

Total No. of printed pages = 11

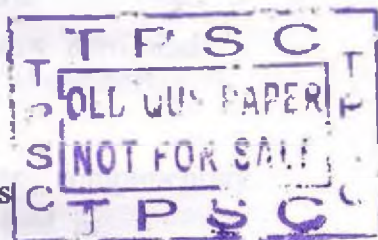
TR/FST/BOT/I/21

BOTANY

Paper : I

Full Marks – 100

Time – Three hours



Instructions :

1. Answer to question No.1 (i to xx) i.e., MCQ type questions under Section-A must be written in English only.

Example :

Question : Nucleosome is the nucleic material of

- (a) Fungus
- (b) Bacteria
- (c) Virus
- (d) None of the above

Answer : (b) Bacteria.

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction must be followed scrupulously.

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3. The figures in the margin indicate full marks for the questions.
4. Candidates are required to give their answers in their own words as far as practicable.

SECTION – A

Answer *all* questions.

1. Select the single best answer and write it in the answer script : $1 \times 20 = 20$

(i) The development of a sporophyte from the gametophyte without sexual fusion is called

- | | |
|--------------|----------------|
| (a) Apomixis | (b) Apogamy |
| (c) Apospory | (d) Amphimixis |

(ii) A group of sporangia developing from placenta and covered by indusium is called

- | | |
|-------------|----------------|
| (a) Cone | (b) Sorus |
| (c) Ramenta | (d) Sporophyll |

(iii) Fungi-where only asexual reproduction is known, are grouped under

- (a) Zygomycetes (b) Ascomycetes
- (c) Deuteromycetes (d) Basidiomycetes

(iv) Gaidukov phenomenon or complimentary chromatic adaptation is found in

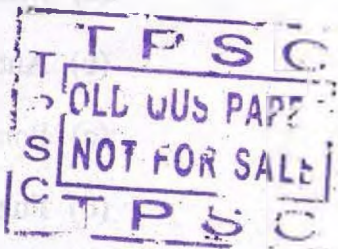
- (a) Cyanophyta (b) Bacillariophyta
- (c) Rhodophyta (d) None of these

(v) Which of the following is a 'club moss' ?

- (a) Equisetum (b) Selaginella
- (c) Lycopodium (d) Marsilea

(vi) Hypanthodium is a type of inflorescence

- (a) Simple racemose
- (b) Special type of cymose
- (c) Compound spike
- (d) Scorpioid cyme



(vii) Cleistogamous flowers

- (a) open during day
- (b) open during night
- (c) always open
- (d) never open

(viii) Fruit developing from hypanthodium is

- (a) Sorosis
- (b) Balaustra
- (c) Syconus
- (d) Hesperidium

(ix) Which among the following is an example of symbiosis in Bryophytes ?

- (a) Marchantia and Volvox
- (b) Anthoceros and Nostoc
- (c) Porella and Volvox
- (d) Funaria and Anabaena

(x) Protandry means

- (a) Anthers of flower mature earlier than the carpels
- (b) Carpels of a flower mature earlier than the other
- (c) Both the anther and carpel mature equally
- (d) None of the above

(xi) When xylem is surrounded by phloem on all outer sides, the vascular bundle is called

- (a) Radial
- (b) Leptocentric
- (c) Amphivasal
- (d) Amphicribal

(xii) In a root system, the lateral roots arise from

- (a) Endodermis
- (b) Pericycle
- (c) Cortex
- (d) Epiblema

(xiii) Which among the following is not a major taxonomic group of Algae ?

- (a) Chamaephycophyta
- (b) Bacillariophycophyta
- (c) Chlorophycophyta
- (d) Phaephycophyta

(xiv) Which of the following is obtained from a flower ?

- (a) Cashew
- (b) Cardamom
- (c) Cotton
- (d) Saffron

(xv) Secondary cambium is developed from

- (a) Apical meristem
- (b) Lateral meristem
- (c) Intercalary meristem
- (d) Pro-meristem

(xvi) Which one of the following is placed in prokaryote ?

