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Formula Book

RELATION BETWEEN DEGREES & RADIANS :

1 radian (1^c) = $\frac{180}{\pi}$ degree = $(180 \times \frac{7}{22})^\circ = 57^\circ\ 16'$

1 degree (1^0) = $\frac{\pi}{180}$ radian = $(\frac{22}{7 \times 180})^c = 0.01746^c$

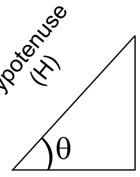
TRIGONOMETRY :

TRIGONOMETRIC RATIOS :

$\sin\theta = \frac{O.S.}{H}$ $\quad \mathrm{cosec}\,\theta = \frac{H}{O.S.}$

$\cos\theta = \frac{A.S.}{H}$ $\quad \sec\theta = \frac{H}{A.S.}$

$\tan\theta = \frac{O.S.}{A.S.}$ $\quad \cot\theta = \frac{A.S.}{O.S.}$



RELATIONS :

i) $\tan\theta = \frac{\sin\theta}{\cos\theta}$ $\quad$ ii) $\cot\theta = \frac{\cos\theta}{\sin\theta}$

iii) $\sec\theta = \frac{1}{\cos\theta}$ $\quad$ iv) $\mathrm{cosec}\,\theta = \frac{1}{\sin\theta}$

v) $\cot\theta = \frac{1}{\tan\theta}$

IDENTITIES :

i) $\sin^2\theta + \cos^2\theta = 1$ $\quad$ ii) $1 + \tan^2\theta = \sec^2\theta$

iii) $1 + \cot^2\theta = \mathrm{cosec}^2\theta$

ADDITION FORMULAE :

$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$

$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

FACTORIZATION FORMULAE

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

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

$\cos C + \cos D = 2\cos\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right)$

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

$= 2\sin\left(\frac{C+D}{2}\right)\sin\left(\frac{D-C}{2}\right)$

S + S = 2 SC
S – S = 2 CS
C + C = 2 CC
C – C = – 2 SS

DE FACTORIZATION FORMULAE :

$2\sin A \cos B = \sin(A+B) + \sin(A-B)$

$2\cos A \sin B = \sin(A+B) - \sin(A-B)$

$2\cos A \cos B = \cos(A+B) + \cos(A-B)$

$2\sin A \sin B = \cos(A-B) - \cos(A+B)$

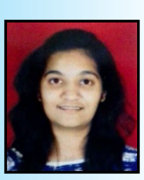
2 SC = S + S
2 CS = S – S
2 CC = C + C
2 SS = C – C

Our Maths Toppers

100 / 100


Aditya Bapat


Ayushi Gupta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Siddhi Pawar


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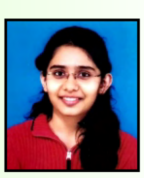
Riya Dharamsi


Ankita Jamdade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Divya Pawar

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MULTIPLE ANGLE FORMULAE

1. Double Angle Formulae :

$\sin 2A = 2\sin A \cos A$

$= \dfrac{2\tan A}{1+\tan^2 A}$

$\tan 2A = \dfrac{2\tan A}{1-\tan^2 A}$

$\cos 2A = \cos^2 A - \sin^2 A$

$= 2\cos^2 A - 1$

$= 1 - 2\sin^2 A$

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

2. Triple Angle Formulae

$\sin 3A = 3\sin A - 4\sin^3 A$,

$\cos 3A = 4\cos^3 A - 3\cos A$,

$\tan 3A = \dfrac{3\tan A - \tan^3 A}{1-3\tan^2 A}$

Remark :

1) $1 - \cos 2\theta = 2\sin^2\theta$

$1 + \cos 2\theta = 2\cos^2\theta$

2) $1 + \sin 2\theta = [\sin\theta + \cos\theta]^2$

$1 - \sin 2\theta = [\sin\theta - \cos\theta]^2$

* $\dfrac{1+\tan\theta}{1-\tan\theta} = \tan\left[\dfrac{\pi}{4}+\theta\right]$

$\dfrac{1-\tan\theta}{1+\tan\theta} = \tan\left[\dfrac{\pi}{4}-\theta\right]$

$\dfrac{\tan\theta-1}{\tan\theta+1} = \tan\left[\theta-\dfrac{\pi}{4}\right]$

$\sin(-\theta) = -\sin\theta$

$\cos(-\theta) = \cos\theta$

$\tan(-\theta) = -\tan\theta$

$\cot(-\theta) = -\cot\theta$

$\sec(-\theta) = \sec\theta$

$\text{cosec}(-\theta) = -\text{cosec}\,\theta$

* $\sin 0 = 0$, $\sin\pi = 0$, $\sin n\pi = 0$, $\sin 2n\pi = 0$, $\sin\pi/2 = 1$

$\cos 0 = 1$, $\cos\pi = -1$, $\cos n\pi = (-1)^n$ $\cos 2n\pi = 1$, , $\cos\pi/2 = 0$

INVERSE TRIGONOMETRIC FUNCTIONS

1. $\sin^{-1}x + \cos^{-1}x = \dfrac{\pi}{2}$

$\text{cos ec}^{-1}x + \sec^{-1}x = \dfrac{\pi}{2}$

$\cot^{-1}x + \tan^{-1}x = \dfrac{\pi}{2}$

2. $\text{cos ec}^{-1}x = \sin^{-1}\dfrac{1}{x}$

$\sec^{-1}x = \cos^{-1}\dfrac{1}{x}$

$\cot^{-1}x + \tan^{-1}\dfrac{1}{x}$

3. $\tan^{-1}x + \tan^{-1}y = \tan^{-1}\left(\dfrac{x+y}{1-xy}\right)$

$\sin^{-1}(-x) = \sin^{-1}x$

$\cos^{-1}(-x) = \pi - \cos^{-1}x$

$\tan^{-1}(-x) = -\tan^{-1}x$

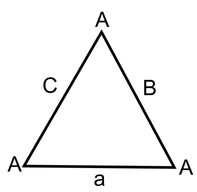
$\cot^{-1}(-x) = \pi - \cot^{-1}x$

$\sec^{-1}(-x) = \pi - \sec^{-1}x$

$\text{cos ec}^{-1}(-x) = -\text{cos ec}^{-1}x$

SINE FORMULAE

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



COSINE FORMULAE

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

$\cos B = \dfrac{c^2+a^2-b^2}{2ca}$

$\cos C = \dfrac{a^2+b^2-c^2}{2ab}$

AREA OF TRIANGLE

$\text{Area} = \dfrac{1}{2}\,bc\sin A$

$= \dfrac{1}{2}\,ca\sin B$

$= \dfrac{1}{2}\,ab\sin C$

PROJECTION RULE

$a = b\cos C + c\cos B$

$b = c\cos A + a\cos C$

$c = a\cos B + b\cos A$

Trigonometric Ratios of Different Quadrants

Quadrant II All + ve $\pi/2 - \theta$, $2\pi + \theta$	Quadrant I sin / cosec + ve $\pi/2 + \theta$, $\pi - \theta$
Quadrant III tan / cot + ve $\pi + \theta$, $3\pi/2 - \theta$	Quadrant IV cos/sec + ve $3\pi/2 + \theta$, $2\pi - \theta$

1. If angle is along X-axis keep the ratio and think of sign. e.g. $\sin(\pi - \theta) = \sin\theta$

2. If angle is along Y-axis change the ratio and think of sign. e.g. $\cos(\pi/2 + \theta) = -\sin\theta$

(change is from sin to cos, tan to cot, sec to cosec)

