{j} + z\underline{k}$
 $\vec{r} = (2t-1)\underline{i} - 3\sqrt{t}\underline{j} + \sin 3t\underline{k}$

$$r(t) = x(t)\underline{i} + y(t)\underline{j} + z(t)\underline{k}$$

Parametric equ. separate

$$x = x(t)$$

$$y = y(t)$$

$$z = z(t)$$

What is derivative following vector-valued function

$$r(t) = (\cos 5t, \tan t, 6\sin t)$$

$$\cos 5t \Rightarrow -5 \sin 5t$$

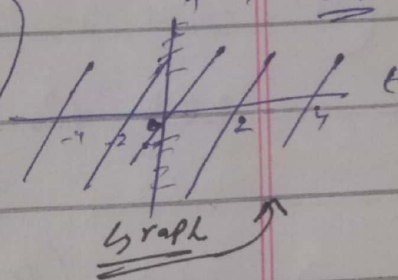
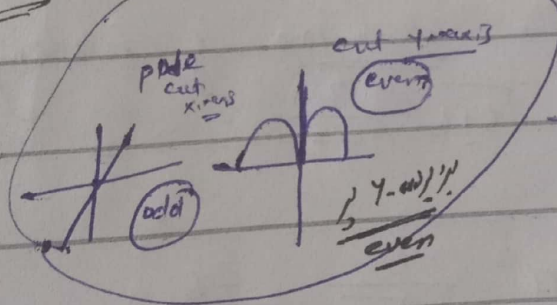
$$\tan t = \sec^2 t$$

$$6 \sin t = 6 \cos t$$

$$\Rightarrow r'(t) = (-5 \sin 5t, \sec^2 t, 6 \cos t)$$

The graph of 'Saw tooth wave' given above

$\Rightarrow$ odd



(2) $w = f(x, y, z)$ and $x = g(r, s)$, $y = h(r, s)$, $z = t(r, s)$

$$\frac{\partial w}{\partial r} = ?$$

$$\Rightarrow \frac{\partial w}{\partial x} \cdot \frac{\partial x}{\partial r} + \frac{\partial w}{\partial y} \cdot \frac{\partial y}{\partial r} + \frac{\partial w}{\partial z} \cdot \frac{\partial z}{\partial r}$$

(22) parametric equations that correspond to following vector

$$r(t) = \sin^2 t \mathbf{i} + (1 - \cos 2t) \mathbf{j}$$

$$\Rightarrow x = \sin^2 t \quad y = 1 - \cos 2t \quad z = 0$$

(23) what is $\mathcal{L}\{-6\}$ if $\mathcal{L}$ denotes Laplace transform?

$$\Rightarrow \mathcal{L}\{-6\} = \frac{-6}{s} \quad \mathcal{L}\{a\} = \frac{a}{s}$$

(24) evaluate the line integral, the integral expressed in term of x, y, z with.

$$\Rightarrow d\mathbf{r} = dx\mathbf{i} + dy\mathbf{j} + dz\mathbf{k} \quad \leftarrow \text{(Formula)} \quad F(t) = d\mathbf{r}$$

$$d\mathbf{r} = dx\mathbf{i} + dy\mathbf{j} + dz\mathbf{k}$$

(25) what is the derivative of following vector-valued function

$$r(t) = t^4, \sqrt{t+1}, \frac{3}{t^2}$$

$$\Rightarrow \dot{r}(t) = \left(4t^3, \frac{1}{2\sqrt{t+1}}, -\frac{6}{t^3} \right)$$

(26) following differential is exact

$$dz = (x^2y + y)dx - xdy$$

$\Rightarrow$ False

Exact diff

$$Pdx + Qdy$$

$$\frac{dP}{dy} \stackrel{?}{=} \frac{dQ}{dx}$$

$\Rightarrow$ false, not exact (2) $\neq$ (1)

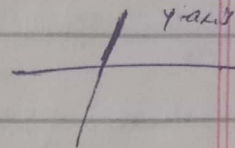
Q7 what is Laplace transform of function $F(t)$ (s is constant)

$\Rightarrow \int_0^{\infty} e^{-st} F(t) dt$

 $\xrightarrow{\text{Formula}} L\{F(t)\}$
 $\Rightarrow \int_0^{\infty} F(t) e^{-st} dt$

Q8 The graph of even function is symmetric about _____.