- (a) Cyanophyceae
- (b) Chlorophyceae
- (c) Ectocarpaceae
- (d) Oedogoniaceae

(xvii) Pappus is the diagnostic features of the flowers belonging to the family

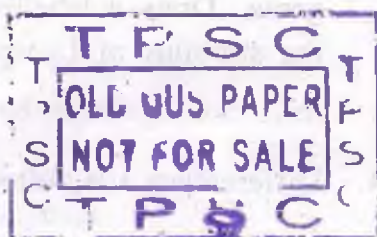
- (a) Myrtaceae
- (b) Asteraceae
- (c) Magnoliaceae
- (d) Verbenaceae

(xviii) Didynamous stamen is found in the flower of the family

- (a) Labiatae (b) Palmae
(c) Enphorbiaceae (d) Cucurbitaceae

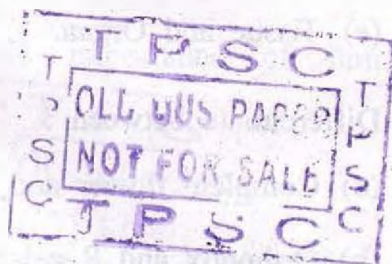
(xix) The arrangement of floral leaves in the floral bud is called

- (a) Aestivation
(b) Phyllotaxy
(c) Vernation
(d) Prefoliation



(xx) The rod shaped bacteria are called

- (a) Cocci
(b) Bacilli
(c) Spirilla
(d) Vibrio



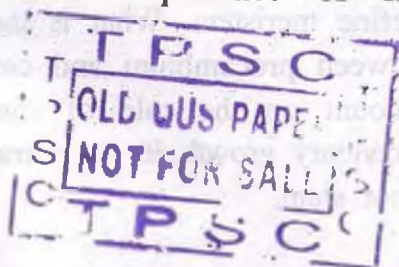
SECTION - B

Answer any *six* questions from the following :

5×6=30

2. Illustrate diagrammatically the raceme, panicle, umbel, spike and capitulum inflorescence in plants. 1+4=5
3. State why Lycopodium is called as homosporic genus. Draw a labelled diagram of the L.S. of the strobilus of Lycopodium and describe it. 1+(2+2)=5
4. Differentiate the following : 1×5=5
 - (a) Cleistogamous and Chasmogamous flower
 - (b) Oviparous and Viviparous plant
 - (c) Caryopsis and Berry fruit
 - (d) Autochory and Allochory seed dispersal
 - (e) Tissue and Organ.
5. Differentiate between : 1×5=5
 - (a) Complete flower and incomplete flower.
 - (b) Orthodox and Recalcitrant seed.

- (c) Polypetalous flower and gemopetalous flower.
 (d) Orthotropous ovule and amphitropous ovule.
 (e) True fruit and false fruit.
6. Describe the macrandrous type of sexual reproduction in *Oedogonium*. 5
7. Give an account on International Code of Botanical Nomenclature. 5
8. Name the families in which the following structures are considered as diagnostic characters : $1 \times 5 = 5$
- (a) Verticillaster inflorescence
 (b) Axile placentation
 (c) Pulvinus
 (d) Bilabiate corolla
 (e) Fruit with liquid endosperm.
9. What is economic importance of family Graminae ? 5



SECTION – C

Answer any five questions from the following :

10×5=50

10. What is isomorphic alternation of generation ?
Explain it with reference to the life cycle of *Ectocarpus*. 10
11. What are the various adaptations or contrivances met within angiospermic flowers which favour cross-pollination. 10
12. Define inflorescence. What is the difference between racemose and cymose type of inflorescence. With suitable diagram and example describe a capitulum type of inflorescence. 1+2+2+5=10
13. Give the salient features of any phylogenetic classification of flowering plants. Also discuss its merits and demerits. 10
14. Define meristem. What is the basic difference between procambium and cambium ? Give an account on the role of cambium in normal secondary growth in the intrastelar region of a dicot stem. 1+2+7=10

15. (a) Why pollination is important in plants ?
Explain kinds of pollination ? Write a short
account on methods of pollination by giving
3-4 examples. Give short account of condition
in plants which favours cross-pollination. 5

(b) What is a zygomorphic and actinomorphic
flower ? Draw a labelled diagram of a flower
in angiosperm. How is it different from a
monocot flower ? 5

16. Describe the characteristic features of orchid
flower with suitable sketch. State why the family
orchidaceae is considered as the most advanced
family among the monocotyledonous plants.

