

Seat No. _____

SUB: CHEMICAL ENGINEERING (CH)

Time: 1 Hour 30 minutes

Instructions:

1. Ensure that all pages are printed.
2. Use Black ball pen only
3. Change in option is not allowed
4. There is no negative marking
5. Use of non-programmable scientific calculator is allowed

1. 'Six-tenth factor' rule is used for estimating the
 - A Equipment installation cost
 - B Cost of piping
 - C Utilities cost
 - D Equipment cost by scaling
2. An investment of Rs. 110 lakhs is to be made for construction of a plant, which will take two years to start production. The annual profit from the operation of the plant is Rs. 22 lakhs. What will be the pay back time?
 - A 7 Years
 - B 5 Years
 - C 10 Years
 - D 12 years
3. The cost of drum dryer is Rs. 10 lakhs. The cost of a drum dryer with double the surface area in lakhs of rupees is
 - A 2×10
 - B 20.6×10
 - C 50.6×10
 - D 100.6×10
4. The original value of an equipment is Rs. 100000. The salvage value is Rs. 5000 at the end of its useful life period of 5 years. What is the asset value in rupees after two years by textbook declining balanced method?
 - A 30172
 - B 35172
 - C 25172
 - D 40072
5. An example of an open loop second order under damped system is
 - A Two non-interacting first order systems in series
 - B RC circuit
 - C U-tube manometer
 - D Thermocouple in a thermo-well
6. A second order system can be obtained by connecting two first order systems $1/(\tau_1 s + 1)$ and $1/(\tau_2 s + 1)$ in series. The damping ratio of the resultant second order system for the case $\tau_1 \neq \tau_2$ will be
 - A > 1
 - B < 1
 - C $= 1$
 - D $= \tau_2 / \tau_1$
7. Bode diagram are generated from output response of the system subjected to which of the following input?
 - A Step
 - B Ramp
 - C Sinusoidal
 - D Impulse
8. The root locus method, a pole of a transfer function $G(s)$ is the value of s for which $G(s)$ approaches.
 - A -1
 - B 0
 - C 1
 - D ∞

9. A system has the transfer function $\frac{Y}{X} = \frac{10}{s^2 + 16s + 4}$. A step change of 4 nits magnitude is introduced in this system. The percent overshoot is
 A 30 B 25
 C 20 D 35
10. Catalytic action in a catalytic chemical reaction follows from the ability of catalyst to change the
 A Heat of reaction B Activation energy
 C Equilibrium constant D None of these
11. Rate of an autocatalytic chemical reaction is a function of
 A Temperature only B Pressure only
 C Composition only D All A, B & C
12. What is the dispersion number for a ideal plug flow reactor?
 A ∞ B 1
 C 0 D 0.5
13. The units of frequency factor in Arrhenius equation
 A Are the same as those of the rate constant. B Depend on the order of the reaction
 C Depend on temperature and pressure of the reaction D Are cycles per unit time
14. Half life period of a first order irreversible reaction $A \rightarrow B$ is
 A $k/2$ B $\ln 2/k$
 C $\ln 0.5/k$ D $\ln k/2$
15. is the controlling step in a highly temperature sensitive fluid-solid non-catalytic reaction.
 A Ash diffusion B Gas film diffusion
 C Chemical reaction D None of these
16. For a packed bed reactor; the presence of a long tail in the residence time distribution curve is an indication of
 A Ideal plug flow B Bypass
 C Dead zone D Channeling
17. If 'n' is the order of reaction, then unit of rate constant is
 A $(\text{time})^{-1} (\text{Concentration})^{1-n}$ B $(\text{time})^{-1} (\text{Concentration})^{n-1}$
 C $(\text{time})^{n-1} (\text{Concentration})^n$ D None of these
18. Rate of a chemical reaction is independent of the concentration of the reactants for a reaction.
 A Zero order B First order
 C Third order D None of these
19. The reaction in which the rate equation corresponds to a stoichiometric equation is called a/an..... reaction
 A Non-elementary B Stoichiometric
 C Elementary D Autokinetics
20. In petroleum refining, the process used for conversion of hydrocarbons to aromatics is

