1. **For what values of α is the angle between $\mathbf{i}+\mathbf{j}+2\mathbf{k}$ and $\mathbf{i}+\alpha\,\mathbf{k}$ equal to $\pi/4$?**

A) 0 **B)** $-1\pm\sqrt{6}$ **C)** $-2\pm\sqrt{6}$ **D)** $-1\pm\sqrt{3}$ **E)** $-2\pm\sqrt{3}$

2. **Let $\vec{u}$ and $\vec{v}$ be vectors and c be a scalar. Which of the following are not always true?**

A) $\vec{u}\cdot\vec{v}=\vec{v}\cdot\vec{u}$

B) $\vec{u}\cdot\vec{u}=|\vec{u}|^2$

C) $(\vec{u}\times\vec{v})\cdot\vec{u}=\vec{v}\cdot(\vec{u}\times\vec{v})$

D) $c(\vec{u}\times\vec{v})=c\vec{v}\times c\vec{u}$

E) $(\vec{u}\times\vec{u})\cdot\vec{u}=0$

3. **Find the speed of the particle with position function $\vec{r}(t) = e^{3t}\,\mathbf{i} + e^{-3t}\,\mathbf{j} + te^{3t}\,\mathbf{k}$ when $t = 0$.**

A) $\mathbf{i} + 2\,\mathbf{j} + \mathbf{k}$ **B)** 1 **C)** $\sqrt{2}$ **D)** $\sqrt{17}$ **E)** $\sqrt{19}$

4. **The plane S passes through the point $P(1, 2, 3)$ and contains the line $x = 3t$, $y = 1 + t$, and $z = 2 - t$. Which of the following vectors is normal to S?**

A) $\mathbf{i} + 2\,\mathbf{j} + \mathbf{k}$

B) $\mathbf{i} - 2\,\mathbf{j} + \mathbf{k}$

C) $\mathbf{i} + \mathbf{k}$

D) $\mathbf{i} - 2\,\mathbf{j}$

E) $\mathbf{i} + 2\,\mathbf{j}$

5. **Let $z = e^r \cos\theta$, $r = 10st$, $\theta = \sqrt{s^2+t^2}$. The partial derivative $\dfrac{\partial z}{\partial s}$ is:**

A) $e^r\left(10t\cos\theta - \dfrac{s\sin\theta}{\sqrt{s^2+t^2}}\right)$

B) $e^r\left(t\cos\theta - \dfrac{s\sin\theta}{\sqrt{s^2+t^2}}\right)$

C) $e^r\left(10t\cos\theta + \dfrac{s\sin\theta}{\sqrt{s^2+t^2}}\right)$

D) $e^r\left(t\cos\theta + \dfrac{s\sin\theta}{\sqrt{s^2+t^2}}\right)$

E) $10t\cos\theta - \dfrac{se^r\sin\theta}{\sqrt{s^2+t^2}}$

6. **The direction in which $f(x,y) = x^2y + e^{xy}\sin y$ increases most rapidly at $(1,0)$ is:**

A) i

B) j

C) $\dfrac{1}{\sqrt{2}}\,\mathrm{i} + \dfrac{1}{\sqrt{2}}\,\mathrm{j}$

D) $\dfrac{1}{\sqrt{5}}\,\mathrm{i} + \dfrac{2}{\sqrt{5}}\,\mathrm{j}$

E) $\dfrac{2}{\sqrt{13}}\,\mathrm{i} + \dfrac{3}{\sqrt{13}}\,\mathrm{j}$

7. **The equation of the tangent plane to $z + 5 = xe^y \cos z$ at $(5, 0, 0)$ is:**

A) $x + 5y + z = 5$

B) $x + y - 5z = 5$

C) $5x + y - z = 5$

D) $x + 5y - z = 5$

E) $x + y - z = 5$

8. **The maximum value of $f(x, y) = 8x^2 - 4y^2$ under the constraint $8x^2 + 4y^2 = 9$ is:**

A) $f(x, y) = 1/9$

B) $f(x, y) = 1/4$

C) $f(x, y) = 1/8$

D) $f(x, y) = 8$

E) $f(x, y) = 9$

9. **Which of the following series is conditionally convergent?**

A) $\sum_{n=1}^{\infty}(-1)^n e^n$

B) $\sum_{n=1}^{\infty}(-1)^n e^{-n}$

C) $\sum_{n=1}^{\infty}(-1)^n n^{1/2}$

D) $\sum_{n=1}^{\infty}(-1)^n n^{-1/2}$

E) $\sum_{n=1}^{\infty}(-1)^n \ln n$

10. **Use the first three terms of the MacLaurin series for** e^{-x^2} **to approximate** $\int_0^1 e^{-x^2}\,dx$

