KEY

Section 1: Algebra

1.1 a,b,c
1.2 a,b,c
1.3 a,c
1.4 $\frac{p-1}{2}$
1.5 3 or 5
1.6 $2, 3, 4$
1.7 $A^{-1} = \frac{4}{3}I - \frac{1}{3}A$
1.8 a
1.9 c
1.10 $W^{\perp} = \{aI \mid a \in \mathbb{R}\}$

Section 2: Analysis

2.1 a,c
2.2 b
2.3 a,b,c
2.4 a,b,c
2.5 b,c
2.6 Only $x = 1$ and $f'(1) = 2$
2.7 a,c
2.8 c
2.9

$$\sum_{n=1}^{\infty} \frac{1}{z^n} + \sum_{n=0}^{\infty} \frac{z^n}{2^{n+1}}$$

2.10 a,b

Section 3: Topology

3.1 a
3.2 None
3.3 a,b
3.4 a,b
3.5 b,c
3.6 a,b
3.7 a,b,c
3.8 None
3.9 a,b,c
3.10 a,b,c

Section 4: Calculus & Differential Equations

4.1

$$\int_{x^2}^{x^3} y^2 \sec^2(xy^2)\ dy + 3x^2 \tan x^7 - 2x \tan x^5$$

4.2

$$\sqrt{\frac{\pi}{2}}$$

4.3 54π.
4.4 2π
4.5

$$\int_{\Omega} (v\Delta u - u\Delta v)\ dx\ dy\ dz,$$

where Δ is the Laplace operator.
4.6 $\frac{1+\sqrt{2}}{2}$
4.7

$$\int_{-2}^{1} \int_{-y}^{\sqrt{2-y}} f(x,y)\ dx\ dy + \int_{1}^{2} \int_{-\sqrt{2-y}}^{\sqrt{2-y}} f(x,y)\ dx\ dy$$

4.8

$$\lambda_n = \frac{(2n-1)^2\pi^2}{4}, u_n = C \sin \frac{(2n-1)\pi x}{2},\ n \in \mathbb{N}$$

4.9 $-2 < a < -1$
4.10

$$u(x,1) = \begin{cases} 1, & \text{if } |x| < 1, \\ \frac{1}{2}, & \text{if } 1 < |x| < 3, \\ 0, & \text{if} |x| > 3. \end{cases}$$

Section 5: Miscellaneous

5.1 $2^{\frac{n}{2}} \sin(x + \frac{n\pi}{4})$
5.2 b
5.3 a,c
5.4 $\frac{2\pi}{3}$
5.5 $\frac{n}{2} \sin \frac{2\pi}{n}$
5.6 19
5.7 a. $\frac{5}{11}$, b. $\frac{53}{66}$
5.8 $\frac{3}{4} - \log 2$
5.9 12
5.10

$$\Pi_{1 \le i < j \le 4}(a_i - a_j).$$

Note: Please accept any correct equivalent form of the answers.