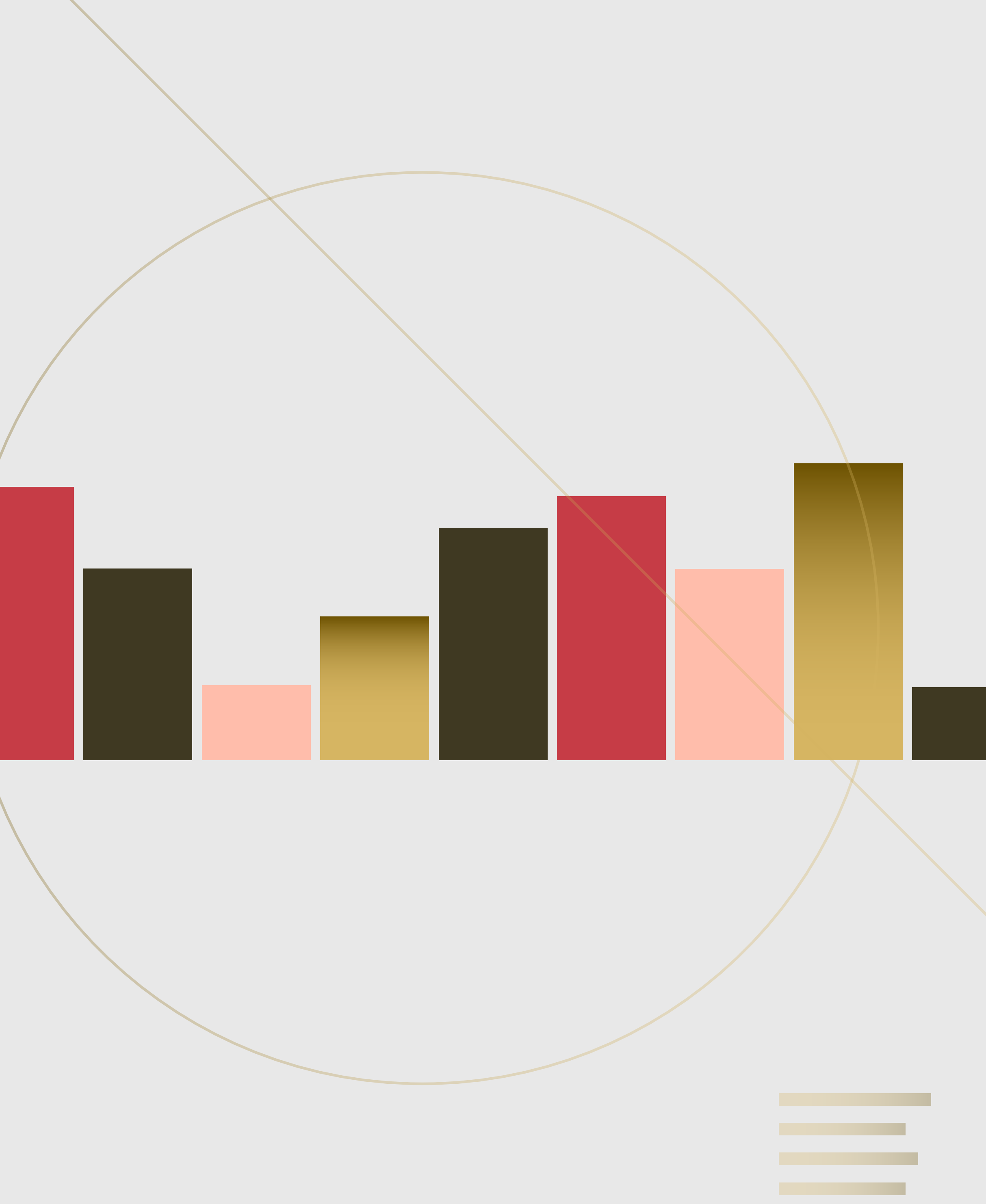
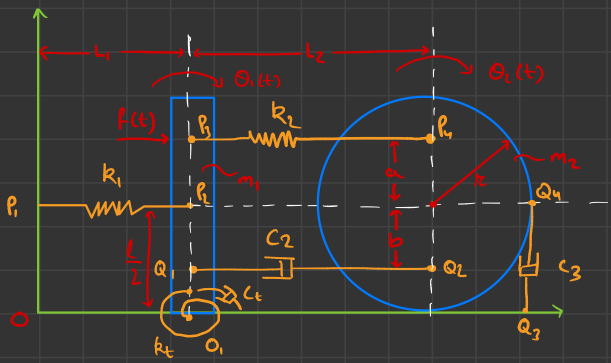
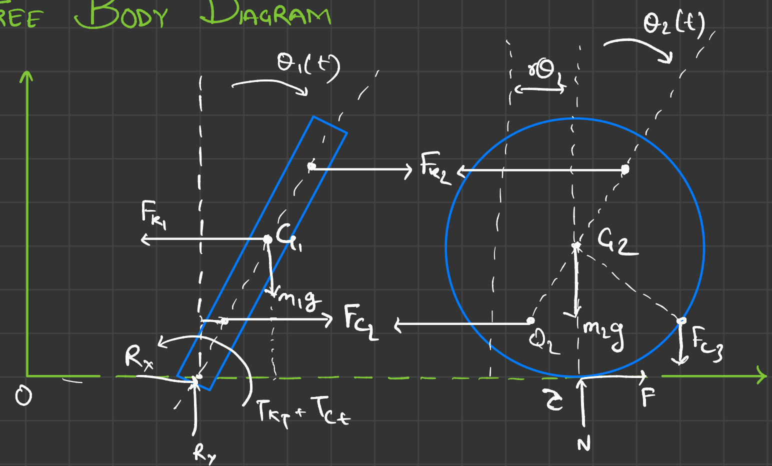


Induced Vibrations



Free Body Diagram



Accelerations :-

$$\bar{r}_{OG_1} = \left(L_1 + \frac{L}{2}\sin\theta_1\right)\hat{i} + \frac{L}{2}\cos\theta_1\hat{j}$$

$$\dot{\bar{r}}_{OG_1} = \frac{L}{2}\dot{\theta}\cos\theta_1\hat{i} - \frac{L}{2}\dot{\theta}\sin\theta_1\hat{j}$$

$$\ddot{\bar{r}}_{OG_1} = \left(\frac{L}{2}\ddot{\theta}\cos\theta_1 - \frac{L}{2}\dot{\theta}^2\sin\theta_1\right)\hat{i} - \left(\frac{L}{2}\dot{\theta}^2\cos\theta_1 + \frac{L}{2}\ddot{\theta}\sin\theta_1\right)\hat{j}$$

$$\bar{r}_{OQ_2} = (L_1 + L_2 + r\theta_2)\hat{i} + r\hat{j}$$

$F_{R_1} = k_1(r_{P_1P_2} - L_1)$

$F_{R_2} = R_2(\bar{r}$

$F_{R_1} = k_1(r_{P_1P_2} - L_1)$
$F_{R_2} = R_2(r_{P_3P_4} - L_2)$
$F_{C_2} = C_2 \dot{\bar{r}}_{Q_1Q_2} \cdot \hat{e}_{Q_1Q_2}$

$F_{C_3} = C_3 \dot{\bar{r}}_{Q_3Q_4} \cdot \hat{e}_{Q_3Q_4}$

$$\hat{e}_{Q_3Q_4} = \frac{\bar{r}_{Q_3Q_4}}{r_{Q_3Q_4}}$$

$$\Sigma M_z = -I_z\ddot{\theta}$$

$$= -\frac{3}{2} m_2 r_2^2 \ddot{\theta}$$

$$-\frac{3}{2} m_2 r_2^2 \ddot{\theta} =$$

$I_z = \frac{3}{2} m_2 r_2^2$ (End Vib)

$I_G = \frac{1}{12} ml^2$ $\quad I_{O_1} = \frac{1}{3} ml^2$

Hello there I am

Danish Ansari and

IDR

Three Phase Drives

1. Three phase half wave converter drives 2Q, 40KW $V_a = \frac{3\sqrt{3}}{2\pi} V_m \cos\alpha_a$ $V_f = \frac{3\sqrt{3}}{2\pi} V_m (1+\cos\alpha_f)$
2. Three phase semi converter drive 1Q, 115 KW $V_a = \frac{3\sqrt{3} V_m}{2\pi} (1+\cos\alpha_a)$ $V_f = \frac{3\sqrt{3} V_m}{2\pi} (1+\cos\alpha_f)$
3. Three phase full converter drives 2Q, 1500 KW $V_a = \frac{3\sqrt{3}}{\pi} V_m \cos\alpha_a$ $V_f = \frac{3\sqrt{3}}{\pi} V_m \cos\alpha_f$
4. Three phase dual converter drives 4Q, 1500 KW "

Single Phase Drives

1. Single Phase half - wave Converter drive 1Q, ½ KW $V_m = \frac{V_m}{2\pi}(1+\cos\alpha_a)$ $V_f = \frac{V_m}{\pi}(1+\cos\alpha_f)$
2. Single Phase semi converter drive 1Q, 15 KW $V_a = \frac{V_m}{\pi}(1+\cos\alpha_a)$ $V_f = \frac{V_m}{\pi}(1+\cos\alpha_f)$
3. Single Phase full converter drive 2Q, 15 KW $V_a = \frac{2V_m}{\pi}\cos\alpha_a$ $V_f = \frac{2V_m}{\pi}\cos\alpha_f$
4. Single Phase dual converter drive 4Q, 15 KW $V_a = \frac{2V_m}{\pi}\cos\alpha_a$ $V_f = \frac{2V_m}{\pi}\cos\alpha_f$

