**SCHEME OF EVALUATION**
**(Scoring Indicators)**

Revision : 2015

Course Title : ENGINEERING MATHEMATICS II

Course Code : 2002

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| | PART–A | | | |
| I 1. | Unit vector in the direction of $\vec{a} = \frac{\vec{a}}{\lvert\vec{a}\rvert}$ | 1 | 2 | |
| | $= \frac{3\hat{i}+2\hat{j}-\hat{k}}{\sqrt{14}}$ | 1 | | |
| 2. | $\begin{vmatrix} \sec\theta & \tan\theta \\ \tan\theta & \sec\theta \end{vmatrix} = \sec^2\theta - \tan^2\theta$ | 1 | 2 | |
| | $= 1$ | 1 | | |
| 3. | $A+B = \begin{bmatrix} 4 & 7 \\ 0 & 2 \end{bmatrix}$ | 1 | 2 | 10 |
| | $(A+B)^T = \begin{bmatrix} 4 & 0 \\ 7 & 2 \end{bmatrix}$ | 1 | | |
| 4. | $\int \sin^2 x \, dx = \int \left(\frac{1-\cos 2x}{2}\right) dx$ | 1 | 2 | |
| | $= \frac{1}{2}\left[x - \frac{\sin 2x}{2}\right] + c$ | 1 | | |
| 5. | $dy = (4x+5)\,dx$ | 1 | 2 | |
| | $y = 4\frac{x^2}{2} + 5x + c$ | 1 | | |

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| | PART – B | | | |
| II 1. | Let $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} - 2\hat{j} + \hat{k}$ | | | |
| | $\vec{a} \cdot \vec{b} = 3+4+3 = 10$ | 2 | | |
| | $a = \sqrt{1+4+9} = \sqrt{14}$ | 1 | | |
| | $b = \sqrt{9+4+1} = \sqrt{14}$ | 1 | 6 | |
| | $\theta = \cos^{-1}\left(\frac{\vec{a} \cdot \vec{b}}{ab}\right) = \frac{10}{14}$ | 1+1 | | |
| 2. | Suppose that $x^4$ occurs in the $(r+1)^{th}$ term. | | | |
| | $t_{r+1} = {}^{n}C_{r} x^{n-r} a^{r}$ | 1 | | |
| | $= {}^{15}C_{r} (x^4)^{15-r} (-1/x^3)^{r}$ | 1 | | |
| | $= {}^{15}C_{r} (-1)^{r} x^{60-7r}$ | 2 | 6 | |
| | $60-7r = 4$, $r = 8$ | 1 | | |
| | Coefficient of $x^4 = {}^{15}C_{8}$ | 1 | | |
| 3. | $\Delta = -3$ | 1 | | |
| | $\Delta_1 = -3$ | 1 | | |
| | $\Delta_2 = 3$ | 1 | | |
| | $\Delta_3 = -6$ | 1 | | |
| | $x = \frac{\Delta_1}{\Delta}, \; y = \frac{\Delta_2}{\Delta}, \; z = \frac{\Delta_3}{\Delta}$ | 1 | 6 | |
| | $x = 1, \; y = -1, \; z = 2$ | 1 | | |

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| 4. | Let $A = \begin{bmatrix} 3 & -2 & 3 \\ 2 & 1 & -1 \\ 4 & -3 & 2 \end{bmatrix}$ | | | |
| | $\lvert A \rvert = -17 \neq 0$ | 1 | | |
| | Cofactor matrix of $A = \begin{bmatrix} -1 & -8 & -10 \\ -5 & -6 & +1 \\ -1 & 9 & 7 \end{bmatrix}$ | 2 | | |
| | $adj A = \begin{bmatrix} -1 & -5 & -1 \\ -8 & -6 & 9 \\ -10 & 1 & 7 \end{bmatrix}$ | 1 | 6 | |
| | $A^{-1} = \frac{adj A}{\lvert A \rvert}$ | 1 | | |
| | $= \frac{\begin{bmatrix} -1 & -5 & -1 \\ -8 & -6 & 9 \\ -10 & 1 & 7 \end{bmatrix}}{-17}$ | 1 | | |
| 5 | $\sin A \cos B = \frac{1}{2}\left[\sin(A+B) + \sin(A-B)\right]$ | 1 | | |
| | $\int \sin 3x \cos x \, dx = \frac{1}{2}\int(\sin 4x + \sin 2x)dx$ | 1 | | |
| | $= \frac{1}{2}\left[\frac{-\cos 4x}{4} - \frac{\cos 2x}{2}\right]$ | 1 | | |
| | $\int_0^{\pi/2} \sin 3x \cos x \, dx = \frac{1}{2}\left[\frac{-\cos 4\pi/2}{4} - \frac{\cos 2\pi/2}{2} + \frac{\cos 0}{4} + \frac{\cos 0}{2}\right]$ | 1 | 6 | |
| | $= \frac{1}{2}\left[-\frac{1}{4} + \frac{1}{2} + \frac{1}{4} + \frac{1}{2}\right] = \frac{1}{2}$ | 1+1 | | |

