PROGRAM	:	NATIONAL DIPLOMA *CHEMICAL ENGINEERING*
SUBJECT	:	**CHEMICAL ENGINEERING TECHNOLOGY 3A**
CODE	:	**CMTA321**
DATE	:	SUPPLEMENTARY EXAMINATION JULY 2019
DURATION	:	3 HOURS
WEIGHT	:	40: 60
TOTAL MARKS	:	100

EXAMINER	:	MS THANDIWE SITHOLE
MODERATOR	:	DR I. AMER
NUMBER OF PAGES	:	04 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS. NON-PROGRAMMABLE CALCULATORS PERMITTED (ONLY ONE PER CANDIDATE).

QUESTION 1

$$\left(\frac{G}{A}\right)^2 \ln\frac{v_2}{v_1} + \frac{P_2^2 - P_1^2}{2P_1v_1} + 2f\frac{L}{D}\left(\frac{G}{A}\right)^2 = 0$$

A mass flux of 41kgm^{-2}s^{-1} methane (μ = 0.000011Pa.s, MW=16.042gmol^{-1}.) has to be delivered at a constant temperature of 300K along a smooth 0.19m diameter line, 3km long, linking a compressor and a processing unit. The methane is to be discharged at the processing unit assume P_1=P_2

1.1. What type of flow gives rise to the form of the compressible fluid equation given above? (2)

1.2. What pressure must be developed at the compressor in order to achieve the mass flux? (14)

1.3. How much heat in W must be added to the gas in order to keep the temperature constant? Note: ρu=(G/A) (13)

1.4. What is the percentage drop in pressure experienced? (2)

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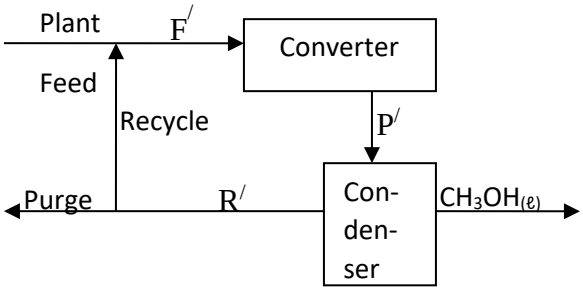
QUESTION 2

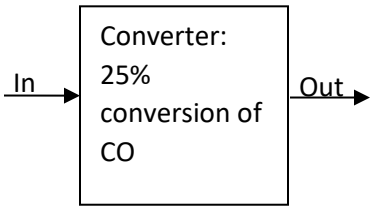


The total Plant Feed to a methanol factory is 1mols^{-1}, and contains carbon monoxide and hydrogen in the correct stoichiometric ratio, and inert argon at 0.01mols^{-1}. The entire produced methanol is removed in the condenser, while un-reacted gases (CO and H_2) are re-cycled to the converter after a purge is taken off as shown. The re-cycle needs to contain a certain mol% of argon, and a certain % of CO in the feed to the converter reacts in the converter to produce methanol.

2.1. Calculate the flow rate of CO in the Plant Feed (mols^{-1}). (7)

2.2. Calculate the flow rate of CO in stream F' (mols^{-1}, 3 dec. places). (18)

2.3. What would you use to calculate the plant $CH_3OH_{(\ell)}$ flow rate? (2)

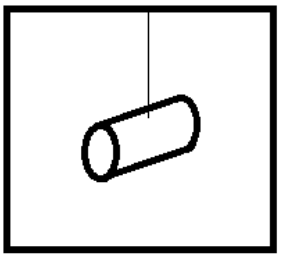


	In	Out	Heat Capacity	Heat of Formation
	mols^{-1}	mols^{-1}	Jmol^{-1}K^{-1}	Jmol^{-1}
CO	2	1.5	30.5	-110599
H_2	4	3	29.5	0
CH_3OH	0	0.5	75	-201301

2.4. Calculate how much heat must be removed from this methanol converter. (11)

[38]

QUESTION 3



A solid rod, 1m×0.05m and at an initial temperature of 25°C, is suspended in a hot oven. The air inside the oven is 190°C, while the inside surfaces of the oven are at 200°C. The surface of the rod acts like a grey body with emissivity 0.8 and the heat transfer coefficient is $25Wm^{-2}K^{-1}$. $\sigma = 5.67\times10^{-8}Wm^{-2}K^{-4}$.