LIMITS

1. $\lim_{x\to 0} \dfrac{\sin x}{x} = 1$,

2. $\lim_{x\to 0} \dfrac{\tan x}{x} = 1$,

3. $\lim_{x\to 0} \dfrac{\sin^{-1}x}{x} = 1$,

4. $\lim_{x\to 0} \dfrac{a^x - 1}{x} = \log a$,

5. $\lim_{x\to 0} \dfrac{e^x - 1}{x} = 1$

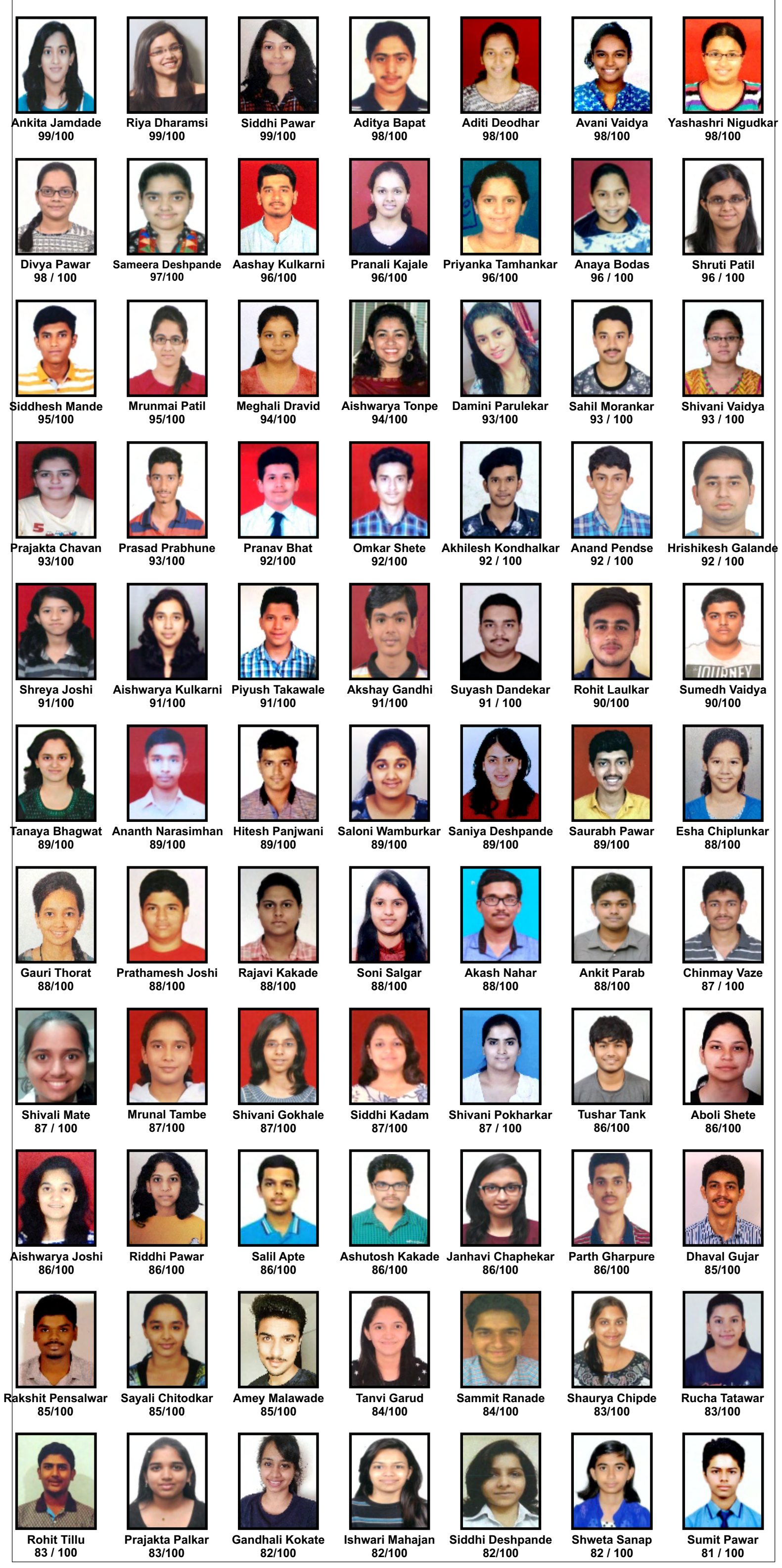
6. $\lim_{x\to\infty} \left(1 + \dfrac{1}{x}\right)^x = e$

7. $\lim_{x\to 0} (1+x)^{\frac{1}{x}} = e$

DERIVATIVE

Function	Derivative	Function	Derivative
x^n	nx^{n-1}	$\sec x$	$\sec x \tan x$
$1/x$	$-1/x^2$	$\text{cosec}\,x$	$-\text{cosec}\,x \cot x$
e^x	e^x	$\sin^{-1}x$	$\dfrac{1}{\sqrt{1-x^2}}$
a^x	$a^x \log a$	$\tan^{-1}x$	$\dfrac{1}{1+x^2}$
$\log x$	$1/x$	$\sec^{-1}x$	$\dfrac{1}{x\sqrt{x^2-1}}$
$\sin x$	$\cos x$	$u \times v$	$u\dfrac{dv}{dx} + v\dfrac{du}{dx}$
$\cos x$	$-\sin x$		
$\tan x$	$\sec^2 x$	$\dfrac{u}{v}$	$\dfrac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$
$\cot x$	$-\text{cosec}^2 x$		

Mathematics 1



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INTEGRATION

Function	Integration
x^n	$\frac{x^{n+1}}{n+1} + C$
$1/x$	$\log x + c$
e^x	$e^x + c$
a^x	$\frac{a^x}{\log a} + c$
$\sin x$	$-\cos x + c$
$\cos x$	$\sin x + c$
$\tan x$	$\log \lvert \sec x \rvert + c$
$\cot x$	$\log \lvert \sin x \rvert + c$
$\sec x$	$\log \lvert \sec x + \tan x \rvert + c$
$\mathrm{cosec}\, x$	$\log \lvert \mathrm{cosec}\, x - \cot x \rvert + c$
$\sec^2 x$	$\tan x + c$
$\mathrm{cosec}^2 x$	$-\cot x + c$
$\sec x \tan x$	$\sec x + c$
$\mathrm{cosec}\, x \cot x$	$-\mathrm{cosec}\, x + c$
$\frac{1}{\sqrt{a^2 - x^2}}$	$\sin^{-1} \frac{x}{a} + c$
$\frac{1}{a^2 + x^2}$	$\frac{1}{a} \tan^{-1} \frac{x}{a} + c$
$\frac{1}{\sqrt{x^2 - a^2}}$	$\log (x + \sqrt{x^2 - a^2}) + c$
$\frac{1}{\sqrt{x^2 + a^2}}$	$\log (x + \sqrt{x^2 + a^2}) + c$
$\frac{1}{a^2 - x^2}$	$\frac{1}{2a} \log \left\lvert \frac{a + x}{a - x} \right\rvert + c$
$\frac{1}{x^2 - a^2}$	$\frac{1}{2a} \log \left\lvert \frac{x - a}{x + a} \right\rvert + c$
$\sqrt{a^2 - x^2}$	$\frac{x}{2} \sqrt{a^2 - x^2} + \frac{a^2}{2} \sin^{-1} \frac{x}{a} + c$
$\sqrt{x^2 - a^2}$	$\frac{x}{2} \sqrt{x^2 - a^2} - \frac{a^2}{2} \log (x + \sqrt{x^2 - a^2}) + c$
$\sqrt{x^2 + a^2}$	$\frac{x}{2} \sqrt{x^2 + a^2} + \frac{a^2}{2} \log (x + \sqrt{x^2 + a^2}) + c$

Imaginary Unit : $i = \sqrt{-1}$

$i^2 = -1,\ i^3 = -i,\ i^4 = 1,\ i^5 = 1,\ 1/i = -i$

Value of any power of i lies between 1, –1, i and –i

Complex Number :

1. Cartesian Form : $z = x + iy$
2. Polar Form : $z = r(\cos\theta + i\sin\theta)$
3. Exponential Form : $z = re^{i\theta}$

Remarks : 1. Modulus : $|z| = r = \sqrt{x^2 + y^2}$

2. Amplitude / Argument : $\theta = \tan^{-1}\left(\frac{y}{x}\right)$

3. Euler's Formulae :

$e^{i\theta} = \cos\theta + i\sin\theta,\ e^{-i\theta} = \cos\theta - i\sin\theta$

$\cos\theta = \frac{e^{i\theta} + e^{-i\theta}}{2},\ \sin\theta = \frac{e^{i\theta} - e^{-i\theta}}{2i}$

4. De Moivre's Theorem :

$(\cos\theta + i\sin\theta)^n = \cos n\theta + i\sin n\theta$

Hyperbolic Functions :

