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Class – 12 Mathematics
Unit – 1: Application of Matrices and Determinants
Important 5 Mark Questions

1. If $A = \frac{1}{7}\begin{bmatrix} 6 & -3 & a \\ b & -2 & 6 \\ 2 & c & 3 \end{bmatrix}$ is orthogonal, find a, b and c, and hence A^{-1}.
2. Decrypt the received encoded message $[2 \quad -3]\ [20 \quad 4]$ with the encryption matrix $\begin{bmatrix} -1 & -1 \\ 2 & 1 \end{bmatrix}$ and the decryption matrix as its inverse, where the system of codes are described by the numbers 1-26 to the letters A-Z respectively, and the number 0 to a blank space.
3. Show that the matrix $\begin{bmatrix} 3 & 1 & 4 \\ 2 & 0 & -1 \\ 5 & 2 & 1 \end{bmatrix}$ is non-singular and reduce it to the identity matrix by elementary row transformations.
4. Find the inverse of $A = \begin{bmatrix} 2 & 1 & 1 \\ 3 & 2 & 1 \\ 2 & 1 & 2 \end{bmatrix}$ by Gauss-Jordan method.
5. Find the inverse of $A = \begin{bmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \\ 6 & -2 & -3 \end{bmatrix}$ by Gauss-Jordan method.
6. If $A = \begin{bmatrix} -4 & 4 & 4 \\ -7 & 1 & 3 \\ 5 & -3 & -1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & -1 & 1 \\ 1 & -2 & -2 \\ 2 & 1 & 3 \end{bmatrix}$, find the products AB and BA and hence solve the system of equations x-y+z = 4, x-2y-2z = 9, 2x+y+3z = 1.
7. The prices of three commodities *A*, *B* and *C* are ₹ *x*, *y* and *c* per units respectively. A person P purchases 4 units of B and sells two units of A and 5 units of C. Person Q purchases 2 units of C and sells 3 units of A and one unit of B. Person R purchases one unit of A and sells 3 unit of B and one unit of C. In the process, P, Q and R earn ₹15,000, ₹1,000 and ₹4,000 respectively. Find the prices per unit of A, B and C. (Use matrix inversion method to solve the problem.)
8. In a T20 match, Chennai Super Kings needed just 6 runs to win with 1 ball left to go in the last over. The last ball was bowled and the batsman at the crease hit it high up. The ball traversed along a path in a vertical plane and the equation of the path is $y = ax^2 + bx + c$ with respect to a xy -coordinate system in the vertical plane and the ball traversed through the points (10,8),(20,16),(40,22), can you conclude that Chennai Super Kings won the match? Justify your answer. (All distances are measured in metres and the meeting point of the plane of the path with the farthest boundary line is (70,0)
9. A family of 3 people went out for dinner in a restaurant. The cost of two dosai, three idlies and two vadais is ₹150. The cost of the two dosai, two idlies and four vadais is ₹200. The cost of five dosai, four idlies and two vadais is ₹250. The family has ₹ 350 in hand and they ate 3 dosai and six idlies and six vadais. Will they be able to manage to pay the bill within the amount they had?
10. The upward speed *v(t)* of a rocket at time t is approximated by $v(t) = at^2+bt+c,\ 0 \le t \le 100$ where *a*, *b* and *c* are constants. It has been found that the speed at times t = 3, t = 6, and t = 9 seconds are respectively 64, 133, and 208 miles per second respectively. Find the speed at time t = 15 seconds. (Use Gaussian elimination method.)
11. An amount of ₹65,000 is invested in three bonds at the rates of 6%, 8% and 10% per annum respectively. The total annual income is ₹5000. The income from the third bond is ₹800 more than that from the second bond. Determine the price of each bond. (Use Gaussian elimination method.)
12. A boy is walking along the path $y = ax^2+bx+c$ through the points (-6,8),(-2,-12), and (3,8). He wants to meet his friend at *P*(7,60). /will he meet his friend? (Use Gaussian elimination method.)
13. Test for consistency of the following system of linear equations and if possible solve: $x+2y-z = 3,\ 3x-y+2z = 1,\ x-2y+3z = 3,\ x-y+z+1 = 0.$
14. Test for consistency of the following system of linear equations and if possible solve: $x-y+z = -9,\ 2x-2y+2z = -18,\ 3x-3y+3z+27 = 0.$
15. Find the condition on *a*, *b* and *c* so that the following system of linear equations has one parameter family of solutions: $x+y+z = a,\ x+2y+3z = b,\ 3x+5y+7z = c.$

16. Investigate for what values of λ and μ the system of linear equations $x+2y+z=7$, $x+y+\lambda z=\mu$, $x+3y-5z=5$ has (i) no solution (ii) a unique solution (iii) an infinite number of solutions.