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| 6 | $y = x^2$ and $y = 3x+4$ | | | |
| | $x^2 = 3x+4$ | | | |
| | $x = -1$ or $4$ | 1 | | |
| | $A = \int_a^b (f(x) - \phi(x))dx$ | | | |
| | $= \int_{-1}^{4} (x^2 - 3x - 4)dx$ | 2 | | |
| | $= \left[\frac{x^3}{3} - 3\frac{x^2}{2} - 4x\right]_{-1}^{4}$ | 1 | 6 | |
| | $= \left[\frac{64}{3} - 3\times\frac{16}{2} - 4\times4\right] - \left[\frac{-1}{3} - \frac{3}{2} + 4\right]$ | 1 | | |
| | $= -\frac{125}{6} = \frac{125}{6}$ sq. units | 1 | | |
| 7. | $\frac{dy}{dx} + Py = Q$. | | | |
| | $P = \tan x$, $Q = \sec x$. | | | |
| | Integrating factor, $IF = e^{\int P dx}$ | 1 | | |
| | $= e^{\int \tan x\, dx}$ | 1 | | |
| | $= e^{\int \log \sec x} = \sec x$ | 2 | 6. | |
| | Solution is, $y \times IF = \int Q\, IF\, dx$ | | | |
| | $y \times \sec x = \int \sec^2 x\, dx$ | 1 | | |
| | $y \times \sec x = \tan x + c$ | 1 | | |

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| | PART – C | | | |
| | Unit - I | | | |
| III a | $\vec{a}+\vec{b} = 6\hat{i}+2\hat{j}-8\hat{k}$ | 1 | | |
| | $\vec{a}-\vec{b} = 4\hat{i}-4\hat{j}+2\hat{k}$ | 1 | | |
| | If $(\vec{a}+\vec{b})\cdot(\vec{a}-\vec{b})=0$, the vectors are perpendicular. | 1 | 5 | |
| | $(\vec{a}+\vec{b})\cdot(\vec{a}-\vec{b}) = 24-8-16=0$ | 2. | | |
| b. | $\vec{AB} = \hat{i}+\hat{j}+6\hat{k}$ | 1 | | |
| | $\vec{AC} = -\hat{i}+\hat{j}+3\hat{k}$ | 1 | | |
| | Area of $\Delta ABC = \frac{1}{2}\lvert \vec{AB}\times\vec{AC}\rvert$ | 1 | | |
| | $\vec{AB}\times\vec{AC} = -3\hat{i}-9\hat{j}+2\hat{k}$ | 1 | 5 | 15 |
| | $\lvert\vec{AB}\times\vec{AC}\rvert = \sqrt{94}$ | | | |
| | Area $= \frac{1}{2}\sqrt{94}$ | 1 | | |
| c. | $(2x+3y)^5 = (2x)^5 + 5C_1(2x)^4 3y + 5C_2(2x)^3(3y)^2 + 5C_3(2x)^2(3y)^3 + 5C_4(2x)(3y)^4 + (3y)^5.$ | 3 | | |
| | $= 32x^5 + 5\times2^4x^4\times3\times y + 10\times2^3\times x^3\times3^2\times y^2 + 10\times2^2\times3^3\times x^2y^3 + 5\times2\times3^4\times x.y^4 + 3^5y^5$ | 1 | 5. | |
| | $= 32x^5 + 240x^4y + 740x^3y^2 + 1080x^2y^3 + 810xy^4 + 243y^5$ | 1 | | |

