FIITJEE COMMON TEST

PHYSICS, CHEMISTRY & MATHEMATICS

CODE:

Time Allotted: 3 Hours **Maximum Marks: 192**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Section.
3. **Section-I** is Physics, Section-**II** is Chemistry and Section-**III** is Mathematics.
4. Each section is further divided into three parts: Part-**A , Part-B & Part-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Part-A (01 – 8)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

PART – A (**09 – 12)** contains **4** Multiple Choice Questions which have **One or More Correct** answer.
For each question in the group **Q. 09 – 11** of **PART – A** you will be awarded
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened. *Negative Marks*: **–1** In all other cases.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–1** marks, as a wrong option is also darkened.

(iii) **Part -B (01 – 06)** contains 6 Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate: _____

Batch: _____ **Date of Examination:** _____

Enrolment Number: _____

BATCHES – 1921

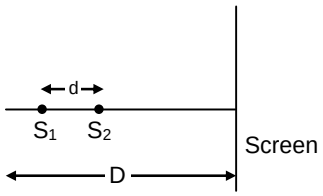
Section – I (Physics)

PART – A

(Single Correct Choice Type)

This section contains 8 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be
(A) semi – circles
(B) concentric circles
(C) points
(D) straight lines



1. **B**

2. A beam of unpolarised light o intensity I_0 is passed through a Polaroid A and then through another Polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of a. The intensity of the emergent light is
(A) $I_0/4$ (B) $I_0/8$ (C) I_0 (D) $I_0/2$

2. **A**

3. A beam of light wavelength 600 nm from a distant source falls on a single slit 1.00 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between the first dark fringes on either side of the central bright fringe is
(A) 1.2 cm (B) 1.2 mm (C) 2.4 cm (D) 2.4 mm

3. **D**

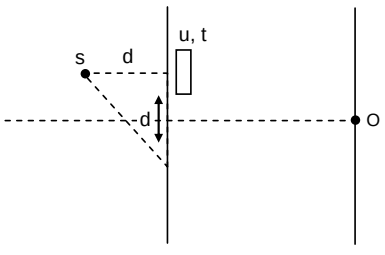
4. When a thin transparent sheet of refractive index $\mu = \frac{3}{2}$ is placed near one the slits in Young's double slits experiment, the intensity at the centre of the screen reduces to half of the maximum intensity. The minimum thickness of the sheet should be
(A) $\frac{\lambda}{4}$ (B) $\frac{\lambda}{8}$ (C) $\frac{\lambda}{2}$ (D) $\frac{\lambda}{3}$

4. **C**

5. In young's double-slit experiment how many maxima can be obtained on a screen (including the central maximum) on both sides of the central fringe if $\lambda = 2000\text{Å}$ and d = 7000Å
(A) 12 (B) 7 (C) 13 (D) 6

5. **B**

6. In a YDSE experiment the source is placed at point S in front of slit S_1, A glass slab is placed in front of S_1 such that there is central maxima at point O. Then the thickness of the slab will be
(A) $\frac{\sqrt{2}\,d}{\mu}$ (B) $\frac{(\sqrt{2}-1)d}{\mu}$
(C) $\frac{(\sqrt{2}-1)d}{(\mu-1)}$ (D) $\frac{\sqrt{2}\,d}{(\mu-1)}$

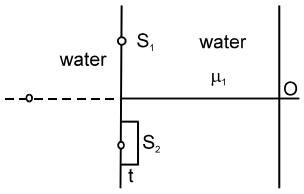


6. **C**

7. A and B are two radio stations antenna radiating electromagnetic radiation of wavelength λ, d is the separation between A and B and O is the mid-point of AB. If we move in a full circle of radius R (> > d) around O, we record a total of 6 maxima, then possibly:
(A) $d = 1.5\,\lambda$ (B) $d = 3\,\lambda$
(C) $d = 2\,\lambda$ (D) $d = \lambda$

7. **A**

8. A Young's double slit experiment is conducted in water (μ_1) as shown in the figure, and a glass plate of thickness t and refractive index μ_2 is placed in the path of S_2. The magnitude of the phase difference at O is: (Assume that 'λ' is the wavelength of light in air)



(A) $\left|\left(\frac{\mu_2}{\mu_1}-1\right)t\right|\frac{2\pi}{\lambda}$ (B) $\left|\left(\frac{\mu_1}{\mu_2}-1\right)t\right|\frac{2\pi}{\lambda}$

