Seat No. : _______________

ND-138

December-2015

M.Sc., Sem.-III

502 : Physics

(Numerical Methods and Analog Electronics)

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) Attempt **all** questions.
(2) **All** questions carry equal marks.
(3) Symbols and terminology have their usual meanings.
(4) Scientific calculator may be permitted.

1. (a) Explain Picard's method of solving ordinary differential equation. Employ this method to obtain, correct to four places of decimal, solution of the differential equation $\frac{dy}{dx} = x^2 + y^2$ for $x = 0.4$, given that $y = 0$ when $x = 0$. **7**

OR

Describe Euler's method for solving the ordinary differential equation. Based on this also deduce Modified Euler's method.

(b) Explain with merits and demerits, the Adams-Bashforth method of solving the ordinary differential equation. **7**

OR

Apply Milnes's method to find approximate solution of the differential equation $\frac{dy}{dx} = x - y^2$ in the range $0 \le x \le 1$ for the boundary condition $y(0) = 0$.

2. (a) Explain in detail the method of finite difference approximations to obtain the first-order and second-order partial derivatives. **7**

OR

Solve $\nabla^2 u = -10(x^2 + y^2 + z^2)$ over the square with sides $x = y = 0$, $x = y = 3$ with u = 0 on the boundary and mesh length = 1.

(b) Find the values of $u(x, t)$ satisfying the parabolic equation $\frac{\partial u}{\partial t} = 4\frac{\partial^2 u}{\partial x^2}$ and the boundary conditions $u(0, t) = 0 = u(8, t)$ and $u(x, 0) = 4x - 0.5x^2$ at the points $x = i : i = 0, 1, 2,\ldots 7$ and $t = (1/8)\, j : j = 0, 1, 2,\ldots., 5$. **7**

OR

Solve the equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}$ subject to the initial conditions $u(x, y, 0) = \sin(2\pi x)\sin(2\pi y)$, $0 \le x, y \le 1$ and the conditions $u(x, y, t) = 0$, $t > 0$ on the boundaries, using ADE method with $h = 1/3$ and $\alpha = 1/8$. Calculate the results for one time level.

3. (a) Design regulated power supply using IC 723 for maximum load current of 50 mA and output voltage of +12 V. It is given that unregulated input voltage is + 15 V dc. **7**

OR

Give internal block diagram and important specifications of IC 723.

(b) Draw circuit diagram of first-order low pass filter using IC 741 and obtain expressions for it gain and phase response. **7**

OR

Design HPF of second order with gain of 16 and cut off frequency of 5 kHz using IC 741. Draw its frequency response.

4. (a) What is a Pole and what is a zero ? Explain. Draw and explain Pole-Zero diagram for a tuned amplifier. What is its use ? **7**

OR

Draw the universal response curves for the double tuned circuit :

$Q_1 = Q_2 = Q$ for various values of KQ – under coupling, critical coupling and over coupling.

Write down the expression for bandwidth of above circuit in terms of bandwidth of single tuned circuit and Q.

(b) Draw block diagram of PLL. Explain Lock Range and Capture Range with help of a diagram. **7**

OR

Explain the terms :

(i) Rise time

(ii) Fall time

(iii) Pulse width

(iv) Over shoot and

(v) Sag for pulse with help of diagram

What is the bandwidth required to receive an ideal square wave of time period of 1 ms ?

5. Answer the following : **14**

(i) Point-out the limitations of Taylor's series method of solving the ordinary differential equation.

(ii) Which method is the first-order RK method of solving the ordinary differential equation ?

(iii) What is the concept of predictor-corrector method of solving the ordinary differential equation ?

(iv) What is the classification of partial differential equation $f_{xx} - 4f_{xy} - 2f_{yy} = 0$?

(v) What is the classification of partial differential equation

$(1 - x^2)\, f_{xx} - (5 - 2x^2)\, f_{xt} - (4 - x^2)\, f_{tt} = 0$?

(vi) What is meant by an interactive method of solving the differential equation ?

(vii) What is limitation of Schmidt explicit formula ?

(viii) If center frequency is 1 MHz and Q is 10000; find the bandwidth.

(ix) Define pulse duration with help of diagram.

(x) Draw frequency – phase response of a tuned amplifier.

(xi) What is reference voltage in IC 723 ?

(xii) Draw block diagram of band reject (stop) filter to reject frequencies in the range 3 KHz to 7 KHz.

(xiii) Define free running frequency in PLL.

(xiv) What is use of Notch Filter ?
