403

POST GRADUATE COMMON ENTRANCE TEST – 2011

DATE and TIME	COURSE	SUBJECT
06-08-2011 10:30 am to 12:30 pm	**ME / M. Tech / M. Arch / MBA (Infrastructure Management) courses offered by VTU / UVCE / UBDTCE**	**CHEMICAL ENGINEERING**

MAXIMUM MARKS	TOTAL DURATION	MAXIMUM TIME FOR ANSWERING
100	**150 Minutes**	**120 Minutes**

MENTION YOUR PGCET NO.					QUESTION BOOKLET DETAILS	
					VERSION CODE	SERIAL NUMBER
					A_2	00000590

DOs

1. Check whether the PGCET No. has been entered and shaded in the respective circles on the OMR answer sheet.
2. This question booklet is issued to you by the invigilator after the **2nd Bell, i.e. after 10:25 am.**
3. The serial number of this question booklet should be entered on the OMR answer sheet.
4. The version code of this question booklet should be entered on the OMR answer sheet and the respective circles should also be shaded completely.
5. Compulsorily sign at the bottom portion of the OMR answer sheet in the space provided.

DON'Ts

1. **The timing and marks printed on the OMR answer sheet should not be damaged / mutilated / spoiled.**
2. The **3rd Bell rings at 10:30 am, till then;**
   - Do not remove the seals of this question booklet.
   - Do not look inside this question booklet.
   - Do not start marking on the OMR answer sheet.

SEAL

IMPORTANT INSTRUCTIONS TO CANDIDATES

1. This question booklet contains 75 (items) questions and each question will have one statement and four answers. (Four different options / responses.)
2. After the 3rd bell is rung at 10:30 am, remove the seals of this question booklet and check that this booklet does not have any unprinted or torn or missing pages or items etc., if so, get it replaced by a complete test booklet. Read each item and start marking on the OMR answer sheet.
3. During the subsequent 120 minutes :
   - Read each question (item) carefully.
   - Choose one correct answer from out of the four available responses (options / choices) given under each question / item. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **only one response** for each question / item.
   - Completely **darken / shade** the relevant circle with a **blue or black ink ballpoint pen against the question number on the OMR answer sheet.**
4. Please note that even a minute unintended ink dot on the OMR answer sheet will also be recognized and recorded by the scanner. Therefore, avoid multiple markings of any kind on the OMR answer sheet.
5. Use the space provided at the bottom on each page of the question booklet for Rough Work. Do not use the OMR answer sheet for the same.
6. After the **last bell is rung at 12:30 pm**, stop marking on the OMR answer sheet and affix your **left hand thumb impression** on the OMR answer sheet as per the instructions.
7. Hand over the **OMR answer sheet** to the room invigilator as it is.
8. After separating the top sheet (KEA copy), the invigilator will return the bottom sheet replica **(candidate's copy)** to you to carry home for self evaluation.
9. Preserve the replica of the OMR answer sheet for a minimum period of ONE year.
10. Only **Non-programmable** calculators are allowed.

Marks Distribution

PART I : 50 Questions carry one mark each (1 to 50)
PART II : 25 Questions carry two marks each (51 to 75)

SEAL

PART – I

Each question carries *one* mark. $50 \times 1 = 50$

1. Time constant of mercury in glass thermometer is given by

   (A) $\frac{mC}{hA}$ (B) $\frac{2\,mC}{hA}$

   (C) $\frac{mC}{2hA}$ (D) RC.

2. A rectangular tank is filled with valve at the bottom and is used for storing liquid. The area of cross-section of the tank is 10 m^2 and flow resistance of the valve is 0·2 s/m^2. The time constant of the tank will be

   (A) 20 (B) 2

   (C) 0·2 (D) 10.

3. The second order system with the transfer function $\frac{4}{s^2 + 3s + 9}$ has a damping ratio of

   (A) 2·0 (B) 0·5

   (C) 4 (D) 4·5.

4. Offset is zero for

   (A) *P* controller only (B) *P – D* controller only

   (C) *P* and *P – D* controller (D) *P – I* and *PID* controller.

5. The system having the transfer function ..... is stable.

   (A) $\frac{1}{s^2 + 2}$ (B) $\frac{1}{s^2 - 2s + 3}$

   (C) $\frac{1}{s^2 + 2s + 2}$ (D) $\frac{1}{s^2 + 3}$.

