MB11 Calculus 3
Indiana University
Fall 2025
Homework 2
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2025-09-06

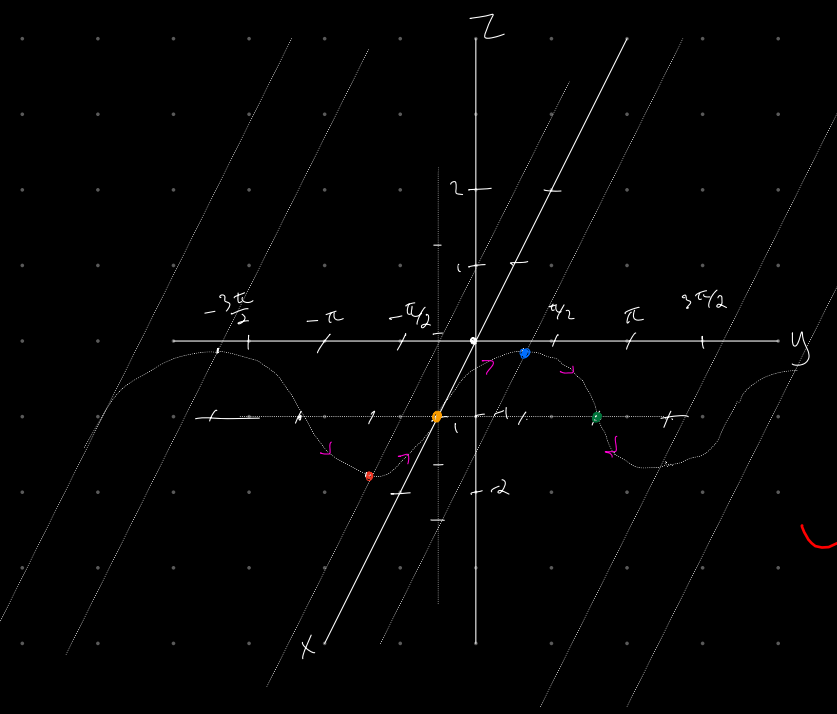
3.1-1)

$$\vec{r}(t) = \langle 1, t, \sin(t) \rangle$$

$x = 1$ $\quad y = t \quad z = \sin(t)$

$z = \sin y$

2 var, cylinder,
trace on zy plane,
directed along x-axis



$x=1, \; y=-\frac{\pi}{2}, \; z=-1$
$x=1, \; y=0, \; z=0$
$x=1, \; y=\frac{\pi}{2}, \; z=1$
$x=1, \; y=\pi, \; z=0$
$x=1, \; y=\frac{3\pi}{2}, \; z=-1$

} space curve

$t=0, \; \langle 1, 0, 0 \rangle$
$t=\frac{\pi}{2}, \; \langle 1, \frac{\pi}{2}, 1 \rangle$
$t=\pi, \; \langle 1, \pi, 0 \rangle$
$t=-\frac{\pi}{2}, \; \langle 1, -\frac{\pi}{2}, -1 \rangle$

} key points

As parameter t increases, the position vector $\vec{r}(t) = \langle 1, t, \sin(t) \rangle$ traces out a sinusoidal curve that lies entirely in the plane $x=1$. The curve oscillates between $z = \pm 1$ while progressing along the y-axis.

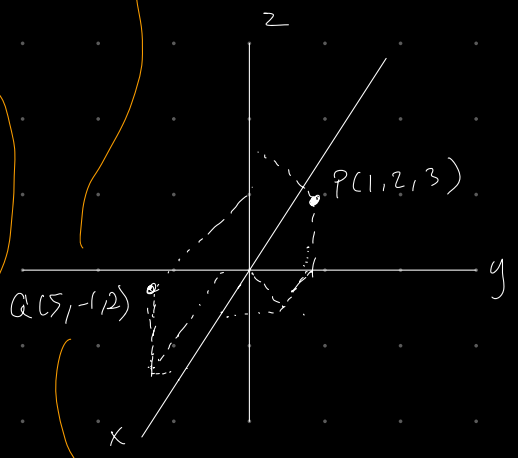
3.1-2)

