Registration Number:

MANIPAL UNIVERSITY

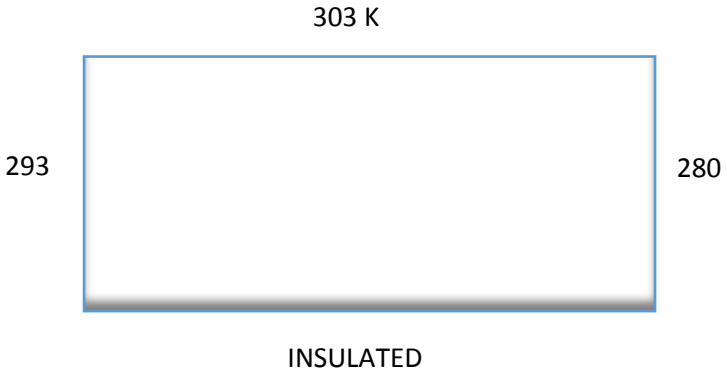
Vth Semester B.Tech (Chemical Engineering)

END SEMESTER EXAMINATION – NOV/DEC 2015

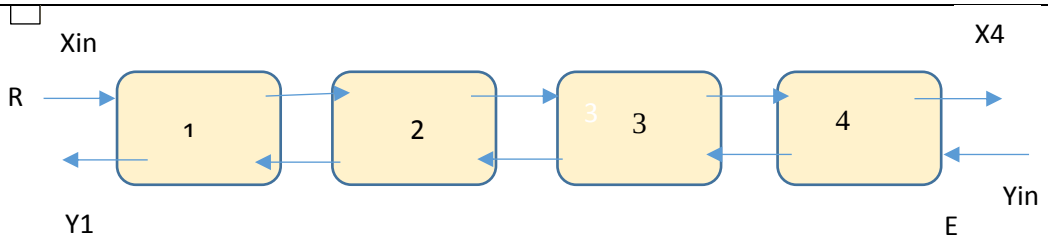
SUBJECT: Computational Methods for Chemical Engineers (CHE 311)

Time: 3 hrs **Max. Marks: 100**

- **Instructions to students**
  1. **Answer any FIVE FULL questions.**
  2. **Make suitable Assumption if required**
  3. **Answer should be correct to three places of decimal**

1	**A**	A reversible reaction $2A + B \leftrightarrow C$ can be characterized by the equilibrium relationship $$K = \frac{(C_{c,0}+X)}{(C_{a,0}-2X)^2(C_{b,0}-X)}$$ where the nomenclature c_i represents the concentration of constituent *i*, the subscript 0 designates the initial concentration of each constituent and variable X represents the number of moles of C that are produced. If K=0.016, $c_{a,0}$=42, $c_{b,0}$=28, and $c_{c,0}$=4, determine the value of X using secant method correct to 3 decimal points.	**10**
1	**B**	Determine the temperature distribution on the surface of a 3×4 cm^2 rectangular slab under steady state if one end is insulated as shown in figure. Take Δx = 1cm and Δy=1 cm  	**10**
2	**A**	The normality of leaching liquid is the most important factor in determining the diffusivity for the study of kinetics of elution of copper compounds from ion exchange resins.	**10**

		Determine the diffusity (cm^2s^{-1}) when N = 2 and 3.5. N: 0.0521, 0.1028, 0.2036, 0.4946, 0.9863, 1.9739, 2.443, 5.06 $D*10^6$: 1.65, 2.1, 2.27, 2.76, 3.12, 3.06, 2.92, 2.07	
2	**B**	Find the quadratic factors of '$x^4 - 1.1x^3 + 2.3x^2 + 0.5x + 3.3 = 0$' using Bairstow method and $x^2 - rx - s$ as starting factor. The ε_a value should be within 5%.	**10**
3	**A**	The data listed in the following table give hourly measurements of heat flux q ($cal.cm^2h^{-1}$) at the surface of a solar collector. Estimate the total heat absorbed by a 150000 cm^2 collector panel during a 10 h period. The panel has an absorbance efficiency e_{ab} of 45%. The total heat absorbed is given by $$H = e_{ab}\int_0^t qAdt$$ t: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 q: 0.1, 1.62, 5.32, 6.29, 7.8, 8.81, 8 , 8.57, 8.03, 7.04, 6.27	**10**
3	**B**	It is known that the tensile strength of a plastic increases as a function of the time it is heat-treated. The following data is collected: Time(min): 10, 15, 20, 25, 40, 50, 55, 60, 75 Tensile strength(Pa): 4, 20, 18, 50, 33, 48, 80, 60, 78 Fit a straight line to this data and use the equation to determine the tensile strength after 30 minutes of heat treatment	**10**
4	**A**	Write a note on the convergence of bisection method	**5**
4	**B**	Discuss the classification of partial differential equations with examples	**5**
4	**C**	A four stage counter current extraction is shown in figure. The component A is present in *phase E* along with a non-diffusing substance as a binary mixture. It is extracted into *phase R* by a non-diffusing solvent. X_i and Y_i represents weight fraction of component A in phase R and E respectively in the stage *i*.	**10**

		 If E =400 kg/h, R = 800 kg/h, Y_{in} = 0.1 and X_{in}=0, determinethe values of Y_{out} and X_{out} if R and E remains constant thoughout. Use Gauss Elimination.	
5		One dimensional transient heat conduction is taking place in a large flat steel plate of 2 cm thickness. If the initial temperatures (^{0}C) within the plate are given as $$T\ (x, 0) = 150 \sin \frac{\pi x}{2}$$ Find the temperatures at t=1 and 2 seconds if Δx =0.4 cm if both faces are maintained at 0^0C at any instant of time. Given α = 0.5. Use implicit method	**20**
6		A non-isothermal batch reactor can be described by the following equations: $$\frac{dC}{dt} = -e^{\left(-\frac{10}{T+273}\right)}C$$ $$\frac{dT}{dt} = -1000e^{\left(-\frac{10}{T+273}\right)}C - 10(T - 20)$$ where C is the concentration of the reactant and T is the temperature of the reactor. Initially the reactor is at 15°C and has a concentration of reactant C of 1.0 gmol/L. Find the concentration and temperature of the reactor at time t=1 min and t=2 min	**20**