$\cosh x = \frac{e^x + e^{-x}}{2},\ \sinh x = \frac{e^x - e^{-x}}{2}$

$\sinh(-x) = -\sinh x \Rightarrow$ odd function

$\cosh(-x) = \cosh x \Rightarrow$ even function

$\cosh^2 x - \sinh^2 x = 1$ $\quad \sinh^{-1} x = \log[x + \sqrt{x^2 + 1}]$

$\tanh^2 x + \mathrm{sech}^2 x = 1$ $\quad \cosh^{-1} x = \log[x + \sqrt{x^2 - 1}]$

$\coth^2 x - \mathrm{cosech}^2 x = 1$ $\quad \tanh^{-1} x = \frac{1}{2} \log\left[\frac{1 + x}{1 - x}\right]$

Logarithm of Complex Number :

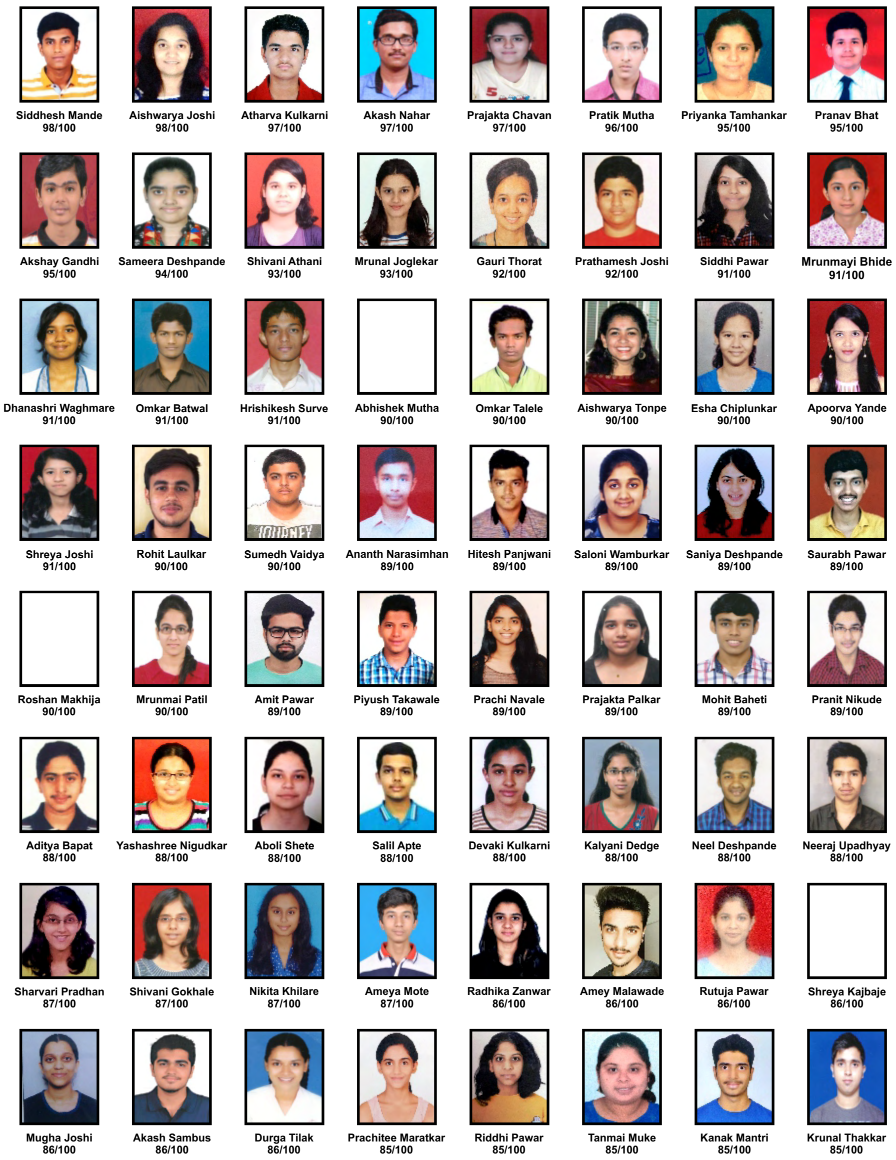
$\log(x + iy) = \log\sqrt{x^2 + y^2} + i\left(2n\pi + \tan^{-1}\frac{y}{x}\right)$

$\log(x + iy) = \log\sqrt{x^2 + y^2} + i\tan^{-1}\frac{y}{x}$

Quadratic Equation :

ax

Mathematics 2



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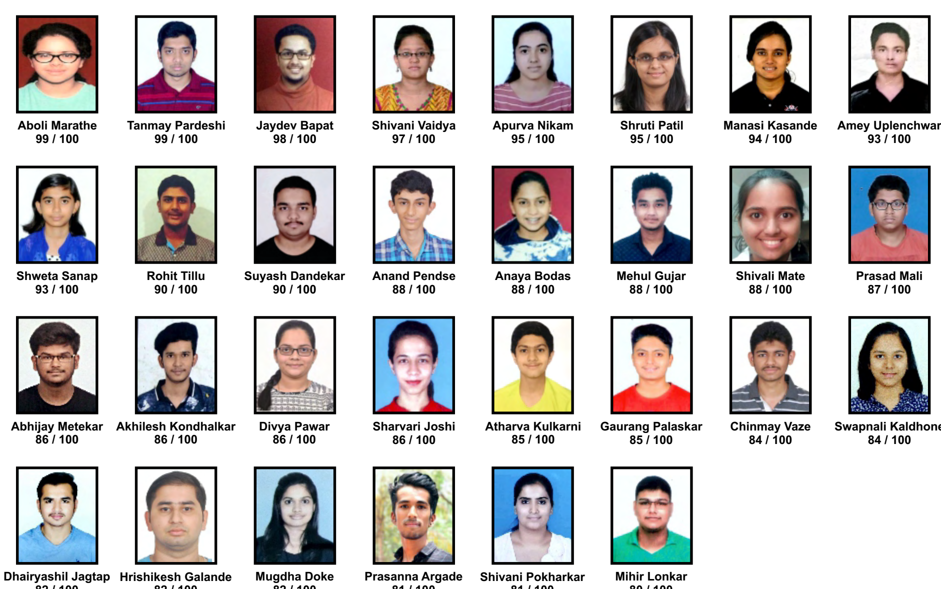
M2 (2018-19)



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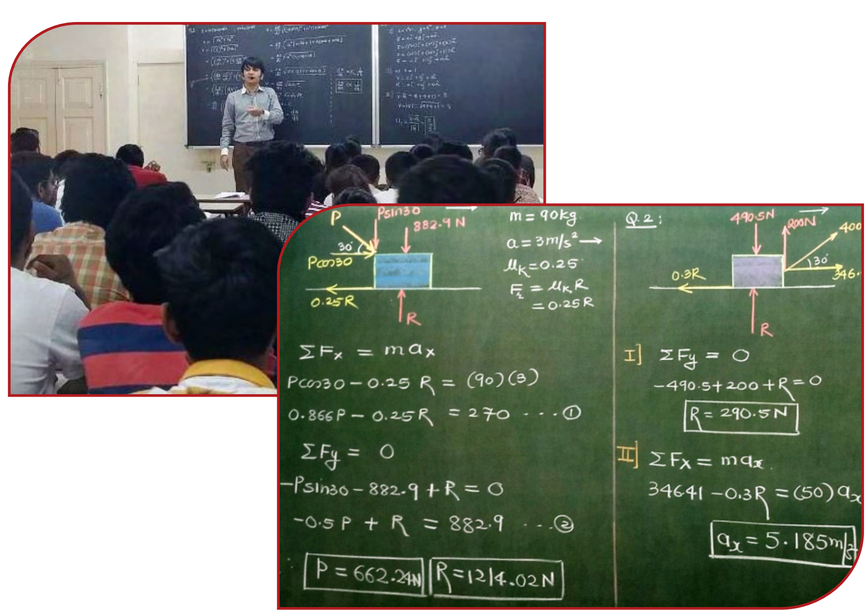


1. $\int e^x [f(x) + f'(x)]dx = e^x f(x)$

2. $\int \frac{f'(x)}{f(x)} dx = \log f(x)$

3. $\int \frac{f'(x)}{\sqrt{f(x)}} dx = 2\sqrt{f(x)}$

4. $\int [f(x)]^n f'(x)\, dx = \frac{f(x)^{n+1}}{n+1}$

5. $\int e^{f(x)} f'(x)\, dx = e^{f(x)}$

6. $\int e^{ax} \cos bx\, dx = \frac{e^{ax}}{a^2 + b^2} (a\cos bx + b\sin bx)$

7. $\int e^{ax} \sin bx\, dx = \frac{e^{ax}}{a^2 + b^2} (a\sin bx - b\cos bx)$

8. $\int u\, v\, dx = u \int v\, dx - \int \left[\frac{du}{dx} \int v\, dx\right] dx$