4+1+5=10

Total No. of printed pages = 9

TR/FST/AE/II/21

AGRICULTURAL ENGINEERING

Paper : II

Full marks – 100

Time – Three hours

The figures in the margin indicate full marks
for the questions.

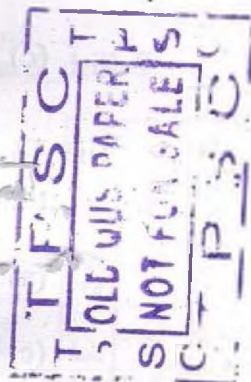
INSTRUCTIONS :

1. Answer to question No. 1 (i to xx) i.e., MCQ type questions under Section – A must be written in English only.

Example : The capital of India is

- (a) Delhi
- (b) New Delhi
- (c) Indraprastha
- (d) None of the above

Answer : (b) New Delhi



[Turn over

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction should be followed scrupulously.
3. Candidates are required to give their answers in their own words as far as practicable.

SECTION – A

1. Choose the correct answer and write it down in the answer script :

(i) Alumina content in good earth brick is

- | | |
|-------------|-------------|
| (a) 20-30 % | (b) 40-60 % |
| (c) 60-70 % | (d) 70-80 % |

(ii) To get the full strength of concrete, curing time should be

- | | |
|-------------|-------------|
| (a) 3 days | (b) 7 days |
| (c) 14 days | (d) 28 days |

(iii) A roof which is used normally in poultry farm is called

- (a) Gable roof (b) Shed roof
- (c) Hip roof (d) Flat roof

(iv) The wire used for construction of barbed wire fencing is

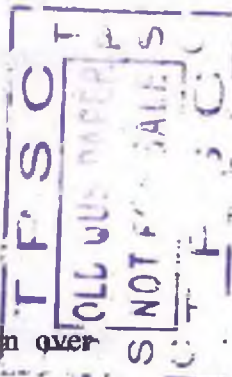
- (a) 10 gauge (b) 12 gauge
- (c) 14 gauge (d) 16 gauge

(v) Structural frames used in multistory poultry houses are

- (a) Beam and post (b) Trusses
- (c) Arches (d) Braces

(vi) What is the main function of seed drill ?

- (a) To carry seeds
- (b) To meter seeds
- (c) To deposit seeds in furrow
- (d) All of the above are correct



(vii) What voltage will an ac voltmeter display ?

- (a) peak-to-peak
- (b) average
- (c) rms
- (d) peak

(viii) The MB plough works on the principle of

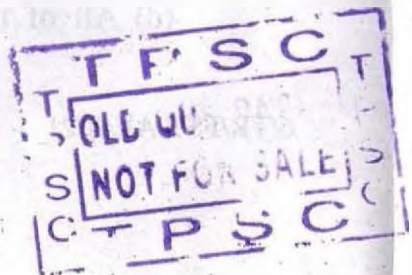
- (a) Friction
- (b) Rolling
- (c) Suction
- (d) Scoring

(ix) The compression pressure of diesel engine varies from

- (a) 8-10 kg/sq.cm
- (b) 10-40 kg/sq.cm
- (c) 35-50 kg/sq.cm
- (d) 45-50 kg/sq.cm

(x) If stroke : bore ratio of an engine increases, the thermal efficiency

- (a) increases
- (b) decreases
- (c) remains same
- (d) None of these



(xi) The cylinder speed of rotary type thresher is

- (a) 200 rpm
- (b) 300 rpm
- (c) 400 rpm
- (d) 500 rpm

(xii) The size of mould board plough is expressed by

- (a) Width of cut
- (b) Depth of cut
- (c) Size of furrow
- (d) Plough width

(xiii) The viscosity of oil is denoted by which number ?

