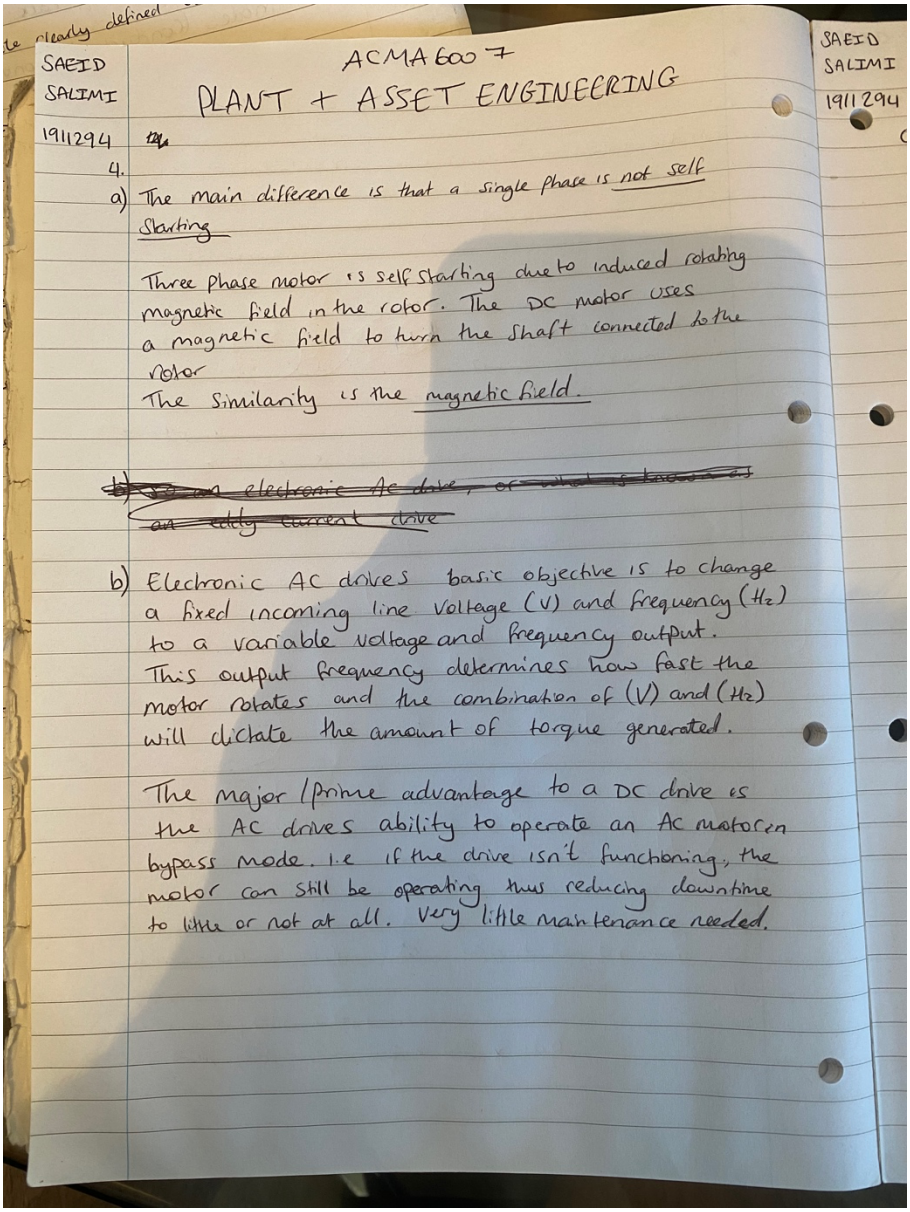


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4.