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| | OR | | | |
| IV (a) | $\frac{n}{2}+1=7$ | | | |
| | $7^{th}$ term is the middle term | 1 | | |
| | $t_{r+1} = {}^{n}C_r x^{n-r} a^r$ | 1 | | |
| | $t_7 = {}^{12}C_6 (2a)^6 (b/3)^6$ | 2 | 5 | |
| | $= {}^{12}C_6 \, 2^6 \frac{a^6 b^6}{3^6}$ | 1 | | |
| b. | Position vector of $A = 3\hat{i}+3\hat{j}+3\hat{k}$ | 1 | | |
| | Position vector of $B = 4\hat{i}-\hat{j}+2\hat{k}$ | 1 | | |
| | $\vec{AB}$ = P.V of B − P.V of A | | | 15 |
| | $= \hat{i}-4\hat{j}-\hat{k}$ | 1 | | |
| | Work done $= \vec{F}\cdot\vec{AB}$ | 1 | 5 | |
| | $= 2\times1+1\times-4+1\times-1=-3$ | 1 | | |
| c. | Moment of $\vec{F}$ about $O = \lvert\vec{OP}\times\vec{F}\rvert$ | 1 | | |
| | $\vec{OP}$ = Position vector of P − Position vector of O. | 1 | | |
| | $=(-2\hat{i}+3\hat{j}+\hat{k})-(\hat{i}+2\hat{j}+3\hat{k})$ | | 5 | |
| | $=-3\hat{i}+\hat{j}-2\hat{k}$ | 1 | | |
| | $\vec{OP}\times\vec{F} = 3\hat{i}+\hat{j}-4\hat{k}$ | 1 | | |
| | $\lvert\vec{OP}\times\vec{F}\rvert = \sqrt{3^2+1^2+(-4)^2}$ | | | |
| | $=\sqrt{26}$ units. | 1 | | |

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| | Unit – II | | | |
| V a | $a+3=2, \quad a=-1$ | 2 | | |
| | $3a-2b=-7+2b, \quad b=+1$ | 2 | 5 | |
| | $a+b+c=8a, \quad c=-8$ | 1 | | |
| (b) | $A^T=\begin{bmatrix}1 & -2 & 3\\ 0 & 1 & 2\\ 5 & 6 & 7\end{bmatrix}$ | 1 | | |
| | $A+A^T=\begin{bmatrix}2 & -2 & 8\\ -2 & 2 & 8\\ 8 & 8 & 14\end{bmatrix}$ | 1 | | |
| | $A-A^T=\begin{bmatrix}0 & 2 & 2\\ -2 & 0 & 4\\ -2 & -4 & 0\end{bmatrix}$ | 1 | 5 | |
| | $(A+A^T)^T=\begin{bmatrix}2 & -2 & 8\\ -2 & 2 & 8\\ 8 & 8 & 14\end{bmatrix}=A+A^T$ | 1 | | |
| | $(A+A^T)^T=A+A^T$, $\therefore A+A^T$ is symmetric | | | |
| | $(A-A^T)^T=-\begin{bmatrix}0 & 2 & 2\\ -2 & 0 & 4\\ -2 & -4 & 0\end{bmatrix}=-(A-A^T)$ | 1 | | |
| | $\therefore A-A^T$ is skewsymmetric | | | |

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| c. | Put $\frac{1}{x} = X$ and $\frac{1}{y} = Y$ the equations become, $5X + 2Y = 4$ and $2X - Y = 7$ | | | |
| | $\Delta = \begin{vmatrix} 5 & 2 \\ 2 & -1 \end{vmatrix} = -9$ | 1 | | |
| | $\Delta_1 = \begin{vmatrix} 4 & 2 \\ 7 & -1 \end{vmatrix} = -18$ | 1 | 5 | |
| | $\Delta_2 = \begin{vmatrix} 5 & 4 \\ 2 & 7 \end{vmatrix} = 27$ | 1 | | |
| | $X = \frac{\Delta_1}{\Delta} = 2$, $Y = \frac{\Delta_2}{\Delta} = -3$ | 1 | | |
| | $x = \frac{1}{X} = \frac{1}{2}$, $y = \frac{1}{Y} = \frac{-1}{3}$ | 1 | | |
| | OR | | | |
| VI a | $\begin{vmatrix} 4 & 1 & 3 \\ 2x & 3 & 6 \\ x^2 & 1 & 3 \end{vmatrix} = 4(9-6) - 1(6x - 6x^2) + 3(2x - 3x^2) = 0.$ | 2 | | |
| | $-3x^2 + 12 = 0$ | 1 | 5 | |
| | $3x^2 = 12$ | 1 | | |
| | $x = \pm 2$ | 1 | | |
| b. | $AB = \begin{bmatrix} 3 & -3 & 1 \\ 6 & 0 & 3 \\ 4 & 6 & 3 \end{bmatrix}$ $(AB)^T = \begin{bmatrix} 3 & 6 & 4 \\ -3 & 0 & 6 \\ 1 & 3 & 3 \end{bmatrix}$ | 1+1 | | 15 |
| | $A^T = \begin{bmatrix} 2 & 3 & 1 \\ -1 & 0 & 2 \end{bmatrix}$ $B^T = \begin{bmatrix} 2 & 1 \\ 0 & 3 \\ 1 & 1 \end{bmatrix}$ | 1+1 | 5 | |
| | $B^T \cdot A^T = \begin{bmatrix} 3 & 6 & 4 \\ -3 & 0 & 6 \\ 1 & 3 & 3 \end{bmatrix}$ $(AB)^T = B^T \cdot A^T.$ | 1 | | |

