

YOUTH COMPETITION TIMES

VOLUME IV

Trigonometry

Chapterwise

Solved Papers

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Syllabus for JEE (Main) - 2024

Syllabus for JEE Main Paper-1 (B.E./B.Tech.)

MATHEMATICS

UNIT 1: SETS, RELATIONS, AND FUNCTIONS: Sets and their representation: Union, intersection, and complement of sets and their algebraic properties; Power set; Relation, Type of relations, equivalence relations, functions; one-one, into and onto functions, the composition of functions.

UNIT 2: COMPLEX NUMBERS AND QUADRATIC EQUATIONS: Complex numbers as ordered pairs of reals, Representation of complex numbers in the form $a + ib$ and their representation in a plane, Argand diagram, algebra of complex number, modulus, and argument (or amplitude) of a complex number, Quadratic equations in real and complex number system and their solutions Relations between roots and co-efficient, nature of roots, the formation of quadratic equation with given roots.

UNIT 3: MATRICES AND DETERMINANTS: Matrices, algebra of matrices, type of matrices, determinants, and matrices of order two and three, evaluation of determinants, area of triangles using determinants, Adjoint, and evaluation of inverse of a square matrix using determinants and, Test of consistency and solution of simultaneous linear equations in two or three variables using matrices.

UNIT 4: PERMUTATIONS AND COMBINATIONS: The fundamental principle of counting, permutation as an arrangement and combination as section, Meaning of $P(n, r)$ and $C(n, r)$, simple applications.

UNIT 5: BINOMIAL THEOREM AND ITS SIMPLE APPLICATIONS: Binomial theorem for a positive integral index, general term and middle term, and simple applications.

UNIT 6: SEQUENCE AND SERIES: Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers, Relation between A.M and G.M.

UNIT 7: LIMIT, CONTINUITY, AND DIFFERENTIABILITY: Real-valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic, and exponential functions, inverse function. Graphs of simple functions. Limits, continuity, and differentiability. Differentiation of the sum, difference, product, and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite, and implicit functions; derivatives of order up to two, Applications of derivatives: Rate of change of quantities, monotonic-Increasing and decreasing functions, Maxima and minima of functions of one variable.

UNIT 8: INTEGRAL CALCULAS: Integral as an anti-derivative, Fundamental integral involving algebraic, trigonometric, exponential, and logarithmic functions. Integrations by substitution, by parts, and by partial functions. Integrations by substitution, by parts, and by partial functions. Integration using trigonometric identities.

Evaluation of simple integrals of the type

$$\int \frac{dx}{x^2 + a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{a^2 - x^2}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c}, \int \frac{dx}{\sqrt{ax^2 + bx + c}}, \int \frac{(px + q)dx}{ax^2 + bx + c}, \int \frac{(px + q)dx}{\sqrt{ax^2 + bx + c}}, \\ \int \sqrt{a^2 \pm x^2} dx, \int \sqrt{x^2 - a^2} dx$$

The fundamental theorem of calculus, properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

UNIT 9 : DIFFERENTIAL EQUATION : Ordinary differential equations, their order, and degree, the solution of differential equation by the method of separation of variables, solution of a homogeneous and linear differential equation of the type

$$\frac{dy}{dx} + p(x)y = q(x)$$

UNIT 10 : CO-ORDINATE GEOMETRY : Cartesian system of rectangular coordinates in a plane, distance formula, sections formula, locus, and its equation, the slope of a line, parallel and perpendicular lines, intercepts of a line on the co-ordinate axis.

Straight line : Various forms of equations of a line, intersection of lines, angles between two lines, conditions for concurrence of three lines, the distance of a point from a line, co-ordinate of the centroid orthocentre, and circumcentre of a triangle.

Circle, conic sections : A standard form of equations of a circle, the general form of the equation of a circle, its radius and central, equation of a circle when the endpoints of a diameter are given, points of intersection of a line and a circle with the centre at the origin and sections of conics, equations of conic sections (parabola, ellipse, and hyperbola) in standard forms.

UNIT 11 : THREE DIMENSIONAL GEOMETRY : Coordinates of a point in space, the distance between two points, section formula, directions ratios, and direction cosines, and the angle between two intersecting lines. Skew lines, the shortest distance between them, and its equation. Equations of a line

UNIT 12: VECTOR ALGEBRA: Vectors and scalars, the addition of vectors, components of a vector in two dimensions and three-dimensional space, scalar and vector products.

UNIT 13: STATISTICS AND PROBABILITY: Measures of discretion; calculation of mean, median, mode of grouped and ungrouped data calculation of standard deviation, variance, and mean deviation for grouped and ungrouped data.

Probability: Probability of an event, addition and multiplication theorems of probability, Baye's theorem, probability distribution of a random variate.

UNIT 14: TRIGONOMETRY : Trigonometrical identities and trigonometrical functions, inverse trigonometrical functions, and their properties.

All India Engineering Entrance Examination & JEE-Main

Previous Years Papers Analysis Chart

Sl No	Exam	Proposed Year		Total Question
Joint Entrance Examination (JEE) Main				
1.	NTA JEE Main (April Session)	April 2024	24 Paper	720
2.	NTA JEE Main (January Session)	January 2024	20 Paper	600
3.	NTA JEE Main	15.04.2023	Shift-I	30
4.	NTA JEE Main	13.04.2023	Shift-I	30
5.	NTA JEE Main	13.04.2023	Shift-II	30
6.	NTA JEE Main	12.04.2023	Shift-I	30
7.	NTA JEE Main	11.04.2023	Shift-I	30
8.	NTA JEE Main	11.04.2023	Shift-II	30
9.	NTA JEE Main	10.04.2023	Shift-I	30
10.	NTA JEE Main	10.04.2023	Shift-II	30
11.	NTA JEE Main	08.04.2023	Shift-I	30
12.	NTA JEE Main	08.04.2023	Shift-II	30
13.	NTA JEE Main	06.04.2023	Shift-I	30
14.	NTA JEE Main	06.04.2023	Shift-II	30
15.	NTA JEE Main	01.02.2023	Shift-I	30
16.	NTA JEE Main	01.02.2023	Shift-II	30
17.	NTA JEE Main	24.01.2023	Shift-I	30
18.	NTA JEE Main	24.01.2023	Shift-II	30
19.	NTA JEE Main	25.01.2023	Shift-I	30
20.	NTA JEE Main	25.01.2023	Shift-II	30
21.	NTA JEE Main	29.01.2023	Shift-I	30
22.	NTA JEE Main	29.01.2023	Shift-II	30
23.	NTA JEE Main	30.01.2023	Shift-I	30
24.	NTA JEE Main	30.01.2023	Shift-II	30
25.	NTA JEE Main	31.01.2023	Shift-I	30
26.	NTA JEE Main	31.01.2023	Shift-II	30
27.	NTA JEE Main	29.07.2022	Shift-I	30
28.	NTA JEE Main	29.07.2022	Shift-II	30
29.	NTA JEE Main	28.07.2022	Shift-I	30
30.	NTA JEE Main	28.07.2022	Shift-II	30
31.	NTA JEE Main	27.07.2022	Shift-I	30
32.	NTA JEE Main	27.07.2022	Shift-II	30
33.	NTA JEE Main	26.07.2022	Shift-I	30
34.	NTA JEE Main	26.07.2022	Shift-II	30
35.	NTA JEE Main	25.07.2022	Shift-I	30
36.	NTA JEE Main	25.07.2022	Shift-II	30
37.	NTA JEE Main	29.06.2022	Shift-I	30
38.	NTA JEE Main	29.06.2022	Shift-II	30
39.	NTA JEE Main	28.06.2022	Shift-I	30
40.	NTA JEE Main	28.06.2022	Shift-II	30
41.	NTA JEE Main	27.06.2022	Shift-I	30
42.	NTA JEE Main	27.06.2022	Shift-II	30
43.	NTA JEE Main	26.06.2022	Shift-I	30
44.	NTA JEE Main	26.06.2022	Shift-II	30
45.	NTA JEE Main	25.06.2022	Shift-I	30

46.	NTA JEE Main	25.06.2022	Shift-II	30
47.	NTA JEE Main	24.06.2022	Shift-I	30
48.	NTA JEE Main	24.06.2022	Shift-II	30
49.	NTA JEE Main	01.09.2021	Shift-I	30
50.	NTA JEE Main	01.09.2021	Shift-II	30
51.	NTA JEE Main	31.08.2021	Shift-I	30
52.	NTA JEE Main	31.08.2021	Shift-II	30
53.	NTA JEE Main	27.08.2021	Shift-I	30
54.	NTA JEE Main	27.08.2021	Shift-II	30
55.	NTA JEE Main	26.08.2021	Shift-I	30
56.	NTA JEE Main	26.08.2021	Shift-II	30
57.	NTA JEE Main	27.07.2021	Shift-I	30
58.	NTA JEE Main	27.07.2021	Shift-II	30
59.	NTA JEE Main	25.07.2021	Shift-I	30
60.	NTA JEE Main	25.07.2021	Shift-II	30
61.	NTA JEE Main	22.07.2021	Shift-I	30
62.	NTA JEE Main	22.07.2021	Shift-II	30
63.	NTA JEE Main	20.07.2021	Shift-I	30
64.	NTA JEE Main	20.07.2021	Shift-II	30
65.	NTA JEE Main	18.03.2021	Shift-I	30
66.	NTA JEE Main	18.03.2021	Shift-II	30
67.	NTA JEE Main	17.03.2021	Shift-I	30
68.	NTA JEE Main	17.03.2021	Shift-II	30
69.	NTA JEE Main	16.03.2021	Shift-I	30
70.	NTA JEE Main	16.03.2021	Shift-II	30
71.	NTA JEE Main	26.02.2021	Shift-I	30
72.	NTA JEE Main	26.02.2021	Shift-II	30
73.	NTA JEE Main	25.02.2021	Shift-I	30
74.	NTA JEE Main	25.02.2021	Shift-II	30
75.	NTA JEE Main	24.02.2021	Shift-I	30
76.	NTA JEE Main	24.02.2021	Shift-II	30
77.	NTA JEE Main	06.09.2020	Shift-I	30
78.	NTA JEE Main	06.09.2020	Shift-II	30
79.	NTA JEE Main	05.09.2020	Shift-I	30
80.	NTA JEE Main	05.09.2020	Shift-II	30
81.	NTA JEE Main	04.09.2020	Shift-I	25
82.	NTA JEE Main	04.09.2020	Shift-II	25
83.	NTA JEE Main	03.09.2020	Shift-I	30
84.	NTA JEE Main	03.09.2020	Shift-II	30
85.	NTA JEE Main	02.09.2020	Shift-I	25
86.	NTA JEE Main	02.09.2020	Shift-II	25
87.	NTA JEE Main	09.01.2020	Shift-I	30
88.	NTA JEE Main	09.01.2020	Shift-II	30
89.	NTA JEE Main	08.01.2020	Shift-I	30
90.	NTA JEE Main	08.01.2020	Shift-II	30
91.	NTA JEE Main	07.01.2020	Shift-I	30
92.	NTA JEE Main	07.01.2020	Shift-II	30
93.	NTA JEE Main	12.04.2019	Shift-I	30
94.	NTA JEE Main	12.04.2019	Shift-II	30
95.	NTA JEE Main	10.04.2019	Shift-I	30
96.	NTA JEE Main	10.04.2019	Shift-II	30
97.	NTA JEE Main	09.04.2019	Shift-I	30

98.	NTA JEE Main	09.04.2019	Shift-II	30
99.	NTA JEE Main	08.04.2019	Shift-I	30
100.	NTA JEE Main	08.04.2019	Shift-II	30
101.	NTA JEE Main	12.01.2019	Shift-I	30
102.	NTA JEE Main	12.01.2019	Shift-II	30
103.	NTA JEE Main	11.01.2019	Shift-I	30
104.	NTA JEE Main	11.01.2019	Shift-II	30
105.	NTA JEE Main	10.01.2019	Shift-I	30
106.	NTA JEE Main	10.01.2019	Shift-II	30
107.	NTA JEE Main	09.01.2019	Shift-I	30
108.	NTA JEE Main	09.01.2019	Shift-II	30
109.	JEE Main	16.04.2018		30
110.	JEE Main	15.04.2018	Shift-I	30
111.	JEE Main	15.04.2018	Shift-II	30
112.	JEE Main	08.04.2018		30
113.	JEE Main	09.04.2017		30
114.	JEE Main	08.04.2017		30
115.	JEE Main	02.04.2017		30
116.	JEE Main	2016		30
117.	JEE Main	2015		30
118.	JEE Main	2014		30
119.	JEE Main	2013		30
120.	AIEEE	2012		30
121.	AIEEE	2011		30
122.	AIEEE	2010		30
123.	AIEEE	2009		30
124.	AIEEE	2008		30
	AIEEE	2007		30
125.	AIEEE	2006		30
126.	AIEEE	2005		30
127.	AIEEE	2004		30
128.	AIEEE	2003		30
129.	AIEEE	2002		30
ASSAM-CEE				
130.	ASSAM-CEE	2023		40
131.	ASSAM-CEE	2022		40
132.	ASSAM-CEE	2021		40
133.	ASSAM-CEE	2020		40
134.	ASSAM-CEE	2019		40
135.	ASSAM-CEE	2018		40
Andhra Pradesh EAMCET/EAPCET				
136.	A.P. EAPCET	15.05.2023	Shift-I	80
137.	A.P. EAPCET	15.05.2023	Shift-II	80
138.	A.P. EAPCET	16.05.2023	Shift-I	80
139.	A.P. EAPCET	16.05.2023	Shift-II	80
140.	A.P. EAPCET	17.05.2023	Shift-I	80
141.	A.P. EAPCET	17.05.2023	Shift-II	80
142.	A.P. EAPCET	18.05.2023	Shift-I	80
143.	A.P. EAPCET	18.05.2023	Shift-II	80
144.	A.P. EAPCET	19.05.2023	Shift-I	80
145.	A.P. EAMCET	04.07.2022	Shift-I	80
146.	A.P. EAMCET	04.07.2022	Shift-II	80

