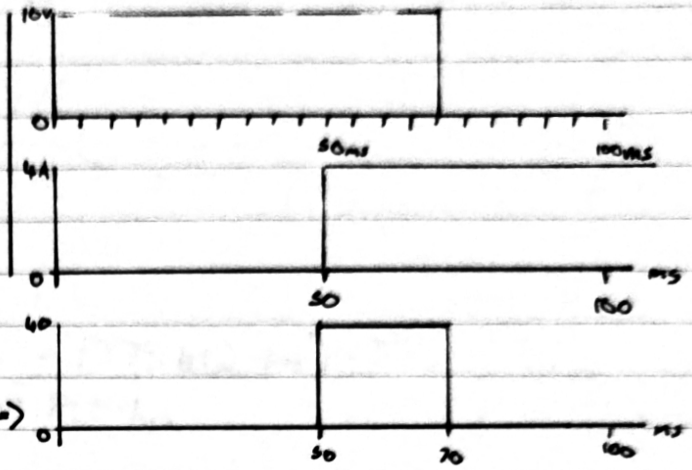
Date No.

Q1

$$v(t) = \begin{cases} 10V & 0 < t < 70ms \\ 0V & 70ms < t < 100ms \end{cases}$$

$$i(t) = \begin{cases} 0A & 0 < t < 50ms \\ 4A & 50ms < t < 100ms \end{cases}$$



$$p(t) = \begin{cases} 0 & 0 < t < 50ms \\ 40 & 50 < t < 70 \\ 0 & 70 < t < 100 \end{cases}$$

$$P_{av} = \frac{1}{T}\int_0^T p(t)\,dt \Rightarrow \frac{1}{100}\int_{50}^{70} 40\,dt$$

$$= \frac{1}{100m}\left[40(70m) - 40(50m)\right]$$

$$= 8W$$

$$W = P_{av}T = 8 \cdot 100ms$$

$$= 0.8J$$

Q2

Usefule power ~~Enue~~ $= 2kW\text{-hrs} \cdot 0.55$
$= 1.1kW\text{-hrs}$

New ~~total~~ daily energy $= \frac{1.1 kW\text{-hrs}}{0.8}$

$= 1375 kW\text{-hrs}$

yearly savings per house $= (2 kW\text{-hrs} - 1375 kW\text{-hrs}) \cdot 365$
$= 228.125 kW\text{-hrs}$

Savings for a million houses $= 228.125 kW\text{-hrs} \cdot 1\times10^6$
$= 228.125 GW\text{-hrs}$

Q3

$50hp = 37.285 kW$

$Q_{motor} = P \cdot \tan(\cos^{-1}(pf)) = 37.285 kW \cdot \tan(\cos^{-1}(0.84))$
$= 24.083\ kVAR$

$Q_{fan} = 13kW \cdot \tan(\cos^{-1}(0.75))$
$= 11.464\ kVAR$

$Q_{tot} = 24.083 kVAR + 11.464 kVAR$
$= \cancel{32.481 kVAR}\ 35.549\ kVAR$

$P_{tot} = 37.285kW + 13 kW + 24 kW$
$= 74.285\ kW$

$S_{tot} = 74.285 + \cancel{32.481j\ kVA}\ 35.549j\ kVA$
$= 82.35 \angle 25.57\ kVA$

Date No.

Q4.