$E_g = K_v \omega I_f$

$V_a = R_a I_a + E_g = R_a I_a + K\omega I_f$

$T_d = K_t I_a I_f = K_v I_f I_a$

$V_m = \sqrt{2} V_s$

$\omega = rpm \cdot \frac{\pi}{30}$

$P_o = V_a I_a$ $P_i = V_a I_a + V_f I_f$

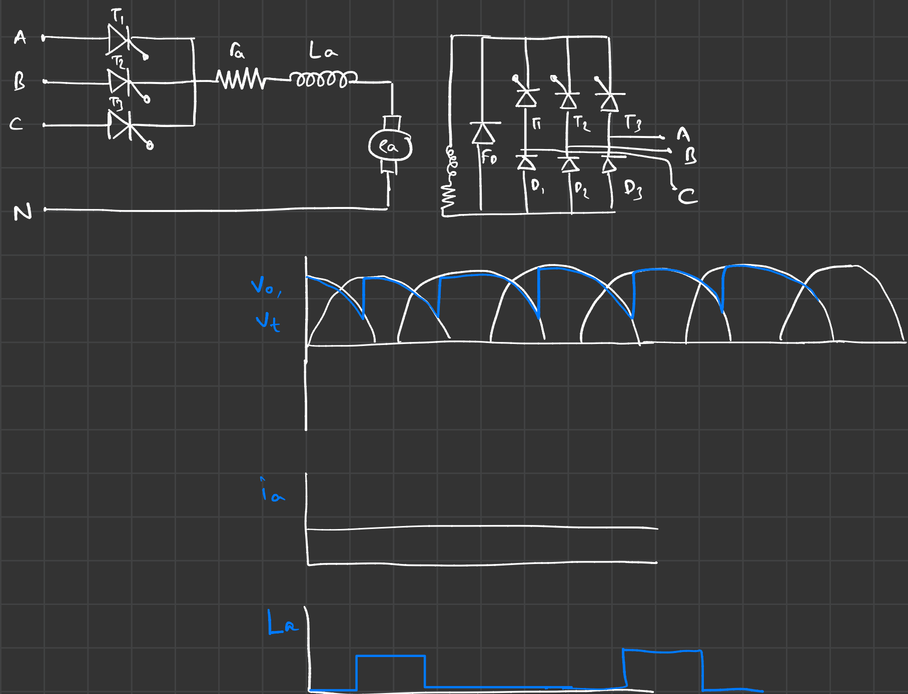
$P_I = V_s I_{sa} = P_a$

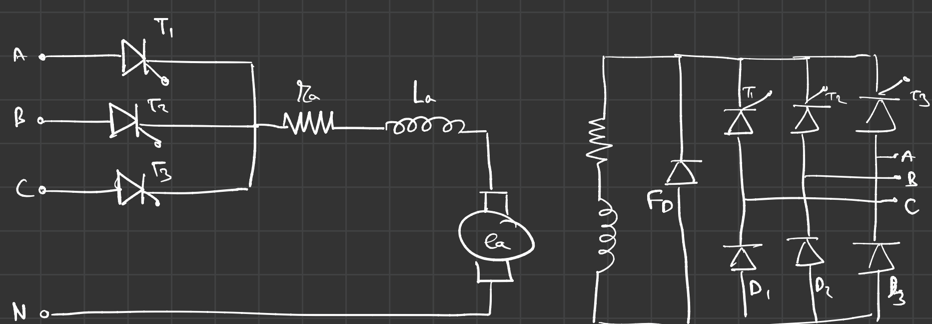
$I_{sa} = I_a \left(\frac{\pi - \alpha_a}{\pi}\right)^{1/2}$

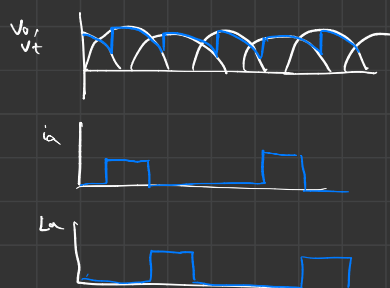
$PF = \frac{P_a}{V_s I_{sa}}$

$V_P = \frac{V_L}{\sqrt{3}}$ $V_m = \sqrt{2} V_P$

Three Phase half wave converter drive



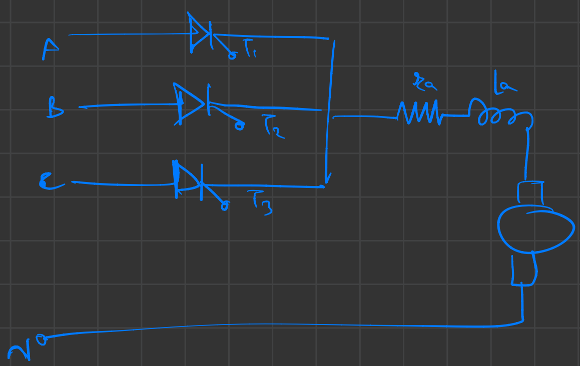


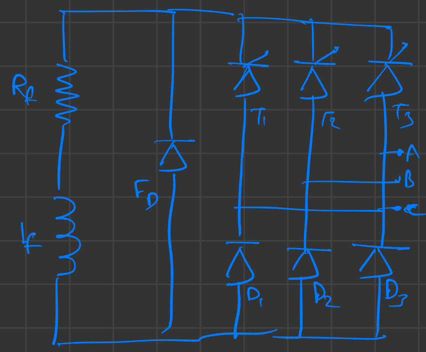


2 quadrant,
40 KW/h
Not used in industrial
as ac supply containg dc compon

$$V_a = \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha$$

$$V_f = \frac{3\sqrt{3}\,V_m}{2\pi}(1+\cos\alpha)$$



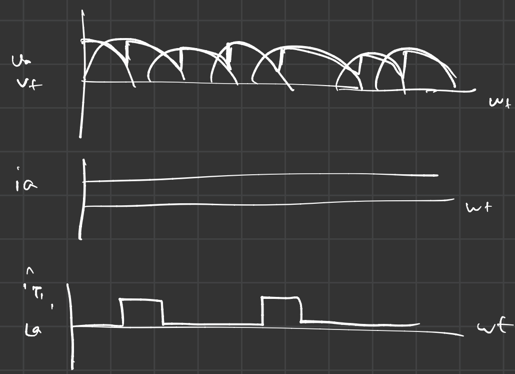


$$v_a = \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha_a$$

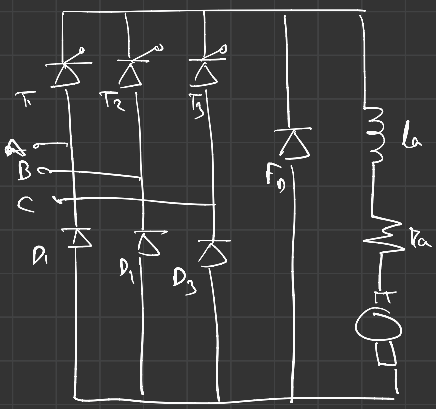
$$v_f = \frac{3\sqrt{3}\,V_m}{2\pi}(1+\cos\alpha_f)$$

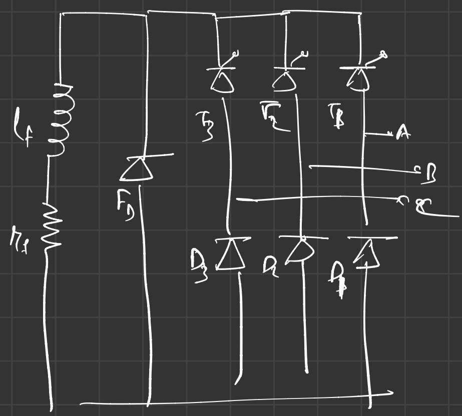
$$V_a = \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha$$

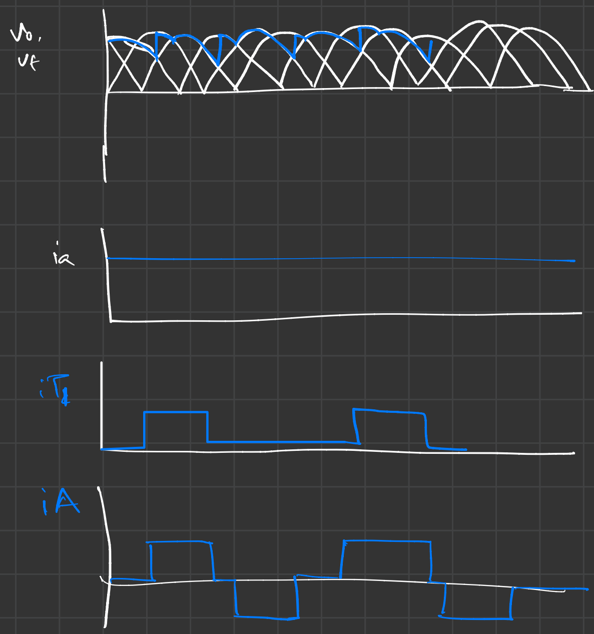
$$V_f = \frac{3\sqrt{3}\,V_m}{2\pi}(1+\cos\alpha)$$