147.	A.P. EAMCET	05.07.2022	Shift-I	80
148.	A.P. EAMCET	05.07.2022	Shift-II	80
149.	A.P. EAMCET	06.07.2022	Shift-I	80
150.	A.P. EAMCET	06.07.2022	Shift-II	80
151.	A.P. EAMCET	07.07.2022	Shift-I	80
152.	A.P. EAMCET	07.07.2022	Shift-II	80
153.	A.P. EAMCET	08.07.2022	Shift-I	80
154.	A.P. EAMCET	08.07.2022	Shift-II	80
155.	A.P. EAMCET	07.09.2021	Shift-I	80
156.	A.P. EAMCET	23.08.2021	Shift-I	80
157.	A.P. EAMCET	23.08.2021	Shift-II	80
158.	A.P. EAMCET	19.08.2021	Shift-II	80
159.	A.P. EAMCET	20.08.2021	Shift-I	80
160.	A.P. EAMCET	20.08.2021	Shift-II	80
161.	A.P. EAMCET	19.08.2021	Shift-I	80
162.	A.P. EAMCET	19.08.2021	Shift-II	80
163.	A.P. EAMCET	05.10.2021	Shift-II	80
164.	A.P. EAMCET	25.08.2021	Shift-I	80
165.	A.P. EAMCET	25.08.2021	Shift-II	80
166.	A.P. EAMCET	24.08.2021	Shift-I	80
167.	A.P. EAMCET	24.08.2021	Shift-II	80
168.	A.P. EAMCET	22.09.2020	Shift-I	80
169.	A.P. EAMCET	22.09.2020	Shift-II	80
170.	A.P. EAMCET	23.09.2020	Shift-I	80
171.	A.P. EAMCET	21.09.2020	Shift-I	80
172.	A.P. EAMCET	21.09.2020	Shift-II	80
173.	A.P. EAMCET	18.09.2020	Shift-I	80
174.	A.P. EAMCET	18.09.2020	Shift-II	80
175.	A.P. EAMCET	17.09.2020	Shift-I	80
176.	A.P. EAMCET	17.09.2020	Shift-II	80
177.	A.P. EAMCET	07.10.2020	Shift-I	80
178.	A.P. EAMCET	20.04.2019	Shift-I	80
179.	A.P. EAMCET	20.04.2019	Shift-II	80
180.	A.P. EAMCET	21.04.2019	Shift-I	80
181.	A.P. EAMCET	21.04.2019	Shift-II	80
182.	A.P. EAMCET	22.04.2019	Shift-I	80
183.	A.P. EAMCET	22.04.2019	Shift-II	80
184.	A.P. EAMCET	23.04.2019	Shift-I	80
185.	A.P. EAMCET	22.04.2018	Shift-I	80
186.	A.P. EAMCET	22.04.2018	Shift-II	80
187.	A.P. EAMCET	23.04.2018	Shift-I	80
188.	A.P. EAMCET	23.04.2018	Shift-II	80
189.	A.P. EAMCET	24.04.2018	Shift-I	80
190.	A.P. EAMCET	24.04.2018	Shift-II	80
191.	A.P. EAMCET	2017		80
192.	A.P. EAMCET	2016		80
193.	A.P. EAMCET	2015		80
194.	A.P. EAMCET	2014		80
195.	A.P. EAMCET	2013		80
196.	A.P. EAMCET	2012		80
197.	A.P. EAMCET	2011		80
198.	A.P. EAMCET	2010		80

199.	A.P. EAMCET	2009		80
200.	A.P. EAMCET	2008		80
201.	A.P. EAMCET	2007		80
202.	A.P. EAMCET	2006		80
203.	A.P. EAMCET	2005		80
204.	A.P. EAMCET	2004		80
205.	A.P. EAMCET	2003		80
206.	A.P. EAMCET	2002		80
207.	A.P. EAMCET	2001		80
208.	A.P. EAMCET	2000		80
209.	A.P. EAMCET	1999		80
210.	A.P. EAMCET	1998		80
211.	A.P. EAMCET	1997		80
212.	A.P. EAMCET	1996		80
213.	A.P. EAMCET	1995		80
214.	A.P. EAMCET	1994		80
215.	A.P. EAMCET	1993		80
216.	A.P. EAMCET	1992		80
217.	A.P. EAMCET	1991		80
AMU (Aligarh Muslim University)				
218.	AMU	2023		50
219.	AMU	2022		50
220.	AMU	2021		50
221.	AMU	2019		50
222.	AMU	2018		50
223.	AMU	2017		50
224.	AMU	2016		50
225.	AMU	2015		50
226.	AMU	2014		50
227.	AMU	2013		50
228.	AMU	2012		50
229.	AMU	2011		50
230.	AMU	2010		70
231.	AMU	2009		70
232.	AMU	2008		70
233.	AMU	2007		70
234.	AMU	2006		70
235.	AMU	2005		70
236.	AMU	2004		70
237.	AMU	2003		70
238.	AMU	2002		100
239.	AMU	2001		100
(Bihar) BCECE				
240.	BCECE	2018		50
241.	BCECE	2017		50
242.	BCECE	2016		50
243.	BCECE	2015		50
244.	BCECE	2014		50
245.	BCECE	2013		50
246.	BCECE	2012		50
247.	BCECE	2011		50
248.	BCECE	2010		50

249.	BCECE	2009		50
250.	BCECE	2008		50
251.	BCECE	2007		50
252.	BCECE	2006		50
253.	BCECE	2005		50
254.	BCECE	2004		50
255.	BCECE	2003		50
BITSAT				
256.	BITSAT	2023		40
257.	BITSAT	2022		40
258.	BITSAT	2021		40
259.	BITSAT	2019		40
260.	BITSAT	2018		40
261.	BITSAT	2017		40
262.	BITSAT	2016		40
263.	BITSAT	2015		40
264.	BITSAT	2014		40
265.	BITSAT	2013		40
266.	BITSAT	2012		40
267.	BITSAT	2011		40
268.	BITSAT	2010		40
269.	BITSAT	2009		40
270.	BITSAT	2008		40
271.	BITSAT	2007		40
272.	BITSAT	2006		40
273.	BITSAT	2005		40
Chhattisgarh-PET				
274.	Chhattisgarh-PET	2023		100
275.	Chhattisgarh-PET	2022		100
276.	Chhattisgarh-PET	2021		100
277.	Chhattisgarh-PET	2020		100
278.	Chhattisgarh-PET	2019		100
279.	Chhattisgarh-PET	2018		100
280.	Chhattisgarh-PET	2017		100
281.	Chhattisgarh-PET	2016		100
282.	Chhattisgarh-PET	2015		100
283.	Chhattisgarh-PET	2014		100
284.	Chhattisgarh-PET	2013		100
285.	Chhattisgarh-PET	2012		100
286.	Chhattisgarh-PET	2011		100
287.	Chhattisgarh-PET	2010		100
288.	Chhattisgarh-PET	2009		100
289.	Chhattisgarh-PET	2008		100
290.	Chhattisgarh-PET	2007		100
291.	Chhattisgarh-PET	2006		100
292.	Chhattisgarh-PET	2005		100
293.	Chhattisgarh-PET	2004		100
COMEDK				
294.	COMEDK-JEE	2023		60
295.	COMEDK-JEE	2022		60
296.	COMEDK-JEE	2021		60
297.	COMEDK-JEE	2020		60

298.	COMEDK-JEE	2019		60
299.	COMEDK-JEE	2018		60
300.	COMEDK-JEE	2017		60
301.	COMEDK-JEE	2016		60
302.	COMEDK-JEE	2015		60
303.	COMEDK-JEE	2014		60
304.	COMEDK-JEE	2013		60
305.	COMEDK-JEE	2012		60
306.	COMEDK-JEE	2011		60
Gujarat Common Entrance Test (GUJCET)				
307.	GUJCET	2023		40
308.	GUJCET	2022		40
309.	GUJCET	2021		40
310.	GUJCET	2020		40
311.	GUJCET	2019		40
312.	GUJCET	2018		40
313.	GUJCET	2017		40
314.	GUJCET	2016		40
315.	GUJCET	2015		40
316.	GUJCET	2014		40
317.	GUJCET	2011		40
318.	GUJCET	2010		40
319.	GUJCET	2009		40
320.	GUJCET	2008		40
321.	GUJCET	2007		40
HIMACHAL PRADESH-CET				
322.	HP-CET	2018		60
J & K-CET				
323.	J & K-CET	2020		75
324.	J & K-CET	2019		75
325.	J & K-CET	2018		75
326.	J & K-CET	2017		75
327.	J & K-CET	2016		75
328.	J & K-CET	2015		75
329.	J & K-CET	2014		75
330.	J & K-CET	2013		75
331.	J & K-CET	2012		75
332.	J & K-CET	2011		75
333.	J & K-CET	2010		75
334.	J & K-CET	2009		75
335.	J & K-CET	2008		75
336.	J & K-CET	2007		75
337.	J & K-CET	2006		75
338.	J & K-CET	2005		75
339.	J & K-CET	2004		75
340.	J & K-CET	2003		75
Jharkhand (JCECE)				
341.	JCECE	2019		50
342.	JCECE	2018		50
343.	JCECE	2017		50
344.	JCECE	2016		50
345.	JCECE	2015		50

346.	JCECE	2014		50
347.	JCECE	2013		50
348.	JCECE	2012		50
349.	JCECE	2011		50
350.	JCECE	2010		50
351.	JCECE	2009		50
352.	JCECE	2008		50
353.	JCECE	2007		50
354.	JCECE	2006		50
355.	JCECE	2005		50
356.	JCECE	2004		50
357.	JCECE	2003		50
358.	JCECE	2002		50
359.	JCECE	2001		50
Jamia Millia Islamia				
360.	Jamia Millia Islamia	2015		60
361.	Jamia Millia Islamia	2014		60
362.	Jamia Millia Islamia	2013		60
363.	Jamia Millia Islamia	2012		60
364.	Jamia Millia Islamia	2011		60
365.	Jamia Millia Islamia	2010		60
366.	Jamia Millia Islamia	2009		60
367.	Jamia Millia Islamia	2008		60
368.	Jamia Millia Islamia	2007		60
369.	Jamia Millia Islamia	2006		60
370.	Jamia Millia Islamia	2005		60
371.	Jamia Millia Islamia	2004		60
Kerala-KEAM				
372.	Kerala KEAM	2023		60
373.	Kerala KEAM	2022		60
374.	Kerala KEAM	2021		60
375.	Kerala KEAM	2020		60
376.	Kerala KEAM	2019		60
377.	Kerala KEAM	2018		60
378.	Kerala KEAM	2017		60
379.	Kerala KEAM	2016		60
380.	Kerala KEAM	2015		60
381.	Kerala KEAM	2014		60
382.	Kerala KEAM	2013		60
383.	Kerala KEAM	2012		60
384.	Kerala KEAM	2011		60
385.	Kerala KEAM	2010		60
386.	Kerala KEAM	2009		60
387.	Kerala KEAM	2008		60
388.	Kerala KEAM	2007		60
389.	Kerala KEAM	2006		60
390.	Kerala KEAM	2005		60
391.	Kerala KEAM	2004		60
Karnataka-CET (KCET)				
392.	Karnataka-CET	2023		60
393.	Karnataka-CET	2022		60
394.	Karnataka-CET	2021		60

395.	Karnataka-CET	2020		60
396.	Karnataka-CET	2019		60
397.	Karnataka-CET	2018		60
398.	Karnataka-CET	2017		60
399.	Karnataka-CET	2016		60
400.	Karnataka-CET	2015		60
401.	Karnataka-CET	2014		60
402.	Karnataka-CET	2013		60
403.	Karnataka-CET	2012		60
404.	Karnataka-CET	2011		60
405.	Karnataka-CET	2010		60
406.	Karnataka-CET	2009		60
407.	Karnataka-CET	2008		60
408.	Karnataka-CET	2007		60
409.	Karnataka-CET	2006		60
410.	Karnataka-CET	2005		60
411.	Karnataka-CET	2004		60
412.	Karnataka-CET	2003		60
413.	Karnataka-CET	2002		60
414.	Karnataka-CET	2001		60
415.	Karnataka-CET	2000		60
Kishore Vaigyanik Protsahan Yojana (KVPY)				
416.	KVPY-SB-SX	2023		15
417.	KVPY-SB-SX	2022		15
418.	KVPY-SB-SX	2021		15
419.	KVPY-SA	2021		15
420.	KVPY-SA	2020		15
421.	KVPY-SB-SX	2018		15
422.	KVPY-SA	2017		15
423.	KVPY-SB-SX	2016		15
424.	KVPY-SB-SX	2015		15
425.	KVPY-SA	2014		15
426.	KVPY-SB-SX	2013		15
427.	KVPY-SA	2012		15
428.	KVPY-SA	2009		15
429.	KVPY-SB-SX	2009		15
Madhya Pradesh Pre Engineering Test (MPPET)				
430.	MPPET	2013		50
431.	MPPET	2012		50
432.	MPPET	2009		50
433.	MPPET	2008		50
Manipal-UGET				
434.	Manipal	2023		50
435.	Manipal	2022		50
436.	Manipal	2021		50
437.	Manipal	2020		50
438.	Manipal	2019		50
439.	Manipal	2018		50
440.	Manipal	2017		50

