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B. Sc Engineering (EEE) , 5th Semester 09 October 2023(Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination **Winter Semester: 2022 - 2023**
Course Number: EEE 4505 **Full Marks: 75**
Course Title: Computational Methods in Engineering **Time: 1.5 Hours**

There are **03 (Three)** questions. Answer **all** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in the brackets.

1. (a) Illustrate some utilities of Taylor Series approximation from the computational point of view. The discharging nature of a source-free RC can be obtained by solving the ODE. $\frac{dv(t)}{dt} + 25v(t) = 0$. With $v(0) = 6$ (V), estimate the value of $v(0.05)$ using quadratic approximation of Taylor series. Also, find the true percent of relative error by comparing the value with the exact solution. **(13) (CO1) (PO1)**

b) A circular charged disk with surface charge density $\rho_s = 10\ nC/m^2$ is placed on the $x-y$ plane at $z = 0$ as shown in Fig. 1(b). The electric field due to this charged disk at $(0,0,z)$ is given by, **(12) CO1) (PO1)**

$$\vec{E} = \frac{\rho_S}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{R^2+z^2}}\right)\widehat{a_z}\ \text{(V/m.}$$

Calculate the value of z numerically where the electric field becomes $250\ V/m$ using the bisection method. The radius R of the disk is 1.0 m. Use $z_u = 0.4\ m$ and $z_L = 1.0\ m$.

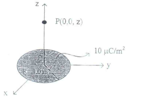

Fig. 1(b)

OR

a) "In general, the nth order Taylor series expansion will be exact for an nth order polynomial"- Justify the statement. **(13) (CO1) (PO1)**

Find the value of $f(6)$, given that $f(4.5) = 145$, $\frac{df}{dx}|_{x=4.5} = 85$, $\frac{d^2f}{dx^2}|_{x=4.5} = 45$, and $\frac{d^3f}{dx^3}|_{x=4.5} = 9$ and all other higher derivatives of $f(x)$ at $x = 4.5$ are zero.

b) A bandpass filter passes signals with frequencies that are within a certain range. In this filter, the ratio of the magnitudes of the voltages is given by, (12) CO1) (PO1

$$G = \left|\frac{V_O}{V_i}\right| = \frac{\omega RC}{\sqrt{(1-\omega^2 LC)^2 + (\omega RC)^2}}$$

Where, ω is the angular frequency of the input signal. Given $R = 1000\Omega$, $L = 11\ mH$, and $C = 8\mu F$, determine the lower cut-off frequency corresponds to $G \geq 0.87$. Using an open numerical method of your choice.

2. a) Derive Newton Raphson iteration equation from the Taylor Series. Determine the input voltage when the output is 1.0 V of the Op-Amp circuit shown in Fig.2 (a) using the Newton Raphson method. Start with an initial guess of 0.0 V. Voltage across the nonlinear element is as a function of i is given as (10) (CO1) PO1)

$v = -1 + i + 0.5i^3 + 0.1i^5 + e^{0.5i}$, where v is in volts and i is in mA.

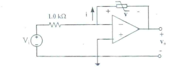

Fig. 2(a)

b) Determine the mesh currents in the circuit of Fig.2(b) using the Gauss-Seidel method with an initial gauze of zero. Show four iterations. (10) (CO1) (PO1)

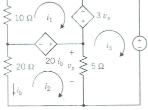

Fig. 2(b)

c) Describe the advantages and disadvantages of the Gauss-Seidel method over the Naïve Gauss Elimination method. (5) (CO3) (PO2)

3. a) The voltage across a 5 MΩ resistor during the charging phase of a capacitor measured every 4 seconds is given below. (10) (CO3, PO2)

t(s)	0	4	8	12	16	20	24	28
V_R	10.0	8.1	5.1	3.7	2.4	1.6	1.1	0.7

Choose an appropriate model for the measurement and use least square curve fitting method to estimate the value of the capacitance.

b) The power generated by a windmill varies with the wind speed. In an experiment, the following five measurements were obtained. **(10) (CO2 PO1)**

Wind Speed(mph)	14	22	30	38	46
Electric Power (W)	320	490	540	500	480

Represent the data by a second-order Newton's interpolation polynomial and find the power at a wind speed of 36 mph.

c) Determine the numbers of iterations needed in a bisection method with starting $x_L = 5$ and $x_U = 3$ and the desired error is 0.0125. **(5) (CO2 PO1)**