※ 注意：請於試卷上「非選擇題作答區」標明題號並依序作答。

Correctly number each of your answers to indicate which question is answered.

- Work need **not** be shown.
- Only answers will be graded.
- 5 points each and 100 points total.

(A). Find the interval on which $y = x^3 - 3x^2 + 2x + 1$ is both decreasing and concave downward. *Answer.* __(1)__.

(B). Find $\frac{dy}{dx} =$ __(2)__ and $\frac{d^2y}{dx^2} =$ __(3)__ at the point $x = 1$, $y = 1$ of the curve $x^3 + xy - 2y^4 = 0$.

(C) Evaluate $\int_2^3 \sqrt{3 + 2x - x^2}\,dx$. *Answer:* __(4)__.

(D) Find the volume of the solid generated by revolving the following region about the y-axis: $\{(x, y) : 0 \leq x \leq \pi \text{ and } 0 \leq y \leq \sin x\}$. *Answer:* __(5)__.

(E) Find the arc length of the curve $y = \int_0^x \sqrt{\sin t}\,dt$ from $x = 0$ to $x = \pi/3$. *Answer:* __(6)__.

(F) Find the solution of the differential equation $y' = (1 + 2x)(1 + y^2)$ with the initial condition $y(0) = 1$. *Answer:* __(7)__.

(G) Find the solution of the differential equation $y' + y\tan x = \sec x$ with the initial condition $y(0) = 2$. *Answer:* __(8)__.

(H) Find the first three nonzero terms of the McLaurin series of $\tan x$. *Answer:* __(9)__.

(I) Let $u = u(x, y)$ be a function of x, y. Express $\dfrac{\partial u}{\partial x}$ in terms of polar coordinates r, θ together with $\dfrac{\partial u}{\partial r}$ and $\dfrac{\partial u}{\partial \theta}$. *Answer:* __(10)__.

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(J) Find the directional derivative of $f(x,y,z) = x^y z^2$ at the point $(e,e,1)$ in the direction $\mathbf{u} = \frac{3}{13}\mathbf{i} + \frac{12}{13}\mathbf{j} + \frac{4}{13}\mathbf{k}$. *Answer:* (11) .

(K) Find the critical points of $f(x,y) = x^2 + y^4 + 3xy^2 - 5x$ which are saddle points. *Answer:* (12) .

(L) Find the minimum of $x^2+y^2+z^2$ for (x,y,z) on the intersection curve of the two surfaces $y+2z=1$ and $3x^2+y^2-z^2=1$. *Answer:* (13) .

(M) Evaluate $\int_0^3 \int_{\sqrt{x/3}}^1 e^{y^3}\,dydx$. *Answer:* (14) .

(N) Let R be the region in the first quadrant of the xy-plane bounded by $xy=1$, $xy=2$, $y=x$ and $y=2x$. Evaluate $\iint_R e^{xy}\,dxdy$. *Answer:* (15) .

(O) Evaluate $\iiint_\Omega \frac{\cos\sqrt{x^2+y^2+z^2}}{x^2+y^2+z^2}\,dxdydz$, where Ω is given by $\Omega = \{(x,y,z) : 1 \le x^2+y^2+z^2 \le 2\}$. *Answer:* (16) .

(P) Evaluate $\iiint_\Omega z e^{x^2+y^2+3z^2}\,dxdydz$, where Ω is the cylinder defined by $\Omega = \{(x,y,z) : x^2+y^2 \le 1 \text{ and } 0 \le z \le 1\}$. *Answer:* (17) .

(Q) Let S be the surface described by $z = x^2 + \frac{y^2}{2}$ with $4x^2+y^2 \le 1$ oriented with normals with positive $\mathbf{k}$-components. Let $\mathbf{F}(x,y,z) = x\mathbf{i} - y\mathbf{j} + \mathbf{k}$. Evaluate $\iint_S \mathbf{F}\cdot d\mathbf{S}$. *Answer:* (18) . Also, evaluate $\iint_S dS$. *Answer:* (19) .

(R) Let C be the counterclockwise oriented boundary of the region in the xy-plane enclosed by $x^2+y^2-2x=0$ and $x^2+y^2-2y=0$. Evaluate the line integral $\oint_C (y+e^{-x^2})dx + (3x+\sin(y^2))dy$. *Answer:* (20) .