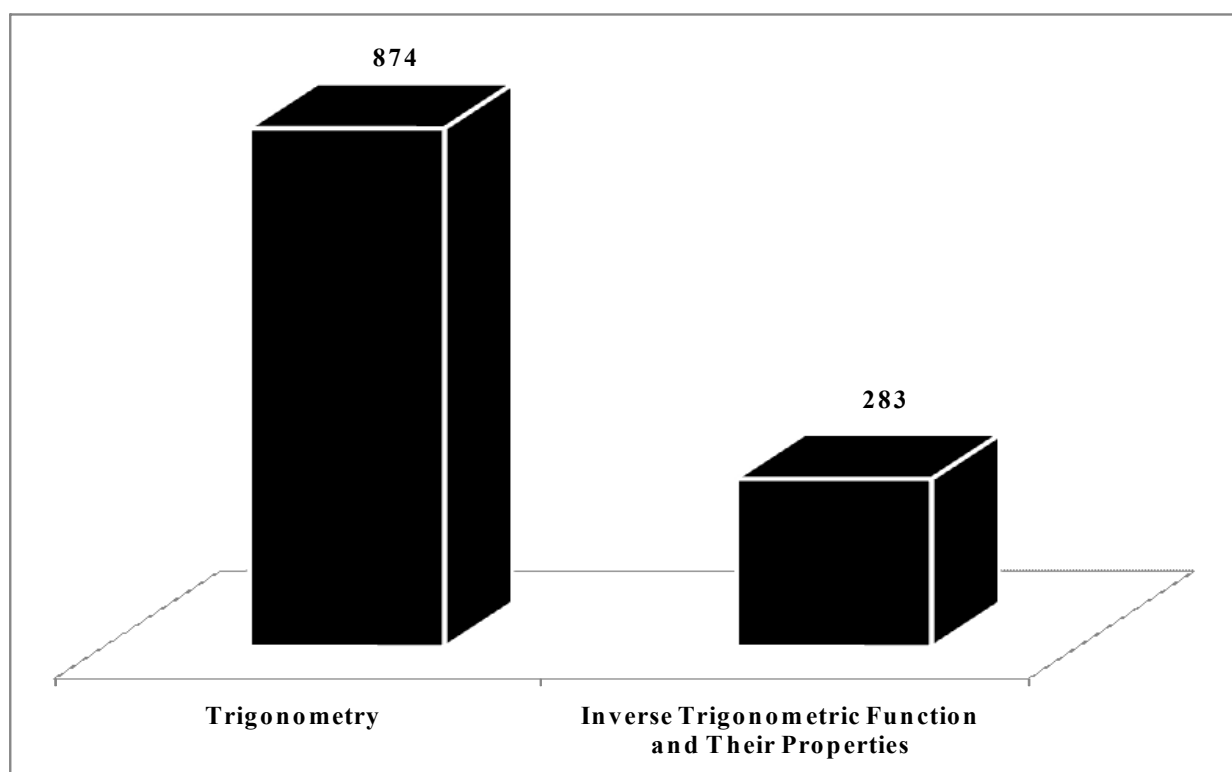
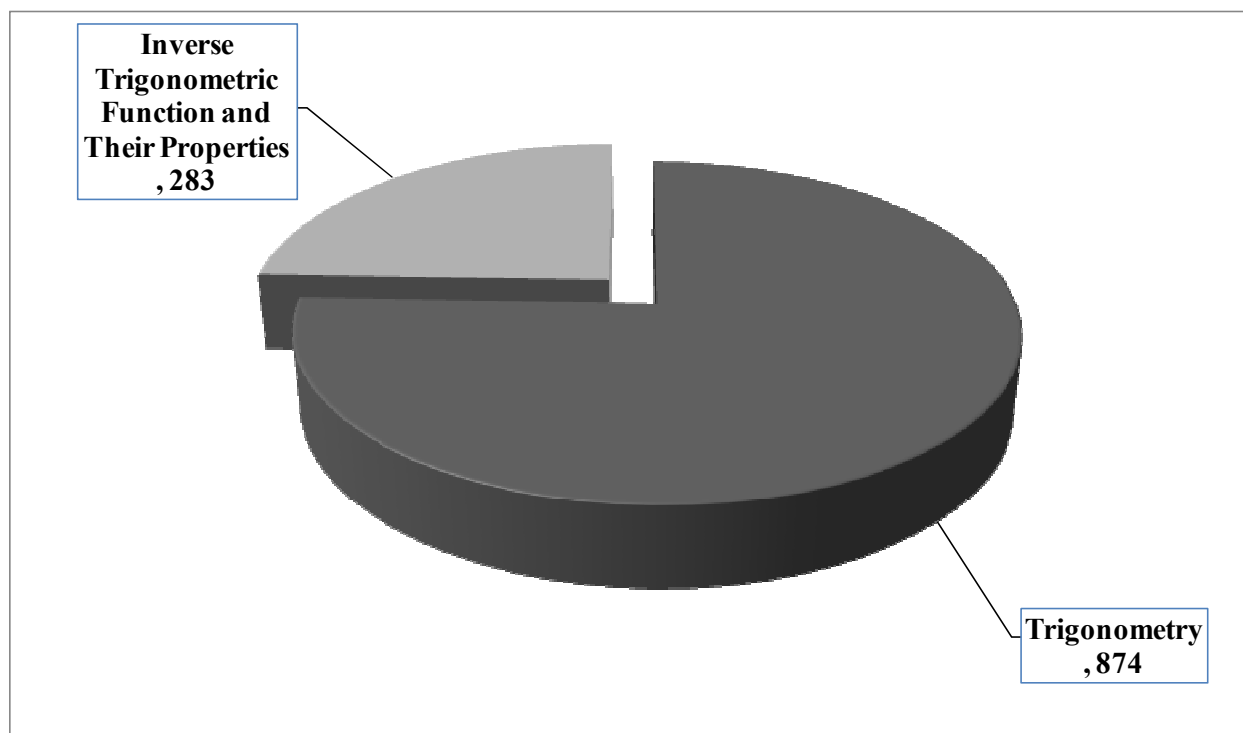
441.	Manipal	2016		50
442.	Manipal	2015		50
443.	Manipal	2014		50
444.	Manipal	2013		50
445.	Manipal	2012		50
446.	Manipal	2011		50
447.	Manipal	2010		50
448.	Manipal	2009		50
449.	Manipal	2008		50
(Maharashtra) MHT-CET				
450.	MHT-CET	2022	All Shifts	500
451.	MHT-CET	2021	All Shifts	500
452.	MHT-CET	13.10.2020	Shift-I	100
453.	MHT-CET	13.10.2020	Shift-II	100
454.	MHT-CET	14.10.2020	Shift-I	100
455.	MHT-CET	14.10.2020	Shift-II	100
456.	MHT-CET	15.10.2020	Shift-I	100
457.	MHT-CET	15.10.2020	Shift-II	100
458.	MHT-CET	16.10.2020	Shift-I	100
459.	MHT-CET	16.10.2020	Shift-II	100
460.	MHT-CET	19.10.2020	Shift-I	100
461.	MHT-CET	19.10.2020	Shift-II	100
462.	MHT-CET	20.10.2020	Shift-I	100
463.	MHT-CET	20.10.2020	Shift-II	100
464.	MHT-CET	02.05.2019	Shift-I	100
465.	MHT-CET	02.05.2019	Shift-II	100
466.	MHT-CET	03.05.2019		100
467.	MHT-CET	2018		100
468.	MHT-CET	2017		100
469.	MHT-CET	2016		100
470.	MHT-CET	2015		100
471.	MHT-CET	2014		100
472.	MHT-CET	2013		100
473.	MHT-CET	2012		100
474.	MHT-CET	2011		100
475.	MHT-CET	2010		100
476.	MHT-CET	2009		100
477.	MHT-CET	2008		100
478.	MHT-CET	2007		100
479.	MHT-CET	2006		100
480.	MHT-CET	2005		100
481.	MHT-CET	2004		100
Rajasthan PET				
482.	Rajasthan PET	2012		40
483.	Rajasthan PET	2011		40

484.	Rajasthan PET	2010		40
485.	Rajasthan PET	2009		40
486.	Rajasthan PET	2008		40
487.	Rajasthan PET	2007		40
488.	Rajasthan PET	2006		40
489.	Rajasthan PET	2005		40
490.	Rajasthan PET	2004		40
491.	Rajasthan PET	2003		40
492.	Rajasthan PET	2002		40
493.	Rajasthan PET	2001		40
SCRA				
494.	SCRA	2015		60
495.	SCRA	2014		60
496.	SCRA	2013		60
497.	SCRA	2012		60
498.	SCRA	2010		60
499.	SCRA	2009		60
SRM-JEEE				
500.	SRM-JEEE	2022		40
501.	SRM-JEEE	2021		40
502.	SRM-JEEE	2020		40
503.	SRM-JEEE	2019		40
504.	SRM-JEEE	2018		40
505.	SRM-JEEE	2016		40
506.	SRM-JEEE	2015		40
507.	SRM-JEEE	2014		40
508.	SRM-JEEE	2013		40
509.	SRM-JEEE	2012		40
510.	SRM-JEEE	2011		40
511.	SRM-JEEE	2010		40
512.	SRM-JEEE	2009		40
513.	SRM-JEEE	2008		40
514.	SRM-JEEE	2007		40
Telangana EAMCET				
515.	TS-EAMCET	12.05.2023	Shift-I	80
516.	TS-EAMCET	12.05.2023	Shift-II	80
517.	TS-EAMCET	13.05.2023	Shift-I	80
518.	TS-EAMCET	13.05.2023	Shift-II	80
519.	TS-EAMCET	14.05.2023	Shift-I	80
520.	TS-EAMCET	14.05.2023	Shift-II	80
521.	TS-EAMCET	18.07.2022	Shift-I	80
522.	TS-EAMCET	18.07.2022	Shift-II	80
523.	TS-EAMCET	19.07.2022	Shift-I	80
524.	TS-EAMCET	19.07.2022	Shift-II	80
525.	TS-EAMCET	20.07.2022	Shift-I	80

526.	TS-EAMCET	20.07.2022	Shift-II	80
527.	TS-EAMCET	06.08.2021	Shift-I	80
528.	TS-EAMCET	06.08.2021	Shift-II	80
529.	TS-EAMCET	05.08.2021	Shift-I	80
530.	TS-EAMCET	05.08.2021	Shift-II	80
531.	TS-EAMCET	04.08.2021	Shift-I	80
532.	TS-EAMCET	04.08.2021	Shift-II	80
533.	TS-EAMCET	09.09.2020	Shift-I	80
534.	TS-EAMCET	09.09.2020	Shift-II	80
535.	TS-EAMCET	10.09.2020	Shift-I	80
536.	TS-EAMCET	10.09.2020	Shift-II	80
537.	TS-EAMCET	11.09.2020	Shift-I	80
538.	TS-EAMCET	11.09.2020	Shift-II	80
539.	TS-EAMCET	14.09.2020	Shift-I	80
540.	TS-EAMCET	14.09.2020	Shift-II	80
541.	TS-EAMCET	03.05.2019	Shift-I	80
542.	TS-EAMCET	03.05.2019	Shift-II	80
543.	TS-EAMCET	04.05.2019	Shift-I	80
544.	TS-EAMCET	04.05.2019	Shift-II	80
545.	TS-EAMCET	06.05.2019	Shift-I	80
546.	TS-EAMCET	05.05.2018	Shift-I	80
547.	TS-EAMCET	05.05.2018	Shift-II	80
548.	TS-EAMCET	02.05.2018	Shift-I	80
549.	TS-EAMCET	04.05.2018	Shift-II	80
550.	TS-EAMCET	07.05.2018	Shift-I	80
551.	TS-EAMCET	24.04.2017	Shift-I	80
552.	TS-EAMCET	2016		80
553.	TS-EAMCET	2015		80
554.	TS-EAMCET	2014		80
Tripura JEE				
555.	Tripura JEE	2023		50
556.	Tripura JEE	2022		50
557.	Tripura JEE	2021		50
558.	Tripura JEE	2019		50
(Uttar Pradesh) UPTU/UPSEE				
559.	UPTU/UPSEE	2020		50
560.	UPTU/UPSEE	2019		50
561.	UPTU/UPSEE	2018		50
562.	UPTU/UPSEE	2017		50
563.	UPTU/UPSEE	2016		50
564.	UPTU/UPSEE	2015		50
565.	UPTU/UPSEE	2014		50
566.	UPTU/UPSEE	2013		50
567.	UPTU/UPSEE	2012		50
568.	UPTU/UPSEE	2011		50

569.	UPTU/UPSEE	2010		50
570.	UPTU/UPSEE	2009		50
571.	UPTU/UPSEE	2008		50
572.	UPTU/UPSEE	2007		50
573.	UPTU/UPSEE	2006		50
574.	UPTU/UPSEE	2005		50
575.	UPTU/UPSEE	2004		50
VITEEE				
576.	VITEEE	2023		40
577.	VITEEE	2022		40
578.	VITEEE	2021		40
579.	VITEEE	2020		40
580.	VITEEE	2019		40
581.	VITEEE	2018		40
582.	VITEEE	2017		40
583.	VITEEE	2016		40
584.	VITEEE	2015		40
585.	VITEEE	2014		40
586.	VITEEE	2013		40
587.	VITEEE	2012		40
588.	VITEEE	2011		40
589.	VITEEE	2010		40
590.	VITEEE	2009		40
591.	VITEEE	2008		40
592.	VITEEE	2007		40
593.	VITEEE	2006		40
WEST BENGAL				
594.	West Bengal	2023		30
595.	West Bengal	2022		30
596.	West Bengal	2021		30
597.	West Bengal	2020		30
598.	West Bengal	2019		30
599.	West Bengal	2018		30
600.	West Bengal	2017		30
601.	West Bengal	2016		30
602.	West Bengal	2015		30
603.	West Bengal	2014		30
604.	West Bengal	2013		30
605.	West Bengal	2012		30
606.	West Bengal	2011		30
607.	West Bengal	2010		30
608.	West Bengal	2009		30
609.	West Bengal	2008		30
	Total			36020

Trend Analysis of previous year paper of IIT JEE Mathematics through Bar graph and Pie chart.