17. Find the value of k for which the equations $kx-2y+z=1$, $x-2ky+z=-2$, $x-2y+kz=1$ have (i) no solution (ii) unique solution (iii) infinitely many solution

18. Investigate the values of λ and μ the system of linear equations $2x+3y+5z=9$, $7x+3y-5z=8$, $2x+3y+\lambda z=\mu$, have (i) no solution (ii) a unique solution (iii) an infinite number of solutions

19. Test for consistency and if possible, solve $2x+2y+z=5$, $x-y+z=1$, $3x+y+2z=4$

20. Determine the values of λ for which the following system of equations $(3\lambda-8)x+3y+3z=0$, $3x+(3\lambda-8)y+3z=0$, $3x+3y+(3\lambda-8)z=0$ has a non-trivial solution.

21. By using Gaussian elimination method, balance the chemical reaction equation: $C_5H_8+O_2 \rightarrow CO_2+H_2O$

22. If the system of equations $px+by+cz=0$, $ax+qy+cz=0$, $ax+by+rz=0$ has a non-trivial solution and $p \neq a$, $q \neq b$, $r \neq c$, prove that $\frac{p}{p-a}+\frac{q}{q-b}+\frac{r}{r-c}=2$.

23. Solve the system of homogenous equations $2x+3y-z=0$, $x-y-2z=0$, $3x+y+3z=0$

24. Determine the values of λ for which the following system of equations $x+y+3z=0$, $4x+3y+\lambda z=0$, $2x+y+2z=0$ has (i) a unique solution (ii) a non-trivai solution.

25. By using Gaussian elimination method, balance the chemical reaction equation: $C_2H_6+O_2 \rightarrow H_2O+CO_2$

Unit – 2: Complex Numbers

1. Find the value of the real numbers x and y, if the complex number $(2+i)x+(1-i)y+2i-3$ and $x+(-1+2i)y+1+i$ are equal.
2. Find the values of the real numbers x and y, if the complex numbers $(3-i)x-(2-i)y+2i+5$ and $2x+(-1+2i)y+3+2i$ are equal.
3. Show that (i) $(2+i\sqrt{3})^{10}+(2-i\sqrt{3})^{10}$ is real and (ii) $\left(\frac{19+9i}{5-3i}\right)^{15}-\left(\frac{8+i}{1+2i}\right)^{15}$ is purely imaginary.