- | | |
|----------------------|-----------------------|
| A Catalytic cracking | B Hydrotreating |
| C Alkylation | D Catalytic reforming |
21. The average boiling point of aviation turbine fuel is closest to that of
- | | |
|--------------------|------------|
| A Lubricating oils | B LPG |
| C Diesel | D Kerosene |
22. Highest quality bitumen is produced from the crude oil
- | | |
|----------------|--------------|
| A Paraffinic | B Naphthenic |
| C Intermediate | D Mixed |
23. Smoke point of a good burning kerosene may be around.....mm.
- | | |
|---------|-----------|
| A 0-5 | B 20-25 |
| C 60-75 | D 100-120 |
24. Octane number of gasoline is a measure of its
- | | |
|------------------------|------------------|
| A Knocking tendency | B Ignition delay |
| C Ignition temperature | D Smoke point |
25. Visbreaking
- | | |
|---|---|
| A Uses natural gas as feed. | B Is carried out at atmospheric pressure. |
| C Produces fuel oil of lower viscosity. | D Produces gasoline only. |
26. Which of the following has the highest gum forming tendency in gasoline?
- | | |
|-------------|--------------|
| A Paraffins | B Diolefins |
| C Aromatics | D Naphthenes |
27. Molecular weight of polymers are in the range of
- | | |
|--------------|---------------|
| A 10 to 103 | B 102 to 107 |
| C 107 to 109 | D 109 to 1011 |
28. Poly Vinyl chloride (PVC) is a material
- | | |
|-----------------|---------------------|
| A Thermoplastic | B Thermosetting |
| C Fibrous | D Chemically active |
29. is regenerated fibre.
- | | |
|-------------|-----------------|
| A Viscous | B Cellulose |
| C Nylon – 6 | D None of these |
30. The gas which may cause explosion in sewer pipes is
- | | |
|-------------------|--------------------|
| A CO | B H ₂ S |
| C NH ₃ | D CH ₄ |
31. If five reactor volumes of feed are being fed into the reactor per hour, what is space velocity?
- | | |
|----------------------|-----------------------|
| A 5 hr ⁻¹ | B 5 hr |
| C 10 hr | D 10 hr ⁻¹ |
32. Half life period of decomposition of a liquid 'A' by irreversible first order reaction is 12 minutes. The time required for 75% Conversion of 'A' isminutes
- | | |
|------|------|
| A 18 | B 24 |
| C 6 | D 12 |
33. The order of the reaction, $\text{H}_2 + \text{Cl}_2 \xrightarrow{\text{Sunlight}} 2\text{HCl}$, is

- | | |
|-----|-----|
| A 2 | B 1 |
| C 0 | D 3 |
34. The response curve for a step input signal from a reactor is called C-curve. The variance of C-curve in a 'tanks in series model' comprising of 'm' tanks is equal to
- | | |
|-----------|-----------------|
| A m^2 | B $1/m$ |
| C $1/m^2$ | D None of these |
35. An exothermic gas phase reaction proceeds according to the equation $3A + 2B \rightarrow 2R$. The equilibrium conversion for this reaction.
- | | |
|---|--|
| A Increases with an increase in temperature | B Decreases on dilution with an inert gas |
| C Decreases with an increase in pressure | D Is unaffected by the presence of catalyst. |
36. What is the exit conversion of reactant A for a zero order reaction taking place in CSTR with the following data (rate constant 1 mol/min L); feed concentration = 1 mol/L; feed flow rate = 0.5 L/min and reactor volume = 1L
- | | |
|--------|--------|
| A 50% | B 75% |
| C 100% | D 200% |
37. The half-life of a first order liquid phase reaction is 30 seconds. Then the rate constant, in min^{-1} , is
- | | |
|----------|---------|
| A 0.0231 | B 0.602 |
| C 1.386 | D 2.0 |
38. Response of a linear control system for a change in set point is called
- | | |
|----------------------|----------------------|
| A Frequency response | B Transient response |
| C Servo problem | D Regulator problem |
39. For measuring the temperature of a red hot furnace, which is the most suitable instrument?
- | | |
|-----------------------------------|--------------------------|
| A Platinum resistance thermometer | B Thermocouple |
| C Optical pyrometer | D Bimetallic thermometer |
40. Which of the following relates the absorption & evolution of heat at the junctions of a thermocouple to the current flow in the circuit?
- | | |
|------------------------|------------------|
| A Seebeck effect | B Peltier effect |
| C Joule heating effect | D Thomson effect |
41. For Laminar flow through a packed bed, the pressure drop is proportional to (V_s is the superficial liquid velocity and D_p is the particle diameter)
- | | |
|-----------------|-----------------|
| A V_s/D_p^2 | B V_s^2/D_p^2 |
| C V_s^2/D_p^3 | D V_s/D_p^3 |
42. Dimension of surface tension is (where, F = force, L = length)
- | | |
|--------------------|--------------------|
| A FL^{-1} | B $F^{-1} \cdot L$ |
| C $F \cdot L^{-2}$ | D $F^{-2} \cdot L$ |
43. Pressure drag does not depend upon the
- | | |
|-------------------------------------|-------------------------------|
| A roughness of surface of the body. | B pressure of main flow only. |
|-------------------------------------|-------------------------------|