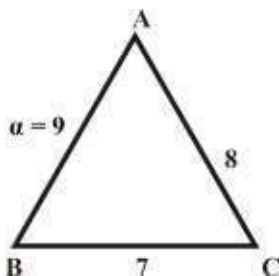


A. Trigonometric Ratios and their Identities

1. In a triangle ABC, $BC = 7$, $AC = 8$, $AB = \alpha \in \mathbb{N}$ and $\cos A = \frac{2}{3}$. If $49\cos(3C) + 42 = \frac{m}{n}$, where $\gcd(m, n) = 1$, then $m + n$ is equal to _____.

JEE MAIN-06.04.2024, Shift-II

Ans. (39) :



$$\therefore \cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\frac{2}{3} = \frac{8^2 + \alpha^2 - 7^2}{2 \times 8 \times \alpha}$$

$$32\alpha = 3\alpha^2 - 45$$

$$3\alpha^2 - 32\alpha - 45 = 0$$

Now, solving this quadratic equation

$$\alpha = 9 \text{ or } \frac{5}{3} \Rightarrow \alpha = 9$$

$$\text{Now, } \cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$\cos C = \frac{7^2 + 8^2 - 9^2}{2 \times 7 \times 8} = \frac{2}{7}$$

The value of $49 \cos 3C + 42$ -

$$= 49(4\cos^3 C - 3\cos C) + 42$$

$$= 49 \left(4 \left(\frac{2}{7} \right)^3 - 3 \left(\frac{2}{7} \right) \right) + 42$$

$$\Rightarrow \frac{32}{7} = \frac{m}{n}$$

So the value of $m + n = 32 + 7 = 39$

2. Let ABC be an equilateral triangle. A new triangle is formed by joining the middle points of all sides of the triangle ABC and the same process is repeated infinitely many times. If P is the sum of perimeters and Q is the sum of areas of all the triangles formed in this process, then:

(a) $P^2 = 36\sqrt{3}Q$

(b) $P^2 = 6\sqrt{3}Q$

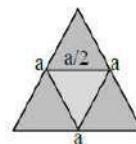
(c) $P = 36\sqrt{3}Q^2$

(d) $P^2 = 72\sqrt{3}Q$

JEE MAIN-06.04.2024, Shift-II

Ans. (a) : We know that,

$$\text{Area of equilateral triangle} = \frac{\sqrt{3}a^2}{4}$$



$$\text{Area of first triangle} = \frac{\sqrt{3}a^2}{4}$$

$$\text{Area of second triangle} = \frac{\sqrt{3}}{4} \frac{a^2}{4} = \frac{\sqrt{3}a^2}{16}$$

$$\text{Area of third triangle} = \frac{\sqrt{3}a^2}{64}$$

$$\text{Sum of all area (Q)} = \sqrt{3}a^2 \left(\frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \dots \right)$$

$$= \frac{\sqrt{3}}{4} a^2 \left(1 + \frac{1}{4} + \frac{1}{16} + \dots \right)$$

$$= \frac{\sqrt{3}}{4} a^2 \left(\frac{1}{1 - \frac{1}{4}} \right) = \frac{a^2}{\sqrt{3}}$$

$$\text{Perimeter of 1st triangle} = 3a$$

$$\text{Perimeter of 2nd triangle} = \frac{3a}{2}$$

$$\text{Perimeter of 3rd triangle} = \frac{3a}{4}$$

$$P = 3a \left(1 + \frac{1}{2} + \frac{1}{4} + \dots \right)$$

$$P = 3a \cdot 2 = 6a$$

$$a = \frac{P}{6}$$

$$Q = \frac{1}{\sqrt{3}} \cdot \frac{P^2}{36}$$

$$P^2 = 36\sqrt{3}Q$$

3. If A(1, -1, 2), B(5, 7, -6), C(3, 4, -10) and D(-1, -4, -2) are the vertices of a quadrilateral ABCD, then its area is:

(a) $12\sqrt{29}$

(b) $24\sqrt{29}$

(c) $24\sqrt{7}$

(d) $48\sqrt{7}$

JEE MAIN-05.04.2024, Shift-I

Ans. (a) : Given co-ordinate of quadrilateral, A (1, -1, 2), B(5, 7, -6), C(3, 4, -10) and D(-1, -4, -2)

$$\text{Area of quadrilateral ABCD} = \frac{1}{2} |\overrightarrow{AC} \times \overrightarrow{BD}|$$

$$= \frac{1}{2} |(2\hat{i} + 5\hat{j} - 12\hat{k}) \times (6\hat{i} + 11\hat{j} - 4\hat{k})|$$

$$A = \frac{1}{2} |112\hat{i} - 64\hat{j} - 8\hat{k}|$$

$$A = 4 |14\hat{i} - 8\hat{j} - \hat{k}|$$

$$A = 4\sqrt{196 + 64 + 1}$$

$$A = 4\sqrt{261}$$

$$A = 12\sqrt{29}$$

4. Let $S = \{\sin^2 2\theta : (\sin^4 \theta + \cos^4 \theta)x^2 + (\sin^2 \theta)x + (\sin^6 \theta + \cos^6 \theta) = 0 \text{ has real roots}\}$. If α and β be the smallest and largest elements of the set S , respectively, then $3((\alpha - 2)^2 + (\beta - 1)^2)$ equals...

JEE MAIN-04.04.2024, Shift-II

Ans.: (4)

$$D = (\sin^2 \theta)^2 -$$

$$4 \left((\sin^2 \theta + \cos^2 \theta)^2 - \frac{\sin^2 2\theta}{2} \right) \left((\sin^2 \theta + \cos^2 \theta)^3 - \frac{3}{4} \sin^2 2\theta \right)$$

$$= (\sin^2 2\theta)^2 - 4 \left(1 - \frac{5}{4} \sin^2 2\theta + \frac{3}{8} \sin^4 2\theta \right)$$

$$D = -\frac{3}{2} \sin^4 2\theta + 6 \sin^2 2\theta - 4 > 0$$

$$3 \sin^4 2\theta - 12 \sin^2 2\theta + 8 < 0$$

$$\sin^2 2\theta = \frac{12 \pm \sqrt{12^2 - 12 \cdot 8}}{6} = \frac{12 \pm 4\sqrt{3}}{6} = \frac{6 \pm 2\sqrt{3}}{3}$$

$$\sin^2 2\theta = 2 \pm \frac{2}{\sqrt{3}}, \text{ but } \sin^2 2\theta \in [0, 1]$$

$$\therefore \alpha = 2 - \frac{2}{\sqrt{3}}, \beta = 1$$

$$(\alpha - 2)^2 = \frac{4}{3}$$

$$(\beta - 1)^2 = 0$$

$$3[(\alpha - 2)^2 + (\beta - 1)^2]$$

$$3 \left[\frac{4}{3} + 0 \right] = 4$$

5. If the value of $\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$ is $\frac{a\sqrt{5} - b}{c}$, where a, b, c are natural numbers and gcd (a, c) = 1, then $a + b + c$ is equal to :
- (a) 50 (b) 40
(c) 52 (d) 54

JEE MAIN-08.04.2024, Shift-II

Ans. (c) : Given,

$$\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$$

$$\text{We know, } \cos 36^\circ = \frac{\sqrt{5} + 1}{4}$$

$$\sin 18^\circ = \frac{\sqrt{5} - 1}{4}$$

$$\frac{3 \left(\frac{\sqrt{5} + 1}{4} \right) + 5 \left(\frac{\sqrt{5} - 1}{4} \right)}{5 \left(\frac{\sqrt{5} + 1}{4} \right) - 3 \left(\frac{\sqrt{5} - 1}{4} \right)} = \frac{8\sqrt{5} - 2}{2\sqrt{5} + 8}$$

$$= \frac{4\sqrt{5} - 1}{\sqrt{5} + 4} \times \frac{\sqrt{5} - 4}{\sqrt{5} - 4}$$

$$= \frac{20 - 16\sqrt{5} - \sqrt{5} + 4}{-11}$$

$$= \frac{17\sqrt{5} - 24}{11} \Rightarrow a = 17, b = 24, c = 11$$

$$\text{So, } a + b + c = 52$$

6. If $\sin x = -\frac{3}{5}$, where $\pi < x < \frac{3\pi}{2}$, then $80(\tan^2 x - \cos x)$ is equal to :

- (a) 109 (b) 108
(c) 18 (d) 19

JEE MAIN-08.04.2024, Shift-I

Ans. (a) : Given,

$$\sin x = -\frac{3}{5}, \pi < x < \frac{3\pi}{2}$$

$$\cos x = -\sqrt{1 - \frac{9}{25}} = -\frac{4}{5}$$

$$\tan x = \frac{3}{4}$$

Then, $80(\tan^2 x - \cos x)$

$$= 80 \left(\frac{9}{16} + \frac{4}{5} \right) = 45 + 64 = 109$$

7. If $\tan A = \frac{1}{\sqrt{x(x^2 - x + 1)}}$, $\tan B = \frac{\sqrt{x}}{\sqrt{x^2 - x + 1}}$

and $\tan C = (x^3 - x^2 - x + 1)^{1/2}$, $0 < A, B, C < \frac{\pi}{2}$;

then $A+B$ is equal to:

- (a) C (b) C
(c) $2 - C$ (d) $\frac{\pi}{2} - C$

JEE MAIN-01.02.2024, Shift-I

Ans. (a) : Given,

$$\tan A = \frac{1}{\sqrt{x(x^2 - x + 1)}}, \tan B = \frac{\sqrt{x}}{\sqrt{x^2 - x + 1}}$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$$

$$\tan(A + B) = \frac{\frac{1}{\sqrt{x(x^2 - x + 1)}} + \frac{\sqrt{x}}{\sqrt{x^2 - x + 1}}}{1 - \frac{1}{\sqrt{x(x^2 - x + 1)}} \cdot \frac{\sqrt{x}}{\sqrt{x^2 - x + 1}}}$$

$$\tan(A + B) = \frac{\frac{1 + x}{\sqrt{x(x^2 - x + 1)}}}{\frac{x(x^2 - x + 1) - 1}{\sqrt{x(x^2 - x + 1)}}} = \frac{1 + x}{x^2 - x + 1}$$

$$\tan(A + B) = \frac{\sqrt{x^2 - x + 1}}{x\sqrt{x}} \quad \dots(i)$$

Given, $\tan C = \frac{1}{x^3} \cdot \frac{1}{x^2} \cdot \frac{1}{x}^{1/2}$

$$\tan C = \frac{\sqrt{1 - x + x^2}}{x\sqrt{x}} \quad \dots(ii)$$

From eq. (i) & (ii),

$$\tan(A + B) = \tan C$$

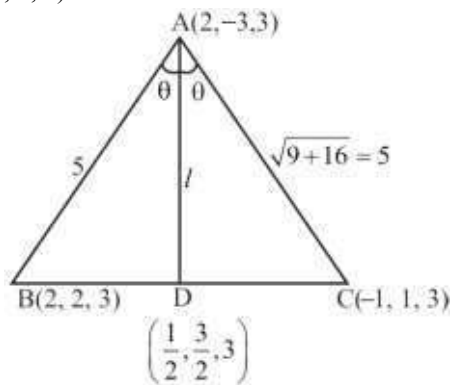
or $A + B = C$

8. The position vectors of the vertices A, B and C of triangle are $2\hat{i} - 3\hat{j} + 3\hat{k}$, $2\hat{i} + 2\hat{j} + 3\hat{k}$ and $-\hat{i} + \hat{j} + 3\hat{k}$ respectively. Let l denotes the length of the angle bisector AD of $\angle BAC$ where D is on the line segment BC, then $2l^2$ equals.