a) The main difference is that a single phase is not self starting

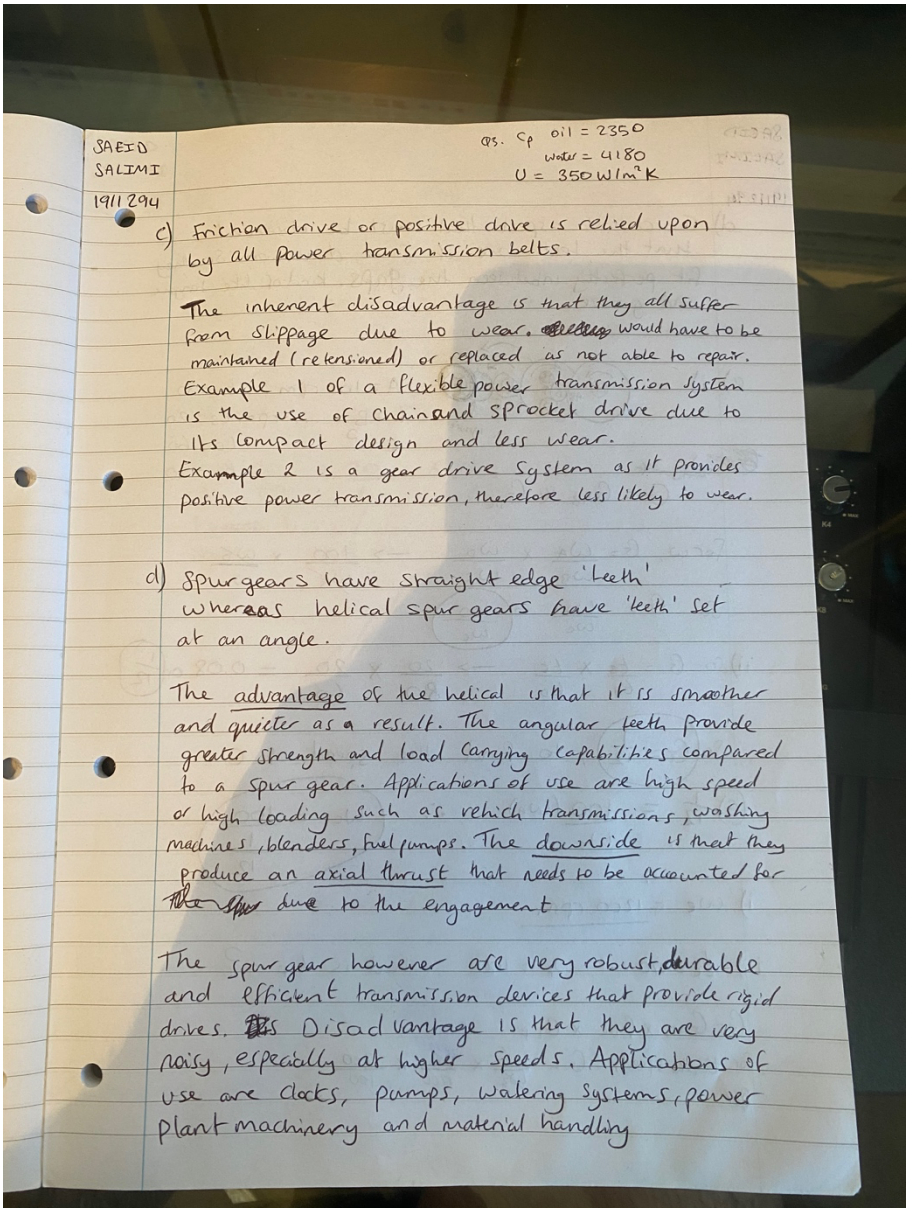
Three phase motor is self starting due to induced rotating magnetic field in the rotor. The DC motor uses a magnetic field to turn the shaft connected to the rotor
The similarity is the magnetic field.

~~b) Is an electronic AC drive, or what is known as an eddy current drive~~

b) Electronic AC drives basic objective is to change a fixed incoming line voltage (V) and frequency (Hz) to a variable voltage and frequency output. This output frequency determines how fast the motor rotates and the combination of (V) and (Hz) will dictate the amount of torque generated.

The major/prime advantage to a DC drive is the AC drives ability to operate an AC motor in bypass mode. i.e if the drive isn't functioning, the motor can still be operating thus reducing downtime to little or not at all. Very little maintenance needed.

Question 4 continued page 2/9



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Qs. C_p oil = 2350
water = 4180
$U = 350 W/m^2K$

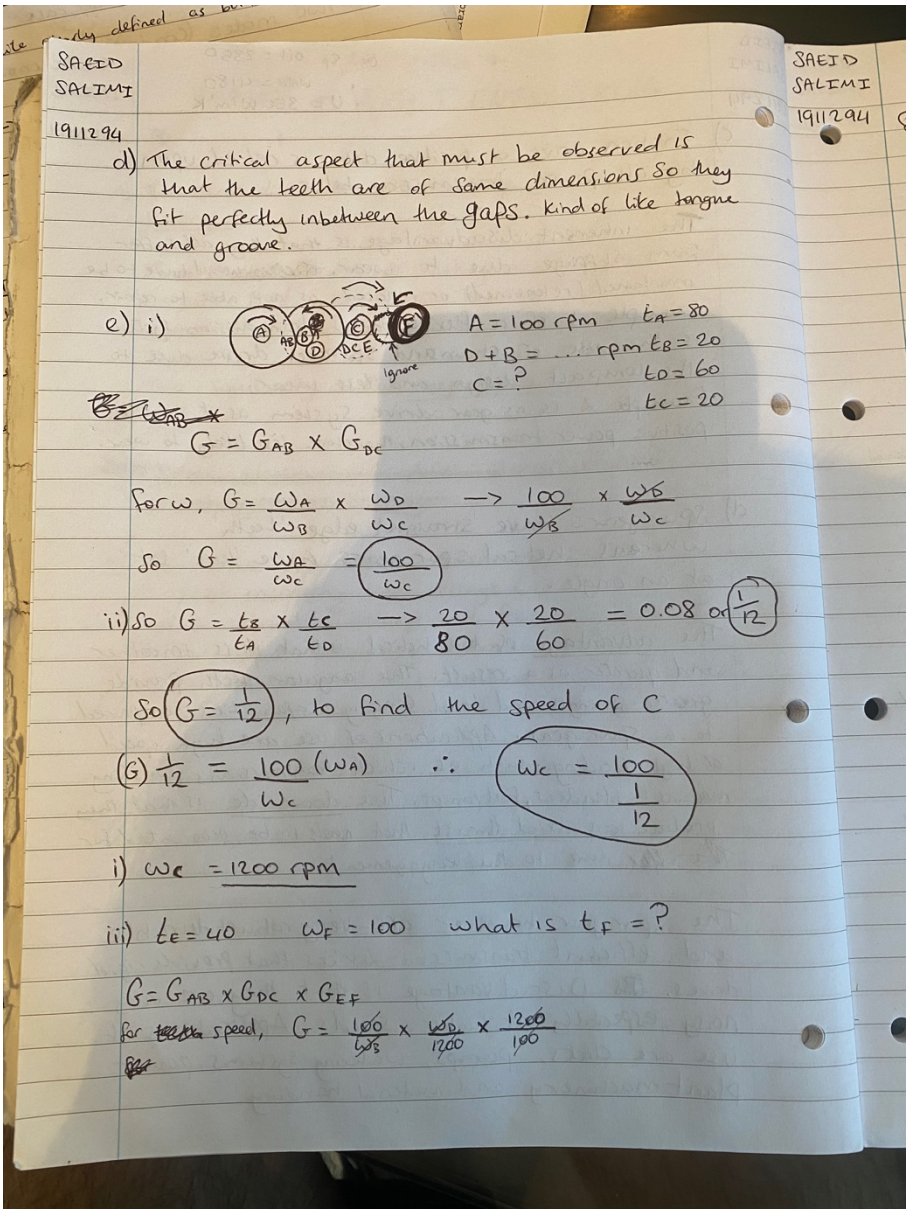
c) Frictien drive or positive drive is relied upon by all power transmission belts.