- C length of the body in flow direction. D all (a), (b) and (c)
44. _____ pumps are axial flow pumps.
 A Turbine B Propeller
 C Diffuser D none of these
45. If the discharge of a centrifugal pump is throttled, then its suction lift
 A increases B decreases
 C remains unchanged D data insufficient to predict
46. Laminar flow of a Newtonian fluid ceases to exist, when the Reynolds number exceeds
 A 4000 B 2100
 C 1500 D 3000
47. Power loss in an orificemeter is _____ that in a venturimeter.
 A less than B same as
 C more than D data insufficient, can't be predicted
48. Which of the following sugars is the sweetest?
 A Glucose B Fructose
 C Sucrose D Lactose
49. All enzymes are made of
 A fats B carbohydrates
 C proteins D amino acids
50. The combustion reaction, $C + O_2 = CO_2$, is
 A exothermic B endothermic
 C autocatalytic D none of these
51. Concentration of NaOH solution produced by mercury electrolytic cell is about _____ percent.
 A 10 B 25
 C 50 D 98
52. Esterification reaction produces
 A detergent B vanaspati
 C soap D mercaptans
53. Atoms of the same element, but of different masses are called
 A isobars B isotones
 C isotopes D none of these
54. Average molecular weight of air is about
 A 21 B 29
 C 23 D 79
55. 1 kgf/cm^2 is not equal to
 A 1 torr B 1 bar
 C 10000 mm wc D $100 \text{ KPa} = 100\,000 \text{ N/m}^2$
56. Which of the following is not a unit of pressure?

- A Torr
C Parsec
- B Newton/m^2
D Ata, bar or pascal
57. Heating of water under atmospheric pressure is an _____ process.
A isochoric
C adiabatic
- B isobaric
D isothermal
58. In a working refrigerator, the value of COP is always
A 0
C < 1
- B < 0
D > 1
59. Entropy of an ideal gas depends upon its
A pressure
C both (a) & (b)
- B temperature
D neither (a) nor (b)
60. Joule-Thomson experiment is
A isobaric
C isenthalpic
- B adiabatic
D both(b) & (c)
61. In the equation $Q = UA\Delta t$; Δt is
A geometric mean temperature difference.
C logarithmic mean temperature difference.
- B arithmetic mean temperature difference
D the difference of average bulk temperatures of hot and cold fluids.
62. For an ideal black body
A absorptivity = 1
C emissivity = 0
- B reflectivity = 1
D transmissivity = 1
63. In a heat exchanger, floating head is provided to
A facilitate cleaning of the exchanger.
C relieve stresses caused by thermal expansion.
- B increase the heat transfer area
D increase log mean temperature gradient
64. Kirchoff's law applies to _____ radiation
A total
C both (a) & (b)
- B monochromatic
D neither (a) nor (b)
65. The equivalent diameter for pressure drop is _____ that for heat transfer.
A smaller than
C equal to
- B greater than
D not related with
66. Which of the following is not the triple point of water
A 273K
C 32°R
- B 492°R
D 32°F
67. When vaporization takes place directly at the heating surface, it is called
A film boiling
C vapor binding
- B nucleate boiling
D none of these
68. Fourier's law applies to the heat transfer by