- (a) 49 (b) 42
(c) 50 (d) 45

JEE MAIN-27.01.2024, Shift-II

Ans. (d) : Vertices of triangle ABC are $(2, -3, 3)$, $(2, 2, 3)$, $(-1, 1, 3)$



$$AB = \sqrt{0 + 25 + 0} = 5$$

$$AC = \sqrt{9 + 16 + 0} = 5$$

$$\Rightarrow AB = AC$$

Also, AD is angle bisector of $\angle BAC$

\Rightarrow D is midpoint of BC

$$D\left(\frac{2-1}{2}, \frac{2+1}{2}, \frac{3+3}{2}\right)$$

$$l = AD = \sqrt{\left(2 - \frac{1}{2}\right)^2 + \left(-3 - \frac{3}{2}\right)^2 + (3-3)^2}$$

$$= \sqrt{\frac{45}{2}}$$

$$\therefore 2l^2 = 2 \times \frac{45}{2} = 45$$

9. If $2\sin^3 x + \sin 2x \cos x + 4\sin x - 4 = 0$ has exactly 3 solutions in the interval $\left[0, \frac{n\pi}{2}\right]$, $n \neq N$,

then the roots of the equation $x^2 + nx + (n-3) = 0$ belong to :

- (a) $(0, \infty)$ (b) $(-\infty, 0)$
(c) $\left(-\frac{\sqrt{17}}{2}, \frac{\sqrt{17}}{2}\right)$ (d) \mathbb{Z}

JEE MAIN-30.01.2024, Shift-I

Ans. (b) : Given,

$$2\sin^3 x + \sin 2x \cos x + 4\sin x - 4 = 0$$

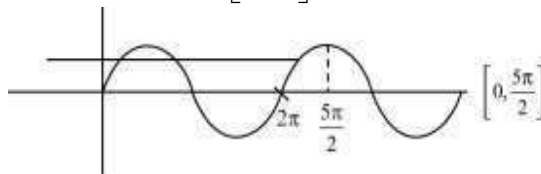
$$2\sin^3 x - 2\sin x \cos^2 x - 4\sin x + 4 = 0$$

$$2\sin^3 x - 2\sin x(1 - \sin^2 x) - 4\sin x + 4 = 0$$

$$2\sin^3 x - 6\sin x + 2\sin^3 x - 4 = 0$$

$$\sin x = \frac{2}{3}$$

For exactly 3 solution in $\left[0, \frac{n\pi}{2}\right]$ $n = 5$



$$\text{So, } x^2 - 5x + 2 = 0$$

, $\frac{5 \pm \sqrt{17}}{2}$ both root negative hence it lies $(-\infty, 0)$.

10. $96 \cos \frac{\pi}{33} \cos \frac{2\pi}{33} \cos \frac{4\pi}{33} \cos \frac{8\pi}{33} \cos \frac{16\pi}{33}$ is equal to:

- (a) 4 (b) 2
(c) 3 (d) 1

JEE MAIN-10.04.2023, Shift-I

Ans. (c) : Given,

$$96 \cos \frac{\pi}{33} \cos \frac{2\pi}{33} \cos \frac{2^2\pi}{33} \cos \frac{2^3\pi}{33} \cos \frac{2^4\pi}{33}$$

$$\therefore \cos A \cos 2A \cos 2^2 A \dots \cos 2^{n-1} A = \frac{\sin(2^n A)}{2^n \sin A}$$

$$\text{Here } A = \frac{\pi}{33}, n = 5$$

$$\begin{aligned}
 &= \frac{96 \sin\left(2^5 \frac{\pi}{33}\right)}{2^5 \sin\left(\frac{\pi}{33}\right)} \\
 &= \frac{96 \sin\left(\frac{32\pi}{33}\right)}{32 \sin\left(\frac{\pi}{33}\right)} \\
 &= \frac{3 \sin\left(\pi - \frac{\pi}{33}\right)}{\sin\left(\frac{\pi}{33}\right)} = 3 \quad \left\{ \because \sin(\pi - \theta) = \sin \theta \right\}
 \end{aligned}$$

11. Let the position vectors of the points A, B, C and D be $5\hat{i} + 5\hat{j} + 2\lambda\hat{k}$, $\hat{i} + 2\hat{j} + 3\hat{k} - 2\hat{i} + \lambda\hat{j} + 4\hat{k}$ and $-\hat{i} + 5\hat{j} + 6\hat{k}$. Let the set $S = \{\lambda \in \mathbb{R} : \text{the points A, B, C and D are coplanar}\}$. Then $\sum_{\lambda \in S} (\lambda + 2)^2$ is equal to:
- (a) $\frac{37}{2}$
 (b) 13
 (c) 25
 (d) 41

JEE MAIN-06.04.2023, Shift-I

Ans. (d) : $\overrightarrow{BA} \cdot (\overrightarrow{BC} \times \overrightarrow{BD}) = 0$

$$\begin{vmatrix} 4 & 3 & 2\lambda - 3 \\ -3 & \lambda - 2 & 1 \\ -2 & 3 & 3 \end{vmatrix} = 0$$

$$4(3\lambda - 6 - 3) - 3(-9 + 2) + (2\lambda - 3)(-9 + 2\lambda - 4) = 0$$

$$4(3\lambda - 9) - 3(-7) + (2\lambda - 3)(2\lambda - 13) = 0$$

$$12\lambda - 36 + 21 + 4\lambda^2 - 6\lambda - 26\lambda + 39 = 0$$

$$4\lambda^2 - 20\lambda + 24 = 0$$

$$\lambda^2 - 5\lambda + 6 = 0$$

$$(\lambda - 2)(\lambda - 3) = 0$$

$$\lambda = 2, 3$$

$$\sum_{\lambda \in S} (\lambda + 2)^2 = (2 + 2)^2 + 16$$

$$= (3 + 2)^2 = 25$$

$$\text{Hence, } 16 + 25 = 41$$

12. The value of $\cos 1^\circ \cos 2^\circ \cos 3^\circ \dots \cos 179^\circ$ is

- (a) $\frac{1}{\sqrt{2}}$
 (b) 0
 (c) 1
 (d) none of these

SRM JEEE-2010

Ans. (b) : Given,

$$\cos 1^\circ \cos 2^\circ \cos 3^\circ \dots \cos 179^\circ$$

$$= \cos 1^\circ \cos 2^\circ \cos 3^\circ \cos 4^\circ \dots \cos 89^\circ \cos 90^\circ \dots \cos 179^\circ$$

$$= \cos 1^\circ \cos 2^\circ \cos 3^\circ \dots \cos 89^\circ \cdot 0 \cdot \cos 91^\circ \dots \cos 179^\circ$$

$$= 0 (\cos 1^\circ \cos 2^\circ \cos 3^\circ \dots \cos 89^\circ \cos 91^\circ \dots \cos 179^\circ)$$

$$= 0$$

13. $\sqrt{2 + \sqrt{2 + 2\cos 4\theta}} =$

- (a) $\sqrt{2} \cdot \cos \theta$
 (b) $\frac{\cos \theta}{2}$
 (c) $2 \cos \theta$
 (d) $\frac{\cos \theta}{\sqrt{2}}$

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COMEDK-2011

Ans. (c) : Given, $\sqrt{2 + \sqrt{2 + 2\cos 4\theta}}$

$$= \sqrt{2 + \sqrt{2 + 2(2\cos^2 2\theta - 1)}}$$

$$= \sqrt{2 + \sqrt{2 + 4\cos^2 2\theta - 2}}$$

$$= \sqrt{2 + \sqrt{4\cos^2 2\theta}}$$

$$= \sqrt{2 + 2\cos 2\theta}$$

$$= \sqrt{2 + 2(2\cos^2 \theta - 1)} = \sqrt{2 + 4\cos^2 \theta - 2}$$

$$= \sqrt{4\cos^2 \theta} = 2 \cos \theta$$

14. Which of the following have the same value?

- (a) $\sin 120^\circ$
 (b) $\cos 930^\circ$
 (c) $\tan 840^\circ$
 (d) $\cot(-1110^\circ)$
 (A) only (c) and (d)
 (B) only (a) and (b)
 (C) only (a) and (c)
 (D) All (a), (b), (c), (d)

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Ans. (A) :

$$\bullet \sin 120^\circ = \sin(90^\circ + 30^\circ)$$

$$= \cos 30^\circ$$

$$= \frac{\sqrt{3}}{2}$$

$$\bullet \cos 930^\circ = \cos[(2 \times 360^\circ) + 210^\circ]$$

$$= \cos(210^\circ)$$

$$= \cos(180^\circ + 30^\circ)$$

$$= -\cos 30^\circ$$

$$= -\frac{\sqrt{3}}{2}$$

$$\bullet \tan 840^\circ = \tan[(2 \times 360^\circ) + 120^\circ]$$

$$= \tan(120^\circ)$$

$$= \tan(90^\circ + 30^\circ)$$

$$= -\cot 30^\circ$$

$$= -\sqrt{3}$$

$$\bullet \cot(-1110^\circ) = -\cot(1110^\circ)$$

$$= -\cot[(3 \times 360^\circ) + 30^\circ]$$

$$= -\cot(30^\circ)$$

$$= -\sqrt{3}$$

So, only (c) and (d) have the same value.

15. $\frac{\cos 12^\circ - \sin 12^\circ}{\cos 12^\circ + \sin 12^\circ} + \frac{\sin 147^\circ}{\cos 147^\circ} =$

- (a) 1
 (b) -1
 (c) 0
 (d) -2

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Ans. (c) : Given, $\frac{\cos 12^\circ - \sin 12^\circ}{\cos 12^\circ + \sin 12^\circ} + \frac{\sin 147^\circ}{\cos 147^\circ}$

$$= \frac{\cos 12^\circ - \sin(90^\circ - 78^\circ)}{\cos 12^\circ + \sin(90^\circ - 78^\circ)} + \tan 147^\circ$$

$$= \frac{\cos 12^\circ - \cos 78^\circ}{\cos 12^\circ + \cos 78^\circ} + \tan 147^\circ$$

$$= \frac{-2 \sin\left(\frac{12^\circ + 78^\circ}{2}\right) \sin\left(\frac{12^\circ - 78^\circ}{2}\right)}{2 \cos\left(\frac{12^\circ + 78^\circ}{2}\right) \cos\left(\frac{12^\circ - 78^\circ}{2}\right)} + \tan(180^\circ - 33^\circ)$$

$$= \frac{-2 \sin 45^\circ \sin(-33^\circ)}{2 \cos 45^\circ \cos(-33^\circ)} + (-\tan 33^\circ) \left\{ \begin{array}{l} \because \sin(-\theta) = -\sin \theta \\ \cos(-\theta) = \cos \theta \end{array} \right\}$$

$$= \tan 45^\circ \tan 33^\circ - \tan 33^\circ$$

$$= \tan 33^\circ - \tan 33^\circ$$

$$= 0$$

16. $\sin 690^\circ \times \sec 240^\circ =$

- (a) $\frac{-1}{2}$ (b) 1
(c) -1 (d) $\frac{1}{2}$

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Ans. (b) : Given, $\sin 690^\circ \times \sec 240^\circ$

$$= \sin(360^\circ + 330^\circ) \times \sec(180^\circ + 60^\circ)$$

$$= \sin 330^\circ \times (-\sec 60^\circ)$$

$$= \sin(360^\circ - 30^\circ) \times (-2)$$

$$= -2 \times (-\sin 30^\circ)$$

$$= -2 \times -\frac{1}{2} = 1$$

17. If $A + B + C = 180^\circ$, then the value of

$$\tan\left(\frac{A}{2}\right)\tan\left(\frac{B}{2}\right) + \tan\left(\frac{B}{2}\right)\tan\left(\frac{C}{2}\right) + \tan\left(\frac{C}{2}\right)\tan\left(\frac{A}{2}\right)$$

is

- (a) 2 (b) 1
(c) -2 (d) -1

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Ans. (b) : Given, $A + B + C = 180^\circ$

Or $A + B = 180^\circ - C$

Dividing both side by 2, we get -

$$\frac{A+B}{2} = \frac{180^\circ - C}{2}$$

$$\tan\left(\frac{A+B}{2}\right) = \tan\left(\frac{180^\circ - C}{2}\right)$$

$$\tan\left(\frac{A}{2} + \frac{B}{2}\right) = \tan\left(90^\circ - \frac{C}{2}\right)$$

$$\frac{\tan \frac{A}{2} + \tan \frac{B}{2}}{1 - \tan \frac{A}{2} \tan \frac{B}{2}} = \cot \frac{C}{2}$$

$$\frac{\tan \frac{A}{2} + \tan \frac{B}{2}}{1 - \tan \frac{A}{2} \tan \frac{B}{2}} = \frac{1}{\tan C/2}$$

$$\tan \frac{C}{2} \left(\tan \frac{A}{2} + \tan \frac{B}{2} \right) = 1 - \tan \frac{A}{2} \tan \frac{B}{2}$$

$$\tan \frac{C}{2} \tan \frac{A}{2} + \tan \frac{B}{2} \tan \frac{C}{2} + \tan \frac{A}{2} \tan \frac{B}{2} = 1$$

18. If A, B, C are angles of a ΔABC , then $\tan 2A + \tan 2B + \tan 2C =$

- (a) $\tan 2A \tan 2B \tan 2C$
(b) $\tan A \tan B \tan C$
(c) $\tan 3A \tan 2B \tan 2C$
(d) $\tan 2A \tan 3B \tan 2C$

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Ans. (a) : We know that,

$$A + B + C = \pi$$

On multiplying by 2 on both the side we get-

$$2A + 2B + 2C = 2\pi$$

$$2A + 2B = 2\pi - 2C$$

$$\tan(2A + 2B) = \tan(2\pi - 2C)$$

$$\frac{\tan 2A + \tan 2B}{1 - \tan 2A \tan 2B} = -\tan 2C$$

$$\tan 2A + \tan 2B = -\tan 2C (1 - \tan 2A \tan 2B)$$

$$\tan 2A + \tan 2B = -\tan 2C + \tan 2A \tan 2B \tan 2C$$

$$\tan 2A + \tan 2B + \tan 2C = \tan 2A \tan 2B \tan 2C$$

19. If $\sin \theta = \frac{-12}{13}$, $\cos \phi = \frac{-4}{5}$ and θ, ϕ lie in the third quadrant, then $\tan(\theta - \phi) =$