A) $\frac{3}{4}$

B) $\frac{23}{30}$

C) $\frac{10}{11}$

D) $\frac{17}{25}$

E) $\frac{5}{7}$

11. **Consider the two series**

$$\textbf{I.}\quad \sum_{n=1}^{\infty}(-1)^{n+1}\sin\left(\frac{1}{n}\right)$$

$$\textbf{II.}\quad \sum_{n=1}^{\infty}(-1)^{n+1}\frac{1}{n(\ln n)^2}$$

A) both series converge absolutely

B) series (I) converges absolutely, while series (II) converges conditionally

C) series (I) converges conditionally, while series (II) converges absolutely

D) both series converge conditionally

E) at least one of the series diverges

12. **The interval of convergence of the power series**

$$\sum_{n=1}^{\infty}\frac{(-1)^{n+1}(x-1)^n}{n3^n}$$

is of the form

A) $[1-r, 1+r]$

B) $[1-r, 1+r)$

C) $(1-r, 1+r]$

D) $(1-r, 1+r)$

E) The series converges only at $x = 1$

13. **Find the volume of the solid bounded by the planes $x + 2y + 3z = 6$, $y = x$, $y = 0$ and $z = 0$.**

A) $\frac{14}{3}$

B) $\frac{16}{3}$

C) $\frac{14}{9}$

D) $\frac{16}{3}$

E) $\frac{15}{4}$

14. **Evaluate the double integral by reversing the order of integration**

$$\int_0^3 \int_{y^2}^9 y \cos\left(x^2\right)\, dx\, dy$$

A) $\frac{\sin 81}{8}$ B) $\frac{\sin 9}{16}$ C) $\frac{\sin 9}{8}$ D) $\frac{\sin 81}{4}$ E) $\frac{\sin 81}{16}$

15. **Use spherical coordinates to find the volume of the solid that lies within the sphere $x^2 + y^2 + z^2 = 4$, above the xy-plane, and below the cone $z = \sqrt{x^2 + y^2}$**

A) $\dfrac{8\sqrt{2}\,\pi}{3}$ B) $\dfrac{16\sqrt{2}\,\pi}{3}$ C) $\dfrac{16\sqrt{2}\,\pi}{9}$ D) $\dfrac{8\sqrt{2}\,\pi}{9}$ E) $\dfrac{4\sqrt{2}\,\pi}{3}$

16. **Evaluate**

$$\int\int_R \sqrt{x^2 + y^2}\, dA$$

where R is the region bounded by the graphs of $y = \sqrt{4 - x^2}$, $y = -x$, and $y = x$

A) $\dfrac{2\pi}{3}$ B) $\dfrac{4\pi}{3}$ C) $\dfrac{3\pi}{4}$ D) $\dfrac{3\pi}{2}$ E) $\dfrac{\pi}{2}$

17. **Evaluate the line integral $\int_C xy^4\,ds$, where C is given by**

$$\vec{r}(t) = 4\cos t\,\mathbf{i} + 4\sin t\,\mathbf{j} \quad \text{for} \quad -\frac{\pi}{2} \le t \le \frac{\pi}{2}$$

18. **Evaluate**

$$\int_C -y\,dx + x\,dy$$

where C **is given by** $\vec{r}(t) = \cos t\,\mathbf{i} + \sin t\,\mathbf{j}$ **for** $0 \leq t \leq 2\pi$.

19. **Show that $\vec{F}(x, y) = (6xy + 4)\,\mathrm{i} + 3x^2\,\mathrm{j}$ is a conservative vector field and evaluate**

$$\int_C (6xy + 4)\,dx + 3x^2\,dy$$

where C is given by

$$\vec{r}(t) = \frac{t+4}{\sqrt{t^3+1}}\,\mathrm{i} + \sqrt{t^4+9}\,\mathrm{j} \text{ for } 0 \le t \le 2$$

20. **Evaluate**

$$\int\int_S 4x \, d\sigma$$

where S **is the surface** $2x^2 + y - z = 0$ **for** $0 \leq x \leq 1$ **and** $0 \leq y \leq 1$