$\Rightarrow$ y-axis



Q9 which point vertex of parabola, represented by equation $y = x^2 - 4x + 3$ occur

$\Rightarrow (2, -1)$

 $\rightarrow x = \frac{-b}{2a}$

 $\frac{a x^2 + b x + c}{1 \quad -4 \quad 3}$

$= \frac{-(-4)}{2(1)} = \frac{4}{2} = 2$

$\Rightarrow y = 2^2 - 4(2) + 3 = 4 - 8 + 3 = -1$

Q10 equation $y = x^2 - 4x + 2$

$\Rightarrow (2, -2)$

$x = \frac{-b}{2a} = \frac{4}{2} = 2$

Q11 what is period of period function defined by?

$f(x) = \frac{4}{A} \cos 3x$

$\Rightarrow \frac{2\pi}{3}$

Period function $\frac{360}{n} = \frac{360}{3} = \frac{2\pi}{3}$

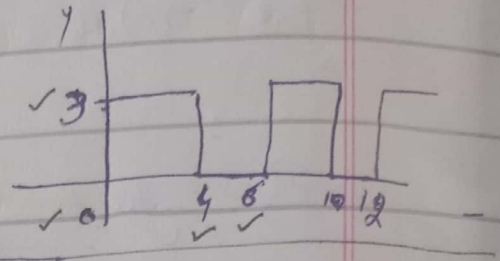
$\odot \sin \theta$
Amplitude

Amplitude $\Rightarrow 4$
digit like $\cos/\sin$

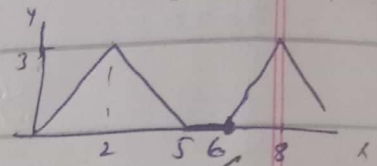
(32) following periodic function with graph.

$$f(x) = \begin{cases} \frac{4}{3} & 0 < x < 4 \\ 0 & 4 < x < 6 \end{cases}$$

⇒



33 What is Period of periodic function whose graph is as below.

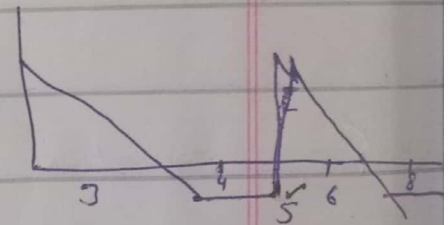


⇒ 6

Period is the distance between two consecutive peaks or troughs. ← Period

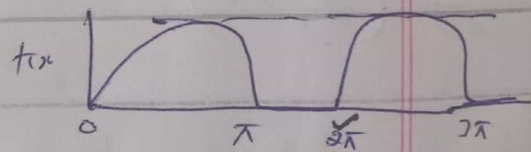
(34) What is period of periodic function

⇒ 5



(35) period of graph

⇒ 2π

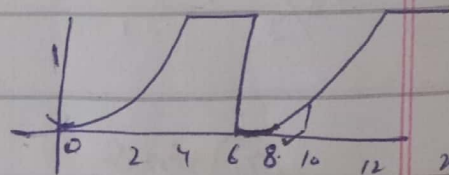


$$\text{equation } y = \sin 3x$$

$$\frac{360}{n} = \frac{360}{3}$$

(36) period of graph

⇒ 8



(37) L dense Laplace transform.