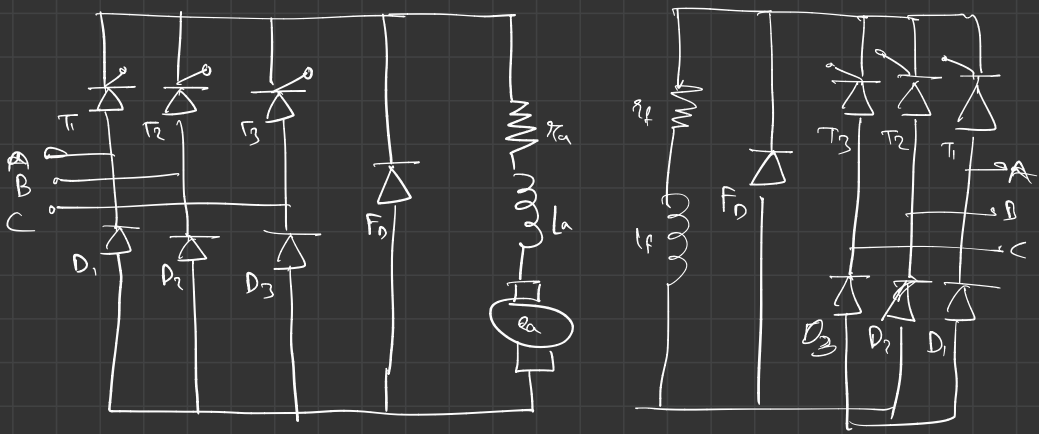
Three phase semi converter drive

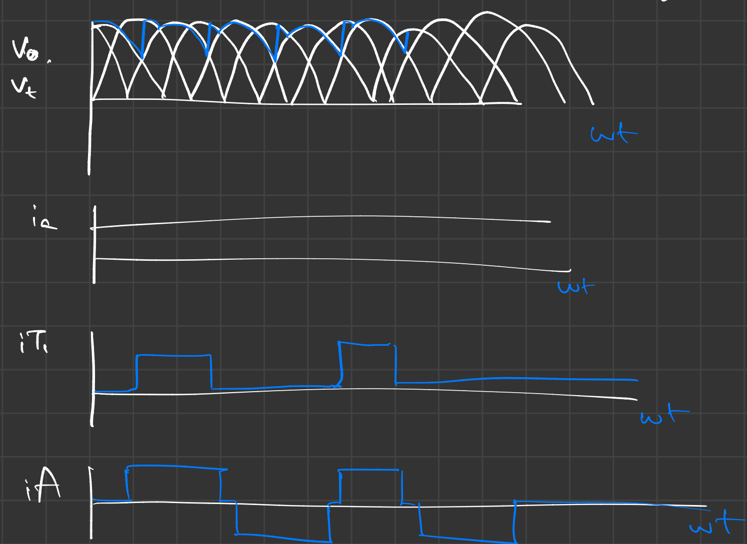






Three phase Semi converter drive

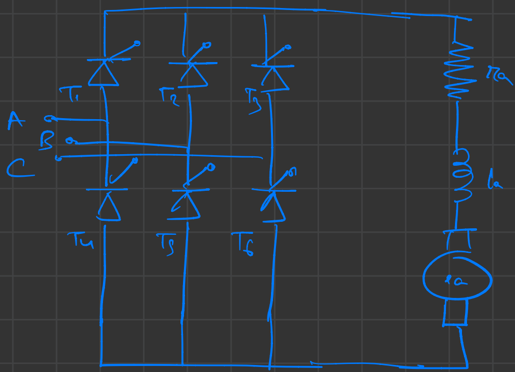


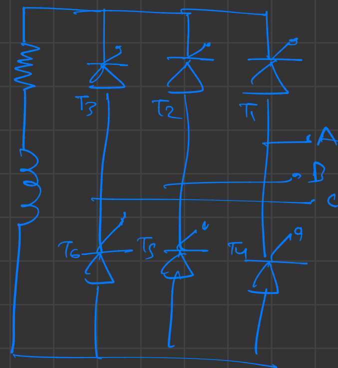


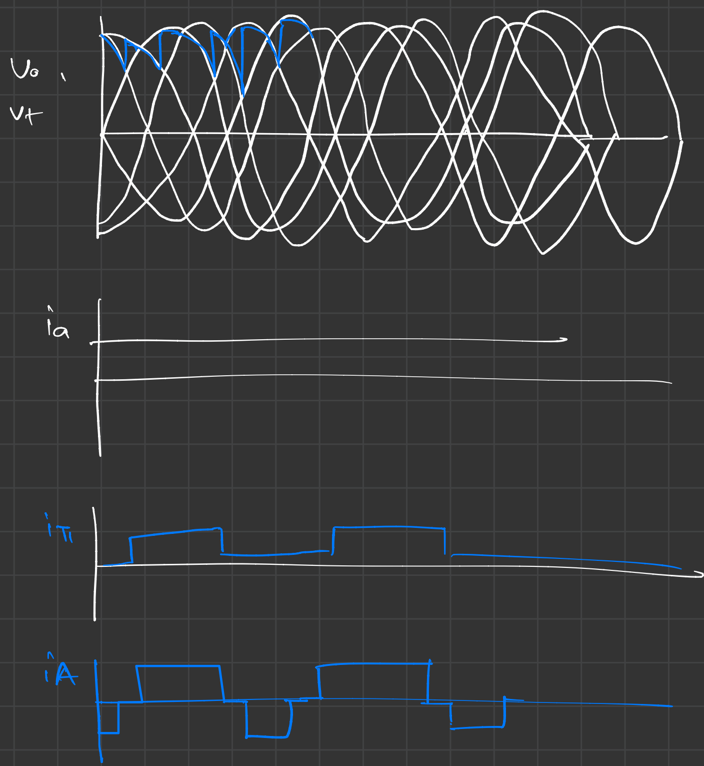
$$V_a = \frac{3\sqrt{3}\, V_m}{2\pi}\left(1+\cos\alpha_a\right)$$

$$V_f = \frac{3\sqrt{3}\, V_m}{2\pi}\left(1+\cos\alpha_f\right)$$

Three Phase full converter Drive



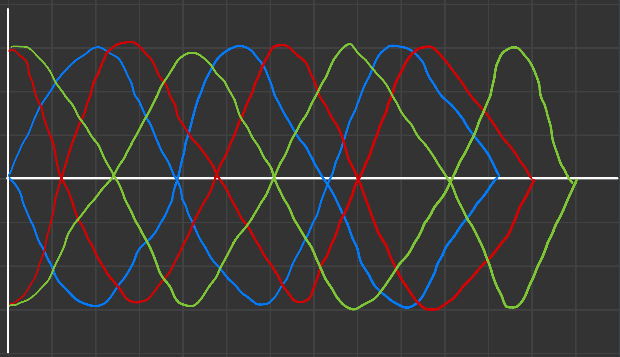




$$V_a = \frac{3\sqrt{3}}{\pi} \cos\alpha_a$$

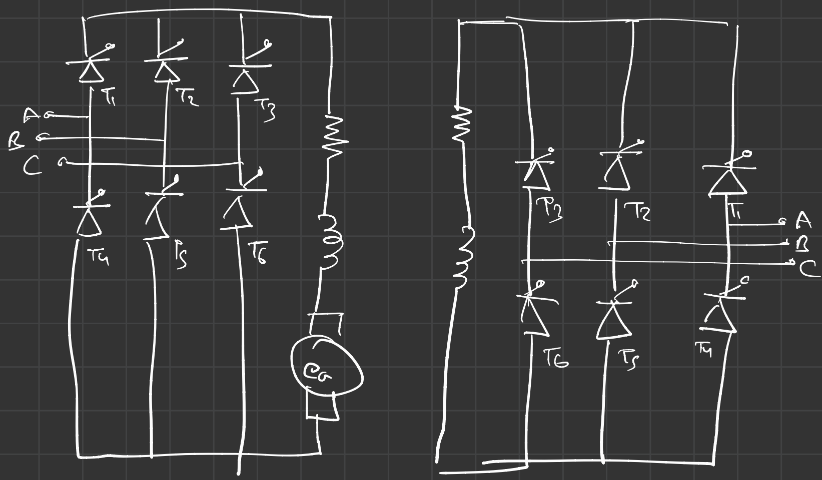
$$V_f = \frac{3\sqrt{3}}{\pi} \cos\alpha_f$$

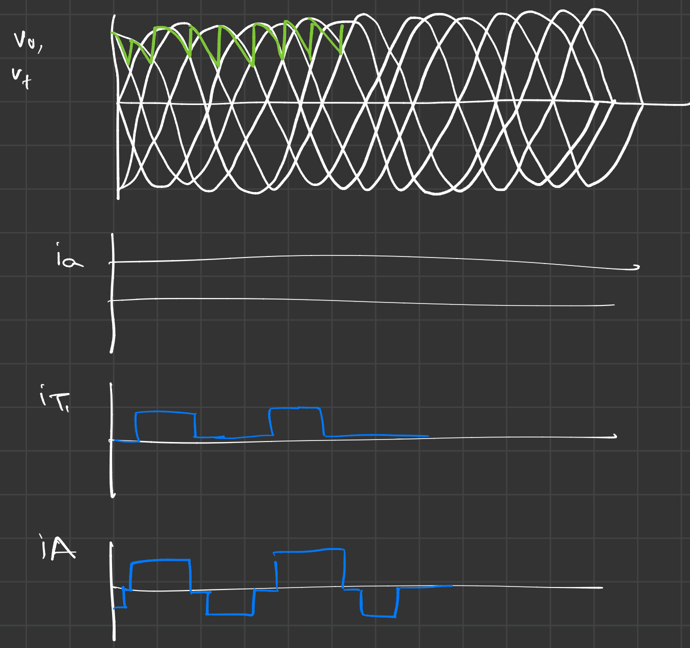
S.no.	ωt	incoming SCR	Conduction pair	Outgoing SCR	line Voltage
1	$30+\alpha$	T_1	(T_6, T_1)	T_6	E_{AB}
2	$90+\alpha$	T_2	(T_1, T_2)	T_5	E_{AC}
3	$150+\alpha$	T_3	(T_2, T_3)	T_1	E_{BC}
4	$210+\alpha$	T_4	(T_3, T_4)	T_2	E_{BA}
5	$270+\alpha$	T_5	(T_4, T_5)	T_3	E_{CA}
6	$330+\alpha$	T_6	(T_5, T_6)	T_4	E_{CB}



III - Phase Full Wave Rectifier

Three phase full converter drive





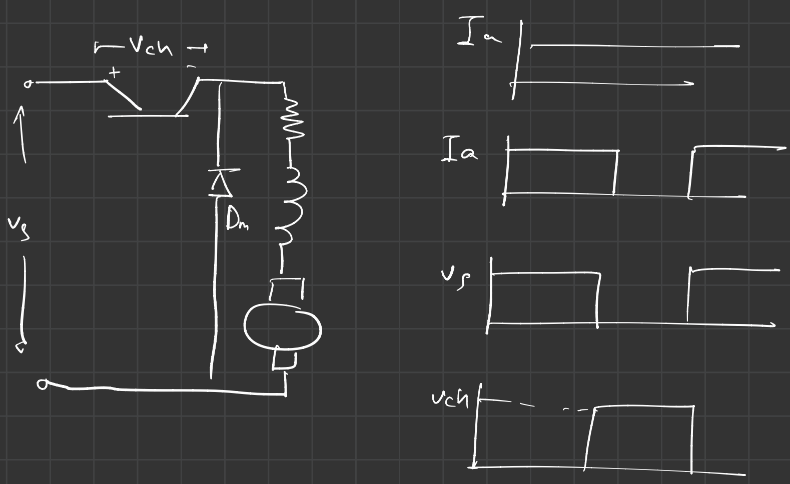
$$V_a = \frac{3\sqrt{3}\, V_m}{\pi} \cos \alpha_a \qquad 0 \le \alpha_a \le \pi$$

$$V_f = \frac{3\sqrt{3}\, V_m}{\pi} \cos \alpha_f \qquad 0 \le \alpha_f \le \pi$$