The inherent disadvantage is that they all suffer from slippage due to wear. ~~Belts~~ would have to be maintained (retensioned) or replaced as not able to repair. Example 1 of a flexible power transmission system is the use of chain and sprocket drive due to its compact design and less wear.
Example 2 is a gear drive system as it provides positive power transmission, therefore less likely to wear.

d) Spur gears have straight edge 'teeth' whereas helical spur gears have 'teeth' set at an angle.

The advantage of the helical is that it is smoother and quieter as a result. The angular teeth provide greater strength and load carrying capabilities compared to a spur gear. Applications of use are high speed or high loading such as vehicle transmissions, washing machines, blenders, fuel pumps. The downside is that they produce an axial thrust that needs to be accounted for ~~the~~ ~~Spur~~ due to the engagement.

The spur gear however are very robust, durable and efficient transmission devices that provide rigid drives. ~~Its~~ Disadvantage is that they are very noisy, especially at higher speeds. Applications of use are clocks, pumps, watering systems, power plant machinery and material handling



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19112944

d) The critical aspect that must be observed is that the teeth are of same dimensions so they fit perfectly inbetween the gaps. Kind of like tongue and groove.

e) i)

A = 100 rpm $t_A = 80$

D + B = ... rpm $t_B = 20$

C = ? $t_D = 60$

$t_C = 20$

~~G_{AB}~~

$G = G_{AB} \times G_{DC}$

for ω, $G = \frac{\omega_A}{\omega_B} \times \frac{\omega_D}{\omega_C} \rightarrow \frac{100}{\omega_B} \times \frac{\omega_D}{\omega_C}$

So $G = \frac{\omega_A}{\omega_C} = \frac{100}{\omega_C}$

ii) So $G = \frac{t_B}{t_A} \times \frac{t_C}{t_D} \rightarrow \frac{20}{80} \times \frac{20}{60} = 0.08$ or $\frac{1}{12}$

So $G = \frac{1}{12}$, to find the speed of C

$(G)\ \frac{1}{12} = \frac{100}{\omega_C}(\omega_A) \quad \therefore \quad \omega_C = \frac{100}{\frac{1}{12}}$

