BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER:IV**
BRANCH: CHEM. ENGG./CEP&P **SESSION : SP/2019**

SUBJECT : CL4005-NUM. METHODS FOR CHEMICAL ENGG.

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) The Stefan-Boltzmann law can be employed to estimate the rate of radiation of energy *H* from a surface, as in $\boldsymbol{H = Ae\sigma T^4}$ where *H* is in watts, *A* = the surface area *(m²)*, *e* = the emissivity that characterizes the emitting properties of the surface (dimensionless), σ = a universal constant called the Stefan-Boltzmann constant *(*= 5.67 × 10^{-8} Wm^{-2} K^{-4}*)*, and *T* = absolute temperature (K). Determine the error of *H* for a steel plate with *A* = 0.15m², *e* = 0.90, and *T* = 650 ± 20. Compare your results with the exact error. Repeat the computation but with *T* = 650 ± 40. Interpret your results. [3]

(b) Beginning with Taylor's series, derive the iteration scheme $x_{n+1} = \frac{1}{2}\left(x_n + \frac{N}{x_n}\right)$ for the square root of a real number N. [2]

Q2 (a) Derive the relationship among initial guesses and root for false position method with appropriate explanation. [2]

(b) Find out the root of square root of 7 using false position method. Do three iterations. Present your results in tabular form. Guess suitable initial guess values. [3]

Q3 (a) Discuss briefly about LU decomposition method. [2]

(b) Solve by LU decomposition method [3]

$$\begin{bmatrix} 1 & -1 & 2 \\ 2 & -2 & 3 \\ 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -8 \\ -20 \\ -2 \end{bmatrix}$$

Q4 (a) (x_0, y_0), (x_1, y_1) and (x_2, y_2) using these data points (equispaced base points), along with Newton's forward differences prove that [2]

$$y(x) = y_0 + \alpha\Delta y_0 + \frac{\alpha(\alpha-1)\Delta^2 y_0}{2!}, where\ is\ defined\ as\ \alpha = \frac{x - x_0}{\Delta x}$$

(b) Show that for equispaced base points, Newton's divided difference interpolating formula reduces to Newton's forward difference formula. [3]

Q5 (a) We have a set (n + 1) of data points (x_0, y_0), (x_1, y_1) ……. (x_n, y_n). Using Newton's divided differences prove that $y[x_n, x_{n-1}, \dots .x_0] = \sum_{i=0}^{n} \frac{y_i}{\prod_{j=0, j\neq i}^{n}(x_i - x_j)}$ [2]

(b) Find f(0.15) using Bessel's interpolating formula from the data [3]

x	0.1	0.2	0.3	0.4	0.5
F(x)	0.09983	0.19867	0.29552	0.38942	0.4794

Q6 Find the least squares line for the data points [5]

x_i	-1	0	1	2	3	4	5	6
f_i	10	9	7	5	4	3	0	-1

Along with the slope and the intercept, compute the standard error of the estimate and the correlation coefficient(index, regression coefficient).

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