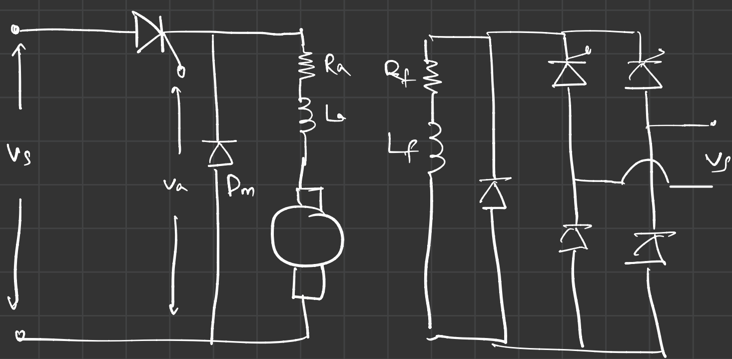
S no. ωt Incoming SCR Conducting pair Outgoing SCR Line Voltage

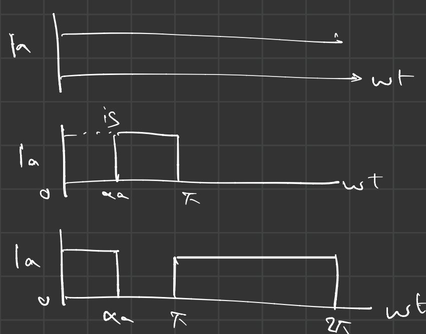
S No.	ωt	incoming SCR	Conducting Pair	Outgoing SCR	Line Voltage
1	$30^\circ+\alpha$	T_1	T_6, T_1	T_6	E_{AB}
2	$90+\alpha$	T_2	T_1, T_2	T_5	E_{AC}
3	$150+\alpha$	T_3	T_2, T_3	T_1	E_{BC}
4	$210+\alpha$	T_4	T_3, T_4	T_2	E_{BA}
5	$270+\alpha$	T_5	T_4, T_5	T_3	E_{CA}
6	$330+\alpha$	T_6	T_5, T_6	T_4	E_{CB}

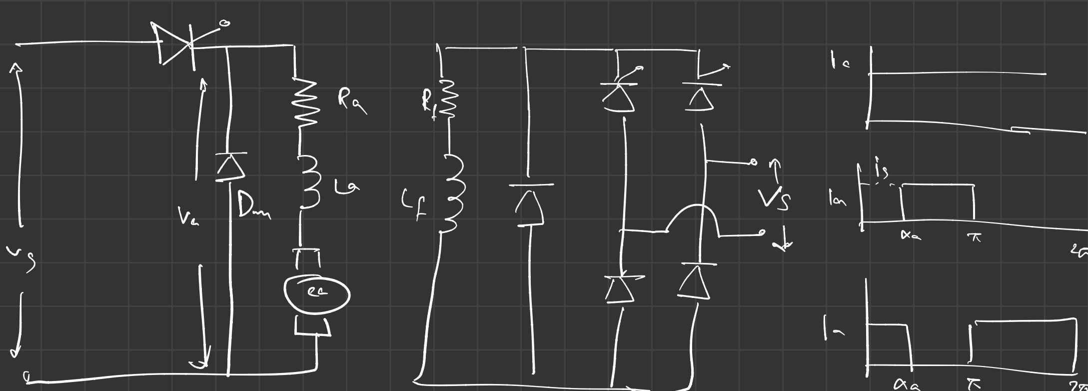
Chopper drive



Single Phase half-wave converter drive



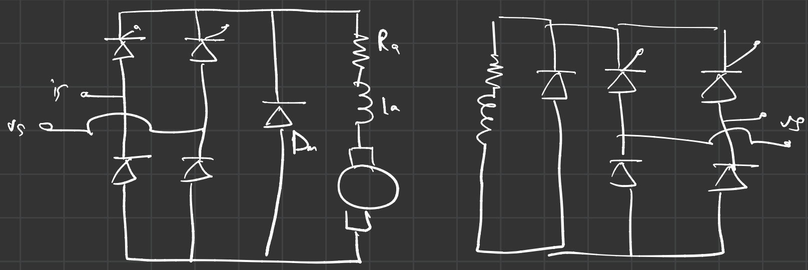


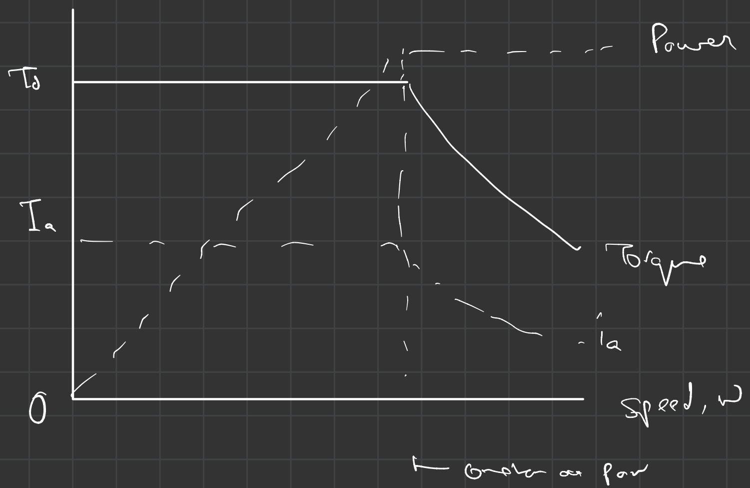


$$V_a = \frac{V_m}{2\pi}(1+\cos\alpha_a)$$

$$V_f = \frac{V_m}{\pi}(1+\cos\alpha_f)$$

Single Phase semi Converter drive





HMI

GOMS

→ Goals, Operators, Methods, Selection

Goals	Operators	Methods	Selection
users want to achieve	basic actions that users must perform in order to use the system	these are the several ways in which a goal can be split into subgoals	Choice of methods according to the convinience of the user.

Goals	Methods
Operators	Selection

COGNITIVE MODEL

→ An area in computer science which deals with simulating human problem solving and mental processing in an computerized mode.
Cognitive model can be used to simulate and predict human behaviour or performance on tasks in an already modeled system to enhance HMI.

WATERFALL METHOD

Requirement Specification
↳ Architectural Design
↳ Detailed Design
↳ Coding and Unit testing
↳ Integration and testing
↳ Operation and maintenance.

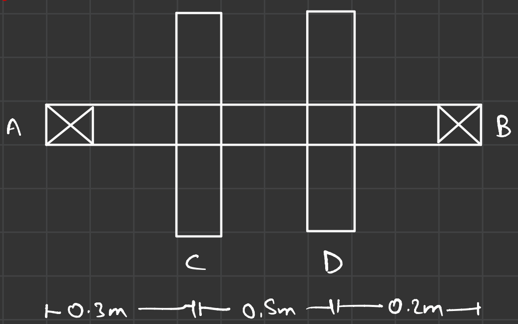
Shneiderman's 8 Golden Rules

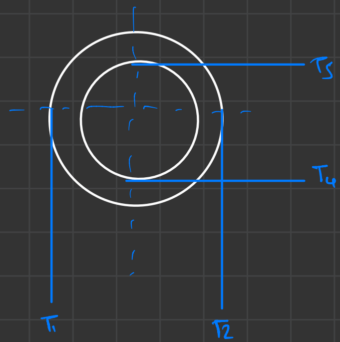
1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogs to yield closure
5. Offer error prevention and simple error handling
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load.

DME

Q. Shaft - pulley $\tau =$ shear , $\sigma_b =$ tension

A.





$T_1 = 3.2 \times 10^3$ KN

$$\boxed{2.3 \log\left(\frac{T_1}{T_2}\right) = \mu \Theta}$$

$T_2 = 1.852 \times 10^3$ N

$$\boxed{T = (T_1 - T_2) R_c}$$

$T = 402$ Nm $= T_D$

$$\boxed{W_c = T_1 + T_2} = 5.08 \times 10^3 \text{ N}$$

Since , $\Sigma y = 0$

$W_c - R_{AV} - R_{BV} = 0$

$W_c = R_{AV} + R_{BV}$

$\Sigma M_B = 0$

$R_{AV} \times 1 - W_c \times 0.7 = 0$

$R_{AV} = 3556$ N

$R_{BV} = 1524$ N

Since, $T_D = (T_3 - T_4) \times R_D$

$$T_3 - T_4 = \frac{402}{0.2}$$

$$T_3 - T_4 = 2010$$

$$2.3 \log\left(\frac{T_3}{T_4}\right) = \mu\theta$$

$$\frac{T_3}{T_4} = 1.7$$

$$T_3 = 4881.42 \text{ N}$$

$$T_4 = 2871.42 \text{ N}$$

$$W_D = T_3 + T_4 = 7752.84$$

$$\Sigma M = 0$$

$$R_{AH} - 1 \times W_D \times 0.8 = 0$$

$$R_{AH} = 6202.272$$

$$W_D = R_{AH} + R_{BH}$$

$$R_{BH} = 1550.56$$

Bending Moment Calculations

i) Vertical Loading

BM @ A = 0

BM @ B = 0

BM @ C = $R_{AV} \times 0.3 = 1066.8$

BM @ D = $R_{BV} \times 0.2 = 457.2$

ii) Horizontal Loading

BM @ A = 0

BM @ B = 0

BM @ C = $R_{AH} \times 0.3$ = 679.75

BM @ D = $R_{BH} \times 0.2$ = 1586.02

Resultant Bending Moment

@ C = $\sqrt{1066.8^2 + 679.75^2}$ = 1264.95

@ D = $\sqrt{457.2^2 + 1586.02^2}$ = 1650.60

Bending moment $\boxed{M = 1650.60\ N}$

$$T_e = \sqrt{M^2 + T^2} = 1698.84$$

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right] = 1674.72\ N$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