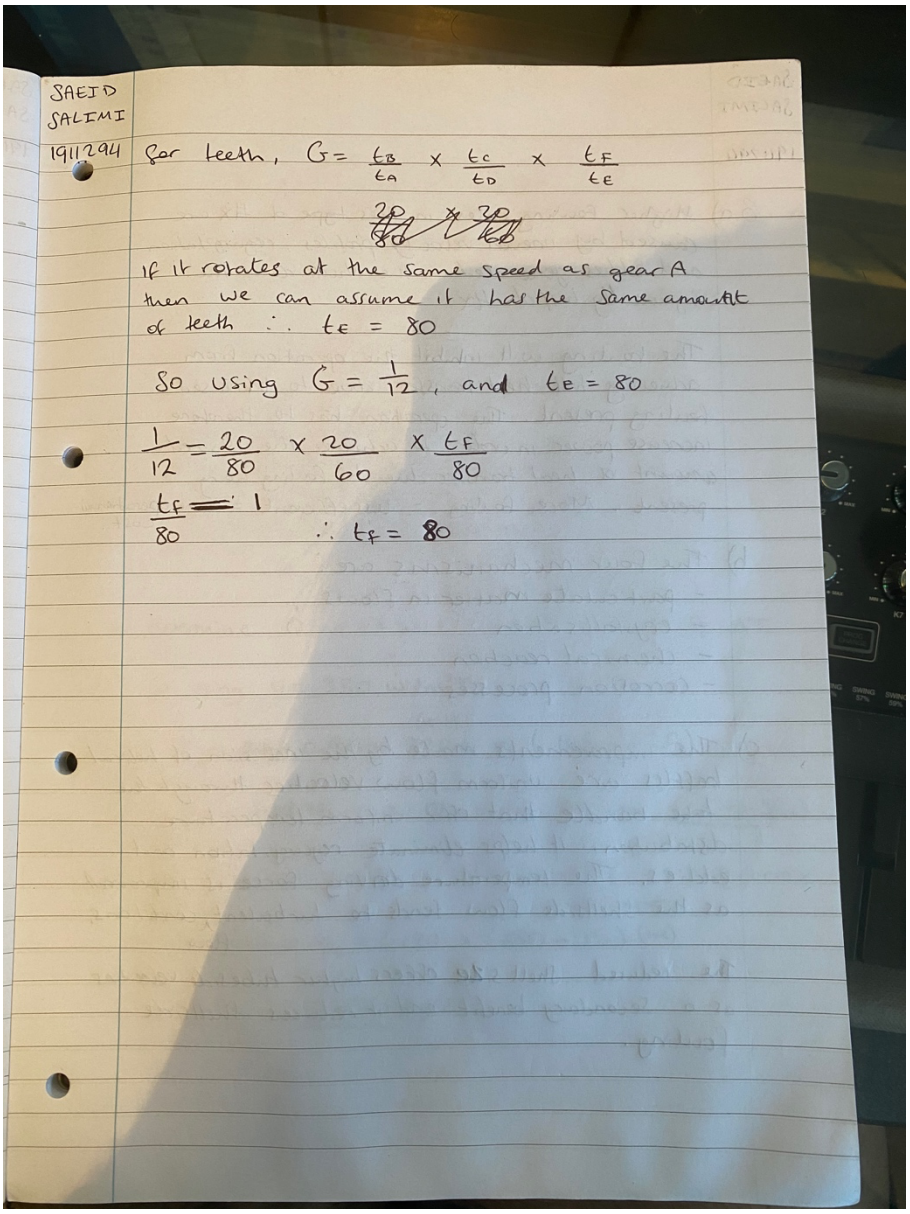
i) $\omega_C = 1200$ rpm

iii) $t_E = 40 \quad \omega_F = 100$ what is $t_F = ?$

$G = G_{AB} \times G_{DC} \times G_{EF}$

for ~~teeth~~ speed, $G = \frac{100}{\omega_B} \times \frac{\omega_D}{1200} \times \frac{1200}{100}$

Question 4 continued page 4/9



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For teeth, $G = \frac{t_B}{t_A} \times \frac{t_C}{t_D} \times \frac{t_F}{t_E}$

$\frac{20}{80} \times \frac{20}{t_D}$

If it rotates at the same speed as gear A then we can assume it has the same amount of teeth $\therefore t_E = 80$

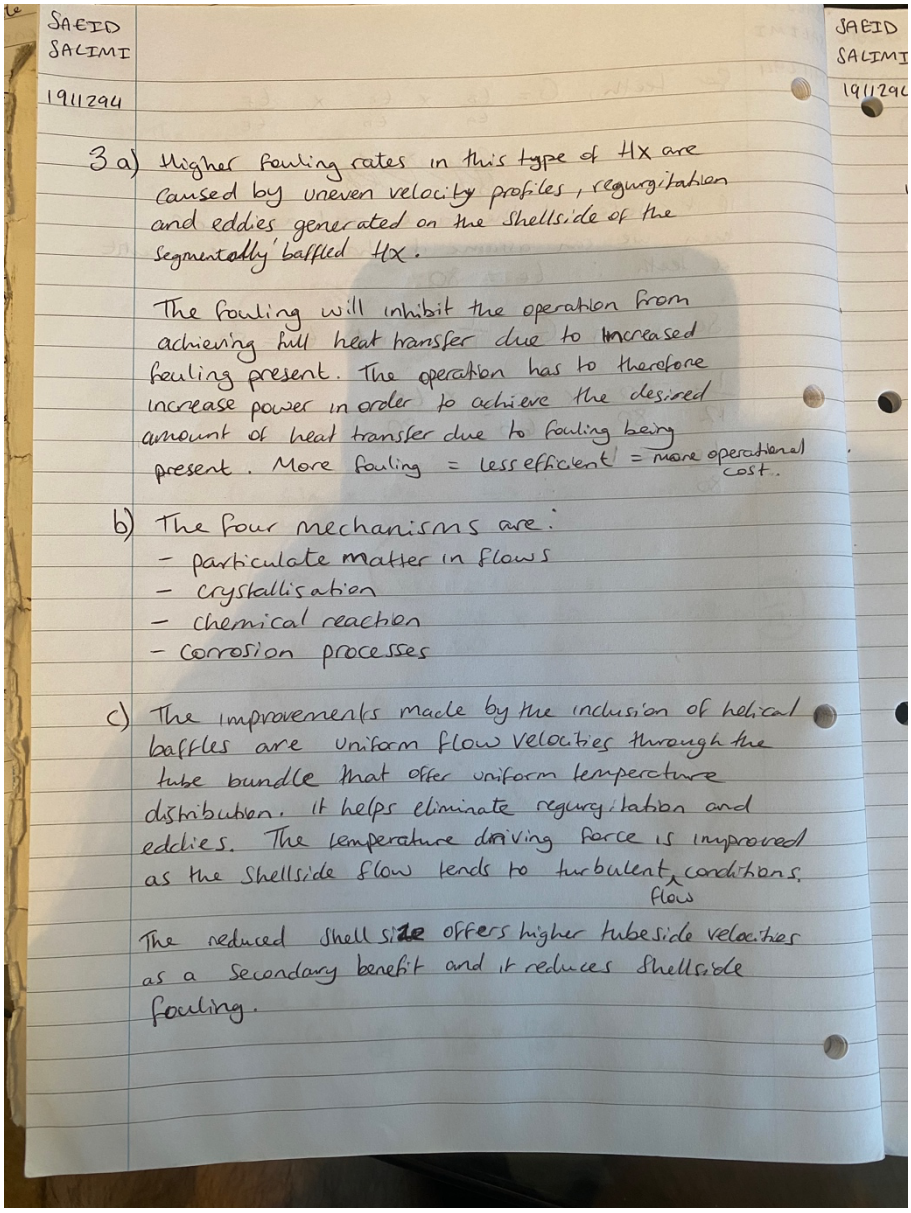
So using $G = \frac{1}{12}$, and $t_E = 80$