- A convection
C conduction
- B radiation
D all (a), (b) & (c)
69. Fouling factor
A is a dimensionless quantity.
C accounts for additional resistances to heat flow.
- B does not provide a safety factor for design.
D none of these
70. The steam ejector is used to
A remove condensate from the steam pipelines.
C superheat the steam
- B create vacuum
D none of these
71. Fenske equation determines the
A maximum number of ideal plates.
C minimum number of theoretical plates.
- B height of the distillation column.
D optimum reflux ratio.
72. Total reflux in a distillation operation requires minimum
A reboiler load
C condenser load
- B number of plates
D all (a), (b) and (c)
73. When the temperature and humidity of air is low, we usually use _____ draft cooling tower
A natural
C induced
- B forced
D none of these
74. _____ columns are used for liquid dispersion in a continuous gas phase.
A Packed
C Bubble cap
- B Pulse
D Sieve plate
75. On addition of solute in the solvent, the _____ of the solution decreases.
A boiling point
C vapour pressure
- B freezing point
D both (b) and (c)
76. Which is the controlling factor for a drum drier?
A Diffusion
C Both (a) and (b)
- B Heat transfer
D Neither (a) nor (b)
77. Stefan's law describes the mass transfer by
A diffusion
C both 'a' & 'b'
- B bulk flow
D neither 'a' nor 'b'
78. At minimum reflux ratio for a given separation
A number of plates is zero.
C minimum number of the theoretical plates is required.
- B number of plates is infinity.
D separation is most efficient
79. Dew point of a gas-vapour mixture
A increases with temperature rise.
C decreases with decrease in pressure.
- B decreases with temperature rise.
D increases with increase in pressure.
80. Physical absorption is
A an irreversible phenomenon.
- B a reversible phenomenon.

C accompanied by evolution of heat. D both (b) and (c)

81. The recurrence relation to solve $x = e^{-x}$ using Newton – Raphson method is

A $x_{n+1} = e^{-x_n}$

B $x_{n+1} = x_n - e^{-x_n}$

C $x_{n+1} = (1 + x_n) \frac{e^{-x_n}}{1 + e^{-x_n}}$

D $x_{n+1} = \frac{x_n^2 - e^{-x_n}(1 + x_n) - 1}{x_n - e^{-x_n}}$

82. The iterative equation of Newton – Raphson method for the equation $x^3 + 4x - 9 = 0$ is

A $x_{k+1} = \frac{2x_k^3 + 9}{3x_k^2 + 4}$

B $x_{k+1} = \frac{3x_k^3 + 4}{2x_k^2 + 9}$

C $x_{k+1} = x_k - 3x_k^2 + 4$

D $x_{k+1} = \frac{4x_k^3 + 3}{9x_k^2 + 2}$

83. In an office, 70 % members are male and 30 % are female. A member is selected at random. Let $x = 0$ if the member is female and $x = 1$ if the member is male. What is the value of $E(X)$?

A 0.1

B 0.49

C 0.3

D 0.7

84. Two dice are thrown and the sum of the numbers which come up on the dice is noted. Consider the following events:

A = the sum is even

B = the sum is multiple of 3

C = the sum is less than 4

D = the sum is greater than 11

Which pairs of these events are mutually exclusive?

