

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI  
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY  
2017/2018 RAIN SEMESTER EXAMINATIONS  
ENG 308- ENGINEERING MATHEMATICS II; DATE: SATURDAY SEPTEMBER 15, 2018  
INSTRUCTION: ATTEMPT ANY 5 QUESTIONS TIME ALLOWED: 3HOURS

1a) List any three factors that can necessitate the use of *numerical* methods in solving ordinary differential equations (3 marks).

b) Using the method of *Runge-Kutta*, solve the initial value problem  $y' = x^2y^{-1}$  given that  $y(0) = 1$  for  $x = 0.0(0.1)0.2$ . Tabulate the results (expressed to 5 places of decimal) and comment on the degree of accuracy of the method.

*Hint:*  $k_1 = hf(x_n, y_n) = h y_n^{-1}$ ;  $k_2 = hf(x_n + \frac{1}{2}h, y_n + \frac{1}{2}k_1)$ ;  $k_3 = hf(x_n + \frac{1}{2}h, y_n + \frac{1}{2}k_2)$ ;  $k_4 = hf(x_n + h, y_n + k_3)$ ;  $y_{n+1} = y_n + \frac{1}{6}(k_1 + 2k_2 + 2k_3 + k_4)$ . (17 marks).

2a) Given the following data: approximate  $f(0.05)$ ,  $f(0.7)$  and  $f(0.43)$  using the Newton's interpolatory division (10 marks).

x	0	0.2	0.4	0.6	0.8
F(x)	1.00000	1.22140	1.49182	1.82212	2.22554

b) Find  $\frac{dy}{dx}$  at  $x = 0.26$  using the 3- point Lagrange interpolation (10marks).

3) SEET FUTO is conducting a research to install solar farm in SEET complex to solve the power problem. Three departments are trying three different approaches for solving this problem. Under present circumstances it have been estimated that the probability of respective departments – call them 1, 2, 3 will fail is 0.4, 0.6 and 0.8. Therefore, the current probability that all three departments will fail is  $0.4 \cdot 0.6 \cdot 0.8 = 0.192$ . The objective is to minimize the probability of failure; two more top engineers have been assigned to the project. Table below gives the estimated probability that the respective departments will fail when 0, 1 or 2 additional engineers are added to that department. Since each engineer will devote full attention to one team, thus only integer numbers of engineers are considered. Determine how to allocate the two additional engineers to minimize the probability that all three departments will fail (20 marks).

New Engineers	Probability of Failure Engineering Department		
	1	2	3
0	0.4	0.6	0.8
1	0.2	0.4	0.5
2	0.15	0.2	0.3

4) A company produces two types of equipment, A and B, each of which needs the three (3) processes of design, fabrication and assembling. Using the information in the table below, determine: a) the weekly output of each type of equipment to minimize cost (15 marks). b) The minimum cost (5 marks).

Equipment type	Process utility per equipment			Cost per equipment (\$)
	Design	Fabrication	Assembling	
A	1.0	3.0	1.0	3.0
B	3.0	1.0	2.0	4.0
Available utility per week	54.0	34.0	At least 12.0	

5a) Obtain a state space representation for:  $y^{(3)} + 9y'' + 26y' + 24y = 5u$  using the controllable canonical form and determine the state Transition Matrix for this system (15marks). b) What will be the zero input solution or response for  $X(0) = [1 \ 0 \ 0]^T$  (5marks).

6ai) Why is the Fourier transform useful in computer vision and graphics (2 marks). ii) What are the advantages of using the Fourier descriptors to describe a shape? (6 marks).

b) Consider a transmitting signal represented by  $S(t) = \begin{cases} \alpha \cos\left(\frac{2\pi t}{\Delta}\right) & -\frac{T}{2} \leq t \leq \frac{T}{2} \\ 0 & (t) > \frac{T}{2} \end{cases}$  within the interval  $-\frac{T}{2} \leq t \leq \frac{T}{2}$ , where  $\alpha$  and  $\Delta$  correspond to the amplitude of the signal and a scaling factor. Obtain the Fourier transform of the signal if it is truly periodic (12 marks).