$\frac{1}{12} = \frac{20}{80} \times \frac{20}{60} \times \frac{t_F}{80}$

$\frac{t_F}{80} = 1$

$\therefore t_F = 80$

Question 3 page 5/9



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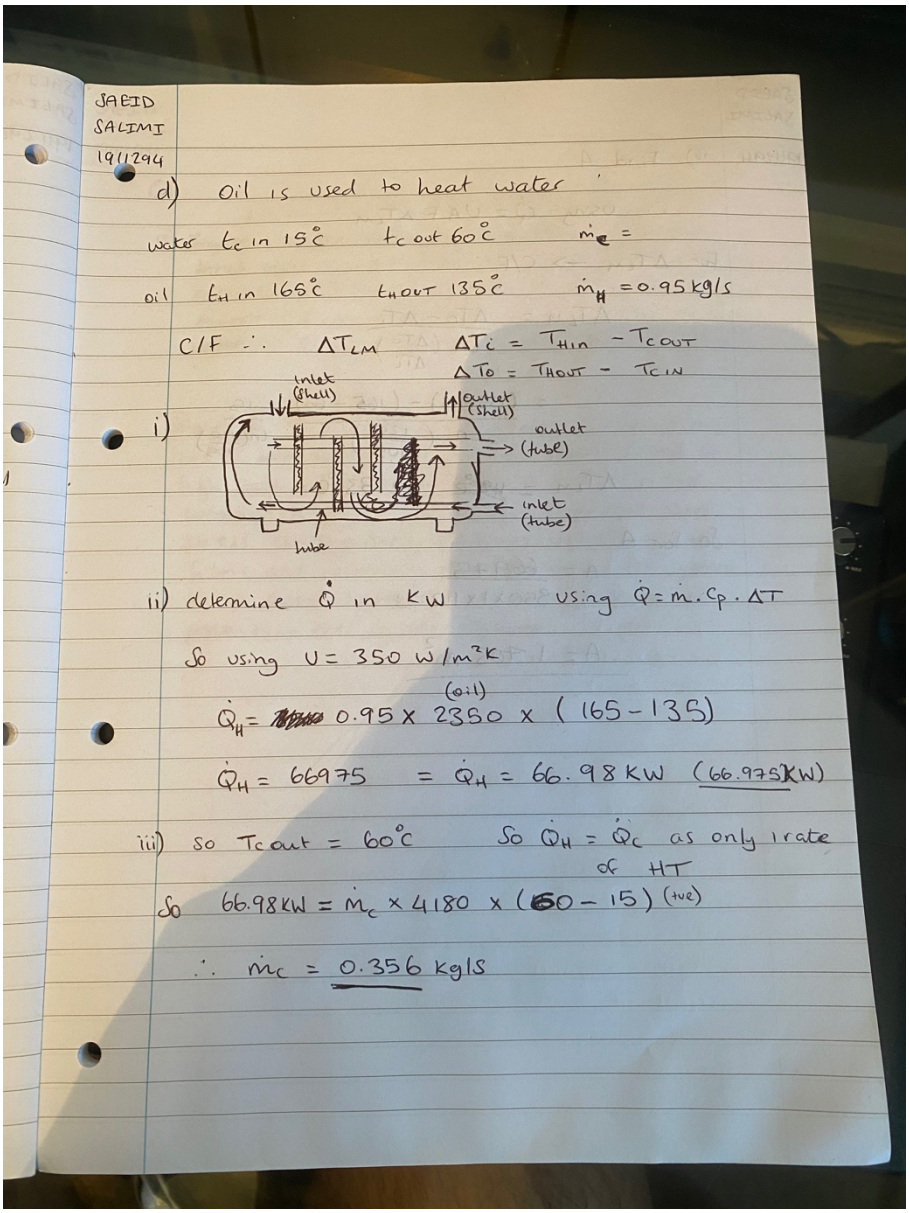
3 a) Higher fouling rates in this type of HX are caused by uneven velocity profiles, regurgitation and eddies generated on the shellside of the segmentally baffled HX.

