FINAL EXAM 2021 – 2022

Program	Year	Semester	Paper
PE	**2**	**1**	**MAIN**

MODULE NAME:	**PROCESS INSTRUMENTATION**		

MODULE CODE:	**TPI**	DATE:	**11 /01/22**

TEACHER'S NAME:	**Dr. ALDRIN**	DURATION:	**… Hrs**

Questions to be answered on:	Allowed requirements	Number of pages
Space provided on the question paper	Pen, Pencil, Calculator, Personal Computer, Mobile Devices	(Incl. Cover Page): **11**

Points of Attention:

- For each question, the maximum earned points are mentioned between brackets at the end of each question.
- Write very clearly! Answers that are not readable are not marked and don't get points!
- Make sure your answers are written to the point.
- All answers should be written **in English**.
- Write all the answers **in blue or black pen only (NO pencil)**.
- Answers can also be **typed in MS Word** using proper formatting instruction provided in the question paper.
- Answer written in **Pencil** will not be marked.
- Use **pencil or Computer graphics** only for **diagrams, graphs & drawing**.
- Show all the calculation steps in the given space.
- Any cheating/copying may result in an instant failing of the examination.

FINAL MARKS

STUDENT NAME:			**40**
STUDENT ID:			**10**

Number of answer scripts: ………………………   **Teacher:** ………………...........

Student's signature: ………………………………   **Time of receipt:** ……………........

SECTION A
ANSWER ALL THE SHORT QUESTIONS [5 x 2 = 10 marks]

1. Recommend a pressure gauge for measuring differential pressure of corrosive liquid state its principle.

2. Determine the volume & mass flow rate of orifice flow meter as per the data given below.

Process instrument	Orifice flow meter
Pipe diameter	18 cm
Hole diameter	9 cm
Density of fluid	1000 kg/m^3
Flow coefficient	0.6
Upstream pressure	32 Pa
Downstream pressure	14 Pa.

3. Determine the change is resistance of the strain gauge as per the data given below.

Sensor name	Strain gauge
Resistance	2K
Diameter	7 cm
Gauge factor	2
Force	20650 N
Modulus of elasticity	$6.89 \times 10^{10} N/m^2$

4. Determine the expansion length of an aluminum rod of length 16 m at 25 $^\circ$C expand when the temperature is changed from 0°C - 180 $^\circ$C.? The thermal coefficient of expansion of aluminum is given as 25 x 10^{-6}/$^\circ$C.

5. Draw the sketch of Variable area flow meter and write its principle of measurement.

ANSWER ALL THE QUESTIONS $6 \times 5 = 30$ MARKS

1. An RTD has $\alpha_0 = 0.005^\circ$ /C and dissipation constant of PD = 30 mw at 25 $^\circ$ C. It is used in bridge circuit such that with R1= R2 = 600 Ω and R3 is variable resistor used to null the bridge if the supply voltage is 15 V and RTD is placed in bath at 0 $^\circ$ C. Calculate the value of R_3 to null the bridge.

2. Draw the sketches of thermocouple & strain gauge and compare their working principles and applications.

3. Recommend a suitable process instrument for measuring very high temperature of gas combustion chamber and explain the physics of measurement with a neat sketch.

.

4. *Modify the process flow diagram [PFD]which is given below into Piping and instrumentation diagram [PID] adding the following features to the process. Draw the modified diagram in the PFD itself.*

   a) Add a high temperature alarm to the vacuum evaporator

   b) Add low pressure alarm and emergency shut down to the urea synthesis tower.

   c) Add a flow control loop between urea synthesis and distillation tower.

