BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

COMPUTATIONAL PHYSICS (**PHY F313**)

Date: 04-11-2022 **Max Time:** 90 min **Max Marks**: 90

IMPORTANT:
Finding numerical answer is good but weightage will be given for correct procedure. Blindly finding the answer have no meaning.

---

1. [5 marks] Write an algorithm (only) to evaluate the roots of an equation $x^3 = 169$ by Newton-Raphson method. Can we find the answer without declaring the *tolerance* in the algorithm?
2. [15 marks] Find the root(s) of the $f(x) = x^3 - 10x^2 - 15x + 22$ after 5 iterations.
   (a) (10 marks) Choose the initial guesses as 5 & 6. The allowed tolerance is 10^{-6}.
   (b) (5 marks) Compare your results after 3 iterations with these two guesses. Comment on the obtained results.
3. [10 marks] Find out the abscissas for the Gauss-Legendre integration rule for $N = 2$ by finding out the relevant Legendre polynomial(s).
4. [10 marks] Evaluate the integral
$$I = \int_0^5 [x^2 e^{-x^2}] dx$$
   (a) (4 marks) Gaussian quadrature method.
   (b) (4 marks) Monte Carlo (uniform sampling) method.
   (c) (2 marks) Compare your results.
5. [20 marks] Evaluate the equation,
$$y' = \frac{x - y}{2}$$
   on [0, 2] with $y(0) = 1$ for $h = 0.5$
   (a) (5 marks) Euler method.
   (b) (10 marks) 4^{th} order Runge-Kutta method.
   (c) (5 marks) Compare your results obtained via two methods. Is there any discrepancy in the results? If yes, why?
6. [20 marks] The charging of a capacitor in an RC circuit is represented by
$$R\frac{dq}{dt} = V - \frac{q}{C}$$
   with $R = 100\ \Omega,\ C = 150\ \mu\text{F},\ V = 12\ \text{V},\ q = 0,\ t = 0.$
   (a) (15 marks) Use Euler method to solve (in 5 steps) and find out the $q(t = 0.005\ s)$.
   (b) (5 marks) Do you find the saturation in $q(t)$? Justify your answer.
7. [10 marks] The integral $u''(t) + 10u'(t) + 9u(t) - 5t = 0$ is subjected to boundary conditions $u(0) = 1,\ u(1) = 10$.
   (a) (6 marks) Convert the equation in a finite difference form.
   (b) (4 marks) Suggest a method to solve it using the finite difference method.

========== ALL THE BEST ==========

Given:

1. A set of 10 random numbers,
   $r[10] = \{0.840188, 0.783099, 0.911647, 0.335223, 0.277775, 0.477397, 0.364784, 0.952230, 0.635712\}$.
2. The Gaussian points:
   Abscissas = $\{\pm 0.9739065285, \pm 0.8650633667, \pm 0.6794095683, \pm 0.4333953941, \pm 0.148874339\}$
   Weights = $\{0.0666713443, 0.1494513492, 0.2190863625, 0.2692667193, 0.2955242247\}$