The fouling will inhibit the operation from achieving full heat transfer due to increased fouling present. The operation has to therefore increase power in order to achieve the desired amount of heat transfer due to fouling being present. More fouling = less efficient = more operational cost.

b) The four mechanisms are:
- particulate matter in flows
- crystallisation
- chemical reaction
- corrosion processes

c) The improvements made by the inclusion of helical baffles are uniform flow velocities through the tube bundle that offer uniform temperature distribution. It helps eliminate regurgitation and eddies. The temperature driving force is improved as the shellside flow tends to turbulent flow conditions.

The reduced shell side offers higher tubeside velocities as a secondary benefit and it reduces shellside fouling.



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d) Oil is used to heat water

water t_c in 15°C t_c out 60°C $\dot{m}_c$ =

oil t_H in 165°C t_H out 135°C $\dot{m}_H$ = 0.95 kg/s

C/F ∴ ΔT_{LM} $\Delta T_i = T_{H\,in} - T_{c\,out}$

$\Delta T_o = T_{H\,out} - T_{c\,in}$

i)

ii) determine $\dot{Q}$ in kW using $\dot{Q} = \dot{m} \cdot C_p \cdot \Delta T$

So using $U = 350\ W/m^2K$

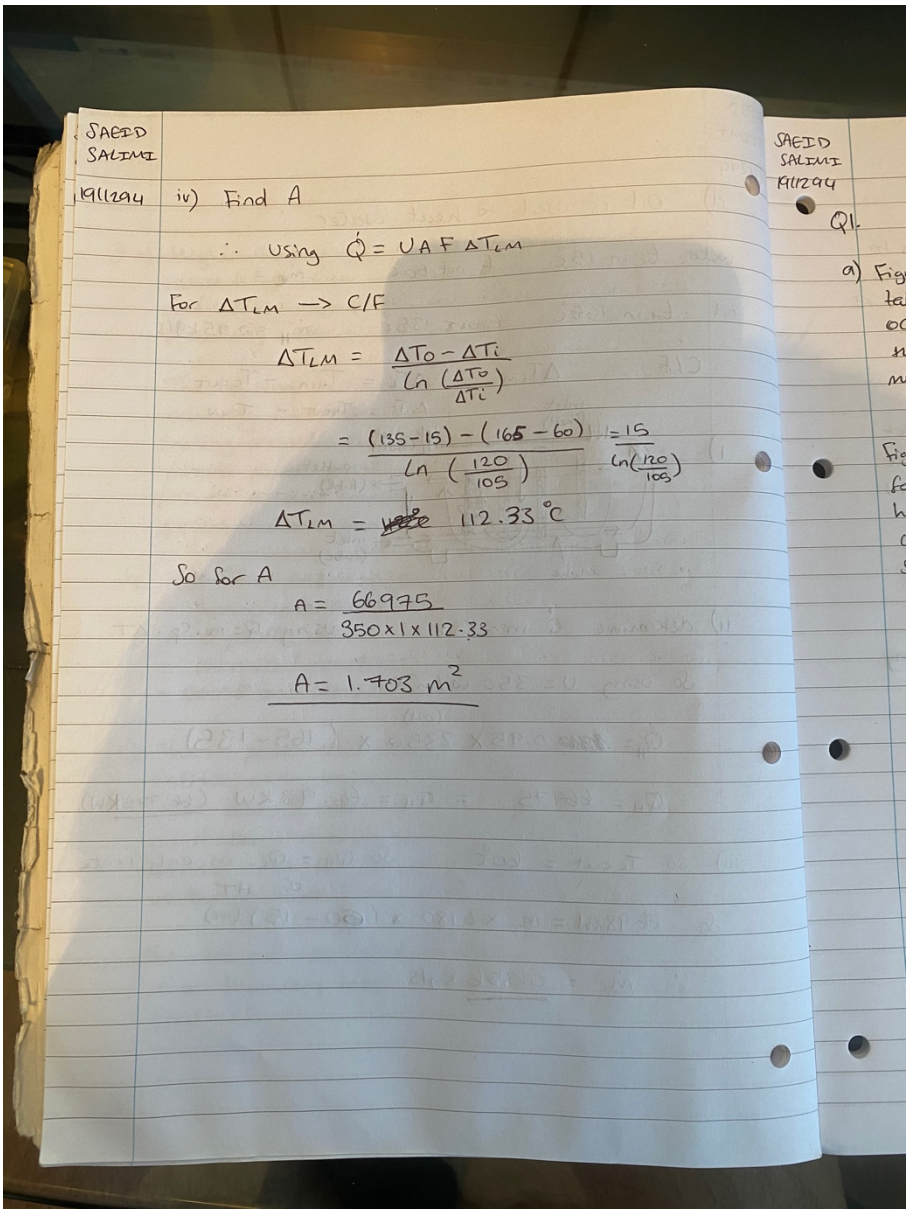
$\dot{Q}_H = 0.95 \times 2350 \times (165 - 135)$ (oil)