6. Overall order of the reaction for which rate constant has units of $(\text{mol/L})^{-3/2}\ \text{sec}^{-1}$ is

   (A) $-\frac{3}{2}$ (B) $\frac{1}{2}$

   (C) $\frac{3}{2}$ (D) $\frac{5}{2}$.

SPACE FOR ROUGH WORK

7. For the reaction $A + 2B \rightarrow B + C$

(A) $r_A = r_B$ (B) $r_A = -r_B$

(C) $r_A = r_{B/2}$ (D) $r_A = 2\, r_B$.

8. From Transition State theory, the reaction rate constant is proportional to

(A) $exp\left(-\frac{E}{RT}\right)$ (B) $exp\left(-\frac{E}{3RT}\right)$

(C) $T\, exp\left(-\frac{E}{RT}\right)$ (D) $T^{0.5}\, exp\left(-\frac{E}{RT}\right)$.

9. Rate constant of a chemical reaction increases by 2·718 times when the temperature is increased by 300 K to 330 K. Assuming Arrhenius law is valid, the value of E/R is

(A) 3300 K (B) 2718 K

(C) 1100 K (D) 4200 K.

10. For a mixed flow reactor operating at steady state, the rate of reaction is given by

(A) $\frac{F_{A_O}}{V} + \frac{dC_A}{dt}$ (B) $\frac{F_{A_O}}{V} = \frac{dC_A}{dt}$

(C) $-\frac{dC_A}{dt}$ (D) $\frac{F_{A_O} X_A}{V}$.

11. The heat flux (from outside to inside) across an insulating wall with thermal conductivity k = 0·04 w/m.K and thickness 0·16 m is 10 w/m^2. The temperature of inside wall is – 5°C. The outside wall temperature is

(A) 35°C (B) 20°C

(C) 40°C (D) 30°C.

12. Heat transfer occurs by natural convection because change in temperature causes differences in

(A) viscosity (B) density

(C) thermal conductivity (D) heat capacity.

SPACE FOR ROUGH WORK

13. The thermal radiative flux from a source of emissivity 0·4 is 22·68 kW/m^2. The approximate surface temperature is

$$\left[\text{Stefan-Boltzmann's constant} = 5{\cdot}67 \times 10^{-8} \frac{W}{m^2 - K^4} \right].$$

(A) 727 K (B) 800 K

(C) 1000 K (D) 1200 K.

14. The advantage of using a 1 – 2 shell and tube heat exchanger over a 1 – 1 shell and tube heat exchanger is

(A) lower tube side pressure drop

(B) lower shell side pressure drop

(C) higher tube side heat transfer coefficient

(D) higher shell side heat transfer coefficient.

15. Diffusion coefficient in binary gas mixture at low pressures varies with pressure as

(A) P (B) P^2

(C) $P^{-1/2}$ (D) independent of P.

16. Hydraulic mean diameter for flow through packed bed of spherical particles of size D_p with porosity ϵ is

(A) $D_p \frac{\epsilon}{6(1-\epsilon)}$ (B) $D_p \frac{(1-\epsilon)}{6\epsilon}$

(C) $D_p \frac{2}{3} \frac{(1-\epsilon)}{\epsilon}$ (D) $D_p \frac{1}{2} \frac{(1-\epsilon)}{\epsilon^2}$.

17. A particle attains terminal settling velocity when

(A) gravity force + drag force = buoyancy force

(B) gravity force – drag force = buoyancy force

(C) buoyancy force + drag force = gravity force

(D) drag force = buoyancy force.

SPACE FOR ROUGH WORK

18. Absolute zero is at

(A) 0°C (B) 100°C

(C) 273°C (D) – 273°C.

19. A cylinder piston assembly contains certain quantity of gas and an electric resistor. The resistor is connected to a storage battery and current passes through it for a specified interval of time while the gas pressure is kept constant. Consider gas and resistor as system

(A) energy added as heat and work done by the system

(B) energy added as heat and work done on the system

(C) energy added as work and work done by the system

(D) energy added as heat only.