$$d = \left(\frac{T_e \times 16}{\pi \times \tau}\right)^{1/3} = 59.05$$

$$M_e = \frac{\pi}{32} \times \sigma_b \times d^3$$

$$d = \left(\frac{M_e \times 32}{\pi \times \sigma_b}\right)^{1/3}$$

$$d = 0.064\ M = 64.69\ mm$$

$\therefore$ Larger Value $\Rightarrow$ $\boxed{d = 64.69\ mm}$

Q. shaft (Pulley)

T_1, $\quad 2.3 \log\left(\frac{T_1}{T_2}\right) = \mu\theta \qquad \mu = 0.4$

T_2, $\quad T = (T_1 - T_2) \times R_C = T_D$

$W_C = T_1 + T_2$

$\Sigma y = 0, \quad W_C - R_{AV} - R_{BV} = 0$

$W_C = R_{AV} + R_{BV}$

$\Sigma M_B = 0 \quad R_{AV} \times 1 - W_C \times 0.7 = 0$

$R_{AV}, \quad R_{BV}$

$T_D = (T_3 - T_4) \times R_D$

$2.3 \log\left(\frac{T_3}{T_4}\right) = \mu\theta$

$T_3, \ T_4, \quad W_D = T_3 + T_4$

$\Sigma M = 0$

$R_{AH} \times 1 - W_D \times 0.8 = 0$

$R_{AH}, \quad W_D = R_{AH} + R_{BH}, \ R_{BH}$

BM calc ... i) VL $\rightarrow$ BM @ A = 0

BM @ B = 0

BM @ C = $R_{AV} \times R_C$

BM @ D = $R_{BV} \times R_D$

ii) HL $\rightarrow$ BM @ A = 0

BM @ B = 0

BM @ C = $R_{AH} \times R_C$

BM @ D = $R_{BH} \times R_D$

Resultant $\rightarrow$ @ C $= \sqrt{\ldots^2 + \ldots^2} =$ ____

@ D $= \sqrt{\ldots^2 + \ldots^2} =$ ____

Max Value $\rightarrow$ M

$$T_e = \sqrt{M^2 + T^2}$$

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right]$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

$$M_e = \frac{\pi}{32} \times \sigma_b \times d^3$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

$$M_e = \frac{\pi}{32} \times \sigma_b \times d^3$$

Q. Shaft (Pulley)

T_1, $2.3 \log\left(\frac{T_1}{T_2}\right) = \mu\theta$, T_2

$$T = (T_1 - T_2) R_C = T_d$$

$$W_C = T_1 + T_2$$

$\Sigma y = 0$, $W_C - R_{AV} - R_{BV} = 0$

$W_C = R_A + R_B$

$\Sigma M_B = 0$, $R_{AV} \times 1 - W_C \times 0.7 = 0$

R_{AV}, R_{BV}

$$T_D = (T_3 - T_4) R_D$$

$$2.3 \log\left(\frac{T_3}{T_4}\right) = \mu\theta$$

T_3, T_4

$$W_D = T_3 + T_4$$

$$\Sigma M = 0$$

$R_{AH} \times 1 - W_D \times 0.8 = 0$

R_{AH}

$W_D = R_{AH} + R_{BH}$

R_{BH}

BMC, i) VL

$BM @ A = 0$

$BM @ B = 0$

$BM @ C = R_{AV} \times R_C$

$BM @ D = R_{BV} \times R_D$

ii) HL

$BM @ A = 0$

$BM @ B = 0$

$BM @ C = R_{AH} \times R_C$

$BM @ D = R_{BH} \times R_D$

Resultant @ C $\Rightarrow \sqrt{\ldots^2 + \ldots^2} =$ ____

@ D $\Rightarrow$ " = ____

Larger value $\rightarrow M$

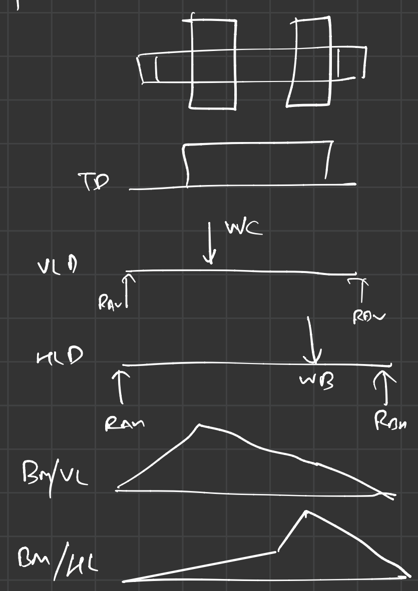
$T_e = \sqrt{M^2 + T^2}$

$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right]$

$T_e = \frac{\pi}{16} \times \tau \times d^3$

$M_e = \frac{\pi}{32} \times \sigma_b \times d^3$

Larger $\underline{\underline{d}}$



Q. Shaft (gear)

A. $\alpha = 20^\circ$

$\tau = 35$ mPa

$N = 210$ rpm

$P = 6.2 \times 10^3$ W

$$P = \frac{2\pi N T}{60}$$

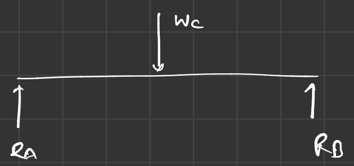
$T = 282$ Nm

W_c = Normal load acting on gear

F_t = Tangential force acts on gear

$$F_t = \frac{2T}{D} \qquad W_c = \frac{F_t}{\cos\alpha}$$

$$W_c = 5456.33 \text{ N}$$



$$R_A = R_B = \frac{W_c}{2} = 2728.16 \text{ N}$$

$$M = \frac{W_c L}{4}$$

$$T_e = \sqrt{M^2 + T^2} \qquad M_e = \frac{\pi}{32} \times \sigma_b \times d^3$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

Q. $\alpha = 20°$

$\tau = 35\ N/mm^2$

$N = 210$ rpm

$P = 6.2 \times 10^3\ W$

$P = \frac{2\pi N T}{60}$

$T = \_\_\_\_$

$F_t = \frac{2T}{D}$ $\quad F_t = \frac{2T}{D}$ $\quad F_t = \frac{2T}{D}$

$W_c = \frac{F_t}{\cos\alpha}$

$R_A = R_B = \frac{W_c}{2}$

$\therefore$ Max bending moment

$M = \frac{WL}{4}$

$T_e = \sqrt{M^2 + T^2}$

$T_e = \frac{\pi}{16} \times \tau \times d^3$

Q $\alpha = 20^{\circ}$

$\tau = 35\ N/mm^2$

$N = 210\ rpm$

$P = 6.2 \times 10^3\ W$

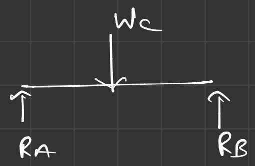
$$P = \frac{2\pi N T}{60}$$

$T = \_\_\_\_\_\_$

W_c = Normal Load

F_t = Tangential Force

$$F_t = \frac{2T}{D}$$



$$W_c = \frac{F_t}{\cos\alpha}$$

∴ Simply supported beam

$$R_A = R_B = \frac{W_c}{2}$$

∴ Max bending moment,

$$M = \frac{W_c L}{4}$$

$M = \_\_\_\_\_\_$

$$T_e = \sqrt{M^2 + T^2}$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

Q. $\alpha =$ ___

$\tau = 35$

$N = 210$ rpm

$P = 6.2 \times 10^3$ W

$$P = \frac{2\pi N T}{60}$$

$T =$ ___

$W_c =$ normal load

$F_t =$ tangential force

$$F_t = \frac{2T}{D}$$

$$W_c = \frac{F_t}{\cos\alpha}$$

As simply supported beam,

$$R_A = R_B = \frac{W_c}{2}$$

$\therefore$ Max bending moment

$$M = \frac{W_c L}{4}$$

$$T_e = \sqrt{M^2 + T^2}$$

$$T_e = \frac{\pi}{16} \times \tau \times d^3$$

MCS - (Venkatesh Sir) Mathematical Approach
FCS / DSM & DSA
Plan motion of robot
State Space Model

DSIP - (Dattoray Sir)
Advance of SAS
Z-transform & Discrete Fourier Transform
Processing images

Embedded System - (Deepak Sir)
MSI & IDS / IDC (CAN Protocol)
Program a task on any processor (16-bit
8-bit)

Biomedical Instrumentation - (Nirmal Sir)
ECG's made

EMAT - (Sunny Nanade)
Hybrid Vehicles
Alternatives of IC engine
Using battery to control automotive components
Advisor Software
Matlab & Simulink

Additive Manufacturing - (Chetna)
3-D printing methods of process
Cura, Blender & Multimaker

CAD CAM CIM - (Chetna)

Solidworks, Master CAM
Simulating, 4-axis robot
GCode, MCode (CNC machine)
Designing parts & using CNC machine to get output
Last practical - make something in CNC machine.

TQM - (MAE)

PPT

→ Circuit Diagram
→ Apparatus
→ Softwares Used
→ Functioning of our model
→ Result

Any arbitrary signal can be expressed as linear combination of harmonically related sine & cosine components.

$$x(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos(n\omega_0)t + b_n \sin(n\omega_0)t\right)$$

$$x(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos(n\omega_0)t + b_n \sin(n\omega_0)t\right) \rightarrow (1)$$

Since

$$A\cos x + B\sin x = C\cos(x - \theta)$$
$$A\cos x - B\sin x = C\cos(x + \theta)$$

Then (1) can be written as

$$x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t - \theta_n) \quad \text{or} \quad x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t + \theta_n)$$

$$C_0 = a_0 \qquad\qquad C_0 = a_0$$

$$|C_n| = \sqrt{a_n^2 + b_n^2} \qquad\qquad |C_n| = \sqrt{a_n^2 + b_n^2}$$

$$\theta_n = \tan^{-1}\left(\frac{b_n}{a_n}\right) \qquad\qquad \theta_n = \tan^{-1}\left(\frac{-b_n}{a_n}\right)$$

$$x(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos(n\omega_0)t + b_n \sin(n\omega_0)t\right)$$