$\dot{Q}_H = 66975$ = $\dot{Q}_H = 66.98\ kW$ (66.975 kW)

iii) So $T_{c\,out} = 60°C$ So $\dot{Q}_H = \dot{Q}_c$ as only rate of HT

So $66.98\ kW = \dot{m}_c \times 4180 \times (60 - 15)$ (tue)

∴ $\dot{m}_c$ = 0.356 kg/s



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iv) Find A

$\therefore$ Using $\dot{Q} = UAF\Delta T_{LM}$

For ΔT_{LM} → C/F

$$\Delta T_{LM} = \frac{\Delta T_o - \Delta T_i}{\ln\left(\frac{\Delta T_o}{\Delta T_i}\right)}$$

$$= \frac{(135-15)-(165-60)}{\ln\left(\frac{120}{105}\right)} = \frac{15}{\ln\left(\frac{120}{105}\right)}$$

$\Delta T_{LM} = 112.33\ ^\circ C$

So for A

$$A = \frac{66975}{350 \times 1 \times 112.33}$$

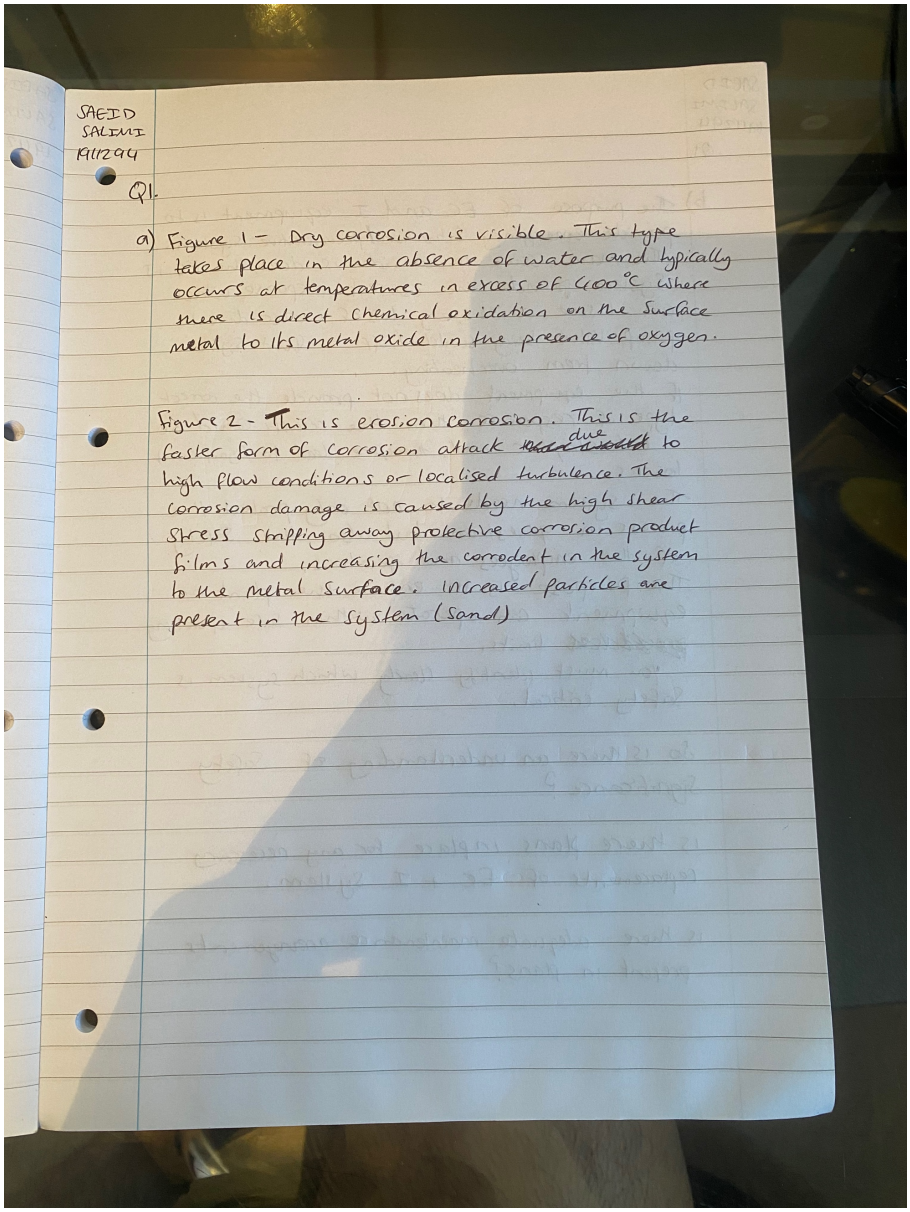
$$A = 1.703\ m^2$$

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Q1.