$P(1,2,3)$, $Q(5,-1,2)$, $\vec{r}(t) = ?$

$$\vec{r}(t) = (1-t)P + tQ$$

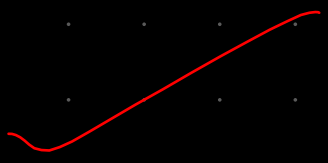
$t=0,\ \vec{r}(0) = (1)P + 0Q = P$

$t=1,\ \vec{r}(1) = 0P + (1)Q = Q$



$$\vec{r}(t) = (1-t)(1,2,3) + t(5,-1,2)$$
$$= (1-t, 2-2t, 3-3t) + (5t, -t, 2t)$$
$$= (1+4t, 2-3t, 3-t)$$

$$\boxed{\vec{r}(t) = \langle 1+4t,\ 2-3t,\ 3-t \rangle}$$



3.2-1)

$$\vec{r}(t) = \langle t^3, t^4 \rangle$$

1a) $\vec{r}'(t) = ?$

$$r'(t) = f'(t) + g'(t)$$

$$f(t) = t^3 \qquad g(t) = t^4$$
$$f'(t) = 3t^2 \qquad g'(t) = 4t^3$$

$$\boxed{\vec{r}'(t) = 3t^2\hat{i} + 4t^3\hat{j}}$$

1b) Find $\vec{T}(1)$, $t = 1$

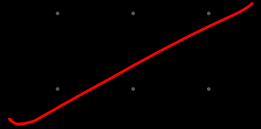
$$\vec{r}'(1) = 3\hat{i} + 4\hat{j}$$

$$\|r'(1)\| = \sqrt{3^2 + 4^2} = \sqrt{9+16} = \sqrt{25} = 5$$

$$u = \frac{1}{\|v\|} v \quad , \quad \vec{T}(1) = \frac{1}{\|\vec{r}'(1)\|} \vec{r}'(1)$$

$$\vec{T}(1) = \frac{1}{5}\langle 3, 4 \rangle$$

$$\boxed{\vec{T}(1) = \left\langle \frac{3}{5}, \frac{4}{5} \right\rangle}$$



3.2-a) $\vec{r}(t) = 60t\,\hat{i} + (80t - 16t^2)\,\hat{k}$

position vector function

(a) Find $\vec{v}(t)$

$\vec{v}(t) = \vec{r}\,'(t)$

$f(t) = 60t\,\hat{i}$ $\qquad$ $h(t) = (80t - 16t^2)\,\hat{k}$

$f'(t) = 60\,\hat{i}$ $\qquad$ $h'(t) = (80 - 32t)\,\hat{k}$

$\vec{r}\,'(t) = f'(t) + h'(t)$

$\vec{r}\,'(t) = 60\,\hat{i} + (80 - 32t)\,\hat{k}$

$$\boxed{\vec{v}(t) = 60\,\hat{i} + (80 - 32t)\,\hat{k}}$$

(b) Find speed (magnitude of velocity, when $t = 0$)

$\|v(t)\|$

$\vec{v}(0) = 60\,\hat{i} + (80 - 32(0))\,\hat{k}$

$= 60\,\hat{i} + 80\,\hat{k}$

$\|\vec{v}(0)\| = \sqrt{60^2 + 80^2} = \sqrt{3600 + 6400} = \sqrt{10{,}000}$

$= 100$

$$\therefore \boxed{\|\vec{v}(0)\| = 100 \text{ ft/s}}$$

(c) $\vec{a}(t) = ?$

$\vec{a}(t) = \vec{v}'(t)$

$\vec{v}(t) = 60\,\hat{i} + (80 - 32t)\hat{k}$

$\vec{v}'(t) = 0 - 32\hat{k}$

$$\boxed{\vec{a}(t) = -32\hat{k} \quad -32\ ft/s^2}$$