- (a) $\frac{-33}{56}$ (b) $\frac{-56}{33}$
(c) $\frac{56}{33}$ (d) $\frac{33}{56}$

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Ans. (d) : Given, $\sin \theta = \frac{-12}{13}$, $\cos \phi = \frac{-4}{5}$

We know that, $\cos \theta = \sqrt{1 - \sin^2 \theta}$

$$\cos \theta = \sqrt{1 - \left(\frac{-12}{13}\right)^2}$$

$$\cos \theta = \sqrt{1 - \frac{144}{169}}$$

$$\cos \theta = \sqrt{\frac{25}{169}}$$

$$\cos \theta = \pm \frac{5}{13}$$

$$\cos \theta = \frac{-5}{13} \quad [\because \theta \text{ lies in third quadrant}]$$

$$\therefore \tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{-12/13}{-5/13} = \frac{12}{5}$$

And $\sin \phi = \sqrt{1 - \cos^2 \phi} = \sqrt{1 - \left(-\frac{4}{5}\right)^2}$

$$\sin \phi = \sqrt{1 - \frac{16}{25}} = \sqrt{\frac{9}{25}} = \pm \frac{3}{5}$$

$$\sin \phi = \frac{-3}{5} \quad [\because \phi \text{ lies in third quadrant}]$$

$$\therefore \tan \phi = \frac{\sin \phi}{\cos \phi}$$

$$\tan \phi = \frac{-3/5}{-4/5}$$

$$\tan \phi = \frac{3}{4}$$

So, $\tan(\theta - \phi) = \frac{\tan \theta - \tan \phi}{1 + \tan \theta \tan \phi}$

$$= \frac{\frac{12}{5} - \frac{3}{4}}{1 + \frac{12}{5} \times \frac{3}{4}} = \frac{\frac{33}{20}}{\frac{56}{20}} = \frac{33}{56}$$

20. $\tan A + 2 \tan 2A + 4 \tan 4A + 8 \cot 8A =$
 (a) $\tan A$ (b) $\tan 2A$
 (c) $\cot A$ (d) $\cot 2A$

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Ans. (c) : Given, $\tan A + 2 \tan 2A + 4 \tan 4A + 8 \cot 8A$

$$\tan A + 2 \tan 2A + 4 \tan 4A + \frac{8}{\tan 8A}$$

$$\tan A + 2 \tan 2A + 4 \tan 4A + \frac{8(1 - \tan^2 4A)}{2 \tan 4A}$$

$$\tan A + 2 \tan 2A + 4 \tan 4A + \frac{4(1 - \tan^2 4A)}{\tan 4A}$$

$$= \tan A + 2 \tan 2A + \frac{4 \tan^2 4A + 4 - 4 \tan^2 4A}{\tan 4A}$$

$$= \tan A + 2 \tan 2A + \frac{4}{\tan 4A}$$

$$= \tan A + 2 \tan 2A + \frac{4(1 - \tan^2 2A)}{2 \tan 2A}$$

$$= \tan A + \frac{4 \tan^2 2A + 4 - 4 \tan^2 2A}{2 \tan 2A}$$

$$= \tan A + \frac{4}{2 \tan 2A} = \tan A + \frac{2}{\tan 2A}$$

$$= \tan A + \frac{2(1 - \tan^2 A)}{2 \tan A}$$

$$= \tan A + \frac{1 - \tan^2 A}{\tan A}$$

$$= \frac{\tan^2 A + 1 - \tan^2 A}{\tan A} = \frac{1}{\tan A} = \cot A$$

21. If $a = \sin 175^\circ + \cos 175^\circ$, then
 (a) $a = 0$ (b) $a < 0$
 (c) $a > 0$ (d) $a = 1$

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Ans. (b) : Given, $a = \sin 175^\circ + \cos 175^\circ$
 $a = \sin(180^\circ - 5^\circ) + \cos(180^\circ - 5^\circ)$
 $a = \sin 5^\circ - \cos 5^\circ$

If, $\theta \in (0, \pi/4)$

Then, $\cos \theta > \sin \theta$

$$\therefore \cos 5^\circ > \sin 5^\circ$$

$$a = \sin 5^\circ - \cos 5^\circ$$

$$\therefore a < 0$$

22. $\cos(36^\circ - A) \cos(36^\circ + A) + \cos(54^\circ + A) \cos(54^\circ - A) =$
 (a) $\cos A$ (b) $\sin A$
 (c) $\sin 2A$ (d) $\cos 2A$

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Ans. (d) : Given,

$$\cos(36^\circ - A) \cos(36^\circ + A) + \cos(54^\circ - A) \cos(54^\circ + A)$$

$$= \cos(36^\circ - A) \cos(36^\circ + A) + \cos[90^\circ - (36^\circ - A)]$$

$$\cos[90^\circ - (36^\circ + A)]$$

$$= \cos(36^\circ - A) \cos(36^\circ + A) + \sin(36^\circ - A) \sin(36^\circ + A)$$

$$= \cos[(36^\circ - A) - (36^\circ + A)]$$

$$[\because \cos(A - B) = \cos A \cos B + \sin A \sin B]$$

$$= \cos[36^\circ - A - 36^\circ - A]$$

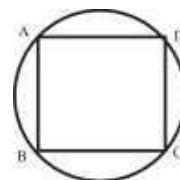
$$= \cos(-2A) \quad \{\cos(-\theta) = \cos \theta\}$$

$$= \cos 2A$$

23. If A, B, C are the angle of a cyclic quadrilateral taken in order, then $\cos A + \cos B + \cos C + \cos D =$
 (a) -1 (b) $\frac{1}{2}$
 (c) 0 (d) 1

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Ans. (c) : It is given that, ABCD is a cyclic quadrilateral



In cyclic quadrilateral sum of opposite angles are supplementary

$$A + C = \pi = 180 \quad \dots(i)$$

$$B + D = \pi = 180 \quad \dots(ii)$$

From equation (i)–

$$A = \pi - C$$

Taking cosines on both sides,

$$\cos A = \cos(\pi - C)$$

$$\cos A = \cos \pi \cdot \cos C + \sin \pi \cdot \sin C$$

$$\cos A = -1 \cdot \cos C + 0 \cdot \sin C$$

$$\cos A + \cos C = 0 \quad \dots(iii)$$

From equation (ii) –

$$B = \pi - D$$

Taking cosines on both sides

$$\begin{aligned}\cos B &= \cos(\pi - D) \\ \cos B &= \cos \pi \cdot \cos D + \sin \pi \cdot \sin D \\ \cos B &= -\cos D + 0 \\ \cos B + \cos D &= 0 \quad \dots (iv) \\ \text{Adding equation (iii) and (iv), we get-} \\ \cos A + \cos B + \cos C + \cos D &= 0\end{aligned}$$

24. If $\sin \theta = \sin 15^\circ + \sin 45^\circ$, where $0^\circ < \theta < 180^\circ$, then $\theta =$
 (a) 45° (b) 60° (c) 75° (d) 150°

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Ans. (c) : Given,
 $\sin \theta = \sin 15^\circ + \sin 45^\circ$
 $\sin \theta = 2 \sin \left(\frac{15^\circ + 45^\circ}{2} \right) \cos \left(\frac{45^\circ - 15^\circ}{2} \right)$
 $\sin \theta = 2 \sin 30^\circ \cos 15^\circ$
 $\sin \theta = 2 \times \frac{1}{2} \cos 15^\circ$
 $\sin \theta = \cos 15^\circ$
 $\sin \theta = \cos(90^\circ - 75^\circ)$
 $\sin \theta = \sin 75^\circ$
 $\theta = 75^\circ$

25. $\cos \left(\frac{3\pi}{4} + x \right) - \sin \left(\frac{\pi}{4} - x \right) =$
 (a) $\sqrt{2} \cos x$ (b) $\sqrt{2} \sin x$
 (c) $-\sqrt{2} \cos x$ (d) $-\sqrt{2} \sin x$

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Ans. (c) : Given, $\cos \left(\frac{3\pi}{4} + x \right) - \sin \left(\frac{\pi}{4} - x \right)$
 $= \left(\cos \frac{3\pi}{4} \cos x - \sin \frac{3\pi}{4} \sin x \right) - \left(\sin \frac{\pi}{4} \cos x - \cos \frac{\pi}{4} \sin x \right)$
 $= \frac{-1}{\sqrt{2}} \cos x - \frac{1}{\sqrt{2}} \sin x - \frac{1}{\sqrt{2}} \cos x + \frac{1}{\sqrt{2}} \sin x$
 $= -\sqrt{2} \cos x$

26. $\sec 2\theta - \tan 2\theta =$
 (a) $\cot \left(\frac{\pi}{4} - \theta \right)$ (b) $\cot 2\theta$
 (c) $\tan 2\theta$ (d) $\tan \left(\frac{\pi}{4} - \theta \right)$

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Ans. (d) : Given, $\sec 2\theta - \tan 2\theta$
 $= \frac{1}{\cos 2\theta} - \frac{\sin 2\theta}{\cos 2\theta} = \frac{1 - \sin 2\theta}{\cos 2\theta}$
 $= \frac{\cos^2 \theta + \sin^2 \theta - 2 \sin \theta \cos \theta}{\cos^2 \theta - \sin^2 \theta}$
 $= \frac{(\cos \theta - \sin \theta)^2}{(\cos \theta - \sin \theta)(\cos \theta + \sin \theta)}$
 $= \frac{\cos \theta - \sin \theta}{\cos \theta + \sin \theta}$

$$\begin{aligned}\frac{\cos \theta - \sin \theta}{\cos \theta + \sin \theta} &= \frac{1 - \tan \theta}{1 + \tan \theta} \\ \frac{\cos \theta}{\cos \theta} &= \frac{1 - \tan \theta}{1 + \tan \theta} \\ \frac{\tan \frac{\pi}{4} - \tan \theta}{1 + \tan \frac{\pi}{4} \cdot \tan \theta} &= \tan \left(\frac{\pi}{4} - \theta \right)\end{aligned}$$

27. If $\sec \theta = \frac{13}{12}$, θ lies in 4th quadrant, then

$$\tan \theta \times \operatorname{cosec} \theta \times \sin \theta \times \cos \theta =$$

- (a) $\frac{25}{169}$ (b) $\frac{-5}{13}$
 (c) $\frac{5}{13}$ (d) $\frac{144}{169}$

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Ans. (b) : Given, $\sec \theta = \frac{13}{12}$ and $\cos \theta = \frac{12}{13}$

$$\begin{aligned}\therefore \sin \theta &= \sqrt{1 - \cos^2 \theta} \\ \sin \theta &= \sqrt{1 - \left(\frac{12}{13} \right)^2} \\ \sin \theta &= \sqrt{1 - \left(\frac{144}{169} \right)} \\ \sin \theta &= \sqrt{\frac{25}{169}} = \pm \frac{5}{13} \\ \sin \theta &= -\frac{5}{13} \quad [\theta \text{ lies in 4}^{\text{th}} \text{ quadrant}] \\ \operatorname{cosec} \theta &= -\frac{13}{5} \\ \therefore \tan \theta &= \frac{\sin \theta}{\cos \theta} = \frac{(-5/13)}{(12/13)} = -\frac{5}{12}\end{aligned}$$

Therefore, $\tan \theta \times \operatorname{cosec} \theta \times \sin \theta \times \cos \theta$

$$= \left(-\frac{5}{12} \right) \times \left(-\frac{13}{5} \right) \times \left(-\frac{5}{13} \right) \times \left(\frac{12}{13} \right) = -\frac{5}{13}$$

28. $\cos x \cdot \cos 7x - \cos 5x \cos 13x =$
 (a) $2 \cos^2 6x \cdot \cos 12x$ (b) $2 \sin 6x \cdot \sin 12x$
 (c) $2 \sin 6x \cdot \cos 12x$ (d) $2 \sin^2 6x \cdot \cos 6x$

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Ans. (d) : Given,
 $\cos x \cos 7x - \cos 5x \cos 13x$
 $= \frac{1}{2} (2 \cos x \cos 7x - 2 \cos 5x \cos 13x)$
 $= \frac{1}{2} \left(\cos(x + 7x) + \cos(x - 7x) - \{ \cos(5x + 13x) + \cos(5x - 13x) \} \right)$
 $= \frac{1}{2} \cos 8x + \cos(-6x) - [\cos 18x + \cos(-8x)]$

$$\begin{aligned}
&= \frac{1}{2}(\cos 8x + \cos 6x - \cos 18x - \cos 8x) \\
&= \frac{1}{2}(\cos 6x - \cos 18x) \\
&= \frac{1}{2}(-2)\sin 12x \sin(-6x) \\
&= \sin 12x \sin 6x = (2 \sin 6x \cos 6x) \sin 6x \\
&= 2\sin^2 6x \cos 6x
\end{aligned}$$

29. If $\cos x + \cos y = -\cos \alpha$ and $\sin x + \sin y = -\sin \alpha$, then $\cot\left(\frac{x+y}{2}\right) =$

- (a) $\cot \alpha$ (b) $-\cot \alpha$
(c) $\tan \alpha$ (d) $-\tan \alpha$

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Ans. (a) : Given, $\sin x + \sin y = -\sin \alpha$

And, $\cos x + \cos y = -\cos \alpha$

$$2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) = -\cos \alpha \quad \dots(i)$$

Similarly, $\sin x + \sin y = -\sin \alpha$

$$2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) = -\sin \alpha \quad \dots(ii)$$