a) Fig

Question 1 Page 8/9

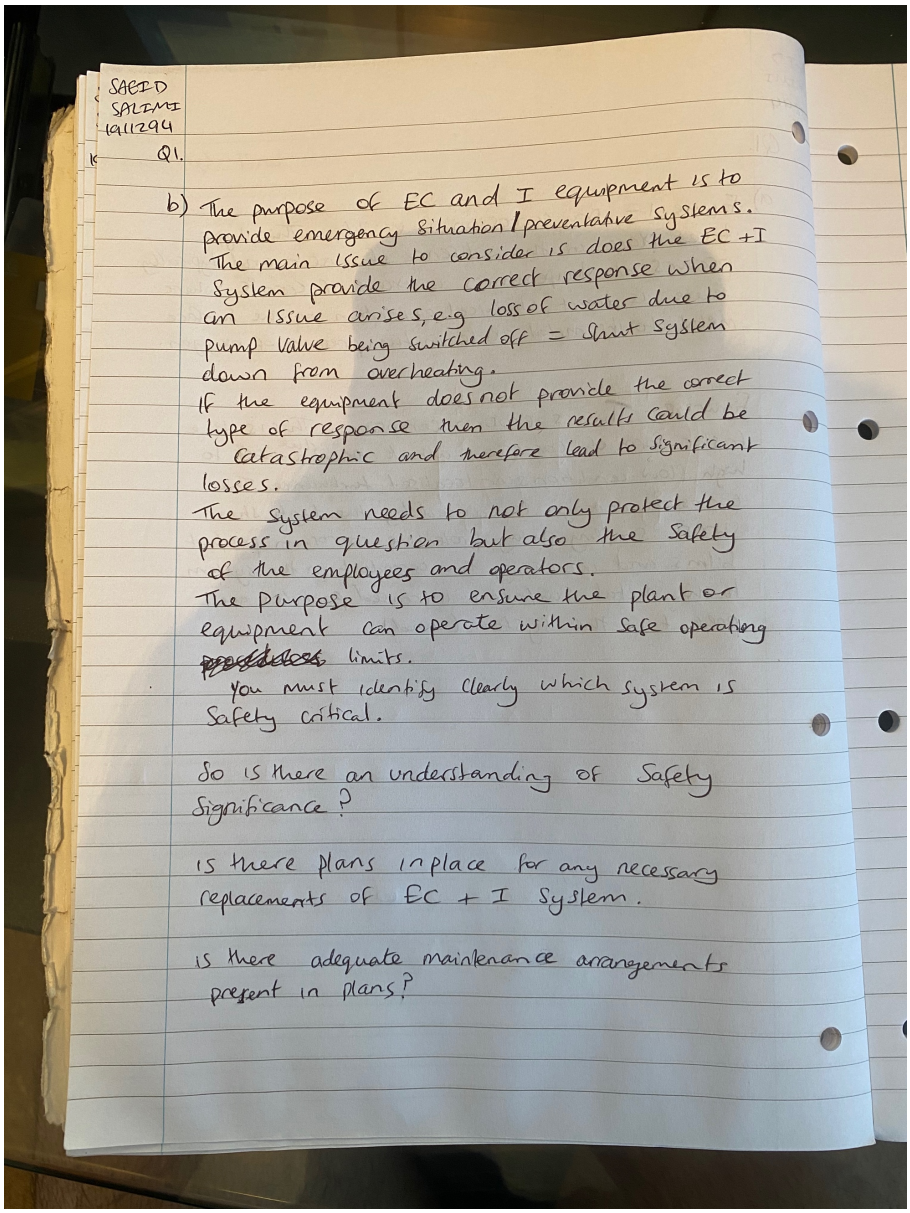


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Q1.

a) Figure 1 - Dry corrosion is visible. This type takes place in the absence of water and typically occurs at temperatures in excess of 400°C where there is direct chemical oxidation on the surface metal to its metal oxide in the presence of oxygen.

Figure 2 - This is erosion corrosion. This is the faster form of corrosion attack ~~[illegible]~~ due to high flow conditions or localised turbulence. The corrosion damage is caused by the high shear stress stripping away protective corrosion product films and increasing the corrodent in the system to the metal surface. Increased particles are present in the system (sand)



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Q1.

b) The purpose of EC and I equipment is to provide emergency situation / preventative systems. The main issue to consider is does the EC + I system provide the correct response when an issue arises, e.g loss of water due to pump valve being switched off = shut system down from overheating.
If the equipment does not provide the correct type of response then the results could be catastrophic and therefore lead to significant losses.
The system needs to not only protect the process in question but also the safety of the employees and operators.
The purpose is to ensure the plant or equipment can operate within safe operating ~~procedures~~ limits.
You must identify clearly which system is safety critical.

So is there an understanding of safety significance?

Is there plans in place for any necessary replacements of EC + I system.

Is there adequate maintenance arrangements present in plans?