9. $\int u\, v\, dx = u\, v_1 - u\, v_2 + u'' v_3 - \ldots.$

DEFINITE INTEGRAL :

1. $\int_a^b f(x)\, dx = \int_a^b f(y)\, dy = \int_a^b f(t)\, dt$

2. $\int_a^b f(x)\, dx = -\int_b^a f(x)\, dx$

3. $\int_a^b f(x)\, dx = \int_a^c f(x)\, dx + \int_c^b f(x)\, dx$

4. $\int_a^b f(x)\, dx = \int_a^b f(a + b - x)\, dx$

5. $\int_0^a f(x)\, dx = \int_0^a f(a - x)\, dx$

6. $\int_0^{2a} f(x)\, dx = \int_0^a [f(x) + f(2a - x)]\, dx$

7. $\int_{-a}^{a} f(x)\, dx = \begin{cases} 2\int_0^a f(x)\, dx & \text{If } f(x) \text{ is even} \\ 0 & \text{If } f(x) \text{ is odd} \end{cases}$

STANDARD EXPANSIONS :

1. $\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots.$

2. $\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} - \ldots.$

3. $\tan x = x + \frac{x^3}{3} + \frac{2x^5}{15} + \frac{17x^7}{315} + \ldots.$

4. $\sinh x = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \frac{x^7}{7!} + \ldots..$

5. $\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \frac{x^6}{6!} + \ldots..$

6. $\tanh x = x - \frac{x^3}{3} + \frac{2x^5}{15} - \frac{17x^7}{315} + \ldots.$

7. $\log(1 + x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} - \ldots.$

8. $\log(1 - x) = -x - \frac{x^2}{2} - \frac{x^3}{3} - \frac{x^4}{4} - \frac{x^5}{5} - \ldots.$

9. $\frac{1}{1 + x} = 1 - x + x^2 - x^3 + \ldots.$

10. $\frac{1}{1 - x} = 1 + x + x^2 + x^3 + \ldots.$

11. $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \ldots..$

Factorial : $n! = 1 \times 2 \times 3 \times \ldots \times n$

$0! = 1$

Permutation: ${}^nP_r = \frac{n!}{(n-r)!}$

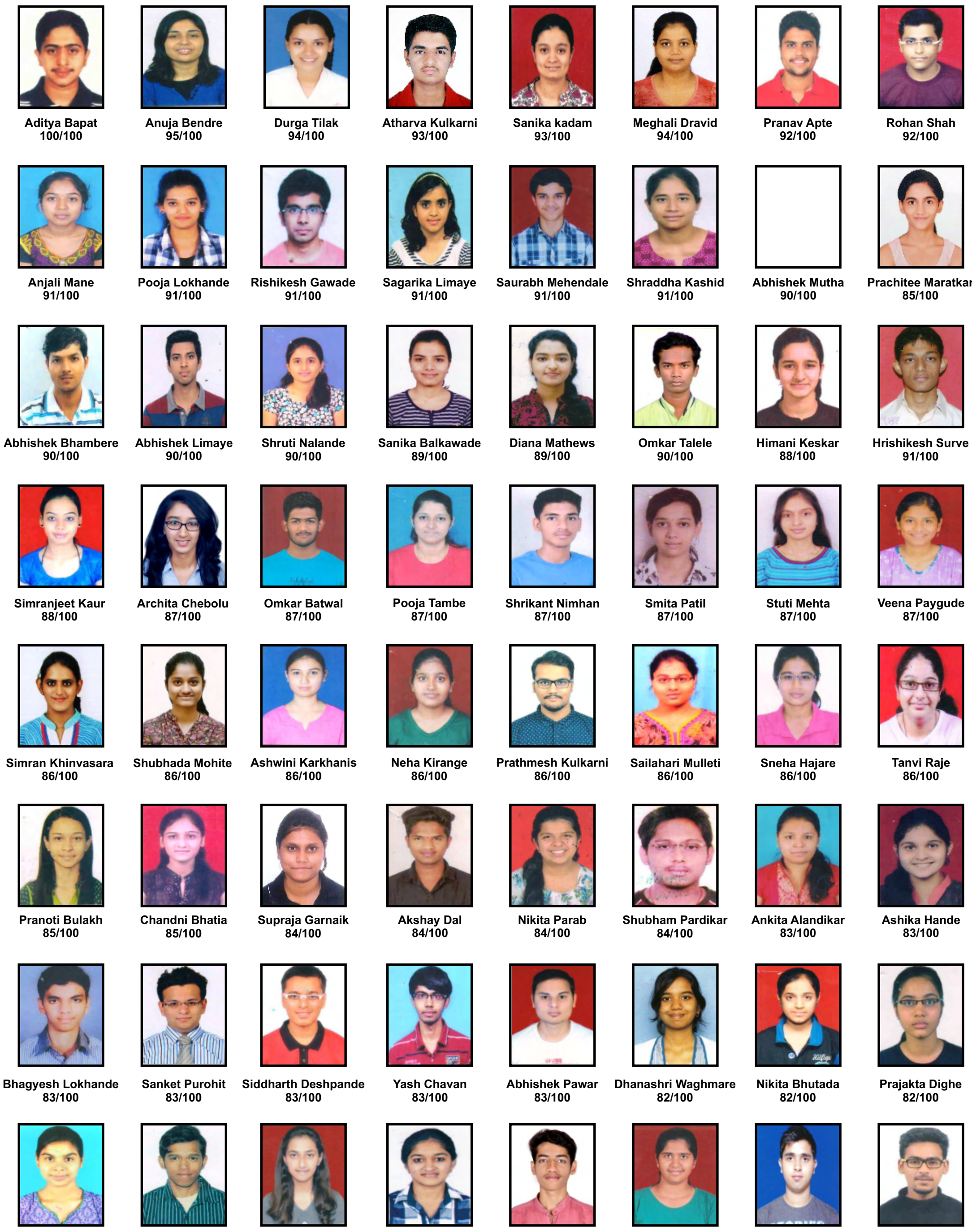
Combination : ${}^nC_r = \frac{n!}{(n-r)!\, r!}$

${}^nC_n = 1,\ {}^nC_0 = 1,\ {}^nC_r = {}^nC_{n-r},\ {}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$