All calculations done for a single phase

$P_{load} = 240\,kW$

$V_L = 2400\,V$

$I_{line} = \dfrac{P_L}{V_L \cdot pf} = 121.95\,A$

$\phi = \cos^{-1}(pf) = -34.91$

$P_{line} = I_{line}^2 \cdot R_{line}$

$= 121.95^2 \times 1.5$

$= 22.308\,kW + 53539.5j\,kW$

Percent effeciency = 91.5%

$V_s = (2400 + ((1.5 + 3.6j) \cdot 121.95 \angle -34.91)$

$= 2801.3 + 255.3j\ V$

$\%VR = \dfrac{|V_s| - |V_{load}|}{|V_{load}|} = 17.2\%$

$S = V_s \cdot I_{line}^*$

$= 2801.3 + 255.3j \cdot 121.95 \angle +34.91$

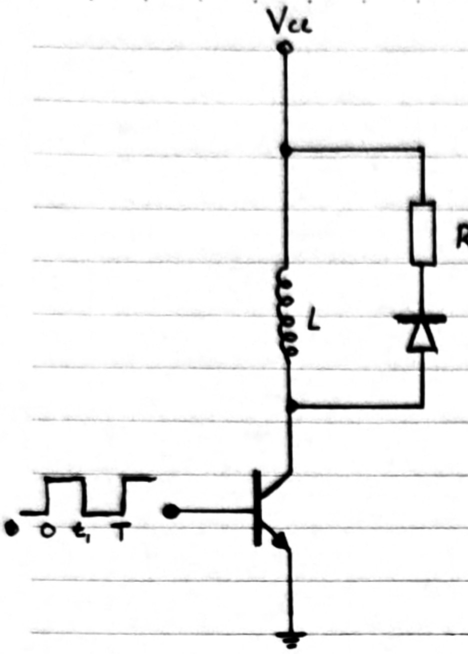
$= 343.034 \angle 40.11\ kVA$

$pf = \cancel{\cos(-29.73)}\ \cos(40.11)$

$= \cancel{0.87\ \text{lagging}}$

pf = 0.764 lagging

Q5

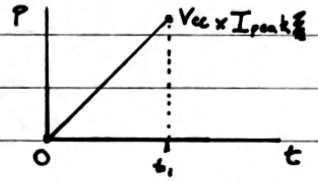


$V_{cc} = 90V$
$L = 200mH$
$R = 20\Omega$
$t_1 = 10ms$
$T = 100ms$

a.) Peak current will be at $t = t_1$.

$$I_{peak} = \frac{V_{cc} \cdot t_1}{L} = 4.5A$$

Peak energy is the area under the power curve untill discharge ($t = t_1$)



This is a triangle with sides of t_1 and $V_{cc} \cdot I_{peak}$

$$E_{peak} = \frac{(V_{cc} \cdot I_{peak}) \cdot t_1}{2} = 2.025J$$

b.) $P_R = \frac{(V_{cc} \cdot t_1)^2}{2LT} = 20.25W$

c.) $P_{S(max)} = I_{peak} \cdot V_{cc} = 405W$

$P_S = \frac{(V_{cc} \cdot t_1)^2}{2LT} = 20.25W$

Date No.

Q6

$Z_L = 5\Omega + 3j\,\Omega$
$Z_{line} = 0.2\,\Omega + 0.25j\,\Omega$
$V_L = 230\,V$

$I_{Line} = V_L / Z_L = \frac{230}{5+3j}\,A$
$= 33.82 - 20.29j\,A$

$V_{Line} = I_{Line} \cdot Z_{line} = (33.82 - 20.29j) \times (0.2 + 0.25j)\,V$
$= 11.84 + 4.4j\,V$

$V_{gen} = V_L + V_{Line}$
$= 241.84 + 4.4j\,V$

$S_{gen} = V_{gen} \cdot I_{Line}^{*} = (241.84 + 4.4j) \cdot (33.82 + 20.29j)$
$= 8089.8 + 5055.7j\,VA$
$= 9539.6 \angle 32\,VA$

$P_s = 8089.8\,W$
$Q_s = 5055.7\,VAR$

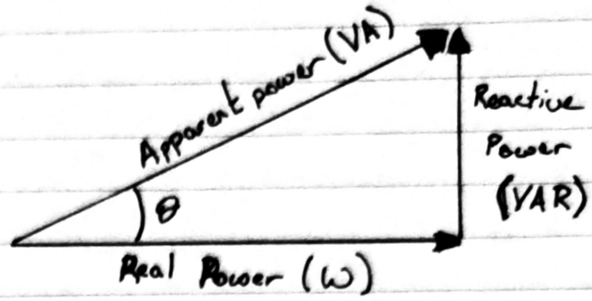
$pf = \cos(\angle S_{gen}) = \cos(32)$
$= 0.848$ lagging

Date No.

Q7.)

In figure 1 we can see the power triangle that visualises the relationship between real, reactive, and apparent power.

Real power denotes the actual power that is consumed by the load. This power is used to do work within the system and is not returned to the supply.



Power Factor = $\cos(\theta)$

figure 1.
Power Triangle

The reactive power denotes the power stored within the reactive components (capacitors and inductors). This power is not consumed by the load and will be returned to the supply.

Apparent power is the magnitude of the combined real and reactive power. The apparent power is the total power that must be provided by the ~~load~~ supply to the load.

The power factor is the ratio between the real and ~~reactive~~ apparent power, and signifies what portion of the power provided by the supply (Apparent Power) will be consumed by the load.

Using this information we can look to correct power factors by providing another reactive load that will counteract the existing one. If a house has a power factor of 0.3, that means that the house has an apparent power of $\frac{1}{0.3}$ times the real power. Assuming that the power factor is lagging with a reactive load of 10j (inductive), ~~and a real load of~~ the real load will be of size:

$\theta = \cos^{-1}(0.3) = 72.5^\circ$, $\therefore$ Real power = 12.8W

To correct this pf to 0.9 lagging, we want to change θ to be $\cos^{-1}(0.9) = 25.8^\circ$

This will require a new reactive load of 5.86j. To achieve this a capacitive load of -4.14j should be added.