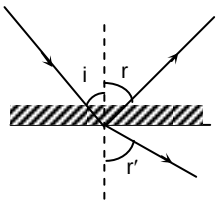
(C) $|(\mu_2-\mu_1)t|\frac{2\pi}{\lambda}$ (D) $|(\mu_2-1)t|\frac{2\pi}{\lambda}$

8. **C**

(Multi Correct Choice Type)

This section contains 4 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

9. A ray of light from a denser medium strike a rarer medium at an angle of incidence i. The reflected and refracted rays make an angle of 90^0 with each other. The angle of reflection and refraction are r and r′. The critical angle is (are)



(A) $\sin^{-1}$ (tan r) (B) $\sin^{-1}$ (tan i)

(C) $\sin^{-1}$ (tan r′) (D) $\tan^{-1}$ (sin i)

9. **AB**

10. Two coherent waves represented by $y_1 = A\sin\left(\frac{2\pi x_1}{\lambda}-\omega t+\frac{\pi}{4}\right)$ and $y_2 = A\sin\left(2\pi\frac{x_2}{\lambda}-\omega t+\frac{\pi}{6}\right)$ are superposed. The two waves will produce

(A) constructive interference at $(x_1-x_2)=\frac{11}{24}\lambda$

(B) constructive interference at $(x_1-x_2)=\frac{23}{24}\lambda$

(C) destructive interference at $(x_1-x_2)=\frac{23}{24}\lambda$

(D) destructive interference at $(x_1-x_2)=\frac{11}{24}\lambda$

10. **BD**

11. White light is used to illuminate the two slits in Young's double slit experiment. The separation between the slits is b and the screen is at a distance d (>>b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are:

(A) $\lambda = b^2/d$ (B) $\lambda = 2b^2/d$ (C) $\lambda = b^2/3d$ (D) $\lambda = 2b^2/3d$

11. **AC**

12. Why is the diffraction of sound waves more evident in daily experience than that of light wave?

(A) They have larger wavelength

(B) They have smaller wavelength

(C) There wavelength is comparable to slit width

(D) There wavelength is very small in comparison to slit width

12. **AC**

PART – B
(Numerical Based)

This section contains 06 Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. In a Young's experiment, two coherent sources are placed 0.90 mm apart and the fringes are observed one meter away. If it produces the second dark fringe at a distance of 1 mm from the central fringe, if the wavelength of monochromatic light used is k micro meter, then find the value of 'k'.

1. **0.6**

2. In Young's double slit experiment the width of one slit is double that of the other. The ratio of intensity of a bright band to that of a dark band in the interference pattern will be 5n. Find the value of 'n'.

2. **1.8**

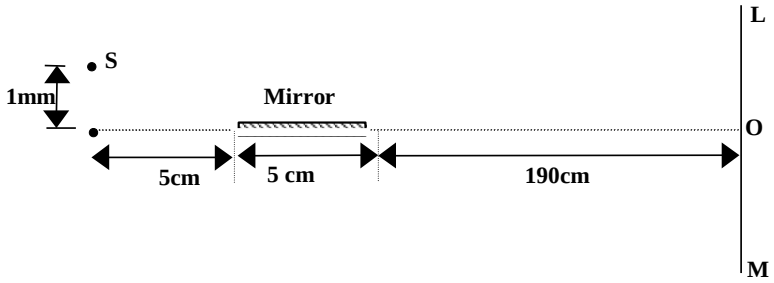
3. In a Young's double slit experiment, the fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index (4/3), without disturbing the geometrical arrangement, if the new fringe width be $\left(\frac{k}{10}\right)$mm then, find the value of 'k'.

3. **3**

4. The maximum intensity in Young's double slit experiment is I_0. Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. Find the ratio of the intensity of the central maxima to intensity of light in front of one of the slits on a screen at a distance D = 10d?

4. **2**

5. The arrangement of the Lloyd's mirror experiment is shown in the figure. 'S' is a point source of frequency 6×10^{14} Hz. A and B represent the two ends of a mirror placed horizontally, and LOM represents the screen.



If the number of fringes on the screen is 8x, then x =

5. **7**

6. Fringes are produced using light of wavelength $\lambda = 4800\ A^0$ in a double-slit experiment. One of the slits is covered by a thin plate of glass of refractive index 1.4 and other slit by another plate of glass of double the thickness and of refractive index 1.7. During this process, the central bright fringe shifts to a position originally occupied by the fifth bright fringe from the centre. If the thickness of glass plate (of double thickness) is x μm then $\frac{10x}{24}$ is

6. **2**

space for rough work

Section – II (Chemistry)
Section – I (Physics)
PART – A
(Single Correct Choice Type)