20. The van der Waals equation of state for N mole of gas is

(A) $\left(P + \frac{a}{NV^2} \right)(V - b) = NRT$ (B) $\left(P + \frac{N^2 a}{V^2} \right)(V - b) = RT$

(C) $\left(P + \frac{N^2 a}{V^2} \right)(V - Nb) = NRT$ (D) $\left(P + \frac{N^2 a}{V^2} \right) = RT (V - b)$.

21. For the case of fuel gas undergoing combustion with air, if air/fuel ratio is increased, the adiabatic flame temperature will

(A) increase

(B) decrease

(C) increase or decrease depending on fuel type

(D) no change.

22. Air contains 21% O_2 and 79% N_2 by volume. The average molecular weight of air is

(A) 28·8 (B) 27·4

(C) 20·4 (D) 26·8.

23. An evaporator while concentrating an aqueous solution from 10 to 40% solids evaporates 30,000 kg of water. The amount of solids handled by system in kg is

(A) 4,000 (B) 4,600

(C) 9,000 (D) 3,000.

SPACE FOR ROUGH WORK

24. The pressure loss is maximum in

(A) venturimeter (B) orifice meter

(C) rotameter (D) flow nozzle.

25. For non-spherical particle, the sphericity (ϕ_s) is defined by the relation

(where D_p = equivalent diameter of particle

S_p = surface area of particle

V_p = volume of particle.)

(A) $\phi_s = \frac{V_p}{D_p S_p}$ (B) $\phi_s = \frac{D_p S_p}{V_p}$

(C) $\phi_s = \frac{6\, V_p}{D_p S_p}$ (D) $\phi_s = \frac{V_p}{6\, D_p S_p}$

26. A first order system with a time constant of 1 min is subjected to frequency response analysis. At an input frequency of 1 rad/min, the phase shift is

(A) 45° (B) – 90°

(C) – 180° (D) – 45°.

27. For protection of aquatic life in fresh water stream, sewage effluent should never lower the dissolved oxygen content lower than

(A) 15 ppm (B) 10 ppm

(C) 5 ppm (D) 20 ppm.

28. Synthetic ammonia is produced by reacting nitrogen and hydrogen. The reaction is

(A) endothermic (B) exothermic

(C) irreversible (D) catalyzed by enzymes.

29. Contact process for the manufacture of sulphuric acid yields

(A) 80% H_2SO_4 only (B) 98% H_2SO_4 and higher

(C) 95% H_2SO_4 only (D) 90% H_2SO_4 only.

SPACE FOR ROUGH WORK

30. Hydrogenation of edible oils

(A) increases their melting point (B) decreases their melting point

(C) does not affect their melting point (D) is an endothermic reaction.

31. If E is exit age of fluid leaving the vessel, then

(A) $\int_0^\infty E\,dt = 1{\cdot}5$ (B) $\int_0^\infty E\,dt = 1$

(C) $\int_0^\infty E\,dt = \infty$ (D) $\int_0^\infty E\,dt = \sqrt{\pi}$.

32. The ratio of actual reaction rate within the pore to the reaction rate in the absence of pore diffusion resistance is

(A) Effectiveness factor (B) Thiele modulus

(C) Activity (D) Diffusivity constant.

33. If a heterogenous reaction consists of parallel steps, the overall rate is

(A) $r_{overall} = \sum_{i=1}^{n} r_i$ (B) $r_{overall} = r_1 = r_2 = \ldots\ldots = r_n$

(C) $r_{overall} = \sum_{i=1}^{n} \sqrt{r_i}$ (D) $r_{overall} = \sum_{i=1}^{n} r_i^{3/2}$.

34. A control system has the following transfer function : $F(s) = \frac{(s+1)^2}{s(s-2)(s-3)}$. The final value of the corresponding time function is

(A) $\frac{2}{3}$ (B) 6

(C) $\frac{1}{6}$ (D) 1.

SPACE FOR ROUGH WORK

35. For an input forcing function $X(t) = 4t^3$, the Laplace transform of this function is

(A) $\frac{4}{s^3}$ (B) $\frac{24}{s^4}$

(C) $\frac{12}{s^3}$ (D) $\frac{8}{s^4}$.

36. According to penetration theory mass transfer coefficient is proportional to (D_e is diffusivity)

(A) $D_e^{1/2}$ (B) D_e

(C) $D_e^{-1/2}$ (D) $D_e^{0.2}$.