   d) Add temperature control loop between distillation tower and flash drum

   e) Add flow control loop to control the flow of liquid ammonia through multistage pump to urea synthesis tower.
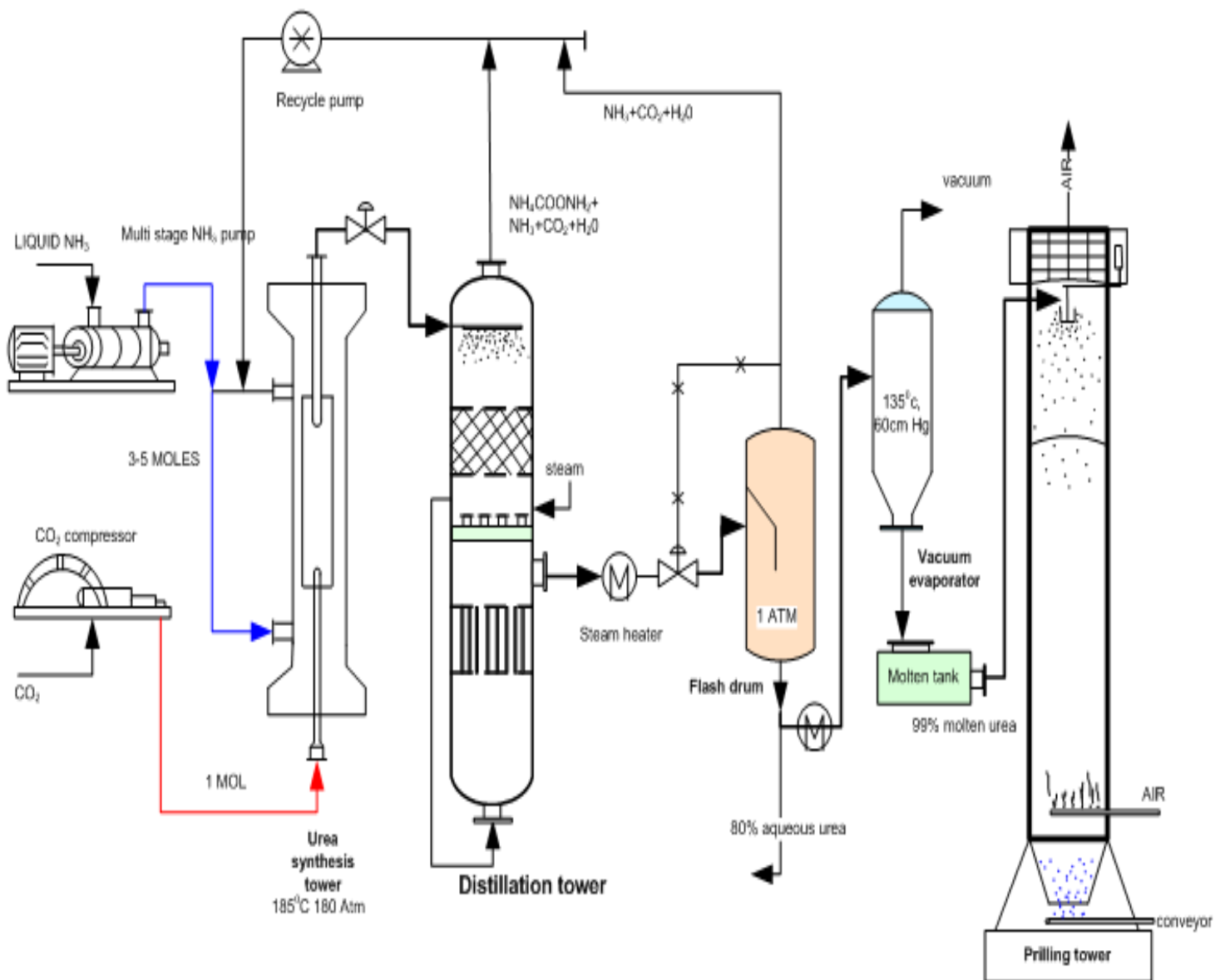
(Engineers Guide, n.d. 2012)

5. A Rotameter uses a float of diameter 3 cm with density 4700 kg/m^3. The inside diameter of pipe is 5 cm. Determine the volume and mass flow rate, if the fluid is naphtha with a density of 740 kg/m^3 assuming flow coefficient as 0.7

6. Explain the principle of measurement of turbine flow meter or reciprocating piston meter with a neat diagram

FORMULA SHEET

1. $Q = C\,A_2\sqrt{\dfrac{2(P_1 - P_2)}{\rho}}$

2. $Q = C\,\dfrac{D_\rho^2 - D_f^2}{D_f}\sqrt{\dfrac{\pi A_f\,g\,(\rho_f - \rho)}{2\rho}}$

3. $GF = \dfrac{\frac{\Delta R}{R}}{\frac{\Delta L}{L}}$

4. $\dfrac{\Delta L}{L} = \dfrac{F}{EA}$

5. $P_{out} = K_p\,e(t) + P_0$

6. $R_{RTD} = R_1\,(1 + \alpha o\,(T_2 - T_1))$

7. $R_{T2} = R_{T1}\,(1 + C\,[T_2 - T_1])$

8. $H = KI + H_0$

Reference

Simons, S. (2002). Process Plant Instrumentation. London: Delmar Cengage Learning

William   Dunn, (2009). Fundamentals of Industrial instrumentation and control, New Delhi: McGraw Hill education, Indian edition