Probability : $p(A) = \frac{n(A)}{n(s)}$ $\quad 0 \le P \le 1$

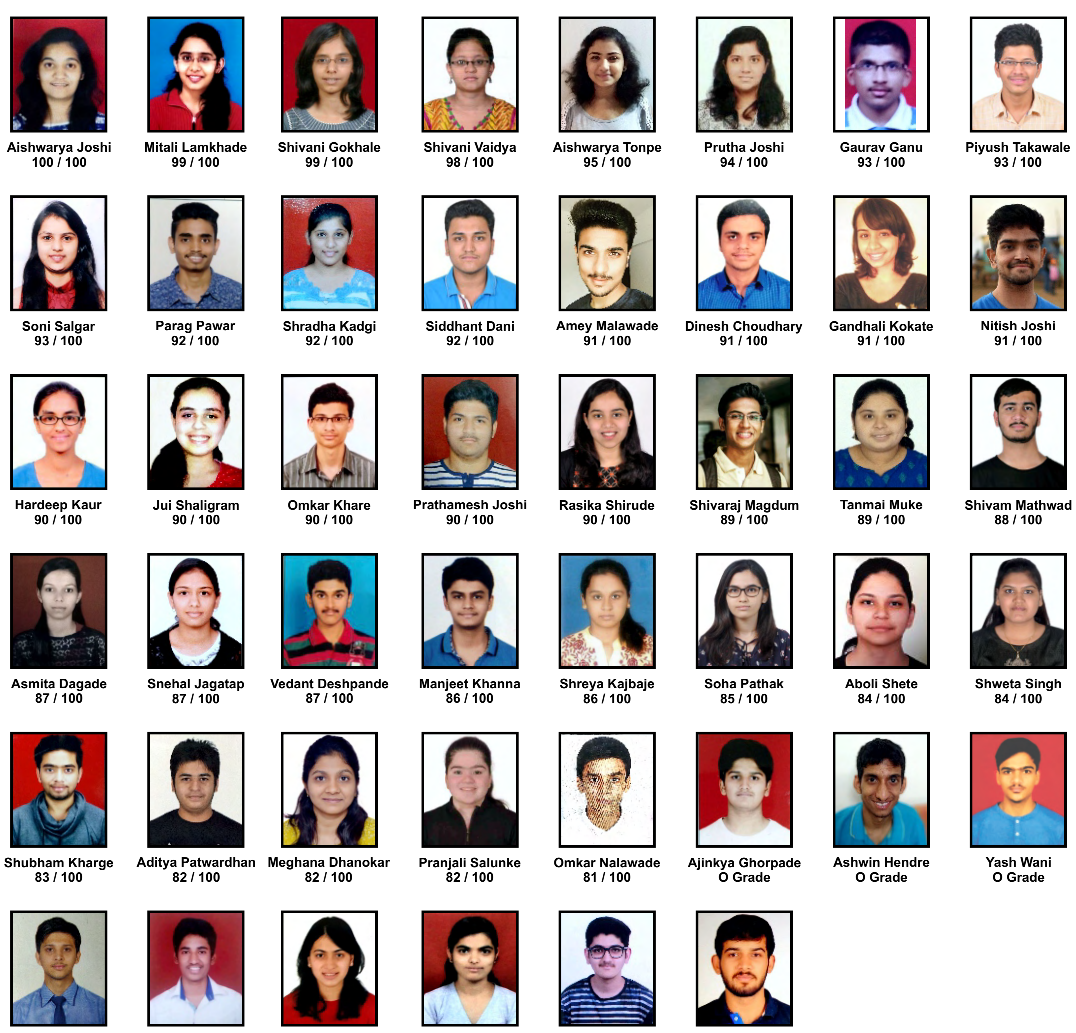
Ari

M3



Aditya Bapat 100/100; Anuja Bendre 95/100; Durga Tilak 94/100; Atharva Kulkarni 93/100; Sanika kadam 93/100; Meghali Dravid 94/100; Pranav Apte 92/100; Rohan Shah 92/100;
Anjali Mane 91/100; Pooja Lokhande 91/100; Rishikesh Gawade 91/100; Sagarika Limaye 91/100; Saurabh Mehendale 91/100; Shraddha Kashid 91/100; Abhishek Mutha 90/100; Prachitee Maratkar 85/100;
Abhishek Bhambere 90/100; Abhishek Limaye 90/100; Shruti Nalande 90/100; Sanika Balkawade 89/100; Diana Mathews 89/100; Omkar Talele 90/100; Himani Keskar 88/100; Hrishikesh Surve 91/100;
Simranjeet Kaur 88/100; Archita Chebolu 87/100; Omkar Batwal 87/100; Pooja Tambe 87/100; Shrikant Nimhan 87/100; Smita Patil 87/100; Stuti Mehta 87/100; Veena Paygude 87/100;
Simran Khinvasara 86/100; Shubhada Mohite 86/100; Ashwini Karkhanis 86/100; Neha Kirange 86/100; Prathmesh Kulkarni 86/100; Sailahari Mulleti 86/100; Sneha Hajare 86/100; Tanvi Raje 86/100;
Pranoti Bulakh 85/100; Chandni Bhatia 85/100; Supraja Garnaik 84/100; Akshay Dal 84/100; Nikita Parab 84/100; Shubham Pardikar 84/100; Ankita Alandikar 83/100; Ashika Hande 83/100;
Bhagyesh Lokhande 83/100; Sanket Purohit 83/100; Siddharth Deshpande 83/100; Yash Chavan 83/100; Abhishek Pawar 83/100; Dhanashri Waghmare 82/100; Nikita Bhutada 82/100; Prajakta Dighe 82/100;
Rachana Kurmi 82/100; Vinit Udas 82/100; Ruchita Baglane 82/100; Asavari Waikul 82/100; Pruthviraj Dhole 81/100; Aishwarya Gadgil 81/100; Krunal thakkar 81/100; Nikhil Borse 81/100

M3 (2018-19)



Aishwarya Joshi 100 / 100; Mitali Lamkhade 99 / 100; Shivani Gokhale 99 / 100; Shivani Vaidya 98 / 100; Aishwarya Tonpe 95 / 100; Prutha Joshi 94 / 100; Gaurav Ganu 93 / 100; Piyush Takawale 93 / 100;
Soni Salgar 93 / 100; Parag Pawar 92 / 100; Shradha Kadgi 92 / 100; Siddhant Dani 92 / 100; Amey Malawade 91 / 100; Dinesh Choudhary 91 / 100; Gandhali Kokate 91 / 100; Nitish Joshi 91 / 100;
Hardeep Kaur 90 / 100; Jui Shaligram 90 / 100; Omkar Khare 90 / 100; Prathamesh Joshi 90 / 100; Rasika Shirude 90 / 100; Shivaraj Magdum 89 / 100; Tanmai Muke 89 / 100; Shivam Mathwad 88 / 100;
Asmita Dagade 87 / 100; Snehal Jagatap 87 / 100; Vedant Deshpande 87 / 100; Manjeet Khanna 86 / 100; Shreya Kajbaje 86 / 100; Soha Pathak 85 / 100; Aboli Shete 84 / 100; Shweta Singh 84 / 100;
Shubham Kharge 83 / 100; Aditya Patwardhan 82 / 100; Meghana Dhanokar 82 / 100; Pranjali Salunke 82 / 100; Omkar Nalawade 81 / 100; Ajinkya Ghorpade O Grade; Ashwin Hendre O Grade; Yash Wani O Grade;
Ojas Shah O Grade; Rohit Kshirsagar O Grade; Saniya Deshpande O Grade; Sonali Patankar O Grade; Tanay Mayee O Grade; Yash Kulkarni O Grade

Geometric progression :

a, ar, ar^2, ..., ar^{n-1} $\quad n^{th}$ term of a G.P. $T_n = ar^{n-1}$

Sum of n terms of a G.P.

$S_n = \frac{a(1-r^n)}{1-r}$, if r < 1 $\quad S_n = \frac{a(r^n-1)}{r-1}$, if r > 1, r ≠ 1

Sum to infinity of a G.P. $S_\infty = \frac{a}{1-r}$

Co-ordinate Geometry :

1. Distance Formulae; $A(x_1, y_1)$, $B(x_2, y_2)$

$AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

2. Section Formulae :

Internal Division $R \equiv \left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n}\right)$

External Division $R \equiv \left(\frac{mx_2 - nx_1}{m-n}, \frac{my_2 - ny_1}{m-n}\right)$

3. Midpoint : $M \equiv \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

4. Centroid : $\equiv \left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3}\right)$

Line :

Slope (m) = $\tan\theta = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-\text{coeff. of } x}{\text{coeff. of } y}$

Equations of Line :

1. $(y - y_1) = m(x - x_1)$, $\quad$ 2. $\frac{y - y_1}{y_1 - y_2} = \frac{x - x_1}{x_1 - x_2}$

3. y = mx + c, $\quad$ 4. ax + by + c = 0

5. $\frac{x}{a} + \frac{y}{b} = 1$ (a and b are x and y intercepts)

*$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$

*Parallel lines : $m_1 = m_2$

Perpendicular line : $m_1 m_2 = -1$

*Length of perpendicular = $\left|\frac{ax_1 + by_1 + c}{\sqrt{a^2 + b^2}}\right|$

Circle :

1. $x^2 + y^2 = r^2$

2. $(x - h)^2 + (y - k)^2 = r^2$, (h, k) ≡ centre

Parabola :

$y^2 = 4ax$, $y^2 = -4ax$, $x^2 = 4ay$, $x^2 = -4ay$

Ellipse : $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, **Hyperbola :** $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

Vector :

1. Dot (Scalar/Inner) product :

$\bar{a}.\bar{b} = |\bar{a}|\,|\bar{b}|\cos\theta = ab\cos\theta \ldots 0 \le \theta \le \pi$

i) Angle between $\bar{a}$ and $\bar{b}$ is $\cos\theta = \frac{\bar{a}.\bar{b}}{ab}$

ii) $\bar{a}.\bar{b} > 0$, θ is acute, $\bar{a}.\bar{b} < 0$, θ is obtuse.

