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| **Scheme of Valuation/Answer Key**  (Scheme of evaluation (marks in brackets) and answers of problems/key) | | | |
| **APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  **FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2019** | | | |
| **Course Code: CH204** | | | |
| **Course Name: CHEMICAL ENGINEERING THERMODYNAMICS (CH)** | | | |
| General instruction: Proper credits should be given for the correct approach towards solution for numerical and derivation problems.  **PART A** | | | |
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| 1 | a) | Statement of first law of thermodynamics – 2 marks  mathematical statement with reference to a closed system – 2 marks  along with explanation of the notations can be given credit (considering both sign conventions) | (4) |
|  | b) | Start with expression of first law applied to flow system-1 mark  Simplify with the assumptions applicable for the given case-1 mark  Expression for shaft work  -2 marks | (4) |
|  | c) | Consider the Maxwell’s equation  -1 mark  Apply the assumption of VLE to reduce the eqn to the form -1 mark  Derivation of Clapeyron equation – 1marks  Simplifying assumptions – 2 marks  Derivation of Clausius-Clapeyron equation – 2 marks | (7) |
| 2 | a) | Expression of first law applied to flow system -1 mark  Assumptions applicable for the nozzle -1 mark  - 1 marks  – 1 mark  Derivation of critical pressure ratio – 4 marks | (8) |
|  | b) | RTd(lnf)=VdP - 2 marks  - 2 marks  - 3 marks | (7) |
| 3 | a) | Diagram – 3 marks  Description – 4 marks | (7) |
|  | b) | Start with  - 1 Mark  Derive expressions for and  - 1 Mark  obtain expressions for  and  - 1 Mark  hence prove and for an ideal gas – 1 Mark  Start with  - 1 Mark  Derive expressions for and  - 1 Mark  obtain expressions for  and  - 1 Mark  hence prove and for an ideal gas – 1 Mark | (8) |

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| **PART B** | | | |
| 4 | a) | State L-R rule -1 mark  Assumptions -2 marks  Derivation of Raoult’s law – 1 mark | (4) |
|  | b) | Derive General form of Gibbs-Duhem equation  – 2 marks  In terms of chemical potential  – 2 marks | (4) |
|  | c) | start from GD eqn in the form  – 2 marks Derivation of the coexistence equation  -3 marks  Application for checking consistency of – 2 marks | (7) |
| 5 | a) | Total number of variables in terms of no. of components and no. of phases– 1 mark  Number of dependencies based on phase equilibrium condition– 2 mark  Number of independent variables = Total number of variables - Number of dependencies, F = C-P+2  (phase rule expression) – 2 marks | (2) |
|  | b) | Naming based on volatility 1- hexane, 2- ethyl alcohol  At y=x, calculate activity coefficients  and  – 2 marks  State van Laar eqn – 2 mark  Determine van Laar constants A (1.6625) and B (2.7474) using activity coefficient values – 2 marks  Using A and B, calculate activity coefficients at the given composition -2 marks  Calculate P = (101.41 kPa) – 1 Mark  Calculate y =  (0.693) – 1 mark | (10) |
| 6 | a) | Use of Gibbs Duhem equation – 3 marks  Proof – 4 marks | (7) |
|  | b) | This question is from module 2 and hence those students who attempt to answer this part should be given full credit. | (8) |
| **PART C** | | | |
| 7 | a) | Principle of steam distillation – 3 marks  Use in separating heat sensitive materials – 3 marks  Phase diagram – 4 marks | (10) |
|  | b) | relation between moles and extent of reaction – 3 marks  expression for conversion – 2 marks | (5) |
|  | c) | significance of pressure of decomposition -3 marks  example – 2 marks | (5) |
| 8 | a) | phase diagram – 3 marks  definition of three phase equilibrium temperature – 2 marks  features of constant pressure equilibria in partially miscible system – 3 marks | (8) |
|  | b) | Basis of calculation – 1 mark  Relation between Ky and extent of reaction  – 3 marks  Calculate Ky by the eqn =12.6 – 2 marks  Solve the equation  for extent of reaction (20.363)  – 2 marks  Expression for  – 2 marks  Calculate conversion (67.8%) – 2 marks | (12) |
| 9 | a) | Effect of pressure on the T-x-y phase diagram of VLLE- 3 marks  Diagram – 2 marks | (5) |
|  | b) | Ternary equilibrium representation on triangular coordinates.  Diagram – 2 marks  Description of apex and sides , plait point -3 marks | (5) |
|  | c) | Basis of calculation – 1 mark  Relation between Ky and extent of reaction  – 3 marks  Assuming ideal gas behaviour, =K 1 mark  Calculate K using standard Gibbs free energy change (0.01) – 1 mark    Solve the equation for extent of reaction (1.764)  – 2 marks  Calculate molar composition – 1 marks  Calculate the partial pressures of all species (N2 – 1381.78 kPa; O2 – 369.28 kPa; NO – 71.44 kPa; Inert – 202.5 kPa) – 1 mark | (10) |