Department of Mathematics
National Institute of Technology Kurukshetra

B.Tech. (First Semester) END SEMESTER EXAMINATION March 2021

Question Paper

Subject: Differential Calculus and Differential Equations

Code: MAIR 11 **Max. Marks: 50**

Branch: CE, CS, EC, EE, IT, ME, PI Timings: **11:00a.m-01:00 p.m.**

(Online submission of pdf of answer sheet and google form response by **1:20pm)**

Note: a) All questions are compulsory.

b) The Question Paper consists of 15 MCQ. **It has 1 MCQ (Q. No. 9) of 2M, 8MCQ (Q. No. 1, 3, 4, 5, 6, 7, 8, 10) of 3M each, and 6MCQ (Q. No. 2,11, 12, 13, 14, 15) of 4M each.**

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1. If A=$\begin{pmatrix} 1 & 4 \\ 2 & 3 \end{pmatrix}$, the linear polynomial $A^5 - 4A^4 - 7A^3 + 11A^2 - A - 10I$ can be written as

   A. A+3 B. A+5 C. 2A+5 D. A-3

2. The value of a, b, c is ……, so that A is orthogonal , where $A = \begin{bmatrix} 0 & 2b & c \\ a & b & -c \\ a & -b & c \end{bmatrix}$

   A. $a = \pm\frac{1}{\sqrt{6}}\ , b = \pm\frac{1}{\sqrt{2}}\ , c = \pm\frac{1}{\sqrt{3}}$ B. $a = \pm\frac{1}{\sqrt{2}}\ , b = \pm\frac{1}{\sqrt{2}}\ , c = \pm\frac{1}{\sqrt{2}}$

   C. $a = \pm\frac{1}{\sqrt{2}}\ , b = \pm\frac{1}{\sqrt{6}}\ , c = \pm\frac{1}{\sqrt{3}}$ $D.$ $a = \pm\frac{1}{\sqrt{3}}\ , b = \pm\frac{1}{\sqrt{2}}\ , c = \pm\frac{1}{\sqrt{3}}$

3. Quadratic form $-3x_1^2 - 3x_2^2 - 3x_3^2 - 2x_1x_2 - 2x_1x_3 + 2x_3x_2$ is classified as

   A. Negative Semi Definite B. Positive Definite

   C. Positive Semi Definite D. Negative Definite

4. The Characteristic equation of A=$\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ is

   A. $\lambda^3 - 13\lambda^2 - 5\lambda + 1 = 0$ B. $\lambda^3 - 11\lambda^2 - 4\lambda + 1 = 0$

   C. $\lambda^3 + 11\lambda^2 + 4\lambda + 1 = 0$ D. $\lambda^3 + 13\lambda^2 + 5\lambda + 1 = 0$

5. If $x^2 + y^2 + u^2 - v^2 = 0$ and $uv + xy = 0$, Jacobian $\frac{\partial(u,v)}{\partial(x,y)}\ is$

   A. $\frac{x^2+y^2}{u^2+v^2}$ B. $\frac{x^2-y^2}{u^2+v^2}$ C. $\frac{x^2}{u^2+v^2}$ D. $\frac{x^2+y^2}{u^2+v^2}$

6. Function $x^2 + y^2 + 6x + 12$ has

A. Saddle Point at (-3,0) B. Maximum value 3 at (-3,0)

C. Minimum Value 3 at (-3,0) D. Case is Doubtful

7. If $z = f(x,y),\ x = e^u + e^{-v}, y = e^{-u} - e^v$ then $\frac{\partial z}{\partial u} - \frac{\partial z}{\partial v}$ is ....

A. $x\frac{\partial z}{\partial x} - y\frac{\partial z}{\partial y}$ B. $\frac{\partial z}{\partial x} + \frac{\partial z}{\partial y}$ C. $\frac{\partial z}{\partial x} - \frac{\partial z}{\partial y}$ D. $y\frac{\partial z}{\partial x} - x\frac{\partial z}{\partial y}$

8. If $u = \frac{x}{y}, v = \frac{x+y}{x-y}$ then u and v are –

A. Functionally Independent B. Functionally dependent C. Cannot be predicted D. None

9. The diff. eqn. $y''' + 12y'' + y' + 9y = e^x sin3x$ is –

A. Homogeneous, non-Linear diff.eqn. with constant coeff.

B. Homogeneous, Linear diff.eqn. with constant coeff.

C. Non-Homogeneous, non-Linear diff.eqn. with constant coeff.

D. Non-Homogeneous, Linear diff.eqn. with constant coeff.

10. By using the transformation $x = e^z$, the diff. eqn $x^2\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} = \log x$ can be reduced into the diff. eqn. as–

A. $\frac{d^2y}{dz^2} + \frac{dy}{dz} + y = z$ B. $\frac{d^2y}{dz^2} + \frac{dy}{dz} = z$

C. $\frac{d^2y}{dz^2} - 2\frac{dy}{dz} + y = z$ D. $\frac{d^2y}{dz^2} - \frac{dy}{dz} + 2y = z$

11. A generator having emf 100 volts is connected in series with 10 ohm resistor and an inductor of 2 Henry. If the switch is closed at a time t = 0, then the current at time t > 0 is

A. $I = 10(1 - e^{-0.5t})$ B. $I = 20(1 - e^{-5t})$ C. $I = 10(1 - e^{-5t})$ D. $I = 20(1 - e^{-0.5t})$

12. In case of Resonance, in presence of external force F(t), the equation of motion of a mass 'm' at one end of a spring suspended from ceiling is-

A. $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$ B. $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F(t)$

C. $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} = F(t)$ D. $m\frac{d^2x}{dt^2} + kx = F(t)$

13. L[100^t+2t^{10}]=

A. $\frac{1}{s-100}+\frac{2.10!}{s^{11}}$ B. $\frac{1}{s+100}+\frac{2.11!}{s^{10}}$

C. $\frac{1}{s-2\ln 10}+\frac{2.10!}{s^{11}}$ D. $\frac{1}{s-\ln 100}+\frac{2.11!}{s^{11}}$

14. If y(t) is the solution of $\frac{dy}{dt}-2y=4, y(0)=1,$ then y(t)=

A. $3e^{-2t}-2$ B. $2e^{2t}-2$ C. $2e^{3t}-3$ D. $3e^{2t}-2$

15. $L^{-1}\left[\log\frac{s^2+1}{s(s+1)}\right]=$

A. $\frac{1}{t}(1-e^{t}+2\cos t)$ B. $\frac{1}{t}(1+e^{-t}-2\cos t)$ C. $\frac{1}{t}(1-e^{-t}-2\sin t)$ D. $\frac{1}{t}(1+e^{t}+2\cos t)$.

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