A.ABDUL MUNAB M.SC., B.ED.,
FATIMA MATRIC HR SEC SCHOOL,
JAYANKONDAM
CELL: 9524103797

4. The complex numbers u, v and w are related by $\frac{1}{u}=\frac{1}{v}+\frac{1}{w}$. If $v=3-4i$ and $w=4+3i$, find u in rectangular form.
5. Prove the following properties: (i) z is real if and only if $z=\bar{z}$ (ii) $\text{Re}(z)=\frac{z+\bar{z}}{2}$ and $\text{Im}(z)=\frac{z-\bar{z}}{2i}$
6. Find the least value of the positive integer n for which $(\sqrt{3}+i)^n$ (i) real (ii) purely imaginary.
7. Show that (i) $(2+i\sqrt{3})^{10}-(2-i\sqrt{3})^{10}$ is purely imaginary (ii) $\left(\frac{19-7i}{9+i}\right)^{12}-\left(\frac{20-5i}{7-6i}\right)^{12}$ is real.
8. If z_1, z_2 and z_3 are complex numbers such that $|z_1|=|z_2|=|z_3|=|z_1+z_2+z_3|=1$, find the value of $\left|\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}\right|$.
9. Let z_1, z_2 and z_3 be complex numbers such that $|z_1|=|z_2|=|z_3|=r>0$ and $z_1+z_2+z_3 \neq 0$. Prove that $\left|\frac{z_1z_2+z_2z_3+z_3z_1}{z_1+z_2+z_3}\right|=r$.
10. If $\left|z-\frac{2}{z}\right|=2$, show that the greatest and least value of $|z|$ are $\sqrt{3}+1$ and $\sqrt{3}-1$ respectively.
11. If z_1, z_2 and z_3 are three complex numbers such that $|z_1|=1$, $|z_2|=2$, $|z_3|=3$ and $|z_1+z_2+z_3|=1$, show that $|9z_1z_2+4z_1z_3+z_2z_3|=6$.
12. If the area of the triangle formed by the vertices z, iz, and z+iz is 50 square units, find the value of $|z|$.
13. Given the complex number $z=3+2i$, represent the complex numbers z, iz, and z+iz in one Argand diagram. Show that these complex numbers form the vertices of an isosceles right triangle.
14. If $z=x+iy$ is a complex number such that $\text{Im}\left(\frac{2z+1}{iz+1}\right)=0$, show that the locus of z is $2x^2+2y^2+x-2y=0$.
15. Find the quotient $\frac{2\left(\cos\frac{9\pi}{4}+i\sin\frac{9\pi}{4}\right)}{4\left(\cos\left(\frac{-3\pi}{2}\right)+i\sin\left(\frac{-3\pi}{2}\right)\right)}$ in rectangular form.
16. If $z=x+iy$ and $\arg\left(\frac{z-1}{z+1}\right)=\frac{\pi}{2}$, show that $x^2+y^2=1$.
17. Find the rectangular form of the complex number $\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)\left(\cos\frac{\pi}{12}+i\sin\frac{\pi}{12}\right)$.

A.ABDUL MUNAB M.SC., B.ED.,
FATIMA MATRIC HR SEC SCHOOL,
JAYANKONDAM
CELL: 9524103797

18. Find the rectangular form of the complex number $\frac{\cos\frac{\pi}{6} - i\sin\frac{\pi}{6})}{2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)}$
19. If $\cos\alpha + \cos\beta + \cos\gamma = \sin\alpha + \sin\beta + \sin\gamma = 0$, show that
   (i) $\cos 3\alpha + \cos 3\beta + \cos 3\gamma = 3\cos(\alpha+\beta+\gamma)$ and
   (ii) $\sin 3\alpha + \sin 3\beta + \sin 3\gamma = 3\sin(\alpha+\beta+\gamma)$
20. If $z = x+iy$ and $\arg\left(\frac{z-i}{z+2}\right) = \frac{\pi}{4}$, show that $x^2+y^2+3x-3y+2= 0$.
21. Simplify $(\sin\frac{\pi}{6}+i\cos\frac{\pi}{6})^{18}$
22. Simplify (i) $(1 + i)^{18}$ (ii) $(-\sqrt{3} + 3i)^{31}$
23. Find the cube roots of unity.
24. Find the fourth roots of unity.
25. Solve the equation $z^3+8i = 0$, where $z\in C$.
26. Find all cube roots of $\sqrt{3} + i$.
27. Suppose z_1, z_2 and z_3 are the vertices of an equilateral triangle inscribed in the circle $|z| = 2$. If $z_1 = 1+i\sqrt{3}$, then find z_2 and z_3.
28. If $2\cos\alpha = x + \frac{1}{x}$ and $2\cos\beta = y + \frac{1}{y}$, show that
   (i) $\frac{x}{y} + \frac{y}{x} = 2\cos(\alpha - \beta)$ (ii) $xy - \frac{1}{xy} = 2i\sin((\alpha + \beta)$
29. If $z = 2 - 2i$, find the rotation of z by θ radians in the counter clockwise direction about the origin when
   (i) $\theta = \frac{\pi}{3}$ (ii) $\theta = \frac{2\pi}{3}$ (iii) $\theta = \frac{3\pi}{2}$
30. Prove that the values of $\sqrt[4]{-1}$ are $\pm\frac{1}{\sqrt{2}}(1\pm i)$.