iii) $\bar{a} \perp \bar{b}$ i.e. θ = 90, cos 90 = 0 ∴ $\bar{a}.\bar{b} = 0$

$\bar{i}.\bar{j} = \bar{j}.\bar{k} = \bar{k}.\bar{i} = 0$

iv) $\bar{a}.\bar{b} = \bar{b}.\bar{a}$ commutative

v) $\bar{a}$ collinear with $\bar{b}$ i.e. θ = 0, cos 0 = 1

∴ $\bar{a}.\bar{b} = ab$

$\bar{i}.\bar{i} = \bar{j}.\bar{j} = \bar{k}.\bar{k} = 1$, $\bar{a}.\bar{a} = a^2$

vi) If $\bar{r}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$ $\quad \bar{r}_2 = a_2\hat{i} + b_2\hat{j} + c_2\hat{k}$

then $\bar{r}_1.\bar{r}_2 = a_1a_2 + b_1b_2 + c_1c_2$

2. Cross Product :

$\bar{a} \times \bar{b} = |\bar{a}|\,|\bar{b}|\sin\theta\,\hat{n}$, $|\bar{a} \times \bar{b}| = |\bar{a}|\,|\bar{b}|\sin\theta$

i) Vector product is not commutative

$\bar{a} \times \bar{b} \neq \bar{b} \times \bar{a}$ ∴ $\bar{a} \times \bar{b} = -(\bar{b} \times \bar{a})$

ii) $\bar{a} \times \bar{a} = \bar{0}$, $\bar{a}$, $\bar{b}$ are collinear iff $\bar{a} \times \bar{b} = \bar{0}$

$\hat{i} \times \hat{i} = \bar{0}$ $\quad \hat{j} \times \hat{j} = \bar{0}$ $\quad \hat{k} \times \hat{k} = \bar{0}$

$\hat{i} \times \hat{j} = \hat{k}$ $\quad \hat{j} \times \hat{k} = \hat{i}$ $\quad \hat{k} \times \hat{i} = \hat{j}$

iii) If $\bar{r}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$ $\quad \bar{r}_2 = a_2\hat{i} + b_2\hat{j} + c_2\hat{k}$, the

$$\bar{r}_1 \times \bar{r}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}$$

3. Scalar Triple Product :

$$(\bar{a} \times \bar{b}).\bar{c} = [\bar{a}\ \bar{b}\ \bar{c}] = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

4. Vector Triple Product :

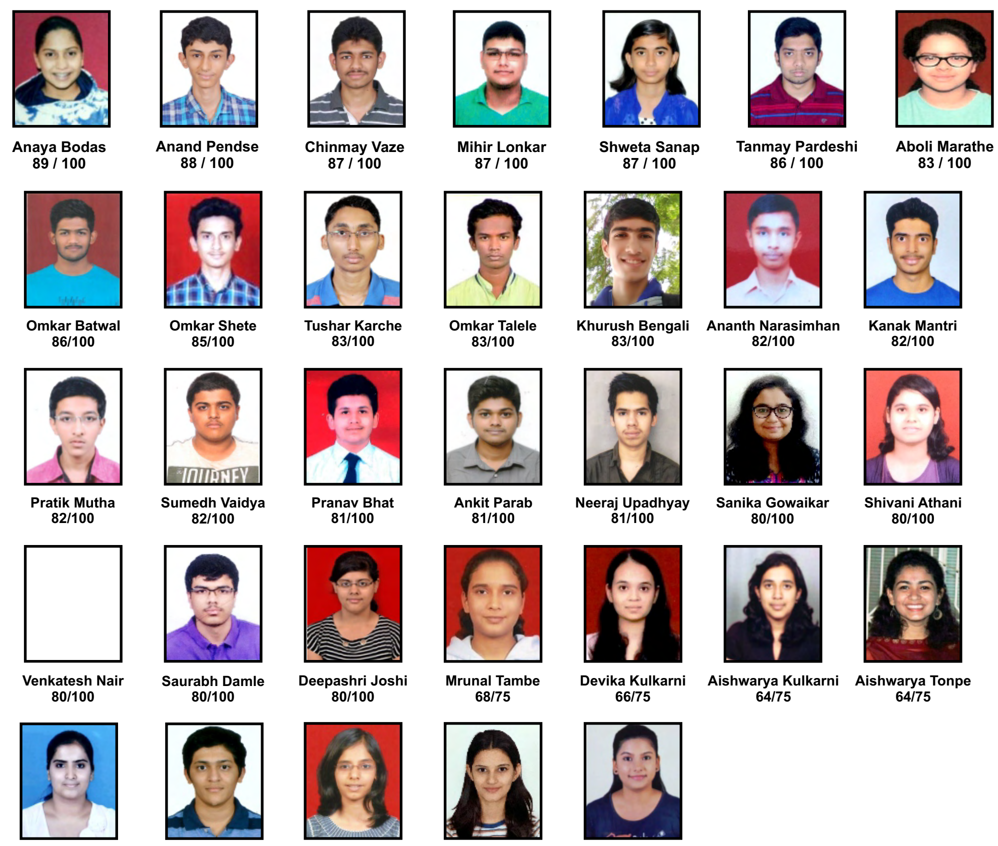
$\bar{a} \times (\bar{b} \times \bar{c}) = (\bar{a}.\bar{c})\,\bar{b} - (\bar{a}.\bar{b})\,\bar{c}$

5. Vector Quadruple Product :

$$(\bar{a} \times \bar{b}).(\bar{c} \times \bar{d}) = \begin{vmatrix} \bar{a}.\bar{c} & \bar{a}.\bar{d} \\ \bar{b}.\bar{c} & \bar{b}.\bar{d} \end{vmatrix}$$

$(\bar{a} \times \bar{b}) \times (\bar{c} \times \bar{d}) = [\bar{a}\ \bar{b}\ \bar{d}]\,\bar{c} - [\bar{a}\ \bar{b}\ \bar{c}]\,\bar{d}$

Engineering Mechanics



Anaya Bodas 89 / 100 | Anand Pendse 88 / 100 | Chinmay Vaze 87 / 100 | Mihir Lonkar 87 / 100 | Shweta Sanap 87 / 100 | Tanmay Pardeshi 86 / 100 | Aboli Marathe 83 / 100

Omkar Batwal 86/100 | Omkar Shete 85/100 | Tushar Karche 83/100 | Omkar Talele 83/100 | Khurush Bengali 83/100 | Ananth Narasimhan 82/100 | Kanak Mantri 82/100

Pratik Mutha 82/100 | Sumedh Vaidya 82/100 | Pranav Bhat 81/100 | Ankit Parab 81/100 | Neeraj Upadhyay 81/100 | Sanika Gowaikar 80/100 | Shivani Athani 80/100

Venkatesh Nair 80/100 | Saurabh Damle 80/100 | Deepashri Joshi 80/100 | Mrunal Tambe 68/75 | Devika Kulkarni 66/75 | Aishwarya Kulkarni 64/75 | Aishwarya Tonpe 64/75

Shivani Pokharkar 83 / 100 | Suhrud Joglekar 83 / 100 | Shivani Gokhale 64/75 | Mrunal Joglekar 61/75 | Rucha Tatawar 60/75

PHYSICAL QUANTITIES :

Sr. No.	Physical Quantity	Formula	Unit
1.	Velocity (v)	$v = \frac{\text{displacement}}{\text{time}} = \frac{ds}{dt}$	m/s
2.	Acceleration (a)	$a = \frac{\text{Change in velocity}}{\text{time}} = \frac{dv}{dt} = \frac{d^2s}{dt^2}$	m/s^2
3.	Momentum (P)	P = m v	kg m/s
4.	Force (F)	F = m a	N or Kg m/s^2
5.	Impulse (I)	I = Force × Change in time	N s
6.	Work (W)	W = F.S.	N m or J
7.	Power (P)	$P = \frac{W}{t} = \frac{F.S}{t} = F v$	J/s or W
8.	Pressure (P)	$P = \frac{F}{A}$	N/m^2
9.	Density (ρ)	$\rho = \frac{m}{v}$	kg/m^3
10.	Kinetic Energy (K.E.)	$K.E. = \frac{1}{2} m v^2$	J
11.	Potential Energy (P.E.)	P.E. = m g h	J