$$\lim_{t \rightarrow 0} \left[\frac{F(t)}{t} \right]$$

$$L\{F(t)\} = f(s) \text{ where } s \text{ dense and}$$

$$L\{F(t)\} = f(s)$$

$$\rightarrow \text{ii) } L\{tF(t)\} = -\frac{f'(s)}{s}$$

$$\Rightarrow L\left[\frac{F(t)}{t}\right] = \int_s^\infty f(s) ds$$

$$\text{ii) } L\left\{\frac{F(t)}{t}\right\} = \int_s^\infty f(s) ds$$

$$L\{e^{at} f(t)\} = f(s+a)$$

(38) which of following Laplace Inverse transform

$$f(s) = \frac{3}{s-2} - \frac{2}{s}$$

$$L\{ae^{st}\} = \frac{a}{s-a}$$

$$\Rightarrow 3e^{2t} - 2$$

$$\frac{3}{s-2} - \frac{2}{s} \Rightarrow 3e^{2t} - 2$$

(39) which of following is correct. $\int_0^{\pi/2} \sin^n x dx$

$$\int_0^{\pi/2} \sin^n x dx = \frac{3\pi}{16}$$

$$\text{Formula } \int_0^{\pi/2} \sin^n x dx = \frac{\pi/2 \cdot \frac{n-1}{n} \cdot \frac{n-3}{n-2} \cdot \frac{n-5}{n-4} \cdots \frac{1}{2}}$$

$$\begin{aligned} & \int_0^{\pi/2} \sin^4 x dx = \frac{\pi/2 \cdot \frac{4-1}{4} \cdot \frac{1}{2} \cdot \frac{1}{2}}{2} \\ & = \frac{\pi/2 \cdot \frac{3}{4} \cdot \frac{1}{2}}{2} \\ & = \frac{\pi/2 \cdot \frac{3}{8}}{2} = \frac{3\pi}{16} \end{aligned}$$

(40) Let (x_1, y_1, z_1) and (x_2, y_2, z_2) be any

two point in three dimensional space

$$\text{what does formula } \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2 + (z_2-z_1)^2}$$

~~Mid point of line joining these two points~~

$\Rightarrow$ Distance formula these two points

(41) Mid Point formula

$$\left(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2}, \frac{z_2 - z_1}{2} \right)$$

(42) let functions $P(x, y)$ and $Q(x, y)$ are finite and continuous on side and at boundary of a closed curve C in the xy -plane. if $(Pdx + Qdy)$ is an exact differential

closed curve

$$\oint_C (Pdx + Qdy) =$$



closed
curve
answer



zero

→ zero

(43) which one of following is correct formula when

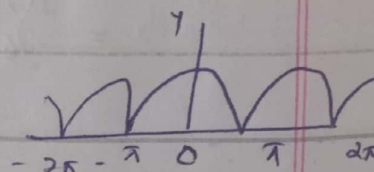
odd power n is odd and $n \geq 3$?

$$\Rightarrow \int \sin^n x dx = \frac{n-1}{n} \int \sin^{n-2} x dx - \frac{1}{n} \cos x \sin^{n-1} x$$

odd power
 $\pi/2, 1/2$

(44) Periodic function graph

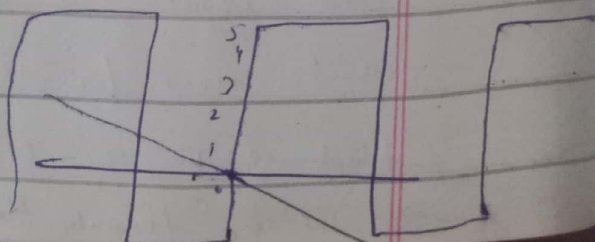
→ Even function.



$y = \cos x$ - even
Pole → odd
no pole → neither

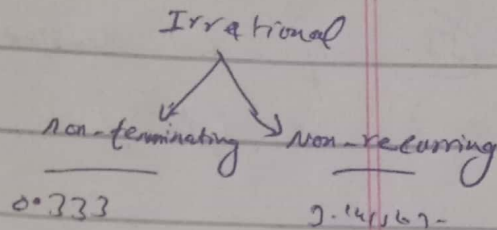
(45) function with graph

→ An odd function



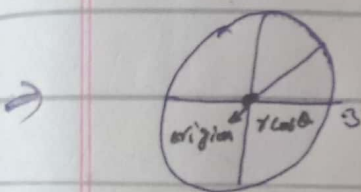
Q6 each point of domain, the function is defined

Q6 π is an example of irrational number



Q7 vector-valued function with graph.