This section contains 8 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A sodium salt of ternary acid of molybdenum(atomic mass = 96) has the formula Na_2MoO_n. When an acidified solution of Na_2MoO_n is electrolyzed, O_2 gas is liberated corresponding to a volume of 0.112 L at STP and 0.32 g of Mo is deposited. Find the formula of salt.
   (A) Na_2MnO_3 (B) Na_2MnO_4
   (C) Na_2MnO_2 (D) Na_2MnO_6

1. B

2. Out of the following which is industrial method of preparation oxygen?
   (A) By heating oxygen containing salts such as chlorates, nitrates and permanganates e.g.
   $$2KClO_3 \xrightarrow{\text{Heat}} 2KCl + 3O_2$$
   (B) By thermal decomposition of oxides of metals low in electrochemical series and higher oxides of some metals e.g.
   $$2Ag_2O(s) \longrightarrow 4Ag(s) + O_2(g)$$
   $$2Pb_3O_4(s) \longrightarrow 6PbO(s) + O_2(g)$$
   (C) Hydrogen peroxide is readily decomposed into H_2O & O_2
   (D) Fractional distillation of air

2. D

3. Marshall's acid ($H_2S_2O_8$) or peroxodisulphuric acid is prepared by the electrolytic oxidation of H_2SO_4 as
   $$2H_2SO_4 \longrightarrow H_2S_2O_8 + 2H^+ + 2e^-$$
   $O_2(g)$ and $H_2(g)$ are obtained as byproducts. In such electrolysis 4.48 L of $H_2(g)$ and 1.12 L of $O_2(g)$ were produced at STP. The weight of $H_2S_2O_8$ formed is
   (A) 9.7 g (B) 19.4 g
   (C) 14.5 g (D) 29.1 g

3. B

4. Out of the following what is the correct order for bond dissociation enthalpy of halogens(in kJ/mol)?
   (A) $F_2 > Cl_2 > Br_2 > I_2$ (B) $Cl_2 > F_2 > Br_2 > I_2$
   (C) $F_2 > Br_2 > Cl_2 > I_2$ (D) $Cl_2 > Br_2 > F_2 > I_2$

4. D

5. Salicylic acid reacts with ICI vapour to produce
   (A) iodinated product (B) chlorinated product
   (C) mixture of both (D) virtually no reaction

5. B

6. The density of copper is 8.95 g mL^{-1}. Find out the number of coulombs needed to plate an area of 100 cm^2 to a thickness of 10^{-2} cm using $CuSO_4$ solution as electrolyte(Atomic weight of Cu = 63.5 g)
   (A) 27202 C (B) 26500 C
   (C) 27.02C (D) 29809 C

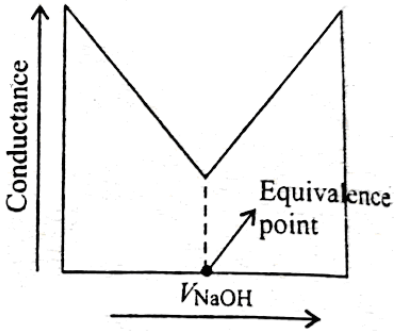
6. A

7. The resistance of a solution A is 50 ohm and that of solution B is 100 ohm, both solutions are taken in the same conductivity cell. If equal volumes of solution A and B are mixed, what is the resistance of the mixture using the same cell? (Assume there is not change or increase in the α of A and B on mixing)
(A) 62 ohm (B) 67 ohm
(C) 70 ohm (D) 80 ohm

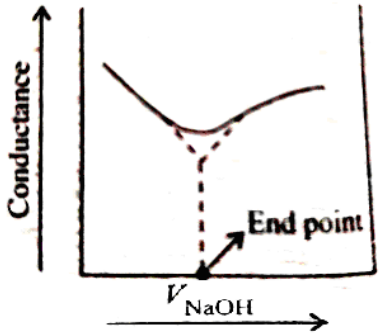
7. B

8. What is correct titration curve for the titration of (HCl + CH_3COOH) against a strong base(NaOH)?

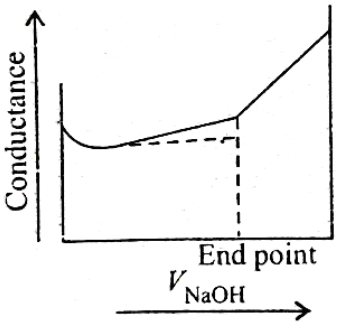
(A)