- (a) Cetane number
- (b) Octane number
- (c) SAE number
- (d) None of these

(xiv) The compression ratio of diesel engine is

- (a) 4 to 8:1
- (b) 14 to 20:1
- (c) 4 to 15:1
- (d) 14 to 22:1

(xv) The firing order of 4 stroke 4-cylinder engine is

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

(xvi) To reduce Electrical energy bill, power factor should be kept

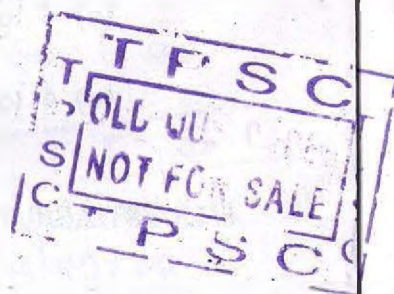
- (a) as less as possible
- (b) power factor does not affect energy bill
- (c) as high as possible
- (d) as close to unity as possible

(xvii) Earth pit value resistance is measured in which type of meter ?

- (a) Insulation megger
- (b) Volt meter
- (c) Earth megger
- (d) Ammeter

(xviii) The current produced by AC generators is

- (a) alternative current
- (b) fixed current
- (c) direct current
- (d) negative current



(xix) On the two sides of a star / delta transformer

(a) voltages and currents are both in phase

(b) voltages and currents both differ in phase by 30°

(c) Voltages differ in phase by 30° but currents are in phase

(d) Currents differ in phase by 30° but voltages are in phase.

(xx) Kilowatt-hour (kWh) is a unit of

(a) Current

(b) Power

(c) Energy

(d) Resistance.

SECTION – B

(Questions Nos. 2 to 9)

Answer any six questions :

$6 \times 5 = 30$

2. Explain the advantages of DEEP LITTER Poultry house in comparison to CAGE HOUSES.

3. What are the different components of a mould board plough with neat sketch ?

4. Discuss dairy barns, their types and their components.

5. Discuss the parts of a double disc type furrow opener, and its suitability for specific purposes.
6. Define tillage. What do you understand by primary tillage and secondary tillage ?
7. A four-cylinder four stroke engine having cylinder bore 7.5 cm and stroke length 10 cm develops 15 kW at 1650 rev/min. assuming a mechanical efficiency of 85%, find indicated power and mean effective pressure.
8. Compare the different types of Potato Planters, their advantages and disadvantages.
9. Compare conventional grid connected electricity and its alternatives for rural India.

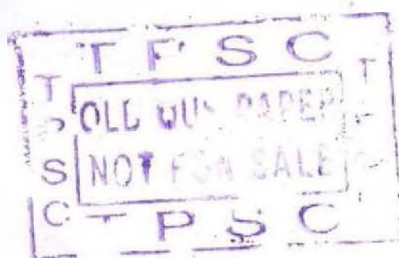
SECTION – C

(Questions Nos. 10 to 16)

Answer any *five* questions : 10×5=50

10. Draw a model layout of a dairy for a 20 cow/ buffalo unit.
11. Explain the types of shear failures in a beam with neat sketch ?

12. Explain about the working principles of combine harvester with neat diagram.
13. Compare the fundamental technical/economic differences between Diesel and Petrol IC engines.
14. Discuss the design and utility of human operated paddy thresher.
15. Differentiate between Single Phase and Poly Phase motor on technical considerations in improving the agriculture productivity.
16. Discuss about safety and maintenance measures of electric motors to be used for agricultural operations. What types of transformers are normally used in Agricultural sector ?



Total No. of printed pages = 12

TR/FST/MATH/I/21

MATHEMATICS

Paper – I

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Instructions :

1. Answers to Question No. 1(i to xx) i.e, MCQ type questions under Section-A must be written in English only.

Example : The capital of India is

- (a) Delhi
- (b) New Delhi
- (c) Indraprastha
- (d) None of these

Answer : (b) New Delhi.

2. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION - A

1. Choose the correct answer and write it on the answer script. 1×20=20

(i) The principal value of the argument of $z = -\sqrt{3} - i$ is

(a) $-\frac{\pi}{6}$ (b) $\frac{\pi}{6}$

(c) $-\frac{5\pi}{6}$ (d) $\frac{5\pi}{6}$

(ii) If $a = \cos \alpha + i \sin \alpha$ and $b = \cos \beta + i \sin \beta$, then the value of $\frac{1}{2} \left(ab + \frac{1}{ab} \right)$ is

(a) $\sin (\alpha + \beta)$ (b) $\cos (\alpha + \beta)$

(c) $\sin (\alpha - \beta)$ (d) $\cos (\alpha - \beta)$

(iii) If w is a cube root of unity, then

$$\begin{vmatrix} 1 & 1+iw^2 & w^2 \\ 1-i & -1 & w^2-1 \\ -1 & i+w-1 & -1 \end{vmatrix} =$$

(a) 0 (b) 1

(c) i (d) w

(iv) If $B = (I - A)(I + A)^{-1}$ is orthogonal then A is

- (a) Orthogonal
- (b) Symmetric
- (c) Skew symmetric
- (d) None of these

(v) If z_1, z_2, z_3 are complex numbers such that

$$|z_1| = |z_2| = |z_3| = \left| \frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3} \right| = 1$$

then $|z_1 + z_2 + z_3|$ is

- (a) 1
- (b) < 1
- (c) > 3
- (d) 3

(vi) If C is the mid point of AB and P is any point outside AB then

- (a) $\overline{PA} + \overline{PB} = 2\overline{PC}$
- (b) $\overline{PA} + \overline{PB} = \overline{PC}$
- (c) $\overline{PA} + \overline{PB} + 2\overline{PC} = \overline{0}$
- (d) $\overline{PA} + \overline{PB} + \overline{PC} = \overline{0}$

(vii) The value of $\sqrt{-2 + \sqrt{-2 + \sqrt{-2 + \dots}}}$ is

(a) $\sqrt{2}i$ (b) $-\sqrt{2}i$

(c) $-\frac{1-i\sqrt{7}}{2}$ (d) $\frac{1+i\sqrt{7}}{2}$

(viii) The series $\sum (\sqrt{n^4+1} - \sqrt{n^4-1})$ is

(a) Convergent

(b) Divergent

(c) Oscillates finitely

(d) Oscillates infinitely

(ix) Let a, b, c be distinct non-negative numbers.

If the vectors $a\hat{i} + a\hat{j} + c\hat{k}$, $\hat{i} + \hat{k}$ and $c\hat{i} + c\hat{j} + b\hat{k}$ lie in a plane then c is

(a) AM of a and b

(b) GM of a and b

(c) HM of a and b

(d) 0

- (x) If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are unit coplaner vectors, then the scalar triple product

$$[2\vec{a} - \vec{b}, 2\vec{b} - \vec{c}, 2\vec{c} - \vec{a}] =$$

- (a) 0 (b) 1
(c) $-\sqrt{3}$ (d) $\sqrt{3}$
- (xi) The value of limit $\frac{\tan x - x}{x - \sin x}$ is
- (a) 0 (b) 1
(c) 2 (d) None of these
- (xii) General solution of the differential equation

$\frac{dy}{dx} + Px = Q$, where P, Q are functions of y only is

(a) $y e^{\int P dx} = \int Q e^{\int P dx} dx + c$

(b) $x e^{\int P dy} = \int Q e^{\int P dy} dy + c$

(c) $y = \int Q e^{\int P dy} dx + c$

(d) $x = \int Q e^{\int P dy} dy + c$

(xiii) If $u = \frac{x^2 + y^2}{\sqrt{x + y}}$, $(x, y) \neq (0, 0)$ then the value

of K so that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = K$ is

(a) $\frac{2}{3}$

(b) $\frac{1}{3}$

(c) $\frac{3}{2}$

(d) $\frac{5}{2}$

(xiv) The value of $\int_0^{\pi/2} \frac{\sqrt{\sin x}}{\sqrt{\sin x} + \sqrt{\cos x}} dx$ is

(a) $\frac{\pi}{2}$

(b) $\frac{\pi}{4}$

(c) $\frac{\pi}{8}$

(d) π

(xv) Which of the following is the equation of an asymptote for the function

$$f(x) = \frac{6x^4 - x^2 + 1}{2x^4 + 2} ?$$

(a) $y = 3$

(b) $x = -1$

(c) $y = 6$

(d) $y = 2$

(xvi) The area between the cubic $y = x^3$ and the parabola $y = x^2$ (in sq units) is