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| C | $2A = \begin{bmatrix} 4 & 6 \\ 4 & 4 \end{bmatrix}$ | 1 | | |
| | $A = \begin{bmatrix} 2 & 3 \\ 2 & 2 \end{bmatrix}$ | 1 | | |
| | $B = A - \begin{bmatrix} 3 & 5 \\ 1 & 2 \end{bmatrix}$ | 1 | 5 | |
| | $= \begin{bmatrix} 2 & 3 \\ 2 & 2 \end{bmatrix} - \begin{bmatrix} 3 & 5 \\ 1 & 2 \end{bmatrix}$ | 1 | | |
| | $= \begin{bmatrix} -1 & -2 \\ 1 & 0 \end{bmatrix}$ | 1 | | |
| | Unit - III | | | |
| VII (a) | 1. $\int_0^1 \frac{1}{1+x^2}dx = [\tan^{-1}x]_0^1$ | 1 | | |
| | $= \tan^{-1}1 - \tan^{-1}0 = \pi/4$ | 1 | | |
| | 2. $\int (3x+4)(2x-1)dx = \int (6x^2+5x-4)dx$ | 1 | 5 | |
| | $= 6\frac{x^3}{3} + 5\frac{x^2}{2} - 4x + C$ | 2 | | |
| (b) | $\int \frac{4\cos x + 5}{\sin^2 x}dx = \int \frac{4\cos x}{\sin^2 x}dx + \int \frac{5}{\sin^2 x}dx$ | 1 | | 15 |
| | $= 4\int \frac{\cos x}{\sin x} \cdot \frac{1}{\sin x}dx + \int 5\operatorname{cosec}^2 x\,dx$ | 1 | 5 | |
| | $= 4\int \cot x \operatorname{cosec} x\,dx + 5\int \operatorname{cosec}^2 x\,dx$ | 1 | | |
| | $= -4\operatorname{cosec} x - 5\cot x + C$ | 2 | | |

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| c. | Put $u = x^3+3x,\ du = (3x^2+3)dx$ | | | |
| | $\frac{du}{3} = (x^2+1)dx$ | 1 | | |
| | $\int \frac{x^2+1}{x^3+3x}dx = \int \frac{1}{u}\frac{du}{3}$ | 1 | | |
| | $= \frac{1}{3}\log(x^3+3x)$ | 1 | | |
| | $\int_1^2 \frac{x^2+1}{x^3+3x}dx = \frac{1}{3}\left[\log(x^3+3x)\right]_1^2$ | | 5 | |
| | $= \frac{1}{3}\left[\log 14 - \log 4\right]$ | 1 | | |
| | $= \frac{1}{3}\log\left(\frac{14}{4}\right)$ | 1 | | |
| | OR | | | |
| VIII a. | $\cos^2 2x = \frac{1+\cos 4x}{2}$ | 1 | | |
| | $\int \cos^2 2x\,dx = \int\left(\frac{1+\cos 4x}{2}\right)dx$ | 1 | | |
| | $= \frac{1}{2}\left[x + \frac{\sin 4x}{4}\right] + C$ | 1 | | |
| | $\int_0^{\pi} \cos^2 2x\,dx = \frac{1}{2}\left[x + \frac{\sin 4x}{4}\right]_0^{\pi}$ | | 5 | |
| | $= \frac{1}{2}\left[\pi + \frac{\sin 4\pi}{4} - 0 - \frac{\sin 0}{4}\right]$ | 1 | | |
| | $= \pi/2$ | 1 | | |

