ELIZADE UNIVERSITY

ILARA-MOKIN

FACULTY: BASIC AND APPLIED SCIENCES
DEPARTMENT: MATHEMATICS AND COMPUTER SCIENCE
1st SEMESTER EXAMINATION
2017 / 2018 ACADEMIC SESSION

COURSE CODE: CSC 435

COURSE TITLE: Numerical Analysis

COURSE LEADER: Dr. Vincent Akpan

DURATION: 2 ½ Hours

HOD's SIGNATURE

INSTRUCTION:

Candidates should answer any THREE Questions in all.

Students are warned that possession of any unauthorized materials in an examination is a serious offence.

1. (a) Distinguish between the following terms:
(i) Interpolation (ii) Curve fitting (iii) Time-Series
(b) Given the following data points,

x	0	2	3
y	7	11	28

Use the Lagrange's method to determine y at $x = 1$.

(c) Determine the parameters a and b so that $f(x) = ae^{bx}$ fits the following data in the least-squares sense:

x	1.2	2.8	4.3	5.4	6.8	7.9
y	7.5	16.1	38.9	67.0	146.6	266.2

Fit $\ln y_i$ and compute the standard deviation.

2. (a) (i) What is least-squares fit?
(ii) What is linear regression?
(b) Suppose that following data points lie on a polynomial.

x	-2	1	4	-1	3	-4
y	-1	2	59	4	24	-53

Determine the degree of this polynomial by constructing the divided difference table.
(c) Use natural cubic spline to determine y at $x = 1.5$. The data points are:

x	1	2	3	4	5
y	0	1	0	1	0

3. (a) The behaviour of a fairly large class of discrete-time systems can be modeled by the following general mathematical formula:

$$A(z^{-1})Y(k) = z^{-d}\frac{B(z^{-1})}{F(z^{-1})}U(k) + \frac{C(z^{-1})}{D(z^{-1})}e(k)$$

(where all symbols have their usual meaning).
Using the above equation, deduce the mathematical model structure that corresponds to the:
(i) AutoRegressive with eXogenous inputs (ARX) model.
(ii) AutoRegressive Moving Average with eXogenous inputs (ARMAX) model.
(iii) Output Error (OE) model.

(c) Using the results in (c) and starting from any known principles, deduce an expression and draw the resulting neural network model structure that corresponds to the:
(i) Neural Network AutoRegressive with eXogenous inputs (NNARX) model.
(ii) Neural Network AutoRegressive Moving Average with eXogenous inputs (NNARMAX) model.
(iii) Neural Network Output Error (NNOE) model.

(c) Assuming that 3 past inputs and outputs are sufficient to model a 5-input 3-output system using a dynamic feedforward neural network autoregressive moving average with exogenous inputs (NNARMAX) model with 15 input-to-hidden layer neurons.
(i) What is the number of output neurons?
(ii) Compute the total number of inputs to the neural network.
(iii) Compute the dimension of the input-to-hidden layer weight.
(iv) Compute the dimension of the hidden-to-output layer weight.

4. (a) Fuzzy logic model comes in two flavours, namely: Mamdani-type and Sugeno-type (also called Takagi-Sugeno-Kang (TKS)).
(i) State where each type of the above fuzzy logic models can find applications.
(ii) Briefly state three advantages each for the two model types.
(b) (i) What is the main argument for the introduction of the Adaptive neural fuzzy inference system (ANFIS).
(ii) Draw the typical architecture of a five-layer ANFIS and state the function of each layer.
(c) A single layer perceptron is initialized with weights $w_1 = 1$ and $w_2 = 2$ with bias $b = -2$ for a simple output classification problem. Given the inputs $u = [0.5, 0.5]$ and the target output as $y = +1$. Assuming that the network has an Heaviside activation function where $F(\cdot) = 1$, if $(\cdot) > 0$ and $F(\cdot) = -1$, otherwise.
(i) What are the final values of the weights and bias?
(ii) In how many iterations does the perceptron output converges to the desired target output?

5. (a) (i) Distinguish between numerical differentiation and numerical integration.
(ii) State which of numerical differentiation or integration is more efficient. Give at least two reasons to support your answer.
(b) (i) Derive the Newton-Cotes formulas.
(ii) Derive the trapezoidal rule from 3(b)(i) above.
(iii) Derive the composite trapezoidal rule from 3(b)(ii) above.