Calculus for Engineers

Lab Report

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Experiment No. 1: Flow Control and Conditional Statements

Q1. Plot a circle of given radius with centre (h,k). Input the numerical values for h, k and r.

Q2. Write a matlab code to print your name if the last two digits of your roll number form an even number, otherwise plot a circle centered at origin having radius as the last two digits of your roll number.

Experiment No. 2: Application to Derivatives

Question 1: A box with an open top is to be constructed from a rectangular piece of cardboard with dimensions 12 in. by 20 in. by cutting out equal squares of side x at each corner and then folding up the sides as in the figure. Find x so that the volume is maximum.

Question 2: An open rectangular box with the square base is to be made from 48ft^2 of material. What dimensions will result in a box with the largest possible volume?

Experiment No. 3: Application to Integrals

Q1. Find the mass of a plate bounded by $y = x$ and $x = 1$, with density $\mu(x, y) = 3 - x - y$. Print the output with your name and roll number.

Q2. Find the volume of the region D enclosed by the surfaces $z = x^2 + 3y^2$ and $z = 8 - x^2 - y^2$.

Q3. Find average value of $F(x, y, z) = xyz$ throughout the cubical region D bounded by the coordinate planes $x = 2$, $y = 2$, and $z = 2$ in the first octant.

Experiment No. 4: Vector Calculus

Q1. Find the gradient of the function $f = xyz$ and curl and divergence of vector field $\boldsymbol{F} = x^2y\boldsymbol{i} + y\boldsymbol{j} + xy\boldsymbol{k}$.

Q2. Find the directional derivative of the function $f = x\cos(yz)$ at point $(-1,2,1)$ in the direction of the vector, $2i + j + 3k$. Print the output with your roll number and name.

Q3. Draw the two dimensional vector field for the vector $x^2y\boldsymbol{i} + xy\boldsymbol{j}$.

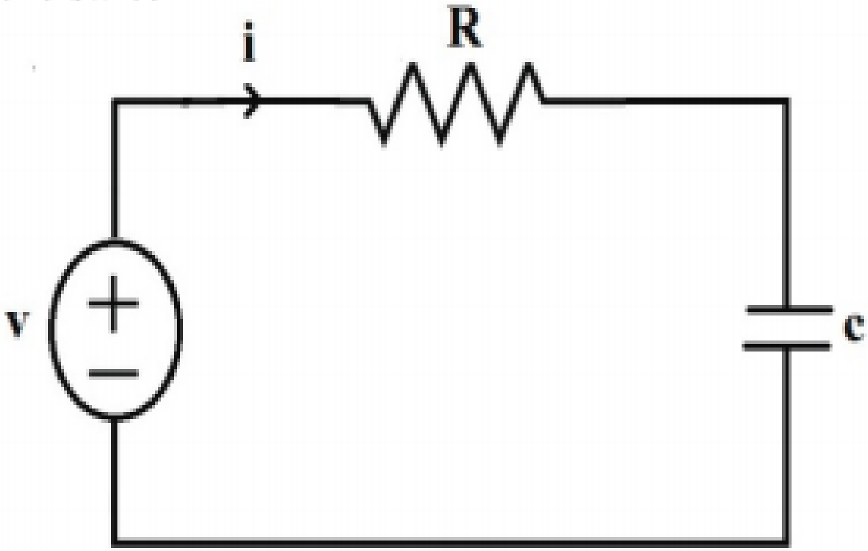
Experiment No. 5: Application to Vector Integrals

Q1. Integrate $f(x, y, z) = x - 3y^2 + z$ over the line segment C joining the origin to the point (1, 1, 1).

Q2. Evaluate the line integral of $\boldsymbol{F}(x, y, z) = z\boldsymbol{i} + xy\boldsymbol{j} - y^2\boldsymbol{k}$ along the curve C given by $\boldsymbol{r}(t) = t^2\boldsymbol{i} + t\boldsymbol{j} + \sqrt{t}\,\boldsymbol{k}, \quad 0 \leq t \leq 1.$

Experiment No. 6: Solving Differential Equations

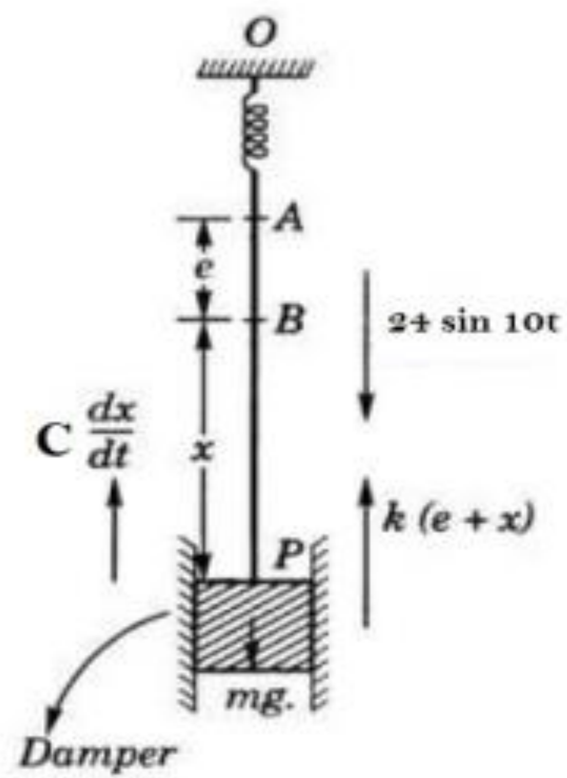
Q1. A condenser of capacity $C = 5 \times 10^{-5}$ farad is charged through a resistance $R = 200$ ohms by steady voltage $E = 2000$ volts. Calculate the current at the instant of closing the switch.



Hint: Let i be the current flowing in the circuit at any time t. Then by Kirchhoff's first law, we have sum of voltage drops across R and $C = E$.
i.e. $Ri + \frac{q}{C} = E \implies \frac{dQ}{dt} + \frac{1}{RC}Q = \frac{E}{R}$.
From the given data, we obtain the following eqaution

$$\frac{dQ}{dt} + 100Q = 10, Q(0) = 0.$$

Q2. **Example** A $16lb$ weight is suspended from a spring having a constant $5lb/ft$. Assume that an external force given by $24\sin 10t$ and a damping force $4v$ are acting on the spring. Initially the weight is at rest as its equilibrium position. Find the position of the weight at any time.



Hint: $\frac{d^2x}{dt^2} + \frac{C}{m}\frac{dx}{dt} + \frac{k}{m}x = \frac{F(t)}{m}$. Here $m = w/g = 16/32 = 1/2, C = 4v, k = 5lb/ft, F(t) = 24\sin 10t, x(0) = 0, x'(0) = 0.$

by using we get $\frac{d^2x}{dt^2} + 8\frac{dx}{dt} + 10x = 48\sin 10t.$

Experiment No. 7: Solving ODEs using Laplace Transform

Q1. Find the Laplace Transform of the following functions

a). $f(x) = 1 - x + 2x^2$

b). $f(x) = 4e^{-3t} - 10\sin 2t$

Q2. Solve the ordinary differential equation $y'' + 2y' = 8t, y(0) = 1, y'(0) = 0$, using Laplace transform.

Q3. Solve the equation y''+ 16y = 16sin(2t) with the initial conditions that y(0) = 1, and y ' (0) = 0.