$\mathbf{r}(t) = 3\cos t \mathbf{i} + 3\sin t \mathbf{j}$ and $0 \leq t < 2\pi$



$$\begin{aligned}
 x &= 3\cos t \\
 y &= 3\sin t \\
 x^2 + y^2 &= 9\cos^2 t + 9\sin^2 t \\
 x^2 + y^2 &= 9(\cos^2 t + \sin^2 t) \\
 \boxed{x^2 + y^2 = 9} &\rightarrow \text{circle form} \\
 x^2 + y^2 &= r^2
 \end{aligned}$$

Q8 What is period of periodic function $f(x) = \sin \frac{\pi}{2}x$?

$\Rightarrow 4\pi$

$\sin \frac{\pi}{2}x$ has period 2π (if $\sin \theta = 0$ then $\theta = 0, 2\pi, 4\pi, \dots$)
 $\sin \frac{\pi}{2}(x+4\pi) = \sin \frac{\pi}{2}x$

Q9 following condition must be satisfied for a vector field $\vec{F}$ to be conservative vector field:

$\Rightarrow \vec{\nabla} \times \vec{F} = 0$

close path = 0

(50) function $f(x) = x^2 \cos 2x$ is —

$$f(x) = (-x)^2 \cos 2(-x) \\ = x^2 \cos 2x$$

→ Even function

(51) If L denoted Laplace transform then
 $L(te^{st}) =$

$$\Rightarrow L(te^{st}) = \frac{1}{(s-s)^2}$$

اس مسئلے کے لیے "ایک" اور "دو" کے فرق کو دیکھنا
 اگر $L(te^{st}) = \frac{1}{(s-s)^2}$ اور $L(e^{st}) = \frac{1}{s-s}$ ہے

(52) Curl of vector function is always a —
 → Vector

$$\nabla \times \vec{A} \\ \left(\frac{\partial}{\partial x} \vec{i} + \frac{\partial}{\partial y} \vec{j} + \frac{\partial}{\partial z} \vec{k} \right) \times ()$$

(53) following is geometrical representation of the real number?
 → Co-ordinate Line

(54) following is interval notation of real line?
 → $(-\infty, +\infty)$

(55) what is distance between point $(3, 2, 0)$ & $(1, 0, -1)$?
 → 3

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2} \\ \sqrt{9} = 3$$

(56) following direction ratio for the line joining the point $(1, 3, 5)$ and $(2, -1, 4)$?

$$\Rightarrow 1, -4, -1$$

(57) In three dimensional space, the equation $y = x^2$ always represent. —

$\Rightarrow$ Parabola

(58) function $f(x, y, z)$ is equation $\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} = 0$ known

$\Rightarrow$ Laplace's Equation

(59) function $f(x, y, z)$ is equation $\frac{\partial f}{\partial x} + \frac{\partial f}{\partial y} + \frac{\partial f}{\partial z} = 0$ Euler's equation

(60) Every differentiable function is always —

$\Rightarrow$ Continuous

(61) Gradient of scalar function always results — function.

$\Rightarrow$ Vector

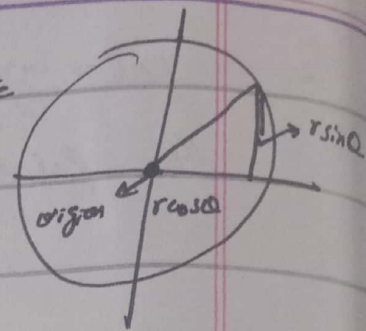
(62) Two normal lines surface $f(x, y, z) = 0$ and $g(x, y, z) = 0$ are orthogonal if and only if — where f_x, f_y, f_z

and g_x, g_y, g_z are directional ratios two normal lines

$$\Rightarrow f_x g_x + f_y g_y + f_z g_z = 0$$

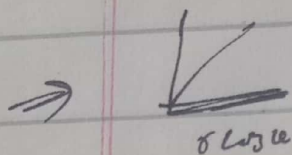
(63) following equation in polar co-ordinate with graph. $r \cos \theta = a$

where a is an arbitrary constant.