Unit – 3: Theory of Equations

1. Solve the equation $x^3-9x^2+14x+24= 0$ if it is given that two of its roots are in the ratio 3:2.
2. If p and q are the roots of the equation $lx^2+nx+n = 0$, show that $\sqrt{\frac{p}{q}} + \sqrt{\frac{q}{p}} + \sqrt{\frac{n}{l}} = 0$.
3. A 12 metre tall tree was broken into two parts. It was found that the height of the part which was left standing was the cube root of the length of the part that was cut away. Formulate this into a mathematical problem to find the height of the part which was cut away.
4. Write Complex Conjugate Root Theorem
5. Form a polynomial equation with integer coefficients with $\sqrt{\frac{\sqrt{2}}{\sqrt{3}}}$ as a root.
6. Find a polynomial equation of minimum degree with rational coefficients, having $\sqrt{5} - \sqrt{3}$ as a root.
7. Prove that a straight line and parabola cannot intersect at more than two points.
8. If $2+i$ and $3-\sqrt{2}$ are roots of the equation $X^6-13x^5+62x^4-126x^3+65x^2+127x-140 = 0$, find all roots.
9. Find the condition that the roots of $ax^3+bx^2+cx+d = 0$ are in geometric progression. Assume $a, b, c, d \neq 0$.
10. If the roots of $x^3+px^2+qx+r = 0$ are in H.P., prove that $9pqr = 27r^3+ 2p$. Assume $p, q, r \neq 0$.
11. Determine k and solve the equation $2x^3-6x^2+3x+k = 0$ if one of its roots is twice the sum of the other two roots.
12. Find all zeros of the polynomial $X^6-3x^5-5x^4+22x^3-39x^2-39x+135 = 0$, if it is known that $1+2i$ and $\sqrt{3}$ are two of its zeros.
13. Solve the equation $(x-2)(x-7)(x-3)(x+2)+19 = 0$
14. Solve the equation $(2x-3)(6x-1)(3x-2)(x-12)-7 = 0$
15. Solve $(x-5)(x-7)(x+6)(x+4) = 504$
16. Solve the equation $7x^3-43x^2 = 43x-7$.
17. Find solution, if any, of the equation $2\cos^2x - 9\cos x +4 = 0$
18. Solve: $8x^{3/2n} - 8x^{-3/2n} = 63$
19. Solve: $2\sqrt{\frac{x}{a}} + 3\sqrt{\frac{a}{x}} = \frac{b}{a} + \frac{6a}{b}$.
20. Solve the equations $6x^4-35x^3+62x^2 - 35x + 6 = 0$.
21. Find all real numbers satisfying $4^x-3(2^{x+2}) + 2^5 = 0$.
22. Solve the equation $6x^4-5x^3-38x^2 - 5x + 6 = 0$ if it is known that $\frac{1}{3}$ is a solution.
23. Discuss the nature of the roots of the following polynomials.
   (i) $x^{208}+1947x^{1950}+15x^8+26x^6+ 2019$ (ii) $x^5-19x^4+2x^3+ 5x^2 + 11$
24. Discuss the maximum possible number of positive and negative zeros of the polynomials $x^2 - 5x + 6$ and $x^2 - 5x + 16$. Also draw rough sketch of the graphs.
25. Show that the equation $x^9-5x^5+4x^4 + 2x^2 + 1 = 0$ has at least 6 imaginary solutions.

A.ABDUL MUNAB M.SC., B.ED.,
FATIMA MATRIC HR SEC SCHOOL,
JAYANKONDAM
CELL: 9524103797

Unit – 5: Two Dimensional Analytical Geometry II

1. Find the equation of the circle passing through the points (1, 1), (2, -1) and (3, 2).
2. If the equation $3x^2+(3-p)xy+3y^2-2px=8pq$ represents a circle, find p and q. Also determine the centre and radius of the circle.
3. Derive the equation of a parabola in standard form.
4. Derive the equation of an Ellipse in standard form.
5. Derive the equation of a Hyperbola in standard form.
6. Find the equation of the ellipse whose eccentricity is $\frac{1}{2}$, one of the foci is (2, 3) and a directrix is x = 7. Also find the length of the major and minor axes of the ellipse.
7. Find the foci, vertices and length of major and minor axis of the conic $4x^2+36y^2+40x-288y+532=0$.
8. For the ellipse $4x^2+y^2+24x-2y+21=0$, find the centre, vertices, and foci. Also prove that the length of latus rectum is 2.
9. Find the vertex, focus, equation of directrix and length of the latus rectum of $x^2-2x+8y+17=0$
10. Find the vertex, focus, equation of directrix and length of the latus rectum of $y^2-4y-8x+12=0$
11. Identify the type of conic and find centre, foci, vertices and directrices of $\frac{x^2}{25}-\frac{y^2}{144}=1$
12. Identify the type of conic and find centre, foci, vertices and directrices of $\frac{y^2}{16}-\frac{x^2}{9}=1$
13. Prove that the length of the latus rectum of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ is $\frac{2b^2}{a}$.
14. Show that the absolute value of difference of the focal distances of any point P on the hyperbola is the length of its transverse axis.
15. Identify the type of conic and find centre, foci, vertices and directrices of $\frac{(x+3)^2}{225}-\frac{(y-4)^2}{64}=1$.
16. Identify the type of conic and find centre, foci, vertices and directrices of $18x^2+12y^2-144x+48y+120=0$
17. Identify the type of conic and find centre, foci, vertices and directrices of $9x^2-y^2-36x-6y+18=0$.

