Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Course: Chemical Engineering Computing

Semester: I

Programme: M. Tech. CE-PD (Chemical Engineering- Sp. Process Design)

Time: 03 hrs. **Max. Marks: 100**

Instructions: **Open Books and Notes, etc.**

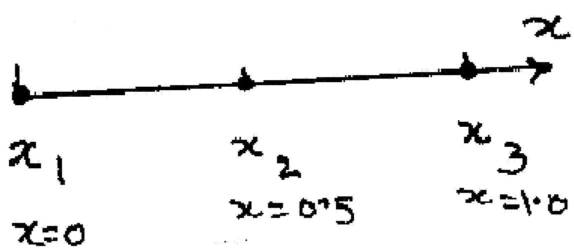
Question Paper has to be returned at the end of the exam

ALL THREE QUESTIONS ARE COMPULSORY (Total 100 Marks)

Q1 — **30 marks** — **CO5**

Consider the following ODE-BVP:

$$\frac{d^2y}{dx^2}+2yx=xy\int_{x=0}^{1}\left(y^2e^x\right)dx;\ 0\le x\le 1$$



with $y(x=0)=4$;

and $y(x=1)=9$

Use $N=2$ (therefore, $N+1=3$ FD points, x_1, x_2 and x_3)

(a) Write the values of y_1 and y_3 (05)

(b) Use Simpson's rule (with $h=0.5$) to evaluate the integral on the right hand side. Compute all the values and give a simple ***final*** expression (10)

(c) Use the finite difference technique to obtain an equation for y_2. Simplify as much as possible (10)

	(d) Check if y_2 = 0.02345 satisfies this equation (05)		
Q2	Consider the following ODE-IVP involving two variables, y_1(t) and y_2(t): ¿ with $\boldsymbol{y}(t = 0) = \boldsymbol{y}_0 = [3 \quad 0]^T$ (a) Apply the ***implicit*** Euler technique (for one step only, i.e., from $t = 0$ to $t = h = 0.1$) to obtain your answers in the following form: $F(y) \equiv$ ¿ (10) (b) Now use the Newton-Raphson-Kantarovich technique ***WITHOUT*** using inverses in any part of this question to obtain ¿ Do ***one*** NRK iteration only. Obtain ***numerical*** answers (10) (c) Plug in your answers in part (b) of this question (i.e., into the $\boldsymbol{F}(\boldsymbol{y}) = \boldsymbol{0}$ equation) and see what you get (05) (d) Comment on your answer to part (c) of this question. (10)	**35 marks**	**CO 2, CO 3 CO 4**
Q3	Consider the third order ($q - 1 = 3$) implicit Hermite algorithm (in Table 5.1) of integrating ODE-IVPs for a single variable, $y(x)$, with $\alpha_0 = \frac{1}{2}$ $\alpha_1 = \alpha_3 = \alpha_4 = \ldots = 0$ $\alpha_2 = \frac{1}{2}$ $\beta_0 = \frac{-1}{4}$	**35 marks**	**CO 2, CO 3**

$\beta_1 = \beta_3 = \beta_4 = \ldots = 0$

$\beta_2 = \frac{1}{4}$

Continued . . .

(a) Write down the algorithm for y_{n+1} in terms of y_i and $y_i^{'}$ (05)

(b) Using $\frac{dy}{dt} = \lambda y$, $y(t=0) = y_0$, obtain the characteristic equation for μ and solve for μ_i [Hint: Note that you will get ***two*** values of μ_i] (10)

(c) Which of these two roots is the ***genuine*** root and which is the ***spurious*** root (05)

(d) What is the ***requirement of stability*** for this problem? (15)

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