Equations of Motion :

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

Curvilinear Motion :

Direction	Velocity Comp.	Acceleration Comp
x	$v_x = \frac{dx}{dt}$	$a_x = \frac{dv_x}{dt}$
y	$v_y = \frac{dy}{dt}$	$a_y = \frac{dv_y}{dt}$
tangential (t)	$v_t = v$	$a_t = \frac{dv}{dt}$
normal (n)	$v_n = 0$	$a_n = \frac{v^2}{\rho}$
radial (r)	$v_r = \dot{r}$	$a_r = \ddot{r} - r\dot{\theta}^2$
transverse (θ)	$v_\theta = r\dot{\theta}$	$a_\theta = 2\dot{r}\dot{\theta} + r\ddot{\theta}$

RECTILINIAR MOTION :

Motion Diagram:

I] v-t diagram :

- slope = Acceleration = $\frac{dv}{dt}$
- Area under v-t curve = change in position = $(x_2 - x_1)$
- displacement = Algebraic sum of area of v - t diagram
- distance = sum of area (all +ve) of v - t diagram
- for vel. to be max. $\frac{dv}{dt} = a = 0$

II] a-t diagram :

- slope = Jerk = $\frac{da}{dt}$
- Area = change in velocity = $(V_2 - V_1)$
- To find position use moment equation $x_t = x_0 + v_0 t + M_t$

III] x-t diagram :

- slope = velocity = $\frac{dx}{dt}$
- for x to be max. $\frac{dx}{dt} = v = 0$

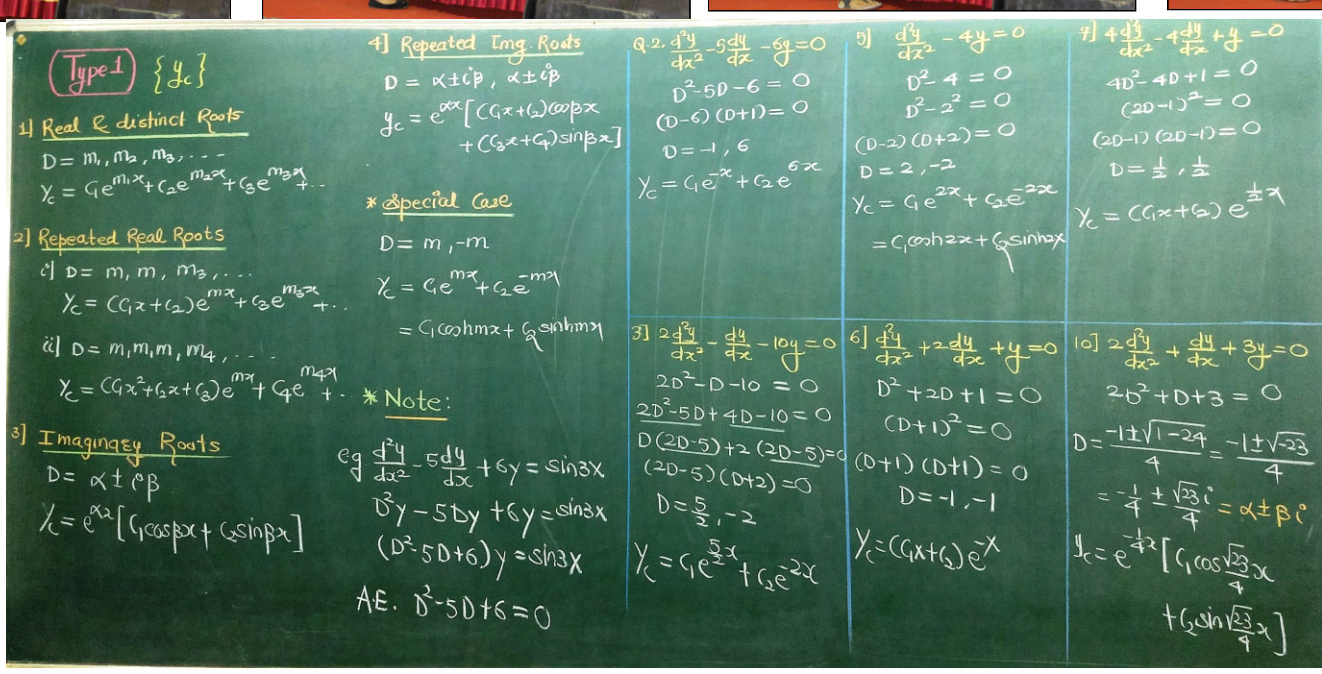
IV] v-x diagram :

- Accleration = velocity × slope of v–x diagram

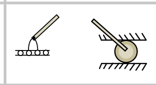
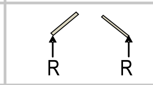
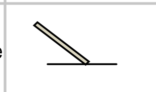
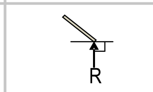
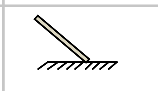
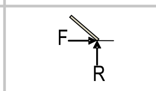
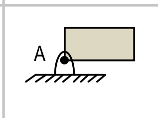
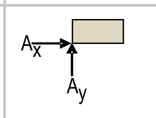
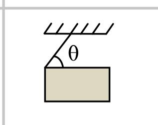
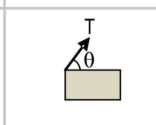
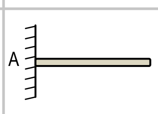
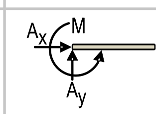
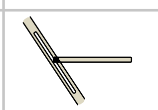
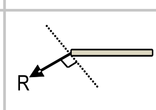
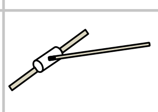
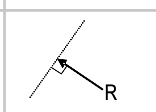
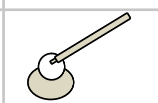
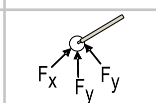
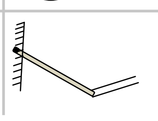
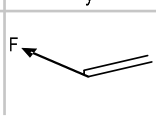
v] a-x diagram : Area = $\frac{v_2^2 - v_1^2}{2}$

PROJECTILE MOTION :

Sr. No.	Term	Horizontal Plane	Inclined Plane
1.	Time of flight (t)	$t = \frac{2u \sin\alpha}{g}$	$t = \frac{2u \sin\alpha}{g \cos\theta}$
2.	Range (R)	$R = \frac{u^2 \sin 2\alpha}{g}$	$R = \frac{2u^2 \sin\alpha}{g \cos^2\theta} \cos(\alpha+\theta)$
3.	Angle of projection for max. Range	$\alpha = 45° = \frac{\pi}{4}$	$\alpha = \frac{\pi}{4} - \frac{\theta}{2}$
4.	Max. Range	$Rmax = \frac{u^2}{g}$	$Rmax = \frac{u^2}{g(1+\sin\theta)}$
5.	Max. Height	$H = \frac{u^2 \sin^2\alpha}{2g}$	$H = \frac{u^2 \sin^2\alpha}{2g \cos\theta}$
6.	Equation of Trajectory	$y = x\tan\alpha - \frac{gx^2}{2u^2\cos^2\alpha}$	-



TYPES OF SUPPORTS & CORRESPONDING REACTIONS :

Sr. No.	Support/ Connection	Sketch	Reaction	Specification	No. of unknowns
1.	Rollers			Known reaction which is $\perp^{er}$ to plane of roller	One
2.	Smooth surface			Reaction is $\perp^{er}$ to the surface	One
3.	Rough surface			Two reaction components with unknown directions	Two
4.	Smooth pin or Hinge			Two reaction components with unknown directions	Two
5.	Flexible cord, rope or cable of negligible weight			One axial force acting away from body (Tension)	One
6.	Fixed support			Two reaction components and one moment with all components unknown in directions.	Three
7.	A smooth pin in a slot			Reaction with known line of action which is always $\perp^{er}$ to slot in which pin is sliding.	One
8.	A sliding collar			Reaction is perpendicular to the rod along which collar is sliding without friction	One
9.	Ball and socket joint			Three reaction components in unknown directions.	Three
10.	A short link			Force with known line of action	One

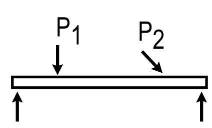
WORK ENERGY PRINCIPLE

work = U = F × S, Scalar quantity, Unit - N m (J)