Since, $A\cos x + B\sin x = C\cos(x - \theta)$ $\qquad$ $A\cos x - B\sin x = C\cos(x + \theta)$

$$(1) \Rightarrow x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 - \theta_n) \qquad x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t + \theta)$$

$$C_0 = a_0 \qquad\qquad C_0 = a_0$$

$$|C_n| = \sqrt{a_n^2 + b_n^2} \qquad\qquad |C_n| = \sqrt{a_n^2 + b_n^2}$$

$$\theta = \tan^{-1}\left(\frac{b_n}{a_n}\right) \qquad\qquad \theta = \tan^{-1}\left(\frac{-b_n}{a_n}\right)$$

$$x(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos(n\omega_0)t + b_n \sin(n\omega_0)t \right)$$

Since, $A\cos x - B\sin x = C\cos(x-\theta)$ & $A\cos x + B\sin x = C\cos(x+\theta)$

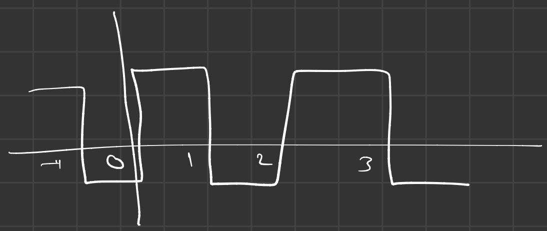
Then ① ⇒ $x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t - \theta_n)$ & $x(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_0 t + \theta_n)$

$a_0 = C_0$ $\qquad$ $C_0 = a_0$

$|C_n| = \sqrt{a_n^2 + b_n^2}$ $\qquad$ $|C_n| = \sqrt{a_n^2 + b_n^2}$

$\theta = \tan^{-1}\left(\frac{b_n}{a_n}\right)$ $\qquad$ $\theta = \tan^{-1}\left(\frac{-b_n}{a_n}\right)$

A.



i) $a_0 = 0$

ii) Odd signal :- $x(-t) = -x(t)$

$x(t) = A$, $\quad 0 < t < 1$

$x(t) = -A$, $\quad -1 < t < 0$

$a_n = 0$

iii) $x(t) = \sum_{n=1}^{\infty} b_n \sin(n\omega_0)t$

$$b_n = \frac{2}{T_0} \int_{T_0} x(t) \sin n\omega_0 t \, dt$$

$$T_0 = 2$$

$$x(t) = A \ , \quad 0 < t < 1$$
$$x(t) = -A \ , \quad 1 < t < 2$$

$$b_n = \frac{2}{T_0} \int_{T_0} x(t) \sin n\omega_0 t$$

$$b_n = 1 \left[\int_0^1 A \sin n\omega_0 t \, dt + \int_1^2 -A \sin n\omega_0 t \, dt \right]$$

$$= 1 \left[A \left(-\frac{\cos n\omega_0 t}{n\omega_0} \right)_0^1 - A \left(-\frac{\cos n\omega_0 t}{n\omega_0} \right)_1^2 \right]$$

$$= \frac{A}{n\omega_0} \left[-\cos n\omega_0 t \right]_0^1 - \left(\cos n\omega_0 t \right)_1^2 \Big]$$

$$= \frac{A}{n\omega_0} \left[-(\cos n\omega_0 - \cos 0) - (-(\cos 2n\omega_0 - \cos n\omega_0)) \right]$$

$$= \frac{A}{n\omega_0} \left[-\cos n\omega_0 + \cos 0 + \cos 2n\omega_0 - \cos n\omega_0 \right]$$

$$= \frac{A}{n\omega_0} \left(-(-1)^n + 1 + 1 - (-1)^n \right)$$

$$= \frac{A}{n\omega_0} \left(-2(-1)^n + 2 \right)$$

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

$$x(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos n\omega_0 t + b_n \sin \omega_0 t \right)$$

$$= 0 + \sum_{n=1}^{\infty} b_n \sin n\omega_0 t$$

$$x(t) = \sum_{n=1}^{\infty} \frac{2A}{n\pi}\left[\frac{1-(-1)^n}{n}\right] \sin n\omega_0 t$$

$n = 2, 4, 6 \ldots$ even

$= 1, 3, 5 \ldots$ Odd

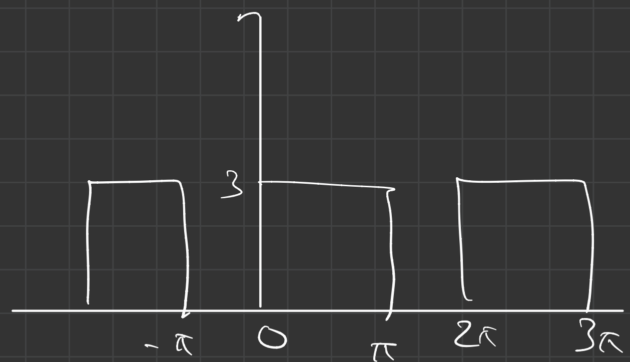
when $n =$ even, $(1) - (-1)^n = 0$

$n =$ odd, $(1) - (-1)^n = 2$

$$x(t) = \frac{2A}{\pi n}\left[2 \sin n\pi t\right], \quad n = \text{odd}$$

$$x(t) = \frac{4A}{\pi}\left[\frac{\sin \pi t}{1} + \frac{\sin 3\pi t}{3} + \frac{\sin 5\pi t}{5} + \ldots\right)$$

Q.



$$x(t) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos n\omega_0 t + b_n \sin n\omega_0 t\right)$$

i) Not symmetric.

$$a_n = \frac{1}{T_0}\int_{T_0} x(t)\,dt$$

$T_0 = 2\pi$

$$\omega_0 = \frac{2\pi}{T_0} = 1$$

$$a_0 = \frac{1}{2\pi}\left[\int_0^{\pi} 3\,dt + \int_{\pi}^{2\pi} 0\,dt\right]$$

$$a_0 = \frac{1}{2\pi}\left(3(t)_0^{\pi}\right)$$

$$a_0 = \frac{3}{2\pi}(\pi)$$

$$a_0 = \frac{3}{2}$$

$$a_n = \frac{2}{T_0}\int_{T_0} x(t)\cos n\omega_0 t\,dt$$

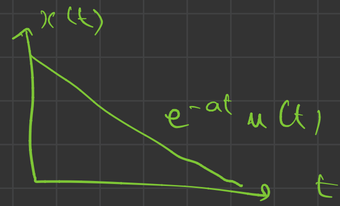
$$a_n = \frac{2}{2\pi}\left[\int_0^{\pi} 3\cos t\,dt + \int_{\pi}^{2\pi} 0\cos t\,dt\right]$$

$$a_n = \frac{3}{\pi}\left[\frac{\sin nt}{n}\right]_0^{\pi}$$

$$a_n = \frac{3}{n\pi}\left[\sin n\pi - \sin 0\right]$$

$$a_n = 0$$

$$x(t) = e^{-at}\, u(t)$$



$$X(\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt$$

$$= \int_{0}^{\infty} e^{-at}\, e^{-j\omega t}\, dt$$

$$= \int_{0}^{\infty} e^{-t(a+j\omega)}\, dt$$

$$= \left[\frac{e^{-t(a+j\omega)}}{-(a+j\omega)} \right]_{0}^{\infty}$$

$$= \frac{e^{-\infty} - e^{0}}{-(a+j\omega)}$$

$$= \frac{1}{a+j\omega}$$

Amplitude $\rightarrow$ $|X(\omega)| = \dfrac{1}{\sqrt{a^2+\omega^2}}$

$$X(\omega) = \frac{1}{a+j\omega} \times \frac{a-j\omega}{a-j\omega}$$

$$X\omega = \frac{a - j\omega}{a^2 - j^2\omega^2}$$

f_1^2

$$X\omega = \frac{a - j\omega}{a^2 + \omega^2}$$

$$X(\omega) = \underbrace{\frac{a}{a^2 + \omega^2}}_{R} - \underbrace{\frac{j\omega}{a^2 + \omega^2}}_{I}$$

$$|X(\omega)| = \sqrt{R^2 + I^2}$$

$$|X(\omega)| = \sqrt{\frac{(a^2 + \omega^2)}{(a^2 + \omega^2)^2}}$$

$$|X(\omega)| = \frac{1}{\sqrt{a^2 + \omega^2}}$$

ω	$\lvert X(\omega) \rvert$	$\theta = \tan^{-1} I/R = \tan^{-1}\left(\frac{\omega}{a}\right)$
$-\infty$	0	$\pi/2$
$-a$	$1/a\sqrt{2}$	$\pi/4$
0	$1/a$	0
a	$1/a\sqrt{2}$	$\pi/4$
∞	0	$-\pi/2$

$$\frac{d}{dt}y(t) + ay(t) = x(t)$$

$$\frac{d}{dt}y(t) + ay(t) = x(t)$$

$$j\omega\, y(\omega) + ay(\omega) = x(\omega)$$

$$Y(\omega)\,(a+j\omega) = x(\omega)$$

TF $\Rightarrow$ $\dfrac{Y(\omega)}{X(\omega)} = \dfrac{1}{a+j\omega}$

impulse $\Rightarrow$ $h(t) = F^{-1}[H(\omega)]$

$$= F^{-1}\left[\frac{1}{a+j\omega}\right]$$

$$e^{-at}u(t) = \frac{1}{a+j\omega}$$

$$h(t) = e^{-at}u(t)$$

$$x(t) = e^{-t} u(t)$$

$$H(w) = \frac{jw+2}{(jw+3)(jw+1)}$$

$$Y(w) = H(w) \cdot X(w)$$

$$X(w) = \mathcal{F}[e^{-t}u(t)] = \frac{1}{1+jw}$$

$$Y(w) = \frac{jw+2}{(jw+3)(jw+1)^2}$$

$$\frac{jw+2}{(jw+3)(jw+1)(jw+1)} = \frac{A}{jw+3} + \frac{B}{jw+1} + \frac{C}{jw+1}$$

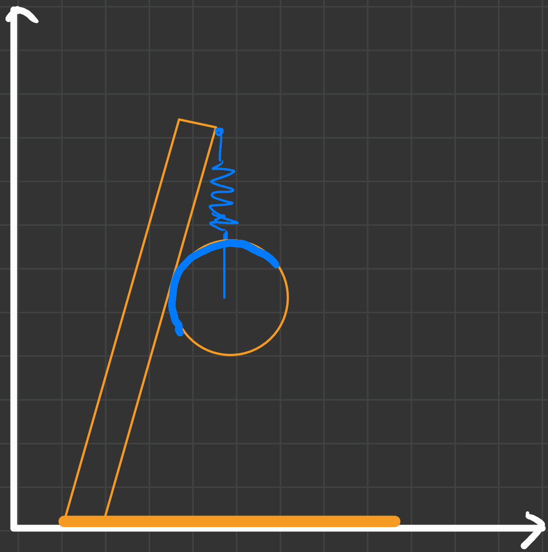
$$A = \frac{(jw+2)}{\cancel{(jw+3)}(jw+1)^2} \times \cancel{(jw+3)} \Bigg|_{jw=-3}$$