3.1. Draw a diagram of the rod in your answer script and indicate by means of arrows where heat will be absorbed by convection. (3)

3.2. Estimate the initial heat gain of the rod due to convection. (12)

Hint: Not all data given is required in your calculations. **[15]**

QUESTION 4

An incompressible Newtonian fluid flows in a 3inch schedule 80 steel pipe

4.1. What is the difference between a Newtonian and Bingham Plastic fluid? (4)

4.2. A velocity gradient of $0.5s^{-1}$ results if shear of $2Nm^{-2}$ is applied to the Newtonian fluid. What is the viscosity of the fluid in Pa.s? (3)

4.3. Why is the fluid incompressible? (2)

4.4. What is the volumetric flow-rate of the Newtonian fluid (in m^3s^{-1}) if its average linear velocity in the pipe is $1ms^{-1}$? (5)

[14]

Appendix

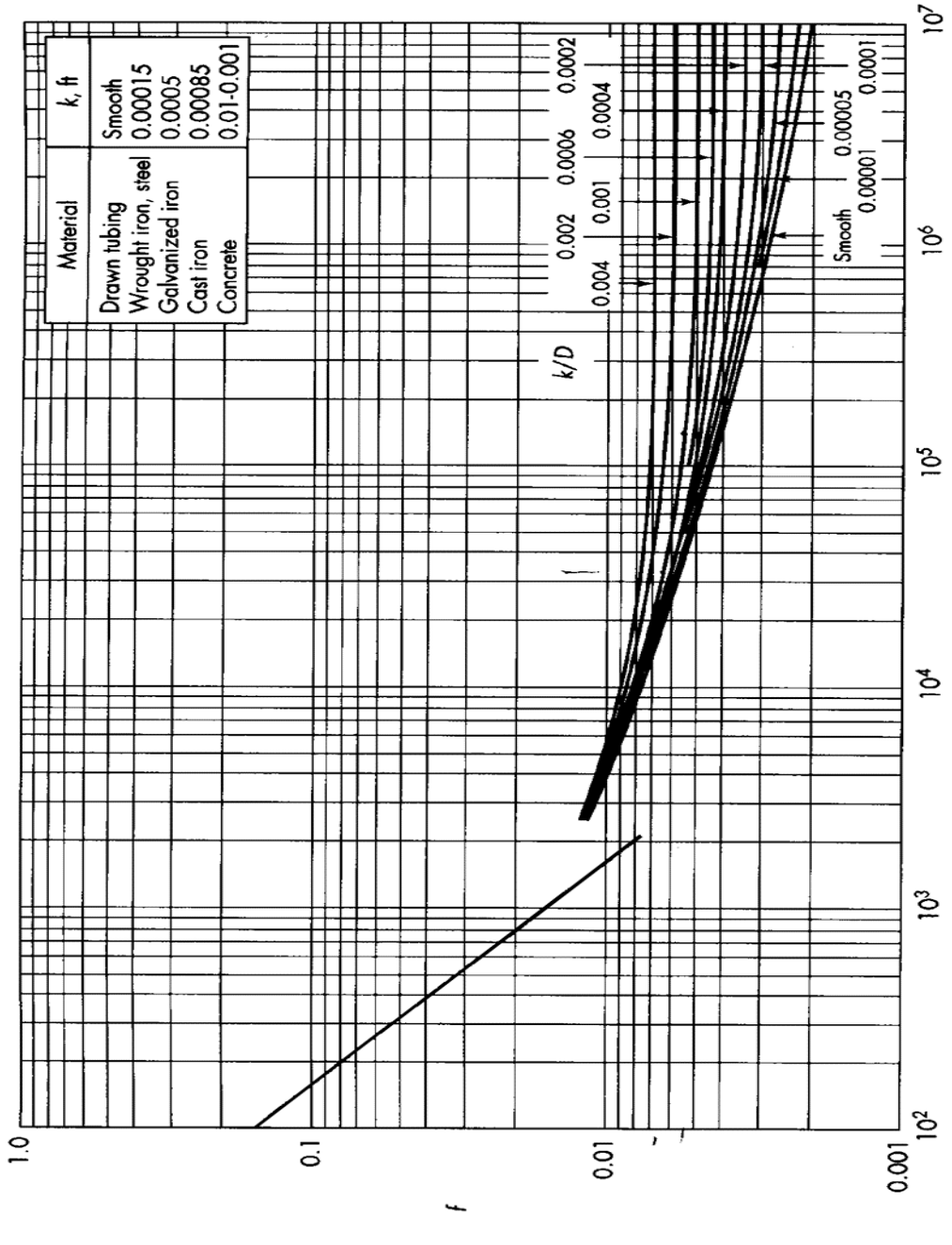


FIGURE 5.10
Friction factor chart.