18. Find the equations of tangent and normal to the parabola $x^2+6x+4y+5=0$ at (1, -3).
19. Find the equations of tangent and normal to the ellipse $x^2+4y^2=32$ when $\theta=\frac{\pi}{4}$.
20. Find the equations of the two tangents that can be drawn from (5, 2) to the ellipse $2x^2+7y^2=14$.
21. Show that the line $x-y+4=0$ is a tangent to the ellipse $x^2+3y^2=12$. Also find the coordinates of the point of contact.
22. Find the equation of the tangent at t = 2 to the parabola $y^2=8x$. (Hint: Use parametric form)
23. Find the equations of the tangent and normal to hyperbola $12x^2-9y^2=108$ at $\theta=\frac{\pi}{3}$.
24. Prove that the point of intersection of the tangents at 't_1' and 't_2' on the parabola $y^2=4ax$ is $[at_1t_2, a(t_1+t_2)]$.
25. If the normal at the point 't_1' on the parabola $y^2=4ax$ meets the parabola again at the point 't_2', then prove that $t_2=-\left(t_1+\frac{2}{t_1}\right)$.
26. Two coast guard stations are located 600km apart at points A(0,0) and B(0,600). A distress signal from a ship at P is received at slightly different times by two stations. It is determined that the ship is 200km farther from station A than it is from station B. Determine the equation of hyperbola that passes through the location of the ship.
27. Certain telescopes contain both parabolic mirror and a hyperbolic mirror. In the telescope shown in figure 5.68 the parabola and hyperbola share focus F_1 which is 14m above the vertex of the parabola. The hyperbola's second focus F_2 is 2m above the parabola's vertex. The vertex of the hyperbolic mirror is 1m below F_1. Position a coordinate system with the origin at the centre of the hyperbola and with the foci on the y-axis. Then find the equation of the hyperbola.
28. A tunnel through a mountain for a four lane highway is to have a elliptical opening. The total width of the highway (not the opening) is to be 16m, and the height at the edge of the road must be sufficient for a truck 4m high to clear if the highest point of the opening is to be 5m approximately. How wide must the opening be?

29. An engineer designs a satellite dish with a parabolic cross section. The dish is 5m wide at the opening, and the focus is placed 1.2m from the vertex
    (a) Position a coordinate system with the origin at the vertex and the x-axis on the parabola's axis of symmetry and find an equation of the parabola.
    (b) Find the depth of the satellite dish at the vertex.

30. Parabolic cable of a 60m portion of the roadbed of a suspension bridge is positioned as shown below. Vertical Cables are to be spaced every 6m along this portion of the roadbed. Calculate the lengths of first two of these vertical cables from the vertex.

31. Cross section of a Nuclear cooling tower is in the shape of a hyperbola with equation $\frac{x^2}{30^2} - \frac{y^2}{44^2} = 1$. The tower is 150m tall and the distance from the top of the tower to the centre of the hyperbola is half the distance from the base of the tower to the centre of the hyperbola. Find the diameter of the top and base of the tower.

32. Assume that water issuing from the end of a horizontal pipe, 7.5m above the ground, describes a parabolic path. The vertex of the parabolic path is at the end of the pipe. At a position 2.5m below the line of the pipe, the flow of water has curved outward 3m beyond the vertical line through the end of the pipe. How far beyond this vertical line will the water strike the ground?

33. On lighting a rocket cracker it gets projected in a parabolic path and reaches a maximum height of 4m when it is 6m away from the point of projection. Finally it reaches the ground 12m away from the starting point. Find the angle of projection.

34. Points A and B are 10km apart and it is determined from the sound of an explosion heard at those points at different times that the location of the explosion is 6km closer to A than B. Show that the location of the explosion is restricted to a particular curve and find an equation of it.