$$r \cos \theta = a$$

$$r \sin \theta = a$$



(64) Polar co-ordinate of point are $(-2, -3\pi/2)$

where another possible polar co-ordinate represent point?

plus π
 $\Rightarrow (2, -\pi/2)$

$-3\pi/2 + \pi$ ^{p add}
 $= -3\pi/2 + 2\pi$
 $= -\pi/2$
 $\Rightarrow (2, -\pi/2)$

(65) If equation of curve, in polar co-ordinate remain unchanged after replacing (r, θ) by $(r, -\theta)$ then curve said to be symmetric about

$\Rightarrow$ initial line

(66) integral $\iint_R f(x, y) dx dy$, after converting to polar coordinate it will become — where $a < \theta < b$ and $c < r < d$

$$\Rightarrow \int_a^b \int_c^d f(r, \theta) r dr d\theta$$

67 graph of equation $r = 3i + 2j - k$ is point —
 $\Rightarrow (3, -2, -1)$

68 if $R(t)$ is the anti-derivative of a given vector valued defined $\dot{r}(t) \hat{=}$ e, $\dot{R}(t) = \dot{r}(t)$
 then $\int_a^b \dot{r}(t) dt = \underline{\hspace{2cm}}$

$\Rightarrow R(b) - R(a)$ ~~where $\dot{r}$ is constant~~ ^{$\dot{r}$ is constant}

69 given vector of function $r_1(t)$ and $r_2(t)$ $\frac{d}{dt}(r_1 \times r_2)$
 — where 'x' and '.' represent cross and dot product.

$$\Rightarrow \dot{r}_1 \times \frac{dr_2}{dt} + \frac{dr_1}{dt} \times r_2$$

70 A vector valued function $\dot{r}(t) = x(t)i + y(t)j + z(t)k$
Continuous if —

$\Rightarrow$ All of its components are necessarily differentiable.

71 A single curve can be represent by — vector
 value function

$\Rightarrow$ single

(72) A function is said to be smooth if its derivative is — on any value of its domain.

⇒ Continuous and non-zero.

(73) Point $(-42, 35^\circ)$ and the point — are the same in polar system

⇒ $(42, 215^\circ)$ $\left(\begin{matrix} \text{Distance from origin} \\ \text{Angle from positive x-axis} \end{matrix} \right) = 215$

(74) If $\vec{r}(t) = 3t^2\hat{i} + 2t\hat{j}$; then $\int \vec{r}(t) dt =$ —

⇒ $t^3\hat{i} + t^2\hat{j} + C$

(75) In polar co-ordinate system, the equation $r=a$ represent a circle with center at —

⇒ origin

(76) The graph of equation $r = a(1 + \sin\theta)$ is symmetric about

⇒ y-axis

$\sin \rightarrow y$ -axis

(77) differential equation $dx = x^2 dx + y^2 dy$ is an exact diff

⇒ True

- (78) Arc length of portion of the circle helix
where $(dx/dt) = -\sin t$, $dy/dt = \cos t$ and
 $dz/dt = 1$ and $0 \leq t \leq \pi$ arc length.

$$\Rightarrow L = \int_0^{\pi} \sqrt{2} dt$$

- (79) Smooth vector-valued function has a — line at
every point on its graph.

→ tangent

- (80) A parametric curve 'C' in 2 space or 3 space
is called — if it is graph of some smooth
vector-valued function.