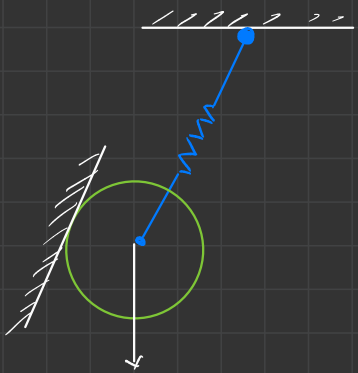
$$A = \frac{-1}{4}$$

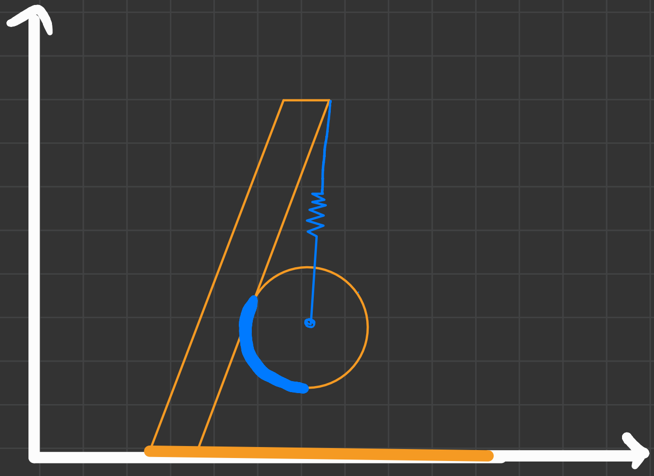
$$B = \frac{jw+2}{(jw+3)(jw+1)^2} \times (jw+1) \Bigg|_{jw=-1}$$

$$B = \frac{3}{8}$$

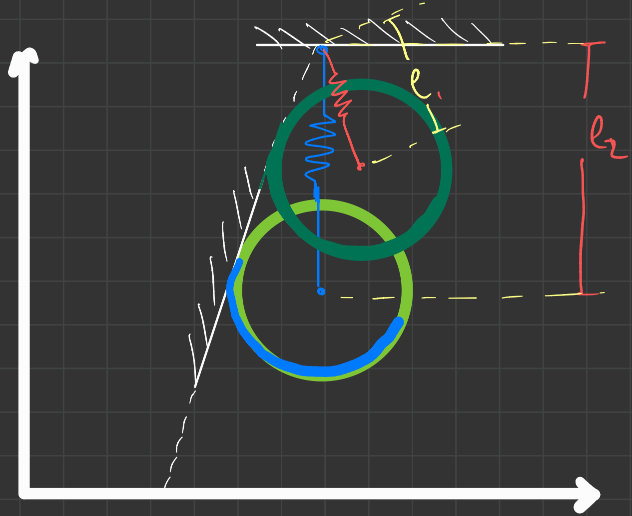
DSM PROJECT

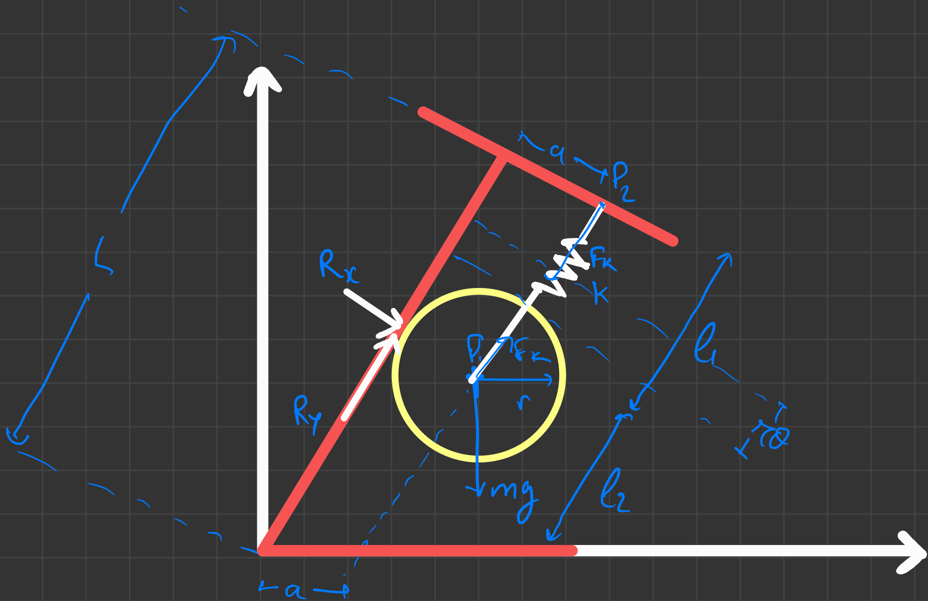


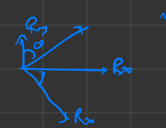




FBD



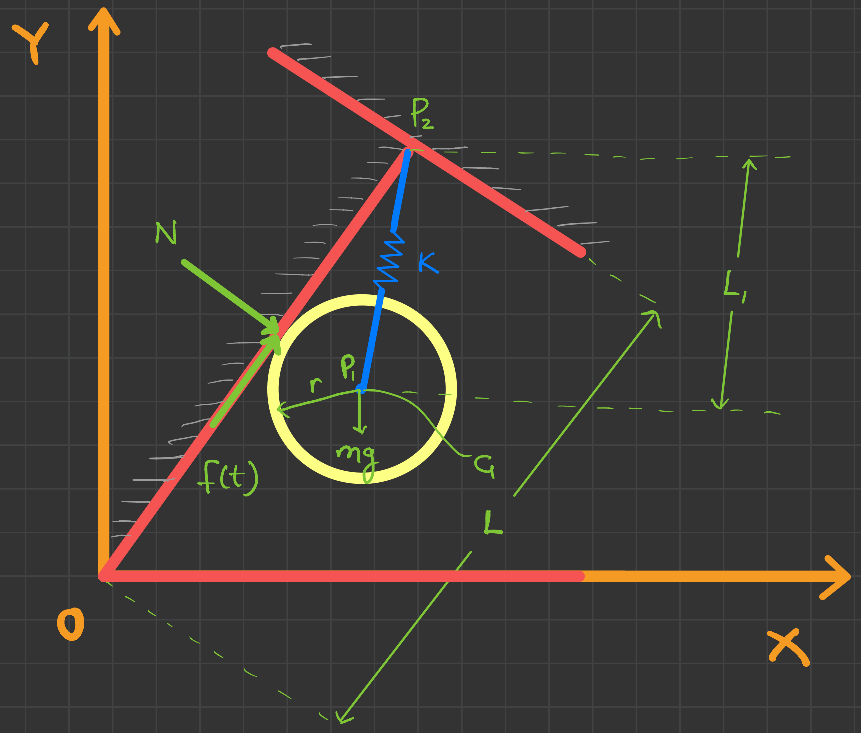




FORCES

$$F_{k_1} = k_1 \left(r_{P_1 P_2} - L \right)$$

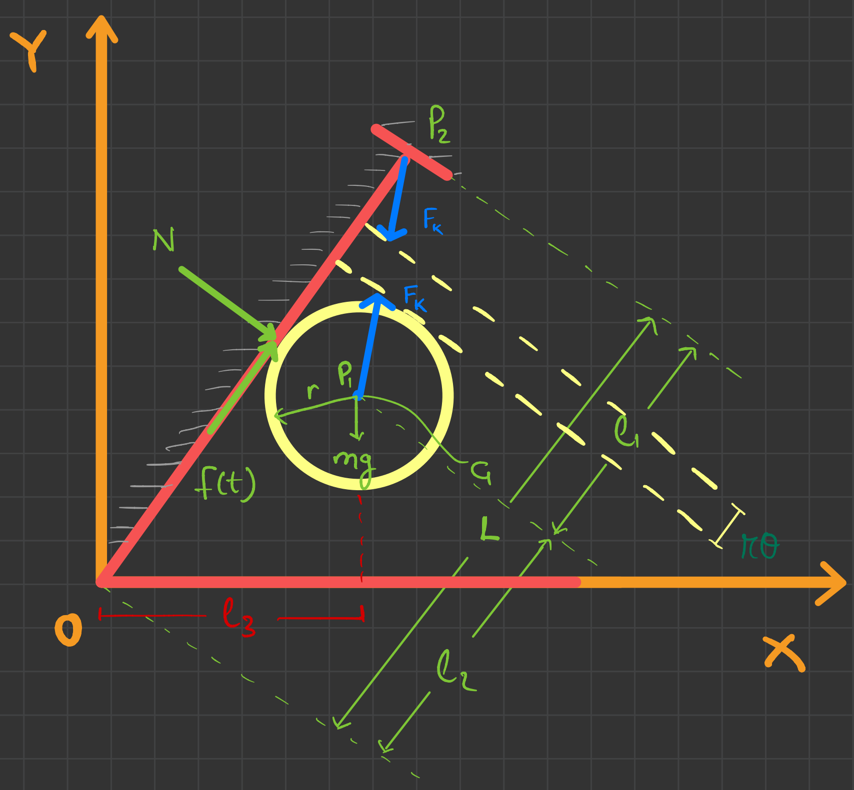
$$\overline{r_{OP_1}} =$$


Y
X
O
N
P2
K
P1
r
mg
G
f(t)
L1
L

initial velocity :-

Time of flight , $t = \dfrac{2 v_0 \sin\theta}{g}$

Initial velocity , $v_0 = \dfrac{tg}{2 \sin\theta} = 1.56 \ m/s$



$$F_K = K\left(r_{P_1P_2} - L_1\right)$$

$$\bar{r}_{OP_1} = l_2\hat{j} + l_3\cos\theta\,\hat{i} - l_3\sin\theta\,\hat{j}$$