A A and B

B B and C

C C and D

D A and D

85. The argument of the complex number $\frac{1+i}{1-i}$, where $i = \sqrt{-1}$ is
- A $-\pi$ B $-\pi/2$
- C π D $\pi/2$
86. If $f(z) = c_0 + c_1 z^{-1}$, then $\oint_{\text{unit circle}} \frac{1+f(z)}{z} dz$ is given by
- A $2\pi c_1$ B $2\pi i (1+c_0)$
- C $2\pi i c_1$ D $2\pi (1+c_0)$
87. What is the value of $\oint_c \frac{e^{2z}}{(z+i)^4} dz$, if c is the circle $|z| = 3$?
- A $i e^{-2}$ B $\pi i e^2$
- C $i \pi / 3 e^4$ D $\frac{8\pi i}{3} e^{-2}$
88. Which one of the following is a linear non-homogeneous differential equation, where x and y are the independent and dependent variables, respectively?
- A $\frac{dy}{dx} + xy = e^{-x}$ B $\frac{dy}{dx} + xy = 0$
- C $\frac{dy}{dx} + xy = e^{-y}$ D $\frac{dy}{dx} + e^{-y} = 0$
89. It is given that $\frac{d^2 y}{dx^2} + 2\frac{dy}{dx} + y = 0$, $y(0) = 0$, $y(1) = 0$. What is $y(0.5)$?
- A 0.37 B 0.62
- C 0 D 1.12
90. Find the solution to $9\frac{d^2 y}{dx^2} + 6\frac{dy}{dx} + y = 0$ for $y(0) = 4$ and $y'(0) = -1/3$.
- A $y = (4-x)e^{-x/3}$ B $y = (4+x)e^{-x/3}$

C $y = (8 - 2x)e^{x/3}$

D $y = (1 - x)e^{-x/3}$

91. Find the solution to $(x+1)\frac{dy}{dx} = 2xy$

A $\ln y = 2(x - \ln|x+1|) + c$

B $\ln x = 2\ln(y+1) + c$

C $\ln y = (1/x) + 2$

D $y/x = c$

92. If $P = \int_1^{\infty} x^{-3} dx$, then P has the value

A $-1/3$

B $1/4$

C $1/2$

D $1/6$

93. If $\phi = x^2 y z^3$ and $\bar{F} = xz\hat{i} - y^2\hat{j} + 2x^2 y\hat{k}$, then what is the value of $\text{div}(\phi\bar{F})$?

A $x^2 y z^4 + x^2 y^2 z^3 + 2x^4 y^2 z^2$

B $x y z^3 + x y^2 z^3 + 4x^3 y z$

C $-3x^2 y z + 3x^2 y^2 z^3 + 6x^4 y^2 z^2$

D $3x^2 y z^4 - 3x^2 y^2 z^3 + 6x^4 y^2 z^2$

94. For what interval is $f(x) = x^4 - 2x^2$ decreasing?

A $(-1, \infty)$

B $(-1, 1)$

C $(-\infty, -1) \cup (0, 1)$

D $(-\infty, 0) \cup (1, \infty)$

95. Find the value of 'k' such that the following function is continuous at $x = 0$.

$$f(x) = \begin{cases} \frac{1 - \cos 2x}{2x^2} & x \neq 0 \\ k & x = 0 \end{cases}$$

A 2

B 1

C 0

D 3

96. What is the value of $\lim_{x \rightarrow 2} \frac{x^3 - 6x^2 + 11x - 6}{x^2 - 6x + 8}$?

A $1/2$

B $1/4$

C $1/3$

D 1

97. Given the matrix $\begin{bmatrix} -4 & 2 \\ 4 & 3 \end{bmatrix}$, the eigenvector is

A $\begin{bmatrix} 4 \\ 3 \end{bmatrix}$

B $\begin{bmatrix} 3 \\ 2 \end{bmatrix}$

C $\begin{bmatrix} 2 \\ -1 \end{bmatrix}$

D $\begin{bmatrix} -1 \\ 2 \end{bmatrix}$

98. Consider the matrices $X_{(4 \times 3)}$, $Y_{(4 \times 3)}$ and $P_{(2 \times 3)}$. The order of $\left[P(X^T Y)^{-1} P^T \right]^T$ will be

A (3×4)

B (3×3)

C (4×3)

D (2×2)

99. What are the eigenvectors of the matrix $\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$?

A $\begin{bmatrix} 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

B $\begin{bmatrix} 1 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ -2 \end{bmatrix}$

C $\begin{bmatrix} 2 \\ 1 \end{bmatrix}, \begin{bmatrix} 2 \\ -1 \end{bmatrix}$

D $\begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

100. If $A = \begin{bmatrix} x & 2 & 0 \\ 2 & 0 & 1 \\ 6 & 3 & 0 \end{bmatrix}$ is singular, then what is the value of x ?

A 2

B 4

C 6

D 0