B.Tech THIRD SEMESTER EXAMINATION JUNE-2025

(Branches for NEP-2020 : CM/ME & for AICTE : CE/CM/ME)

MA-3401 / MA-3301 MATHEMATICS - III

Time : Three Hours

Maximum Marks : **70**
Min. Pass Marks : **22**

Note : Attempt any five questions. Each question carries equal marks.

1(a) Find the Laplace transform for the following :

(i) $e^{-2t} \sin 3t \cos 2t$.   (ii) $\frac{1-\cos at}{t}$.

(b) Find the inverse Laplace transform for the following :

(i) $\frac{s-2}{s\,(s+2)(s-1)}$.   (ii) $\log\left(\frac{s+a}{s+b}\right)$.

2(a) Find the inverse Laplace transform $\frac{s}{(s^2+4)(s^2+9)}$ by using convolution theorem.

(b) Solve the differential equation $\frac{d^2y}{dt^2} - 3\frac{dy}{dt} + 2y = e^{-t}$, with $y(0) = 1$ and $y'(0) = 0$ by using Laplace transform.

3(a) Solve $x^2(y-z)p + y^2(z-x)q = z^2(x-y)$.

(b) Solve $x^2p^2 + y^2q^2 = 1$.

4(a) Solve the boundary value problem

$$\frac{\partial^2 u}{\partial t^2} = a^2 \frac{\partial^2 u}{\partial x^2};\ 0 < x < l; t > 0$$

with $u(0,t) = 0, u(l,t) = 0$ and $u(x,0) = 0, u_t(x,0) = sin^3\left(\frac{\pi x}{l}\right)$

(b) Solve $\frac{\partial^2 z}{\partial x^2} - 5\frac{\partial^2 z}{\partial x \partial y} + \frac{\partial^2 z}{\partial y^2} = e^{x+y}$.

5(a) Assume that 50% of all engineering students are good in mathematics. Determine the probabilities that among 18 engineering students :

(i) exactly 10   (ii) at least 10   (iii) at most 8

(iv) at least 2 and at most 9 are good in mathematics.

(b) A manufacturer of television set known that on an average 5% of their product is defective. They sell television in consignment of 100 and guarantees that not more than 2 set will be defective. What is the probability that the TV set will fail to meet the guaranteed quality?

6(a) Find Karl Pearson's coefficient from the following data:

Ht. in inches	57	59	62	63	64	65	55	58	57
Weight in lbs	113	117	126	126	130	129	111	116	112

(b) The equations of two regression lines are $7x - 16y + 9 = 0$ and $5y - 4x - 3 = 0$. Find the coefficient of correlation and the mean of x and y.

P.T.O.

7(a) A manufacturer claimed that at least 95% of the equipment which he supplied to a factory conformed to specifications. An experiment of a sample of 200 piece of equipment revealed that 18 were faulty. Test the claim at 5% los

(b) The average marks scored by 32 boys is 72 with a S.D. of 8. While that for 36 girls is 70 with a S.D. 6. Does this data indicate that the boys perform better than girls at 5% los?

8(a) A sample of 26 bulbs gives a mean life of 990 hours with a S.D. of 20 hours. The manufacturer claims that the mean life of bulbs is 1000 hours. Is the sample not up to the standard?

(b) Ten soldiers participated in a shooting competition in the first week. After intensive training the participated in the competition in the second week. Their scores before and after training age given below :

Scores before	67	24	57	55	63	54	56	68	33	43
Scores after	70	38	58	58	56	67	68	75	42	38

Do the data indicate that the soldiers have been benefited by the training?

*****

B.Tech THIRD SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-3401 CHEMICAL ENGINEERING THERMODYNAMICS

Time : Three Hours

Maximum Marks : **70**
Min. Pass Marks : **22**

Note : Attempt any five questions. Each question carries equal marks. Draw neat sketch and assume suitable data wherever you required.

1(a) What is a steady-flow process?

 (b) State mathematically the first law of thermodynamics that can be used for solving steady state fluid flow problems.

2(a) What is general cubic equation of state?

 (b) What are limitations of virial equation?

3(a) What is the Joule-Thomson effect? Show that, for an ideal gas, the Joule coefficient is zero.

 (b) Explain the Consequences of the third law of thermodynamics.

4(a) Show that for air undergoing isentropic expansion process;

$$ds = c_p \, \frac{dv}{v} + c_v \, \frac{dp}{p}$$

 (b) Air is compressed in a piston–cylinder device from 90 kPa and 20°C to 400 kPa in a reversible isothermal process. Determine :

   (i) the entropy change of air   and   (ii) the work done.

5(a) Derive first of the four Maxwell's Equations and state its significance in thermodynamics.

 (b) Express the relation of fugacity from compressibility factor

$$f = P \exp\left(\int_0^P \frac{Z-1}{P} \, dP \right)$$

6(a) What are the dimensions of activity coefficient and fugacity?