A.ABDUL MUNAB M.SC., B.ED.,
FATIMA MATRIC HR SEC SCHOOL,
JAYANKONDAM
CELL: 9524103797

Unit – 4: Inverse Trigonometric Functions

1. Find the domain of $\sin^{-1}(2-3x^2)$ 2. Find the domain $f(x) = \sin^{-1}\left(\frac{x^2+1}{2x}\right)$

3. Find the domain of $\cos^{-1}\left(\frac{2+\sin x}{3}\right)$

4. Find the value of $\cos^{-1}\left(\cos\frac{\pi}{7}\cos\frac{\pi}{17} - \sin\frac{\pi}{7}\sin\frac{\pi}{17}\right)$

5. Find the domain of $f(x) = \sin^{-1}\left(\frac{|x|-2}{3}\right) + \cos^{-1}\left(\frac{1-|x|}{4}\right)$

6. Find the value of $\cos^{-1}\left(\cos\left(\frac{4\pi}{3}\right)\right) + \cos^{-1}\left(\cos\left(\frac{5\pi}{4}\right)\right)$

7. If $\cos^{-1}x + \cos^{-1}y + \cos^{-1}z = \pi$ and $0 < x, y, z < 1$
   Show that $x^2 + y^2 + z^2 + 2xyz = 1$

8. Solve. $2\tan^{-1}x = \cos^{-1}\frac{1-a^2}{1+a^2} - \cos^{-1}\frac{1-b^2}{1+b^2}$, a, b > 0

9. Solve. $\cos\left(\sin^{-1}\left(\frac{x}{\sqrt{1+x^2}}\right)\right) = \sin\left\{\cot^{-1}\left(\frac{3}{4}\right)\right\}$

10. Find the value of $\tan\left[\frac{1}{2}\sin^{-1}\left(\frac{2a}{1+a^2}\right) + \frac{1}{2}\cos^{-1}\left(\frac{1-a^2}{1+a^2}\right)\right]$

11. Find the number of solution of the equation
    $\tan^{-1}(x-1) + \tan^{-1}(x) + \tan^{-1}(x+1) = \tan^{-1}3x$

12. Prove that $\tan^{-1}(x) + \tan^{-1}\left(\frac{2x}{1-x^2}\right) = \tan^{-1}\left(\frac{3x-x^3}{1-3x^2}\right)$, $|x| < \frac{1}{\sqrt{3}}$

13. Find the value of $\sin^{-1}[\sin 10]$

14. Find the value of $\tan\left(\cos^{-1}\left(\frac{1}{2}\right) - \sin^{-1}\left(\frac{-1}{2}\right)\right)$

15. Find the value of $\cos\left(\sin^{-1}\left(\frac{4}{5}\right) - \tan^{-1}\left(\frac{3}{4}\right)\right)$

16. Evaluate $\sin\left(\sin^{-1}\left(\frac{3}{5}\right) + \sec^{-1}\left(\frac{5}{4}\right)\right)$

17. If $a_1, a_2, a_3 \ldots a_n$ is an A.P with common difference d, Prove that
    $\left[\tan^{-1}\left(\frac{d}{1+a_1a_2}\right) + \tan^{-1}\left(\frac{d}{1+a_2a_3}\right) + \ldots + \tan^{-1}\left(\frac{d}{1+a_na_{n-1}}\right)\right] = \frac{a_n-a_1}{1+a_1a_n}$

18. Solve $\tan^{-1}2x + \tan^{-1}3x = \frac{\pi}{4}$, if $6x^2 < 1$.

19. Prove that $\sin^{-1}\frac{3}{5} - \cos^{-1}\frac{12}{13} = \sin^{-1}\frac{16}{65}$

20. Prove that $\tan^{-1}x + \tan^{-1}y + \tan^{-1}z = \tan^{-1}\left[\frac{x+y+z-xyz}{1-xy-yz-zx}\right]$

21. If $\tan^{-1}x + \tan^{-1}y + \tan^{-1}z = \pi$, show that $x+y+z = xyz$

22. Solve $\sin^{-1}\frac{5}{x} + \sin^{-1}\frac{12}{x} = \frac{\pi}{2}$

23. Solve $2\tan^{-1}(\cos x) = \tan^{-1}(2\operatorname{cosec} x)$