37. Absorption towers are operated under conditions of

(A) low pressure, high temperature

(B) high pressure, high temperature

(C) high pressure, low temperature

(D) low pressure, low temperature.

38. Use of Raschig rings in case of crusted stone as packing in packed beds (other things are same)

(A) increases pressure drop, increases surface area

(B) increases pressure drop, decreases surface area

(C) decreases pressure drop, increases surface area

(D) decreases pressure drop, decreases surface area.

39. The vapour pressures of benzene and toluene are 3 and 4 atmospheres respectively. A liquid of feed of 0·4 mole of benzene and 0·6 mole of toluene is vaporized. Assuming the products are in equilibrium, the vapour phase mole fraction of benzene is

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) 0·8 (D) 0·2.

SPACE FOR ROUGH WORK

40. While drying a material from a moisture content above critical moisture content to a moisture content very close to equilibrium moisture content the surface temperature of the solid

(A) remains constant

(B) at first remains constant and then increases

(C) increases continuously

(D) at first remains constant and then decreases.

41. The COP of a refrigerator is given by

(A) $\frac{T_H}{T_H - T_L}$ (B) $\frac{T_H - T_L}{T_H}$

(C) $\frac{T_H - T_L}{T_L}$ (D) $\frac{T_L}{T_H - T_L}$.

42. A solid is transformed into its vapour state without passing through the liquid state is called

(A) Triple point (B) Boiling point

(C) Sublimation (D) Evaporation.

43. A gas mixture of four components is brought in contact with an organic phase in water. The degree of freedom of the system is

(A) 2 (B) 5

(C) 4 (D) 0.

44. What is the difference in two specific heats C_p and C_v of one gram of helium ? The molecular weight of Helium is 4. Assume that Helium behaves as an ideal gas.

(A) 2 cal/K (B) 8 cal/K

(C) 1 cal/kg K (D) 0·5 cal/K.

SPACE FOR ROUGH WORK

45. The variation of thermal conductivity of a metal with temperature is given by

$$k = k_o + aT$$

where k is thermal conductivity, T is the temperature in K. The unit of a is

(A) watt/m.K (B) watt/m

(C) watt/m.K^2 (D) no unit.

46. The crushing efficiencies of a machine range between

(A) 0·1 to 2 per cent (B) 10 to 20 per cent

(C) 20 to 30 per cent (D) 30 to 50 per cent.

47. The condition that is not necessary for the applicability of Bernoulli equation is

(A) steady state (B) incompressible

(C) inviscid (D) irrotational.

48. A pipe of I.D. 4 m is bifurcated into two pipes of I.D. 2 m each. If the average velocity of water flowing through the main pipe is 5 m/s, the average velocity through the bifurcated pipes is

(A) 20 m/s (B) 10 m/s

(C) 7·07 m/s (D) 5 m/s.

49. For an ideal fluid flow the Reynolds number is

(A) infinity (B) zero

(C) one (D) 2100.

50. In centrifugal pumps, cavitation occurs when the impeller eye or vane becomes

(A) less than atmospheric pressure

(B) more than liquid vapour pressure

(C) less than liquid vapour pressure

(D) more than atmospheric pressure.

SPACE FOR ROUGH WORK

PART – II

Each question carries *two* marks. $25 \times 2 = 50$

51. If the specific heats of a gas and vapour are 0·2 kJ/kg K and 1·5 kJ/kg K respectively, and the humidity is 0·01, the humid heat in kJ/kg K is

(A) 0·31 (B) 0·107

(C) 0·215 (D) 0·172.

52. The rate of drying of a material found to be $0{\cdot}5 \times 10^{-3}$ kg/m^{2}s when the moisture content reduces from 0·4 to 0·1 on dry basis. The critical moisture content of the material is 0·08 on dry basis. A tray drier is used to dry 100 kg (dry basis) of the same material under identical conditions. The surface area of the material is 0·04 m^2/kg of solid. The time required (in seconds) to reduce the moisture content of the solids from 0·3 to 0·2 (dry basis) is

(A) 2000 (B) 4000

(C) 5000 (D) 6000.

53. At 750 K and 1 atm the approximate value of Schmidt number for air is

(A) 0·01 (B) 0·1

(C) 1 (D) 10.