$$\bar{r}_{OP_2} = L\hat{i}$$

$$r_{P_1P_2} = \left[\left[L - l_3\cos\theta\right]^2\hat{i} + \left[l_3\sin\theta - l_2\right]^2\hat{j}\right]^{1/2}$$

$$\boxed{F_K = K\left[\left[(L - l_3\cos\theta)^2\hat{i} + (l_3\sin\theta - l_2)^2\hat{j}\right]^{1/2} - L_1\right]}$$

$$\boxed{\theta_K(t) = \tan^{-1}\left(\frac{l_3\sin\theta - l_2}{L - l_3\cos\theta}\right)^{-1}}$$

$$\sum F_x = m a_{ax}$$

$$N\cos\theta - F_K\cos\theta_K = m\left[-l_3(\sin\theta)\ddot{\theta} - l_3(\cos\theta)\dot{\theta}\right]$$

$$\sum F_Y = m a_{aY}$$

$$f(t)\sin\theta - mg + F_K\sin\theta_K = m\left[-l_3(\cos\theta)\ddot{\theta} + l_3(\sin\theta)\dot{\theta}\right]$$

$$\text{Translational KE} = \frac{1}{2} m \, \dot{\bar{r}}_{OG} \cdot \dot{\bar{r}}_{OG}$$

$$= \frac{1}{2} m \left[\left((l_3 \sin\theta)\dot{\theta} \right)^2 + \left(l_3 \cos\theta \, \dot{\theta} \right)^2 + 2 l_3^2 (\sin\theta \cos\theta)\dot{\theta}^2 \right]$$

$$\text{Rotational KE} = \frac{1}{2} I_G \dot{\theta}^2$$

$$= \frac{1}{2} m r^2 \dot{\theta}^2$$

$$\text{Restoring PE} = \frac{1}{2} k_1 \left(r_{P_1P_2} - L_1 \right)$$

$$= \frac{1}{2} k_1 \left(\left[[L - l_3 \cos\theta]^2 \hat{i} + [l_3 \sin\theta - l_2]^2 \hat{j} \right]^{1/2} - L_1 \right)$$

$$\text{Gravitational PE} = mg \, \bar{r}_{OG} \cdot \hat{j}$$

$$= mg \left(l_2 - l_3 \sin\theta \right)$$

$$\frac{P_{diss}}{P_{in}} \times 100$$

* HMI *

1. M1 & M2 Papers } 50 - 60 marks
2. Assignment 1 & 2

[25 - Nextion Editor]

3. GOMS Model (10m), Waterfall ~~Method~~ Model (10m)
4. Design Process
5. Implementation
6. Shneiderman's 8 Golden Rules (10m)
7. Standards :- ISO 9241
   ↳ Principles to support Usability (Design Rules)

→ *

Unit → Overview (Point wise)

Software Process

Golden Rules

Design Rules

* Unit :- 3 } User model
* Unit :- 5

Stakeholder

Socio - Organisational issues

{ Cognitive model }
{ Predictive model } (4)

Hueristic Evaluation

GUI v/s webpage } → (3)

HMI

GOMS MODEL

Goals, Operators, Methods, Selection

Goals :- What the user wants to achieve

Operators :- Basic actions that user performs

Methods :- Decomposition of goals into subgoals /operators.

Selection :- Means of chosing b/w competing methods.

Goals	Operators
Methods	Selection

Shneiderman's 8 Golden Rules

SEODOPSR

1. Strive for consistency MS Word / Excel / Mac OS
2. Enable frequent users to use shortcuts Ctrl C / Ctrl A
3. Offer informative feedback Software Update / New post notification / Spell checker
4. Design dialogues to yield closure Download complete / Move to trash
5. Offer error prevention & simple error handling Auto Correction
6. Permit easy reversal of actions Undo / Redo / Back
7. Support internal locus of control Cancel option / Reset Option
8. Reduce short term memory load Captcha / otp paste

The Waterfall Method

RADCIO

Requirements Specification

Designer & Customer try to capture what the system is expected to provide

Architectural Design

High level description of how the system would provide the services required

Detailed Design

Identifying the modules that will be required by system to provide services

Coding & Unit testing

Software design is translated to source code using any suitable programming language

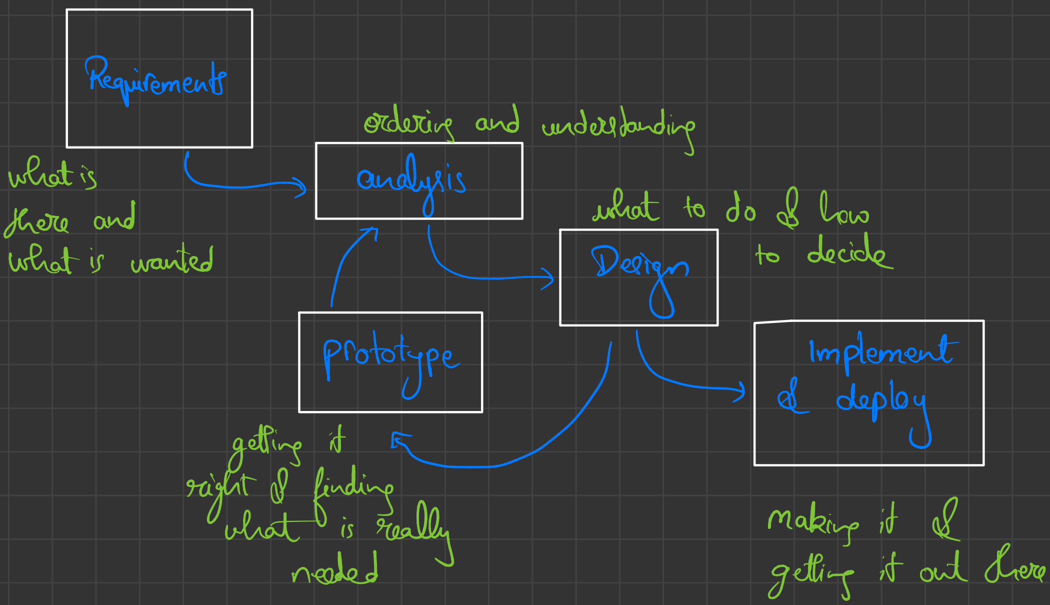
Integration & testing

integration of various modules is carried out incrementally over a no of steps

Operations & maintenance

most important phase. Effort spent of maintenance is 60% of total effort spent to develop software. Errors are corrected, functionalities are enhanced.

The Process of Design



Scenarios

Scenarios are stories for design : rich stories of interaction. They are perhaps the simplest design representation, but one of the most flexible & powerful.

Scenarios can be augmented by sketches, simulated screenshots, etc. These sketches and pictures are called storyboards.

Scenarios can be used to
→ communicate with other designers, clients or users.
→ validate other models
→ Express dynamics

Heuristic

→ is a guideline or general principle or rule of thumb that guides design decision.
→ flexible, relatively cheap. Called as discount usability technique.
→ several evaluators independentally critique a system.
→ 3-5 evaluators
→ 10 point evaluation done on project
→ each point given a no. (0-4).

Human Ear

consists of outer, middle & inner ear

Outer ear :- protects the middle & inner ear and maintains the middle ear at constant temperature

Middle ear :- Amplifies the sound and has small delicate bones

Inner ear :- Has fluid through which waves are transmitted. Delicate hair bend because of vibrations and release chemicals.

Stakeholders

In an organisation, the different people affected by the introduction of a system are known as stakeholders and their needs can be both complex and conflicting.

Primary Stakeholders : actually using the system
eg. students

Secondary Stakeholders : receive output / provide input
eg. faculty

Tertiary Stakeholders : no direct involvement but affected by success or failure.
eg. parents

Facilitating Stakeholders : involved in development or deployment of system.
eg. IT department, design team

Backus - Naur Form (BNF)

```
draw line      ::= select line + choose points + last point
select line    ::= pos mouse + CLICK MOUSE
choose points  ::= choose one | choose one + choose points
choose one     ::= pos mouse + CLICK MOUSE
last point     ::= pos mouse + DBL CLICK MOUSE
pos mouse      ::= NULL | MOVE MOUSE+ pos mouse
```

Basic syntax :- Nonterminal ::= expression

The ::= symbol is read as 'is defined as'. Only non terminals may appear on the left.
The terminals are appeared on the right and are separated with sequence '+' or choice '|'

Terminals - lowest level of human behaviour
Non-terminals - higher level of abstraction.

Memory System

Sensory Memory → Short-term Memory → Long term Memory

Attention

Buffers for stimuli received through senses

Rehersal

Scratchpad for temporary recall.
Capacity : 7 ± 2 chunks

Repository for all our knowledge.
Huge or unlimited capacity.

Layout

Grouping of items
Order of items
} logically together ⇒ physically together

Decoration - fonts, boxes etc — boxes to group logical items, fonts for emphasis & headings

Alignment of items — Text - left to right, Numbers - right to left

White space b/w items — use whitespace to separate blocks, texts etc.

Nextion, principles to support usability, GUI vs WEB

DATA ANALYTICS

Data Analytics

Analytics is defined as scientific process for transforming the data into for making better decisions.

4 scale of measurement

Nominal scale - used for naming variable in no particular order

Ordinal scale - used for variables in ranked order, but the difference b/w is not determined

Interval scale - used for numerical variables with known equal intervals of the same distance

ratio scale - used for variables on a scale that have measurable intervals.

4 data types

List ⇒ [" ", " "], ordered, changeable, duplicate values

Tuple ⇒ (" ", " "), ordered, unchangeable

Set → {" ", " "}, ordered, unchangeable, unindexed

Dictionary ⇒ thisDict = {
" brand " : " ford ",
" model " : " mustang ",
" year " : 1964
}

ordered, changeable, no duplicate values

Data lakes huge data in native format

Data marts summarized specific data

No sql vs RDBMS

1. Nosql are cheaper to scale rapidly as compared to RDBMS

2. Nosql systems help to handle large volume data while data volume managed by RDBS is less.

3. NoSQL has fewer restrictions allowing change management while RDBMS does not allow easy changes

4. NOSQL is cost effective while RDBS is not.

5. NoSQL databases require less management as compared to RDBMS which require highly trained professionals.