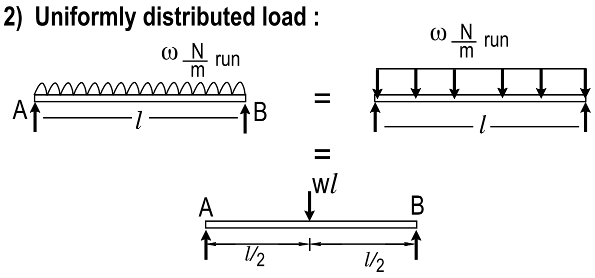
Sr. No.	Type of Force	Work Done
1.	**External force (constant)**	= F × S
2.	**Variable force**	$= \int_{s_1}^{s_2} F\,ds$
3.	**Frictional force** (i) Horizontal plane (ii) Inclined plane	 $= -\mu_k mg\,s$ $= -\mu_k mg\cos\theta\,S$
4.	**Gravity force** (i) Horizontal plane (ii) Inclined plane	 = 0 $= \pm mg\,S\sin\theta$
5.	**Spring force** (i) not connected to particle (ii) connected to particle	 $= \frac{1}{2}k\,[x_1^2 - x_2^2]$ $= \frac{1}{2}k\,[(l_1 - l_0)^2 - (l_2 - l_0)^2]$

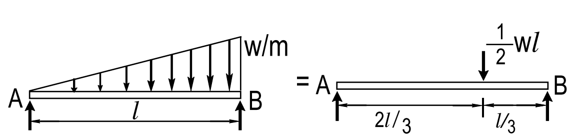
TYPES OF LOADS ON THE BEAM

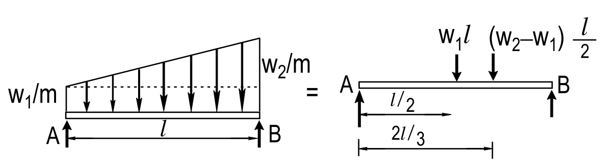
1) **Point / concentrated Load :**

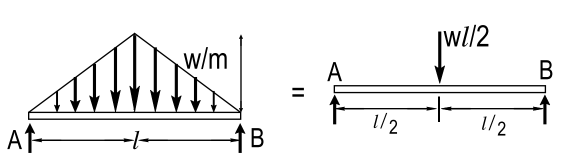


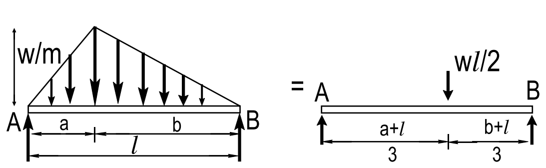
2) **Uniformly distributed load :**



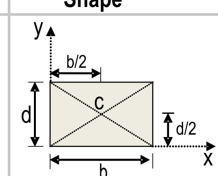
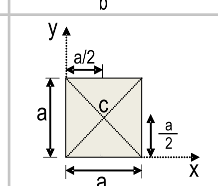
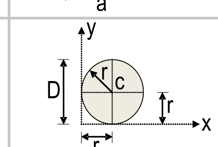
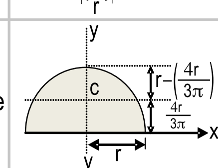
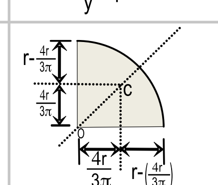
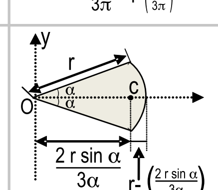
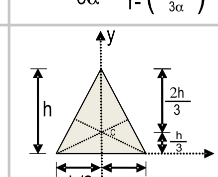
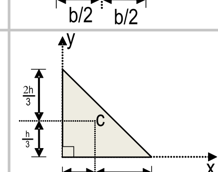




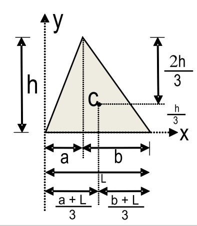
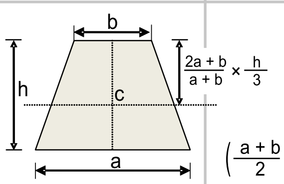
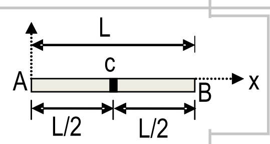
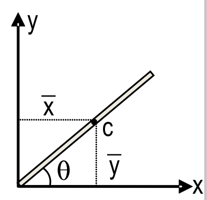
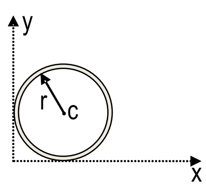
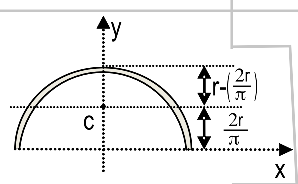


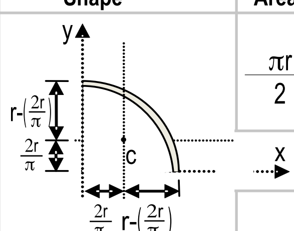
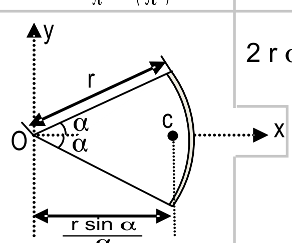
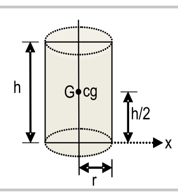
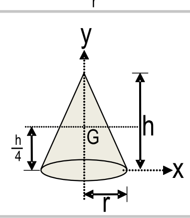
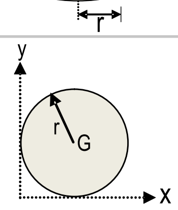
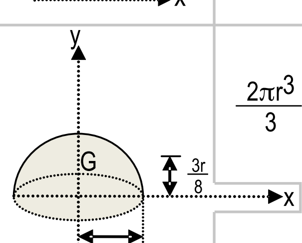


CENTROID :

Sr. No.	Name	Shape	Area	$\bar{X}$	$\bar{Y}$
1	Rectangle		b × d	b/2	d/2
2	Square		a^2 OR $\frac{(\text{Diagonal})^2}{2}$	$\frac{a}{2}$	$\frac{a}{2}$
3	Circle		πr^2 OR $\frac{\pi}{4}D^2$	r	r
4	Semi circle		$\frac{\pi r^2}{2}$	0	$\left(\frac{4r}{3\pi}\right)$
5	Quarter circle		$\frac{\pi r^2}{4}$	$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$
6	Sector of a circle		Note αr^2 (α in radian) α is semiangle	$\frac{2r\sin\alpha}{3\alpha}$ (α in degree) (α in radian)	0
7 (a)	Triangle Symmetrical triangle		$\frac{1}{2}$×b×h	0	h/3
(b)	Right angled triangle		$\frac{1}{2}$×b×h	b/3	h/3

CENTROID :

Sr.No.	Name	Shape	Area	$\bar{X}$	$\bar{Y}$
(c)	Unsymmetrical triangle		$\frac{1}{2}\times L\times h$	$\frac{a+L}{3}$	$\frac{h}{3}$
8.	Trapezoid		$\left(\frac{a+b}{2}\right)h$	-	-
Line segments :					
9.	A straight line		L	L/2	0
10.	An inclined line		L	$\frac{L}{2}\cos\theta$	$\frac{L}{2}\sin\theta$
11.	Circular Arc		$2\pi r$	r	r
12.	Semi circular Arc		πr	0	$\frac{2r}{\pi}$

Sr.No.	Name	Shape	Area	$\bar{X}$	$\bar{Y}$
13	Quarter circular Arc		$\frac{\pi r}{2}$	$\frac{2r}{\pi}$	$\frac{2r}{\pi}$
14	An arc of a circle		$2r\alpha$	$\frac{r\sin\alpha}{\alpha}$	0
15	A solid cylinder		$\pi r^2 h$	0	h/2
16	A solid right circular cone		$\frac{1}{3}\pi r^2 h$	0	$\frac{h}{4}$
17	Sphere		$\frac{4}{3}\pi r^3$	r	r
18	Hemi-Sphere		$\frac{2\pi r^3}{3}$	0	$\frac{3r}{8}$