54. In an aqueous solution, reaction $A \rightarrow B$ occurs under isothermal conditions following first order kinetics. The feed rate is 500 cm^3/min and concentration of A in feed is $1{\cdot}5 \times 10^{-4}$ mol/cm^3 . The reaction is carried out in a 5 litre CSTR. At steady state, 60% conversion is observed. The rate constant (in min^{-1}) is

(A) 0·06 (B) 0·15

(C) 0·21 (D) 0·28.

55. The time taken for a first order reaction $A \xrightarrow{k}$ products, to be 90% complete is

(A) 0·95 k (B) 1·1 k

(C) $1{\cdot}1/k$ (D) $2{\cdot}303/k$.

56. Methane is completely burnt with air. The maximum possible volume per cent of carbon dioxide (on dry basis) in the flue gas is

(A) 11·7 (B) 18

(C) 31 (D) 26.

SPACE FOR ROUGH WORK

57. Pure O_2 is mixed with air to produce an enriched air containing 50% by volume of O_2. The ratio of moles of air to oxygen used is

(A) 1·72 (B) 0·82

(C) 0·56 (D) 0·32.

58. If a fluid (μ/e = 0·01 cm^2/s) is moving at critical flow condition ($N_{Re} = 2100$) through a pipe of diameter 3 cm, velocity of flow is ..... cm/s.

(A) 7 (B) 700

(C) 7000 (D) 630.

59. The pressure head of 320 metres of water in metres of CCl_4 (specific gravity = 1·6) will be

(A) 100 (B) 200

(C) 320 (D) 160.

60. The energy required per unit mass to grind limestone particles of very large size to 100 μm is 12·7 kWh per ton. Estimate (using Bond law) of the energy to grind the particles from a very large size to 50 μm is

(A) 6·35 kWh/ton (B) 9·0 kWh/ton

(C) 18 kWh/ton (D) 25·4 kWh/ton.

61. Maximum limit of sulphur dioxide in air is

(A) 100 ppm (B) 200 ppm

(C) 300 ppm (D) 500 ppm.

62. Permissible limit of mercury in drinking water is

(A) 1 ppm (B) 0·01 ppm

(C) 0·001 ppm (D) 0·0001 ppm.

63. Triple superphosphate is manufactured by heating

(A) phosphate rock with phosphoric acid

(B) phosphate rock with sulphuric acid

(C) phosphate rock with nitric acid

(D) ammonium phosphate and phosphate rock.

SPACE FOR ROUGH WORK

71. The reaction $A \rightarrow B$ is conducted in an isothermal batch reactor. If the conversion of A increases linearly with time, then the order of the reaction is

(A) 0 (B) 1

(C) 1·5 (D) 2.

72. A first order system with unity gain and time constant τ is subjected to sinusoidal input of frequency $\omega = \frac{1}{\tau}$. The amplitude ratio for this system is

(A) 1 (B) 0·5

(C) $\frac{1}{\sqrt{2}}$ (D) 0·25.

73. A process is initially at steady state with its output $y = 1$ for an input $u = 1$. The input is suddenly changed to 2 at $t = 0$. The output response is $y(t) = 1 + 2t$. The transfer function of the process is

(A) $\frac{2}{s}$ (B) $1 + \frac{2}{s^2}$

(C) $1 + \frac{2}{s}$ (D) $\frac{1}{s}\left(1 + \frac{2}{s}\right)$.

74. The value of damping factor $\xi = 0{\cdot}4$. The overshoot is

(A) 0·623 (B) 0·572

(C) 0·324 (D) 0·253.

75. A PID controller output $P(t)$, in time domain is given by

$$P(t) = 30 + 5e(t) + 1{\cdot}25 \int_0^t e(t)\,dt + 15\,\frac{de(t)}{dt}$$

where $e(t)$ is the error at time t. The transfer function of the process to be controlled is $G_p(s) = \frac{10}{200s + 1}$. The measurement of the controlled variable is instantaneous and accurate.

The transfer function of the controller is

(A) $\frac{5\left(12s^2 + 4s + 1\right)}{3s}$ (B) $\frac{5\left(12s^2 + 3s + 1\right)}{3s}$

(C) $\frac{5\left(12s^2 + 4s + 1\right)}{4s}$ (D) $\frac{5\left(12s^2 + 3s + 1\right)}{4s}$.

SPACE FOR ROUGH WORK