On dividing equation (i) & (ii), we get –

$$\frac{2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)}{2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)} = \frac{-\cos \alpha}{-\sin \alpha}$$

$$\cot\left(\frac{x+y}{2}\right) = \cot \alpha$$

30. $\frac{\sin(A+B)}{\sin(A-B)} = \frac{\cos(C+D)}{\cos(C-D)}$, then $\tan A \cot B =$

- (a) $-\cot C \cot D$ (b) $-\tan C \tan D$
(c) $\cot C \cot D$ (d) $\tan C \tan D$

MHT CET-2020

Ans. (a) : Given,

$$\frac{\sin(A+B)}{\sin(A-B)} = \frac{\cos(C+D)}{\cos(C-D)}$$

By using componendo and dividendo rule–

$$\frac{\sin(A+B) + \sin(A-B)}{\sin(A+B) - \sin(A-B)} = \frac{\cos(C+D) + \cos(C-D)}{\cos(C+D) - \cos(C-D)}$$

$$\frac{2\sin A \cos B}{2\cos A \sin B} = \frac{2\cos C \cos D}{-2\sin C \sin D}$$

$$\tan A \cot B = -\cot C \cot D$$

31. The value of $\cos^{-1}\left(\cos\left(\frac{7\pi}{6}\right)\right)$ is

- (a) $\frac{\pi}{3}$ (b) $\frac{7\pi}{6}$
(c) $\frac{5\pi}{6}$ (d) $\frac{\pi}{6}$

MHT CET-2020

Ans. (c) : Given, $\cos^{-1}\left(\cos\left(\frac{7\pi}{6}\right)\right)$

$$= \cos^{-1}\left(\cos\left(2\pi - \frac{5\pi}{6}\right)\right)$$

$$= \cos^{-1}\left(\cos\left(\frac{5\pi}{6}\right)\right) = \frac{5\pi}{6}$$

32. $\operatorname{cosec} 2\theta - \cot 2\theta =$

- (a) $\sin \theta$ (b) $\cos \theta$
(c) $\tan 2\theta$ (d) $\tan \theta$

MHT CET-2020

Ans. (d) : Given, $\operatorname{cosec} 2\theta - \cot 2\theta$

$$= \frac{1}{\sin 2\theta} - \frac{\cos 2\theta}{\sin 2\theta}$$

$$= \frac{1 - \cos 2\theta}{\sin 2\theta} = \frac{1 - (1 - 2\sin^2 \theta)}{\sin 2\theta}$$

$$= \frac{1 - 1 + 2\sin^2 \theta}{2\sin \theta \cos \theta} = \tan \theta$$

33. If A and B are supplementary angles, then $\sin^2 \frac{A}{2} + \sin^2 \frac{B}{2} =$

- (a) $\frac{1}{2}$ (b) $\frac{1}{3}$
(c) 1 (d) 0

MHT CET-2020

Ans. (c) : If A and B are supplementary angles

Then, $A + B = 180^\circ$

$$A = 180^\circ - B$$

$$\frac{A}{2} = 90^\circ - \frac{B}{2}$$

We know that,

$$\sin^2\left(\frac{A}{2}\right) + \cos^2\left(\frac{A}{2}\right) = 1$$

$$\sin^2\left(\frac{A}{2}\right) + \cos^2\left(90^\circ - \frac{B}{2}\right) = 1$$

$$\sin^2\left(\frac{A}{2}\right) + \sin^2\left(\frac{B}{2}\right) = 1$$

34. If two angles of ΔABC are $\frac{\pi}{4}$ and $\frac{\pi}{3}$ and then the ratio of the smallest and greatest side is

- (a) $\sqrt{3} : \sqrt{2}$ (b) $(\sqrt{3} + 1) : (\sqrt{3} - 1)$
(c) $(\sqrt{3} + 1) : 1$ (d) $(\sqrt{3} - 1) : 1$

MHT CET-2020

Ans. (d) : Given, two angle of triangle are $\frac{\pi}{4}$ and $\frac{\pi}{3}$

Let the third angle is α .

$$\therefore \frac{\pi}{4} + \frac{\pi}{3} + \alpha = \pi$$

$$45^\circ + 60^\circ + \alpha = 180^\circ$$

$$\alpha = 75^\circ$$

We know that, side opposite to smallest angle is the smallest side and side opposite to the largest angle is the largest side –

$$\frac{c}{\sin 75^\circ} = \frac{a}{\sin 45^\circ}$$

$$\frac{c}{\frac{\sqrt{3}+1}{2\sqrt{2}}} = \frac{a}{\frac{1}{\sqrt{2}}} \quad \left[\because \sin 75^\circ = \frac{\sqrt{3}+1}{2\sqrt{2}} \right]$$

$$\frac{c(2\sqrt{2})}{\sqrt{3}+1} = \sqrt{2}a$$

$$\frac{a}{c} = \frac{2}{\sqrt{3}+1} = \frac{2}{\sqrt{3}+1} \times \frac{\sqrt{3}-1}{\sqrt{3}-1}$$

$$\frac{a}{c} = \frac{2(\sqrt{3}-1)}{2} = \frac{(\sqrt{3}-1)}{1}$$

Hence, $a : c = (\sqrt{3}-1) : 1$

35. In ΔABC , with usual notations, if

$$(a-b)^2 = c^2 - ab, \text{ then } \tan C =$$

- (a) 1 (b) Not defined
(c) $\frac{1}{\sqrt{3}}$ (d) $\sqrt{3}$

MHT CET-2019

Ans. (d) : Given, $(a-b)^2 = c^2 - ab$

$$a^2 + b^2 - 2ab = c^2 - ab$$

$$a^2 + b^2 - 2ab + ab = c^2$$

$$a^2 + b^2 - c^2 = ab$$

$$\frac{a^2 + b^2 - c^2}{2ab} = \frac{1}{2}$$

$$\cos C = \frac{1}{2}$$

$$\therefore \sin C = \sqrt{1 - \cos^2 C}$$

$$\sin C = \sqrt{1 - \left(\frac{1}{2}\right)^2} = \sqrt{1 - \frac{1}{4}}$$

$$\sin C = \sqrt{\frac{3}{4}}$$

$$\sin C = \frac{\sqrt{3}}{2}$$

$$\therefore \tan C = \frac{\sin C}{\cos C} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}$$

36. In ΔABC , with usual notations; if

$$\cos A = \sin B - \cos C, \text{ then } \cos A \cdot \cos C =$$

- (a) $\frac{1}{4}$ (b) 0 (c) $\frac{1}{2}$ (d) $\frac{\sqrt{3}}{4}$

MHT CET-2019

Ans. (b) : Given, $\cos A = \sin B - \cos C$

$$\text{Or } \cos A + \cos C = \sin B$$

$$2 \cos \left(\frac{A+C}{2} \right) \cdot \cos \left(\frac{A-C}{2} \right) = \sin B$$

$$2 \cos \left(\frac{\pi-B}{2} \right) \cdot \cos \left(\frac{A-C}{2} \right) = \sin B \quad [\because A+B+C=\pi]$$

$$2 \sin \left(\frac{B}{2} \right) \cdot \cos \left(\frac{A-C}{2} \right) = 2 \sin \frac{B}{2} \cos \frac{B}{2}$$

$$\cos \left(\frac{A-C}{2} \right) = \cos \left(\frac{B}{2} \right)$$

$$\frac{A-C}{2} = \frac{B}{2}$$

$$A-C=B$$

$$A=B+C$$

We know that, $A+B+C=180^\circ$

$$A+A=180^\circ$$

$$2A=180^\circ$$

$$A=90^\circ$$

$$\cos A=0$$

Hence, $\cos A \cdot \cos C = 0$

37. In ΔABC ; with usual notations, if

$$\cos A = \frac{\sin B}{\sin C}, \text{ then the triangle is}$$

- (a) Right angled triangle
(b) Equilateral triangle
(c) Acute angled triangle
(d) Obtuse angled triangle

MHT CET-2019

Ans. (a) : Given, $\cos A = \frac{\sin B}{\sin C}$ (i)

By sine rule,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = k$$

$$\therefore \frac{a}{k} = \sin A, \frac{b}{k} = \sin B, \frac{c}{k} = \sin C$$

By cosine rule,

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\therefore \frac{b^2 + c^2 - a^2}{2bc} = \frac{\frac{b}{k}}{\frac{c}{k}}$$

$$\frac{b^2 + c^2 - a^2}{2bc} = \frac{b}{c}$$

$$b^2 + c^2 - a^2 = 2b^2$$

$$c^2 - a^2 = b^2$$

$$c^2 = a^2 + b^2$$

So, ΔABC is right angled triangle.

38. If A, B, C are the angles of ΔABC then
 $\cot A \cdot \cot B + \cot B \cdot \cot C + \cot C \cdot \cot A =$

- (a) 0 (b) 1
(c) 2 (d) -1

MHT CET-2018

Ans. (b) : We know that,
 $\tan A + \tan B + \tan C = \tan A \tan B \tan C$
 Dividing by $\tan A \tan B \tan C$ both side, we get –
 $\therefore \frac{1}{\tan B \tan C} + \frac{1}{\tan A \tan C} + \frac{1}{\tan A \tan B} = 1$
 $\therefore \cot B \cot C + \cot A \cot C + \cot A \cot B = 1$

- 39. The value of $\sin^2 51^\circ + \sin^2 39^\circ$ is**
 (a) 0 (b) $\sin 12^\circ$
 (c) $\cos 12^\circ$ (d) 1

Karnataka CET-2020

Ans. (d) : Given, $\sin^2 51^\circ + \sin^2 39^\circ$
 $= \sin^2 51^\circ + \sin^2 (90^\circ - 51^\circ)$
 $= \sin^2 51^\circ + \cos^2 51^\circ$ [$\therefore \sin(90^\circ - \theta) = \cos \theta$]
 $= 1$

- 40. The value of $\cos^2 45^\circ - \sin^2 15^\circ$ is**

- (a) $\frac{\sqrt{3}+1}{2\sqrt{2}}$ (b) $\frac{\sqrt{3}}{4}$
 (c) $\frac{\sqrt{3}-1}{2\sqrt{2}}$ (d) $\frac{\sqrt{3}}{2}$

Karnataka CET-2017

Ans. (b) : Given,
 $\cos^2 45^\circ - \sin^2 15^\circ$
 $= \left(\frac{1}{\sqrt{2}}\right)^2 - \left(\frac{1 - \cos(2 \times 15^\circ)}{2}\right)$ [$\therefore \cos 2\theta = 1 - 2\sin^2 \theta$]
 $= \frac{1}{2} - \left(\frac{1 - \cos 30^\circ}{2}\right) = \frac{1 - 1 + \cos 30^\circ}{2}$
 $= \frac{\cos 30^\circ}{2} = \frac{\sqrt{3}}{2 \times 2} = \frac{\sqrt{3}}{4}$

- 41. $\sqrt{3} \operatorname{cosec} 20^\circ - \sec 20^\circ =$**

- (a) 2 (b) 4
 (c) 3 (d) 1

Karnataka CET-2019

Ans. (b) : Given, $\sqrt{3} \operatorname{cosec} 20^\circ - \sec 20^\circ$
 $= 2 \left(\frac{\sqrt{3}}{2} \operatorname{cosec} 20^\circ - \frac{1}{2} \sec 20^\circ \right)$
 $= 2 (\sin 60^\circ \operatorname{cosec} 20^\circ - \cos 60^\circ \sec 20^\circ)$
 $= 2 \left(\frac{\sin 60^\circ}{\sin 20^\circ} - \frac{\cos 60^\circ}{\cos 20^\circ} \right)$
 $= 2 \times 2 \left(\frac{\sin 60^\circ \cos 20^\circ - \cos 60^\circ \sin 20^\circ}{2 \sin 20^\circ \cos 20^\circ} \right)$
 $= 4 \left(\frac{\sin(60^\circ - 20^\circ)}{2 \sin 20^\circ \cos 20^\circ} \right)$ [$\therefore \sin 2\theta = 2 \sin \theta \cos \theta$]
 $= 4 \left(\frac{\sin 40^\circ}{\sin 40^\circ} \right) = 4$

- 42. The value of $\tan(1^\circ) + \tan(89^\circ)$ is.....**

- (a) $\frac{2}{\sin(2^\circ)}$ (b) $\frac{1}{\sin(2^\circ)}$
 (c) $\frac{1}{\sin(1^\circ)}$ (d) $\frac{2}{\sin(1^\circ)}$

Karnataka CET-2015

Ans. (a) : Given, $\tan(1^\circ) + \tan(89^\circ)$
 $= \tan(1^\circ) + \tan(90^\circ - 1^\circ)$ [$\therefore \tan(90^\circ - \theta) = \cot \theta$]
 $= \tan(1^\circ) + \cot(1^\circ)$
 $= \frac{\sin 1^\circ}{\cos 1^\circ} + \frac{\cos 1^\circ}{\sin 1^\circ}$
 $= \frac{\sin^2 1^\circ + \cos^2 1^\circ}{\cos 1^\circ \sin 1^\circ}$

On multiply and divide by 2, we get–

$$= \frac{2 \times 1}{2 \cos 1^\circ \sin 1^\circ} = \frac{2}{\sin 2^\circ}$$

- 43. $\log(\sin 1^\circ) \times \log(\sin 2^\circ) \times \log(\sin 3^\circ) \dots \dots \dots$**