→ Smooth

- (81) If $\vec{r}(t) = t\vec{i} + 2t\vec{j}$, then $\frac{d}{dt} |\vec{r}(t)| = \underline{\hspace{2cm}}$

→ $\vec{i} + 2\vec{j}$

- (82) $\int_0^{\pi/4} \int_0^1 r dr d\theta = \underline{\hspace{2cm}}$

→ $\pi/4$

- (83) vector valued function $\vec{r}(t) = 2t\vec{i} + (t-1)\vec{j}$ then length $|\vec{r}(t)|$

$$\Rightarrow |\vec{r}(t)| = \sqrt{4t^2 + (t-1)^2}$$

(84) Graph of a vector-valued function can fail to have a tangent vector at point because
 $\Rightarrow$ derivative does not exist at the point

(85) $\int_0^1 \int_0^1 \int_0^1 x^2 y^2 z^2 dx dy dz = \underline{\hspace{2cm}}$

$\Rightarrow 1/27$

(86) Polar Coordinate $\iint_R f(x, y) dx dy = \underline{\hspace{2cm}}$

$\Rightarrow \int_0^{2\pi} \int_0^r f(r \cos \theta, r \sin \theta) r dr d\theta$

(87) Curve that winds around the origin 'infinitely' many times in such a way that r increase (or decrease) steadily as θ increase (decrease).

$\Rightarrow$ Spiral

(82) Orientation of rose relative to polar depends on the sign of constant a and whether $\sin$ or $\cos$ appears in equation.

$\Rightarrow \sin \theta$ or $\cos \theta$

$$(-3, -3\sqrt{4}) \Rightarrow (-3, \pi/4)$$

INITIAL
STATE

- (83) In 2D space the parametric equation $x = x(t)$
 $y = y(t)$ express the single vector equations
 $\Rightarrow \vec{r}(t) = x(t)\vec{i} + y(t)\vec{j}$

- (84) Arc length of curve $\vec{r}(t) = t^3\vec{i} + t\vec{j} + \frac{1}{2}\sqrt{6}t^2\vec{k}$, $0 \leq t \leq 2$

$$\Rightarrow L = \int_0^2 \sqrt{9t^4 + 1 + 6t^2} dt$$

- (85) Let $\vec{r}(t) = 2t\vec{i} + 3t\vec{j}$ then $\vec{r}'(2) = 2\vec{i} + 3\vec{j}$
 $\Rightarrow$ True

- (86) function $\vec{r}(t) = x(t)\vec{i} + y(t)\vec{j} + z(t)\vec{k}$ in 3 space
 we define $\lim_{t \rightarrow a} \vec{r}(t) = \underline{\hspace{2cm}}$

$$\Rightarrow \left(\lim_{t \rightarrow a} x(t) \right) \vec{i} + \left(\lim_{t \rightarrow a} y(t) \right) \vec{j} + \left(\lim_{t \rightarrow a} z(t) \right) \vec{k}$$

- (87) equation, $r^2 = 4 \cos 2\theta$ represent a
 $\Rightarrow$ Lemniscate

- (88) a 70 equation form

$$r^2 = a^2 \cos 2\theta, \quad r^2 = -a^2 \cos 2\theta$$

$$r^2 = a^2 \sin 2\theta, \quad r^2 = -a^2 \sin 2\theta \quad \text{Curve represent polar sketch}$$

- $\Rightarrow$ Lemniscates

$p(r, \theta)$ i.e. $(6, 45^\circ), (4, 330^\circ)$
 $(3, 225^\circ), (-3, 45^\circ)$ same
 $(8, 0+180^\circ)$
 $45^\circ + 180^\circ = 225^\circ$

(89) Equation $r = a(1 + \cos \theta)$ represent

⇒ Cardioid

(90) equation form

$$r = a \sin n\theta$$

$$r = a \cos n\theta$$

represent flower-shaped curves called

⇒ roses

(91) If $\tilde{P} = 3x^2 + 2y^2$ $\tilde{Q} = 4xy$ then

$$\frac{\partial \tilde{P}}{\partial y} = \frac{\partial \tilde{Q}}{\partial x}$$

Q

(92) rose curve has n -equality spaced petals or loops if n is

⇒ odd

(93) Curve, $r = Q$ ($Q \geq 0$), is an equation of

⇒ spiral with $a=1$

(94) diff equation $dz = (1+2y)dx + (1+2x)dy$
 exact differential equation.

⇒ false

(95) diff dz of function

$$z = x^2 + y^2$$

$$\Rightarrow dz = 2x dx + 2y dy$$

→ r is called radial distance

→ θ is called polar angle or ϕ