B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

TERM 1 EXAMINATION (2026-27)
APPLIED MATHEMATICS-(241)
MARKING KEY

Class: XII B	**Time: 3hrs**
Date: 04-09-26	**Max Marks: 80**
Admission no:	**Roll no**

Section A – MCQs

Q1. 100 mod 7 = 2. Answer: (a) 2.

Q2. A covers 1000 m while B covers 950 m in same time. Since A beats B by 10 s, B takes 200 s and A takes 190 s. Answer: (c) 190 s.

Q3. $-4<3+2x\le 11 \Rightarrow -7<2x\le 8 \Rightarrow -3.5<x\le 4$. Answer: (b).

Q4. When dividing by a negative number the inequality reverses. Answer: (c) $x/b > y/b$.

Q5. $(I+A)^2-3A = I+2A+A^2-3A = I$ (since $A^2=A$). Answer: (a).

Q6. 2×3 matrix has 6 entries, each 0 or 1 $\Rightarrow 2^6=64$. Answer: (d).

Q7. $|3A|=3^3|A|=27|A|$. Answer: (c).

Q8. $|A|=\alpha^2-4$. Given $|A|^3=125 \Rightarrow |A|=5 \Rightarrow \alpha^2=9 \Rightarrow \alpha=\pm 3$. Answer: (a).

Q9. Determinant = $-3x$, and $-3x+3=0 \Rightarrow x=1$. Answer: (c).

Q10. Differentiate implicitly. $dy/dx=(y-4x(x^2+y^2))/(4y(x^2+y^2)-x)$. Answer: (c).

Q11. $y=x^2e^{-x}$, $y'=e^{-x}x(2-x)$. Negative for $x<0$ and $x>2$. Answer: (d).

Q12. Maximum value =1 at x=0 or x=1. Answer: (c).

Q13. $\int(x+1)/x\,dx=x^2/2+\log x+C$. Answer: (b).

Q14. $\int(\log x)/x^7\,dx = -(\log x)/(6x^6)-1/(36x^6)+C$.

Q15. Supply $p=4+x$. Producer surplus = $\int_0^{12}[(16)-(4+x)]dx=72$. Answer: (a).

Q16. Order=4, Degree=2. Answer: (a).

Q17. Fourth-order DE has four arbitrary constants. Answer: (d).

Q18. Area=$(\sqrt{3}/4)a^2$, $dA/dt=(\sqrt{3}/2)a\cdot da/dt$. With $da/dt=4$ and $a=5$, $dA/dt=10\sqrt{3}$ cm^2/s. Answer: (c).

Q19. Assertion and Reason are both true and R explains A. Answer: (A).

Q20. $MR=5+2x+3x^2 \Rightarrow R=5x+x^2+x^3$. Demand $p=R/x=5+x+x^2$. Answer: (A).

Section B – Very Short Answers

Q21. By alligation: (200-165):(165-150)=35:15=7:3.

Q22. $X=-(2A+B)$. $2A+B=[[1,2],[7,13]]$. Therefore $X=[[-1,-2],[-7,-13]]$.

Q22 (OR). Solve the two matrix equations simultaneously to obtain X and Y.

Q23. Differentiate x^x with respect to x log x. Since $d(xx)/dx=x^x(\log x+1)$ and $d(x \log x)/dx=\log x+1$, required derivative = x^x.

Q24. $\int_0^4(\sqrt{x}-2x+x^2)dx=[(2/3)x^{(3/2)}-x^2+x^3/3]_0^4=16/3-16+64/3=32/3$.

Q24 (OR). $\int_0^a x/\sqrt{(a^2+x^2)}\, dx=[\sqrt{(a^2+x^2)}]_0^a=a(\sqrt{2}-1)$.

Q25. $y=ax+bx^2$. Differentiate: $y'=a+2bx$, $y''=2b$. Eliminating a,b gives $y=xy'-(x^2/2)y''$.

Section C – Short Answers

Q26. Let first pipe take x h. Second=x-5, third=x-9. From $1/x+1/(x-5)=1/(x-9)$. Solving gives x=15 h.

Q27. $3(x-2)^5 \geq 5(2-x)^3$. Since $(2-x)^3=-(x-2)^3$, factor $(x-2)^3[3(x-2)^2+5]\geq 0$. Hence $x\geq 2$.

Q28. Expanding the determinant gives (x-y)(y-z)(z-x).

Q28 (OR). Area=$|ab-ay-bx|/2$. For collinear points, ab-ay-bx=0.

Q29. $f(x)=(x+2)e^{-x}$. $f'(x)=-(x+1)e^{-x}$. Increasing on $(-\infty,-1)$; decreasing on $(-1,\infty)$.

Q30. Demand=8/(x+1)-2, Supply=(x+3)/2. Equilibrium: x=1, p=2. Consumer surplus=$\int_0^1(D-2)dx=4\ln 2-2$. Producer surplus=$\int_0^1(2-S)dx=1/4$.

Q30 (OR). $TR=\int(9-2x+4x^2)dx=9x-x^2+4x^3/3$. Demand $p=TR/x=9-x+4x^2/3$.

Q31. Rearranging and separating variables: $y/(1-y^2)dy=-x/(1-x^2)dx$. Integrating gives

$\ln(1-y^2)=\ln(1-x^2)+C$, i.e. $(1-y^2)=C(1-x^2)$.

Section D – Long Answers

Q32. Using Cramer's Rule for $6x+y-3z=5$, $x+3y-2z=5$, $2x+y+4z=8$ gives $x=1$, $y=2$, $z=1$.

Q32 (OR). Compute A^{-1} by adjoint method and solve the given linear equations.

Q33. Total Cost$=x^3/3-x^2+5x+3$. Marginal Cost$=x^2-2x+5$. MC minimum at $x=1$. AVC$=x^2/3-x+5$. AVC minimum at $x=3/2$.

Q34. Equilibrium from $25-5x+x^2/4=5x+x^2/4$ gives $x=2$, $p=16$. Consumer surplus$=\int_0^2(D-16)dx=10$. Producer surplus$=\int_0^2(16-S)dx=10$.

Q34 (OR). Equilibrium from $90-x^2/10=x^2/5+x+50$ gives $x=10$ thousand tyres and $p=80$ thousand rupees. Consumer and producer surplus are obtained by integrating between 0 and 10.

Q35. Family: $(x-a)^2+(y-a)^2=a^2$. Eliminating a by differentiation gives the required differential equation of circles touching both axes.

Section E – Case Study

Q36. Equations: $x+y+z=600$, $3x+2y+z=1000$, $4x+y+3z=1500$. Coefficient matrix A=[[1,1,1],[3,2,1],[4,1,3]]. adj(A)=[[5,-2,-1],[-5,-1,2],[-5,3,-1]]. Solution: $x=100$, $y=200$, $z=300$.

Q37. Demand passes through (25, 20000) and (125, 15000): $D(x) =21250-50x$.

Supply passes through (180, 25000) and (80, 15000): $S(x) =100x+7000$.

Equilibrium $x=95$, $p=16500$. Consumer surplus$=\int_0^{95}(D-16500)dx=225625$ rupees.

Q38. (i) $x(d^2y/dx^2)^3+y(dy/dx)^4+x^3=0$ has order 2 and degree 3.

(ii) $\sqrt{(1-y^2)}dx+y\sqrt{(1-x^2)}dy=0$ has order 1 and degree 1, so the sum is 2.