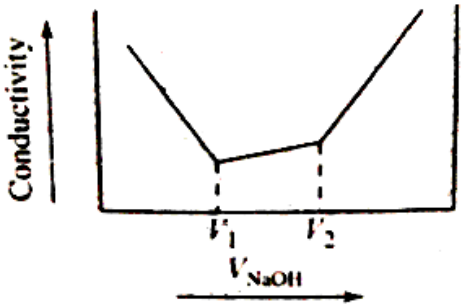
(B)



(C)



(D)



8. D

(Multi Correct Choice Type)

This section contains 4 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

9. Out of the following which statement is correct?
(A) Orthophosphorous acid on heating disproportionate, to give orthosphosphoric acid and phosphine.
(B) The acids which contain P – H bond have strong reducing properties

$$4\,AgNO_3 + 2H_2O + H_3PO_2 \longrightarrow 4\,Ag + 4\,HNO_3 + H_3PO_4$$

Shows reducing property
(C) Out of H_3PO_2, H_3PO_3, H_3PO_4 only H_3PO_4 shows reducing property
(D) Out of H_3PO_2, H_3PO_3, H_3PO_4 only H_3PO_4 do not show any reducing property

9. ABD

10. Out of the following which statement is correct about sulphur?
(A) The yellow rhombic sulphur is stable at room temperature which transform the monoclinic sulphur above 369 K.
(B) At 369 K both α-sulphur and β-sulphur are stable known as transition temperature
(C) Sulphur exist as S_2 molecule in vapour state which is paramagnetic in nature
(D) Rhombic sulphur is soluble in CS_2 but monoclinic sulphur is insoluble in CS_2

10. ABC

11. Which of the following is correct statement about inert gases?
(A) Ionization enthalpy of O_2 and Xe is similar
(B) As O_2PtF_6 form red compound similarly $XePtF_6$ form red compound
(C) XeF_6 can be prepared by interaction of XeF_4 and O_2F_2 at 143 K

$$XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$$

(D) XeF_2, XeF_4 and XeF_6 exists in liquid state at 30°C.

11. ABC

12. SO_2 pollution(from coal fired power station) can be controlled by
(A) passing the flue gas through slurry of $Ca(OH)_2$.
(B) reduction of SO_2 into S using H_2S and activated Al_2O_3 catalyst.
(C) passing through saturated solution of SO_2.
(D) passing through acidified $KMnO_4$ solution

12. AB

PART – B
(Numerical Based)

This section contains 06 Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. A hydrogen electrode place in a solution containing CH_3COOK and CH_3COOH in the ratio of a : b and b : a has electrode potential values of -1.59 and +1.0 V, respectively. Calculate pK_a of CH_3COOH.

1. 5

2. The half cell potential of a half cell A^{x+}, $A^{(x+n)^+}$ | Pt is found to be as follows

a. Percent of reducing form	25	50
b. Cell potential/V	0.10	0.115

Determine the value of n

2. 2

3. The molar conductivity of acetic acid at infinite dilution is 390.7 and for 0.01 M acetic acid is 3.907 S cm^2 mol^{-1}. Calculate the pH of solution

3. 4

4. The standard potential of a cell using the reaction:

$2MnO_4^-(aq) + 3Hg(l) + H_2O \rightleftharpoons 2MnO_2(s) + 3HgO(s) + 2(\bar{O}H)(aq)$ is 0.489V at 25°C. If the equilibrium constant of reaction is 3.63×10^{xy}. Find y - x?

4. 5

5. Find the number of pseudohalide ions from the following
$N_3^-, Cl_3^-, CN_2^{2-}, OCN^-, SCN^-, I_5^-$

5. 4

6. H_2S gas can be dried by how many of the following reagents?
Anhydrous $CaCl_2$, conc. H_2SO_4, P_2O_5, KOH solution, Na_2CO_3 solution

6. 2

space for rough work

Section – III (Mathematics)
Section – I (Physics)
PART – A
(Single Correct Choice Type)

This section contains 8 **multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. If the sum of two unit vectors $\hat{a}$ and $\hat{b}$ is also a unit vector, then $|\hat{a} - \hat{b}|$ is

   (A) $\frac{\sqrt{3}}{2}$ (B) 1

   (C) $\sqrt{3}$ (D) none of these

1. **C**

2. The matrix A= $\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}$ is a

   (A) Idempotent matrix (B) Orthogonal matrix

   (C) Nilpotent matrix (D) Involutary matrix

2. **C**

3. If $\vec{a}+\vec{b}+\vec{c}=\vec{0}$, then $\vec{a}\times\vec{b}$ is equal to

   (A) $\vec{c}\times\vec{a}$ (B) $\vec{c}$

   (C) $\vec{b}\times\vec{c}$ (D) $\vec{a}\times\vec{c}$

3. **C**

4. Let M be a 3 x 3 non – singular matrix with $\det(M)=\alpha$. If $M^{-1}\text{adj}(\text{adj}M)=k.I$, then the value of k is