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| b. | Let $\tan x = u$, $du = \sec^2 x\,dx$ | 2 | | |
| | $\int \frac{\sec^2 x\,dx}{\sqrt{1-\tan^2 x}} = \int \frac{du}{\sqrt{1-u^2}}$ | 1 | | |
| | $= \sin^{-1} u + c$ | 1 | 5 | |
| | $= \sin^{-1}(\tan x) + c$ | 1 | | |
| c. | $\int x^2 \log x\,dx = \int \log x \cdot x^2\,dx$ | 1 | | 15 |
| | $= \log x \int x^2 dx - \int\left(\frac{d}{dx}\log x \cdot \int x^2 dx\right)dx$ | 1 | | |
| | $= \log x \frac{x^3}{3} - \int\left(\frac{1}{x} \times \frac{x^3}{3}\right)dx$ | 1 | | |
| | $= \log x \frac{x^3}{3} - \frac{1}{3}\frac{x^3}{3} + c$ | 1 | 5 | |
| | $\int_0^2 x^2 \log x\,dx = \left[\frac{x^3}{3}\log x - \frac{1}{9}x^3\right]_0^2$ | | | |
| | $= \frac{8}{9}[3\log 2 - 1]$ | 1 | | |
| | Unit – 4 | | | |
| IX a. | $\sin 3x = 0$ | | | |
| | $\Rightarrow 3x = 0$ | | | |
| | $\Rightarrow x = 0, \pi/3, 2\pi/3, \ldots$ | 1 | | |
| | Area $= \int_a^b y\,dx$ | 1 | | |
| | $= \int_0^{\pi/3} \sin 3x\,dx$ | 1 | 5 | |
| | $= \left[\frac{-\cos 3x}{3}\right]_0^{\pi/3}$ | 1 | | |
| | $= \left[\frac{-\cos 3\pi/3}{3} - \frac{-\cos 0}{3}\right] = \frac{2}{3}$ | 1 | | |

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| b. | Volume $= \pi \int_a^b y^2 dx$ | 1 | | |
| | $= \pi \int_0^4 4x\, dx$ | 2 | | |
| | $= \pi \cdot 4 \left[\frac{x^2}{2}\right]_0^4$ | 1 | 5 | |
| | $= 32\pi$ cubic units. | 1 | | |
| c. | $\frac{dy}{dx} = e^{3x} \cdot e^{2y}$ | 1 | | 15 |
| | $\frac{dy}{e^{2y}} = e^{3x} dx$ | 1 | | |
| | Solution is, $\int \frac{dy}{e^{2y}} = \int e^{3x} dx$ | 1 | 5 | |
| | $\frac{e^{-2y}}{-2} = \frac{e^{3x}}{3} + c$ | 2 | | |
| | $-\frac{e^{-2y}}{2} = \frac{e^{3x}}{3} + c$ | | | |
| | **OR** | | | |
| X a | $\frac{x^2}{9} + \frac{y^2}{4} = 1$ | | | |
| | $y = 0 \Rightarrow \frac{x^2}{9} = 1, \quad x = \pm 3$ | 1 | | |
| | Volume $V = \pi \int_a^b y^2 dx$ | 1 | 5 | |
| | $= \pi \cdot \int_{-3}^{3} \frac{4}{9}(9 - x^2) dx$ | 1 | | |
| | $= \frac{4\pi}{9}\left[9x - \frac{x^3}{3}\right]_{-3}^{3}$ | 1 | | |
| | $= 16\pi$ cubic units. | 1 | | |

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| (b) | $x\frac{dy}{dx}+3y=5x^2$ | | | |
| | Dividing the above equation by $x$ | | | |
| | $\frac{dy}{dx}+\frac{3y}{x}=5x$ | 1 | | |
| | Integrating factor, $If = e^{\int p\,dx}$ | 1 | | |
| | $= e^{\int \frac{3}{x}dx} = e^{3\int \frac{1}{x}dx}$ | | 5 | |
| | $= e^{3\log x} = x^3$ | 1 | | |
| | Solution is, $y \times If = \int Q\,If\,dx$ | | | 15 |
| | $y \times x^3 = \int 5x \cdot x^3\,dx$ | 1 | | |
| | $yx^3 = 5\cdot\frac{x^5}{5}+c$ | 1 | | |
| | $yx^3 = x^5+c$ | | | |
| (c) | $\frac{d^2y}{dx^2} = \sec^2 x$ | | | |
| | $\frac{dy}{dx} = \int \sec^2 x\,dx$ | 2 | | |
| | $= \tan x + c_1$ | 1 | 5 | |
| | $y = \int(\tan x + c_1)dx$ | 1 | | |
| | $y = \log \sec x + c_1 x + c_2$ | 1 | | |