(a) $\frac{1}{3}$

(b) $\frac{1}{4}$

(c) $\frac{1}{6}$

(d) $\frac{1}{12}$

(xvii) The solution of $\frac{dy}{dx} + y \frac{d\phi}{dx} = \phi(x) \frac{d\phi}{dx}$ is

(a) $y = \phi(x) - 1 + ce^{-\phi(x)}$

(b) $y = ce^{\phi(x)}$

(c) $y = x\phi(x) - ce^{-\phi(x)}$

(d) $y = [\phi(x) - 1] e^{-\phi(x)} + c$

(xviii) A particular integral of

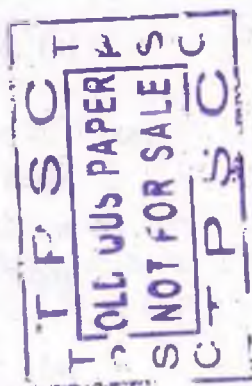
$$\frac{d^2y}{dx^2} - \left(\frac{dy}{dx}\right) - 2y = \cos x + 3\sin x$$
 is

(a) $\sin x$

(b) $\cos x$

(c) $-\sin x$

(d) $-\cos x$



(xix) The solution of the differential equation

$$\frac{dy}{dx} = \frac{y}{x} + \sin \frac{y}{x} \text{ is}$$

(a) $\operatorname{cosec} \frac{y}{x} + \cot \frac{y}{x} = cx$

(b) $\operatorname{cosec} \frac{y}{x} - \cot \frac{y}{x} = cy$

(c) $x = 2y \tan^{-1}(2x)$

(d) $y = 2x \tan^{-1}(cx)$

(xx) The volume of solid of revolution generated when the area bounded by $y = x^2$, the x-axis and the ordinates $x = 0$ and $x = 3$ is revolved about x-axis is

(a) $\frac{567\pi}{5}$

(b) $\frac{27\pi}{2}$

(c) $\frac{81\pi}{2}$

(d) $\frac{243\pi}{5}$

SECTION - B

Answer six questions taking at least two from each group. 5×6=30

GROUP - (1)

2. Prove that $\tan\left(i \log \frac{a-ib}{a+ib}\right) = \frac{2ab}{a^2 - b^2}$
3. If α, β, γ are the roots of the equation $x^3 + px^2 + qx + r = 0$ then find in terms of p, q, r the value of $(\beta + \gamma - 3\alpha)^3 + (\gamma + \alpha - \beta)^3 + (\alpha + \beta + \gamma)^3$.
4. Prove that by vector method

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

5. Find the moment about a line L , through the origin having direction of $2i + 2j + k$ due to a 30kg force acting at a point $A(-4, 2, 5)$ in the direction of $12i - 4j - 3k$.

GROUP - (2)

6. Show that $(R_1^{2/3} + R_2^{2/3})(ab)^{2/3} = a^2 + b^2$, where R_1 and R_2 are the radii of curvature at the extremities of the conjugate diameters of an ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$$

7. Verify Rolle's theorem for the function $f(x) = (x - a)^m (x - b)^n$ where m and n are positive integers.
8. The circle $x^2 + y^2 = a^2$ revolves round the x -axis. Show that the surface area of the sphere generated is $4\pi a^2$.
9. Solve the differential equation

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = \sinh x + \sin \sqrt{2} x.$$

SECTION - C

Answer any *five* questions :

10×5=50

10. If $\cos\alpha + \cos\beta + \cos\gamma = 0$,

$$\sin\alpha + \sin\beta + \sin\gamma = 0$$

Prove that

$$(i) \quad \cos 3\alpha + \cos 3\beta + \cos 3\gamma = 0 = 3\cos(\alpha + \beta + \gamma)$$

and

$$(ii) \quad \sin 3\alpha + \sin 3\beta + \sin 3\gamma = 3\sin(\alpha + \beta + \gamma)$$

5+5=10

11. Prove that the determinant

$$\begin{vmatrix} a-b-c & 2a & 2a \\ 2b & b-c-a & 2b \\ 2c & 2c & c-a-b \end{vmatrix} \text{ is a perfect cube.}$$