 (b) A gas obeys the equation of state $P(v-b) = RT$ for this gas $b = 0.039 \, dm^3 \, mol^{-1}$. Calculate fugacity and fugacity coefficient for the gas at 1000^oC and 1000 atm.

7(a) What do you understand by vapour compression cycle? Explain the processes on *T-s* and *p-h* diagrams.

 (b) An air refrigeration cycle has pressure ratio of 4 and the air enters compressor at 15ºC and expander at 30ºC. Consider compression and expansion index to be 1.25 and 1.35 respectively. Determine COP of refrigeration cycle.

8(a) Define Helmholtz energy and Gibb's free energy.

 (b) What approximations are involved in the Clapeyron-Clausius equation?

*****

B.Tech THIRD SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-3402 / 3302 MATERIAL AND ENERGY BALANCE COMPUTATIONS

Time : Three Hours

*Maximum Marks :* **70**
Min. Pass Marks : **22**

Note : All questions Carry equal marks, draw neat sketch and assume suitable data wherever you required. Use of steam table and psychrometric Chart is permitted in the examination hall.

1(a) Convert the following :

  (i) 120 g mol of NaCl to g.   (ii) 120 lb mol of NaCl to lb.

 (b) A gas mixture contains 40 lb of O_2, 25 lb of SO_2 and 30 lb of SO_3. What is the composition of the mixture in mole fractions?

2(a) Define : (i) Limiting reactant   (ii) Excess reactant   (iii) The percent conversion.

 (b) A liquefied mixture of n-butane, n-pentane and n-hexane has the following composition :

  n-C_4H_{10} 50%,   n-C_5H_{12} 30%   and   n-C_6H_{14} 20%.

  For this mixture, calculate : (i) The weight fraction of each component,
                        (ii) The mole fraction of each component.

3(a) Define Raoult's Law.

 (b) The vapor pressure jof water is 1.0 atm at 373 K and the enthalpy of vaporization is 40.7 kJ mol^{-1}. Apply the Clausius-Clapeyron equation to estimate the vapor pressure at temperature 363 K and 383 K respectively.

4(a) Define the following terms :

  (i) Dry-bulb temperature   (ii) Percentage humidity   (iii) Dew point.

 (b) Air at 30°C and 150 kPa in a closed container is compressed and cooled. It is found that the first droplet of water condenses at 200 kPa and 15°C. Calculate the percent relative humidity of the original air. The vapor pressures of water at 15°C and 30°C are 1.7051 kPa and 4.246 kPa respectively.

5(a) Discuss uses of recycling and bypassing operation.

 (b) In a textile mill, an evaporator concentrates a liquor containing solids of 6% by w/w (weight by weight) to produce an output containing 30% solids w/w. Calculate the evaporation of water per 100 kg of feed to the evaporator.

6(a) Why Purge Streams are Needed?

 (b) Soya bean seeds are extracted with hexane in batch extractors. The flaked seeds contain 18.6% oil, 69% solids and 12.4% moisture. At the end of the extraction process, deoiled cake (DOC) is separated from the hexane oil mixture. DOC analysis yields 0.8% oil, 87.7% solids and 11.5% moisture. Find the percentage recovery of oil. All percentage are by weight.

7(a) Discuss methods of solving material balance problems without chemical reaction.

(b) A distillation column separates 10,000 kg/hr of a mixture containing equal mass of benzene and toluene. The product D recovered from the condenser at the top of the column contains 95% benzene, and the bottom W from the column contains 96% toluene. The vapor V entering the condenser from the top of the column is 8000 kg/hr. A portion of the product from the condenser is returned to the column as reflux R, and the rest is withdrawn as the final product D. Assume that V, R, and D are identical in composition since V is condensed completely. Find the ratio of the amount refluxed R to the product withdrawn D.
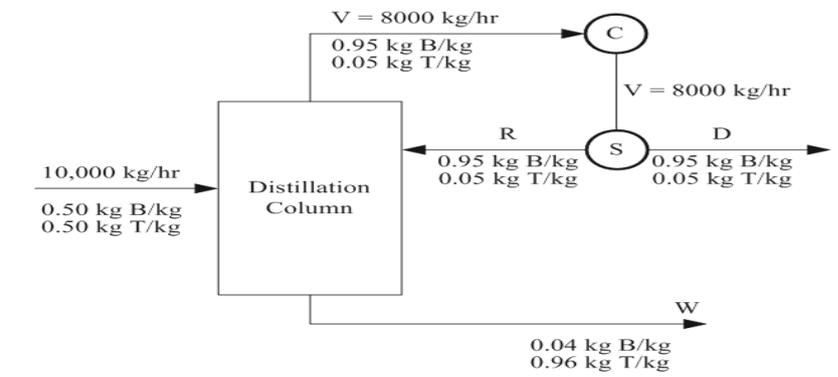
8(a) Explain standard heat of reaction and standard heat of combustion.