   (A) 1 (B) α (C) α^2 (D) α^3

4. **D**

5. If α, β, γ are the roots of the equation $(x^3 + x^2 + x + 1) = 0$ then $\begin{vmatrix} 1+\alpha^2 & 1 & 1 \\ 1 & 1+\beta^2 & 1 \\ 1 & 1 & 1+\gamma^2 \end{vmatrix}$ is equal to

   (A) 1 (B) 0

   (C) 2 (D) none of these

5. **B**

6. Let a, b, c be any real numbers. Suppose that there are real numbers x, y, z not all zero such that $x=cy+bz$, $y=az+cx$ and $z=bx+ay$. Then $a^2+b^2+c^2+2abc$ is equal to

   (A) 2 (B) –1

   (C) 0 (D) 1

6. D

7. The value of x for which the matrix $A=\begin{bmatrix} 2 & 0 & 7 \\ 0 & 1 & 0 \\ 1 & -2 & 1 \end{bmatrix}$ is inverse of $B=\begin{bmatrix} -x & 14x & 7x \\ 0 & 1 & 0 \\ x & -4x & -2x \end{bmatrix}$ is

   (A) $\frac{1}{2}$ (B) $\frac{1}{3}$

   (C) $\frac{1}{4}$ (D) $\frac{1}{5}$

7. **D**

8. Let $\Delta(x)=\begin{vmatrix} 2x^3-3x^2 & 5x+7 & 2 \\ 4x^3-7x & 3x+2 & 1 \\ 7x^3-8x^2 & x-1 & 3 \end{vmatrix}=a_0+a_1x+.....+a_4x^4$. Then a_0 equals

(A) 0 (B) 1
(C) 2 (D) 3

8. **A**

(Multi Correct Choice Type)

This section contains 4 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

9. If $A=\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$, then

(A) $A^3=9A$ (B) $A^3=27A$ (C) $A+A=A^2$ (D) A^{-1} does not exist

9. **BC**

10. The vector $\frac{1}{3}(2\hat{i}-2\hat{j}+\hat{k})$ is

(A) A unit vector

(B) Makes an acute angle $\frac{\pi}{3}$ with the vector $2\hat{i}-4\hat{j}+3\hat{k}$

(C) Parallel to $-\hat{i}+\hat{j}-\frac{1}{2}\hat{k}$

(D) Perpendicular to $3\hat{i}+2\hat{j}-2\hat{k}$

10. ACD

11. If $\Delta=\begin{vmatrix} -x & a & b \\ b & -x & a \\ a & b & -x \end{vmatrix}$, then, a factor of Δ is

(A) $a+b+x$ (B) $x^2-(a-b)x+a^2+b^2+ab$
(C) $x^2+(a+b)x+a^2+b^2-ab$ (D) $a+b-x$

11. CD

12. For two non-singular square matrices A and B of same order 'n', which of the following is correct?

(A) $\text{adj}(AB)=(\text{adj}B)(\text{adj}A)$ (B) $\left(BAB^{-1}\right)^{10}=B^{10}A^{10}\left(B^{-1}\right)^{10}$
(C) $(2A)^{-1}=2^n.A^{-1}$ (D) $\text{adj}(2B)=2^{n-1}(\text{adj}B)$

12. AD

PART – B
(Numerical Based)

This section contains 06 Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. $|\vec{a}|=3$, $|\vec{b}|=4$ and $|\vec{a}+\vec{b}|=5$, then $|\vec{a}-\vec{b}|=$

1. 5

2. If f(x) = $\begin{vmatrix} a & -1 & 0 \\ ax & a & -1 \\ ax^2 & ax & a \end{vmatrix}$ then the degree of polynomial $f(x) - f(-x)$ is

2. 1

3. If A is a square matrix, A.adj A = $\begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ and $\frac{|adj(adj(A))|}{|adj(A)|} = k^2$ then k is

3. **4**

4. Let $A = \begin{bmatrix} 2 & 3 \\ -1 & 5 \end{bmatrix}$ and $A^{-1} = xA + yI$ then the value of x + 2y is

4. 1

5. If $P = \begin{bmatrix} 1 & \alpha & 3 \\ 1 & 3 & 3 \\ 2 & 4 & 4 \end{bmatrix}$ is the adjoint of a 3×3 matrix A and $|A| = 4$, then α is equal to

5. 11

6. The number of non – null Idempotent diagonal matrices of order 4 is

6. 15

space for rough work