$\log(\sin 179^\circ)$

- (a) is positive (b) is negative
 (c) lies between 1 and 180 (d) is zero

Karnataka CET-2013

Ans. (d) : Given,
 $\log(\sin 1^\circ) \times \log(\sin 2^\circ) \times \log(\sin 3^\circ) \dots \times \log(\sin 179^\circ)$
 $= \log(\sin 1^\circ) \times \log(\sin 2^\circ) \times \log(\sin 3^\circ) \dots \times \log(\sin 179^\circ)$
 $= \log(\sin 1^\circ) \times \log(\sin 2^\circ) \times \dots \times \log(1) \times \dots \times \log(\sin 179^\circ)$
 $= \log(\sin 1^\circ) \times \log(\sin 2^\circ) \times \dots \times 0 \times \dots \times \log(\sin 179^\circ)$
 $= 0$

- 44. The value of $\sin 10^\circ \cdot \sin 30^\circ \cdot \sin 50^\circ \cdot \sin 70^\circ$ is**

- (a) $\frac{1}{8}$ (b) $\frac{3}{16}$
 (c) $\frac{\sqrt{3}}{16}$ (d) $\frac{1}{16}$

Karnataka CET-2011

Ans. (d) : Given, $\sin 10^\circ \cdot \sin 30^\circ \cdot \sin 50^\circ \cdot \sin 70^\circ$
 $= \frac{1}{2} (\sin 10^\circ \cdot \sin 50^\circ \cdot \sin 70^\circ)$
 $= \frac{1}{4} (2 \sin 10^\circ \cdot \sin 50^\circ) \cdot \sin 70^\circ$
 $= \frac{1}{4} [\cos(50^\circ - 10^\circ) - \cos(50^\circ + 10^\circ)] \sin 70^\circ$
 $= \frac{1}{4} [\cos(40^\circ) - \cos(60^\circ)] \sin 70^\circ$
 $= \frac{1}{4} \left[\cos(40^\circ) - \frac{1}{2} \right] \sin 70^\circ$
 $= \frac{1}{4} (\cos 40^\circ \sin 70^\circ) - \frac{1}{8} \sin 70^\circ$
 $= \frac{1}{8} (2 \cos 40^\circ \sin 70^\circ) - \frac{1}{8} \sin 70^\circ$

$$\begin{aligned}
&= \frac{1}{8} [\sin(40^\circ + 70^\circ) - \sin(40^\circ - 70^\circ)] - \frac{1}{8} \sin 70^\circ \\
&= \frac{1}{8} [\sin 110^\circ + \sin 30^\circ] - \frac{1}{8} \sin 70^\circ \\
&= \frac{1}{8} [\sin(180^\circ - 70^\circ) + \sin 30^\circ] - \frac{1}{8} \sin 70^\circ \\
&= \frac{1}{8} \sin 70^\circ + \frac{1}{8} \sin 30^\circ - \frac{1}{8} \sin 70^\circ \\
&= \frac{1}{8} \times \frac{1}{2} = \frac{1}{16}
\end{aligned}$$

45. $\frac{\sin 70^\circ + \cos 40^\circ}{\cos 70^\circ + \sin 40^\circ} =$

- (a) 1 (b) $\frac{1}{\sqrt{3}}$
(c) $\sqrt{3}$ (d) $\frac{1}{2}$

Karnataka CET-2012

Ans. (c) : Given, $\frac{\sin 70^\circ + \cos 40^\circ}{\cos 70^\circ + \sin 40^\circ}$

$$\begin{aligned}
&= \frac{\sin 70^\circ + \cos(90^\circ - 50^\circ)}{\cos(90^\circ - 20^\circ) + \sin 40^\circ} \quad [\because \sin(90^\circ - \theta) = \cos \theta] \\
&= \frac{\sin 70^\circ + \sin 50^\circ}{\sin 20^\circ + \sin 40^\circ} \\
&= \frac{2 \sin \left(\frac{70^\circ + 50^\circ}{2} \right) \cos \left(\frac{70^\circ - 50^\circ}{2} \right)}{2 \sin \left(\frac{20^\circ + 40^\circ}{2} \right) \cos \left(\frac{40^\circ - 20^\circ}{2} \right)} \\
&= \frac{2 \sin 60^\circ \cos 10^\circ}{2 \sin 30^\circ \cos 10^\circ} = \frac{\sqrt{3}/2}{1/2} = \sqrt{3}
\end{aligned}$$

46. The expression $\frac{\tan A}{1 - \cot A} + \frac{\cot A}{1 - \tan A}$ can be written as

- (a) $\sec A \operatorname{cosec} A + 1$ (b) $\tan A + \cot A$
(c) $\sec A + \operatorname{cosec} A$ (d) $\sin A \cos A + 1$

COMEDK-2013

Ans. (a) : Given, $\frac{\tan A}{1 - \cot A} + \frac{\cot A}{1 - \tan A}$

$$\begin{aligned}
&= \frac{\frac{\sin A}{\cos A}}{1 - \frac{\cos A}{\sin A}} + \frac{\frac{\cos A}{\sin A}}{1 - \frac{\sin A}{\cos A}} \\
&= \frac{\sin^2 A}{\cos A(\sin A - \cos A)} + \frac{\cos^2 A}{\sin A(\cos A - \sin A)} \\
&= \frac{\sin^3 A - \cos^3 A}{(\sin A - \cos A) \cos A \sin A} \\
&= \frac{(\sin A - \cos A)(\sin^2 A + \sin A \cos A + \cos^2 A)}{(\sin A - \cos A) \sin A \cos A} \\
&= \frac{1 + \sin A \cos A}{\sin A \cos A} = 1 + \sec A \operatorname{cosec} A
\end{aligned}$$

47. If $\cot \alpha \cot \beta = 2$, then $\frac{\cos(\alpha + \beta)}{\cos(\alpha - \beta)}$ is equal to

- (a) 3 (b) $\frac{2}{3}$
(c) $\frac{1}{3}$ (d) $\tan \alpha \tan \beta$

COMEDK-2012

Ans. (c) : Given, $\cot \alpha \cot \beta = 2$

Then, $\frac{\cos(\alpha + \beta)}{\cos(\alpha - \beta)} = \frac{\cos \alpha \cos \beta - \sin \alpha \sin \beta}{\cos \alpha \cos \beta + \sin \alpha \sin \beta}$

Dividing numerator and denominator by $\sin \alpha \sin \beta$

$$\begin{aligned}
&= \frac{\cot \alpha \cot \beta - 1}{\cot \alpha \cot \beta + 1} \\
&= \frac{2 - 1}{2 + 1} \quad [\because \cot \alpha \cot \beta = 2] \\
&= \frac{1}{3}
\end{aligned}$$

48. $\frac{\sin x - \sin 3x}{\sin^2 x - \cos^2 x}$ is equal to

- (a) $-2 \sin x$ (b) $\frac{2}{\sin x}$
(c) $\frac{1}{\sin x}$ (d) $2 \sin x$

COMEDK-2015

Ans. (d) : Given, $\frac{\sin x - \sin 3x}{\sin^2 x - \cos^2 x}$

$$\begin{aligned}
&= \frac{2 \cos \left(\frac{x + 3x}{2} \right) \sin \left(\frac{x - 3x}{2} \right)}{-\cos 2x} \\
&= \frac{2 \cos 2x \cdot \sin(-x)}{-\cos 2x} \\
&= \frac{-2 \cos 2x \sin x}{-\cos 2x} = 2 \sin x
\end{aligned}$$

49. The value of $\frac{\tan 330^\circ \sec 420^\circ \sin 300^\circ}{\tan 135^\circ \sin 210^\circ \sec 315^\circ}$ is equal to

- (a) $\frac{1}{\sqrt{2}}$ (b) $\sqrt{2}$
(c) $\frac{1}{\sqrt{3}}$ (d) $\sqrt{3}$

COMEDK-2014

Ans. (b) : Given, $\frac{\tan 330^\circ \sec 420^\circ \sin 300^\circ}{\tan 135^\circ \sin 210^\circ \sec 315^\circ}$

$$\begin{aligned}
&= \frac{\tan(360^\circ - 30^\circ) \sec(360^\circ + 60^\circ) \sin(360^\circ - 60^\circ)}{\tan(180^\circ - 45^\circ) \sin(180^\circ + 30^\circ) \sec(360^\circ - 45^\circ)} \\
&= \frac{(-\tan 30^\circ) \times \sec 60^\circ \times (-\sin 60^\circ)}{(-\tan 45^\circ) \times (-\sin 30^\circ) \times \sec 45^\circ}
\end{aligned}$$

$$= \frac{\left(-\frac{1}{\sqrt{3}}\right) \times 2 \times \left(\frac{-\sqrt{3}}{2}\right)}{(-1) \times \left(\frac{-1}{2}\right) \times \sqrt{2}}$$

$$= \frac{1}{\frac{\sqrt{2}}{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}$$

50. If $\tan(x+y)=33$ and $x=\tan^{-1} 3$, then y is

- (a) $\frac{3}{10}$ (b) $\frac{33}{10}$
(c) $\tan^{-1}\left(\frac{1}{3}\right)$ (d) $\tan^{-1}\left(\frac{3}{10}\right)$

COMEDK-2015
JCECE-2011

Ans. (d) : Given, $\tan(x+y) = 33$

$$\frac{\tan x + \tan y}{1 - \tan x \tan y} = 33$$

$$\frac{3 + \tan y}{1 - 3 \tan y} = 33 \quad \left[\begin{array}{l} \because x = \tan^{-1} 3 \\ \therefore \tan x = 3 \end{array} \right]$$

$$3 + \tan y = 33 - 99 \tan y$$

$$100 \tan y = 30$$

$$\tan y = \frac{30}{100}$$

$$\tan y = \frac{3}{10}$$

$$y = \tan^{-1}\left(\frac{3}{10}\right)$$

51. The value of $\cos(35^\circ + A) \cos(35^\circ - B) + \sin(35^\circ + A) \sin(35^\circ - B)$ is equal to

- (a) $\sin(A+B)$ (b) $\sin(A-B)$
(c) $\cos(A+B)$ (d) $\cos(A-B)$

COMEDK-2017

Ans. (c) : Given,

$$\cos(35^\circ + A) \cos(35^\circ - B) + \sin(35^\circ + A) \sin(35^\circ - B)$$

$$[\because \cos(A-B) = \cos A \cos B + \sin A \sin B]$$

$$= \cos[(35^\circ + A) - (35^\circ - B)]$$

$$= \cos(35^\circ + A - 35^\circ + B)$$

$$= \cos(A+B)$$

52. If an angle α is divided into two parts A and B such that $A - B = \theta$, and $\tan A : \tan B = m : n$, then $\sin \theta =$

- (a) $\frac{m+n}{m-n} \sin \alpha$ (b) $\frac{m}{m+n} \sin \alpha$
(c) $\frac{m-n}{m+n} \sin \alpha$ (d) $\frac{n}{m+n} \sin \alpha$

COMEDK-2020

Ans. (c) : Given, $A + B = \alpha$ and $A - B = \theta$

$$\text{So, } A = \frac{\alpha + \theta}{2}, B = \frac{\alpha - \theta}{2}$$

$$\text{Now, } \frac{m}{n} = \frac{\tan A}{\tan B}$$

$$\frac{m}{n} = \frac{\tan\left(\frac{\alpha + \theta}{2}\right)}{\tan\left(\frac{\alpha - \theta}{2}\right)}$$

$$\frac{m}{n} = \frac{2 \sin\left(\frac{\alpha + \theta}{2}\right) \cos\left(\frac{\alpha - \theta}{2}\right)}{2 \cos\left(\frac{\alpha + \theta}{2}\right) \sin\left(\frac{\alpha - \theta}{2}\right)}$$

$$\frac{m}{n} = \frac{\sin \alpha + \sin \theta}{\sin \alpha - \sin \theta}$$

$$m \sin \alpha - m \sin \theta = n \sin \alpha + n \sin \theta$$

$$m \sin \alpha - n \sin \alpha = m \sin \theta + n \sin \theta$$

$$\sin \alpha (m - n) = \sin \theta (m + n)$$

$$\sin \theta = \left(\frac{m-n}{m+n}\right) \sin \alpha$$

53. Evaluate $2 \cos 22 \frac{1^\circ}{2} \cdot \cos 67 \frac{1^\circ}{2}$.

- (a) 2 (b) $\sqrt{2}$
(c) $\frac{1}{\sqrt{2}}$ (d) 0

COMEDK-2019

Ans. (c) : Given,

$$2 \cos 22 \frac{1^\circ}{2} \cdot \cos 67 \frac{1^\circ}{2}$$

$$= \cos\left(22 \frac{1^\circ}{2} + 67 \frac{1^\circ}{2}\right) + \cos\left(22 \frac{1^\circ}{2} - 67 \frac{1^\circ}{2}\right)$$

$$= \cos\left(\frac{45}{2} + \frac{135}{2}\right) + \cos\left(\frac{45}{2} - \frac{135}{2}\right)$$

$$= \cos\left(\frac{180}{2}\right) + \cos\left(-\frac{90}{2}\right) \quad \{\because \cos(-\theta) = \cos \theta\}$$

$$= \cos 90^\circ + \cos(-45^\circ)$$

$$= \cos 90^\circ + \cos 45^\circ$$

$$= 0 + \frac{1}{\sqrt{2}}$$

$$= \frac{1}{\sqrt{2}}$$

54. If $\sin \theta + \sin \phi = a$ and $\cos \theta + \cos \phi = b$, then

$$\cos\left(\frac{\theta - \phi}{2}\right) =$$

(a) $\frac{a^2 + b^2 - 2}{4}$ (b) $\frac{\sqrt{a^2 + b^2}}{2}$

(c) $\sqrt{\frac{a^2 + b^2}{2}}$ (d) $\frac{a^2 + b^2 - 2}{2}$

COMEDK-2020