(b) A fuel gas constitutes of CO_2 : 3.4%, C_2H_4 : 3.7%, C_6H_6 : 1.5%, O_2 : 0.3%, CO: 17.4%, H_2 : 36.8%, CH_4 : 24.9% and N_2 : 12.0% (on mole basis). It is burnt with air in a furnace. The analyzer indicated 10.0 mole% CO_2 (on dry basis) in the flue gases.

Find : (i) percent excess air used and (ii) the complete Orsat analysis.

*****

B.Tech THIRD SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-3403 / CM-3303 FLUID MECHANICS

Time : Three Hours	*Maximum Marks : 70*
	Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks.

1(a) Explain and differentiate the given fluid properties in terms of their characteristics and significance : (i) Surface tension and capillarity   (ii) Compressibility and bulk modulus.

 (b) What does the hydrostatic law state about pressure variation in a fluid at rest? How does Archimedes' principle relate to hydrostatic laws?

2(a) Explain the concepts of total pressure and center of pressure and determine the resultant force on a submerged inclined surface.

 (b) A U tube differential manometer connects two pressure pipes A and B. pipe A contains a liquid having a specific gravity 1.5 under a pressure of 125 KPa and pipe B contains oil of specific gravity 0.8 under a pressure of 210 K Pa. Pipe A lies 2.6 m above pipe B and mercury level in the limb communicating with the pipe A lies 4.5 m below pipe A. Find the difference in the levels of mercury in the limbs.

3(a) For a one-dimensional incompressible fluid flow, derive the continuity and momentum equations.

 (b) The diameters of a pipe at section 1 and 2 are 10 and 15 cm respectively. Find the discharge through pipe if the velocity of the water flowing through the pipe at section 1 is 5 m/s. Determine also the velocity at section 2.

4(a) State and derive Bernoulli's theorem for incompressible fluids and explore its practical applications in fluid flow operations.

 (b) The following cases represent the two velocity components; determine the third component of velocity such that they satisfy the continuity equation**.**

   (i) $u = x^2 + y^2 + z^2; \quad v = xy^2 - yz^2 + xy$

   (ii) $v = 2y^2; \quad\quad\quad w = 2xyz$

5(a) Explain key dimensionless numbers in fluid flow and their significance in analyzing fluid dynamics.

 (b) Briefly explain geometric, kinematic and dynamic similarities.

6(a) Show that, under laminar flow conditions in a circular pipe, the fluid's average velocity is precisely half of its maximum velocity.

 (b) Analyze the drag experienced by a sphere in a real fluid flow and demonstrate that Cd = **24/ R_e** for very low velocity, **$R_e \leq 0.2$.**

7(a) Define notches and their classification, and derive an expression for the discharge through a rectangular notch.

(b) The rate of flow of water in a 125 mm diameter pipe is measured with a Venturi meter of 40 mm diameter throat. When the pressure drop over the converging section is 100 mm of water, the flow rate is 2.5 kg/sec. What is the coefficient of the meter?

8(a) A centrifugal pump is being used to draw water from a condenser operating at a vacuum of 640 mm Hg. To prevent cavitations, the net positive suction head at the rated discharge must be at least 3 meters above the vapor pressure of 710 mm Hg. Given that the suction pipe experiences a head loss of 1.5 meters, determine the minimum required height of the liquid level in the condenser above the pump inlet.

(b) Describe the principle, construction, and operation of a Venturi meter and derive the expression for its coefficient of discharge.

*****

B.Tech THIRD SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-3404 / CM-3304 INORGANIC PROCESS TECHNOLOGY

Time   :   Three Hours

Maximum Marks : 70
Min. Pass Marks : 22

Note : Attempt any five questions. Draw neat process flow diagram if required.

1(a) Describe processing of rock salt in India.   **07**

  (b) Classify salts or suitable basis and give their end uses.   **07**

2(a) What kind of major pollution is expected from a chlor-alkali industry?   **07**

  (b) Demonstrate working of membrane cell as used in chlor-alkali industry.   **07**

3(a) Submit comparative statement of uses of hydrochloric acid and sulphuric acid.   **07**

  (b) Explain the salient features of DCDA process for making sulphuric acid.   **07**

4(a) Discuss nitro-phosphates with their respective applications.   **07**

  (b) Explain commercial making of normal superphosphate.   **07**

5(a) What are various feed stocks for making nitrogenous fertilizers?   **07**

  (b) Describe working of a model gas-based urea plant.   **07**

6   Write in short about any two of the following with special reference to green cement   **2*7**
      technology :

      (i)   Size reduction of calcium carbonate rock
      (ii) Computer controlled short-length rotary kiln
      (iii) Pollution abatement

7(a) Write precisely about scope of ceramicwares.   **07**

  (b) Classify ceramics on the basis of applications.   **07**

8   Submit short notes on any two of the following with regard to advancement in respective   **14**
      industry :

      (i)   Safety aspects in chlor-alkali industry
      (ii) N-P-K fertilizers
      (iii) Industrial uses of bromine or iodine

*****