12. Determine the whole length of a loop of the curve $r = a(1 + \cos 2\theta)$ and show that it is equal to

$$\frac{2a}{\sqrt{3}}[2\sqrt{3} + \ln(2 + \sqrt{3})].$$

13. If $lx + my = 1$ touches the curve $(ax)^n + (by)^n = 1$ show that

$$\left(\frac{l}{a}\right)^{\frac{n}{n-1}} + \left(\frac{m}{b}\right)^{\frac{n}{n-1}} = 1.$$

14. (a) If the roots of $x^3 + 2x^2 + 3x + 1 = 0$ are α, β, γ , then find the equation whose roots are

$$\frac{1}{\alpha^2} + \frac{1}{\beta^2} - \frac{1}{\gamma^2}, \quad \frac{1}{\beta^2} + \frac{1}{\gamma^2} - \frac{1}{\alpha^2} \text{ and}$$

$$\frac{1}{\gamma^2} + \frac{1}{\alpha^2} - \frac{1}{\beta^2}.$$

- (b) Use Descartes' rule of signs to find the number of positive and negative roots of the equation

$$x^5 - x^4 + x^3 + 8x^2 + 2x - 2 = 0.$$

15. (a) Show that the series $\sum_{n=1}^{\infty} \sin \frac{1}{n^2}$ converges.

- (b) Test for convergence of the series

$$\frac{\alpha}{\beta} + \frac{1+\alpha}{1+\beta} + \frac{(1+\alpha)(2+\alpha)}{(1+\beta)(2+\beta)} + \dots$$

prove that the series converges for $\beta > \alpha + 1$
and diverges for $\beta \leq \alpha + 1$. 2+8=10

16. (a) Solve the equation :

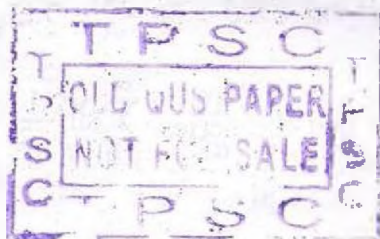
$L \frac{di}{dt} + Ri = E_0 \sin \omega t$, where L, R, E_0 are constants and discuss the case when t increases indefinitely.

- (b) Uranium disintegrates at a rate proportional to the amount present at any instant. If M_1 and M_2 grams of uranium are present at times T_1 and T_2 respectively, show that the

half life of uranium is $\frac{(T_2 - T_1) \ln 2}{\ln(M_1/M_2)}$.

(Half life of uranium is that time by which it decays to half of its initial amount)

5+5=10



Total No. of printed pages = 13

TR/FST/MATH/II/21

MATHEMATICS

Paper – II

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

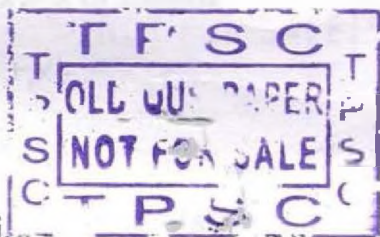
Instructions :

1. Answer to Question No. 1(i to xx) i.e MCQ type questions under Section-A must be written in English only.

Example : The capital of India is –

- (a) Delhi
- (b) New Delhi
- (c) Indraprastha
- (d) None of these

Answer : (b) New Delhi



2. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION - A

1. Select the correct answer and write it on the answer script : $1 \times 20 = 20$

(i) The second degree equation $6x^2 - 5xy - 6y^2 + 14x + 5y + 4 = 0$ represents

- (a) An ellipse
- (b) A circle
- (c) A Parabola
- (d) Pair of intersecting

(ii) The number of Basic Feasible solution of the L.P.P.

$$\text{Max } z = 10x_1 + x_2 + 2x_3$$

$$\text{subject to } x_1 + x_2 - 2x_3 \leq 10$$

$$4x_1 + x_2 + x_3 \leq 20$$

$$x_1 + x_2, x_3 \geq 0 \text{ is}$$

- | | |
|-------|-------|
| (a) 0 | (b) 1 |
| (c) 2 | (d) 3 |

(iii) The lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ and

$\frac{x-1}{-k} = \frac{y-4}{2} = \frac{z-5}{1}$ are coplaner, if

(a) $k = 0$ or -1

(b) $k = 1$ or -1

(c) $k = 0$ or -3

(d) $k = 3$ or -3

(iv) Two extreme points of the set

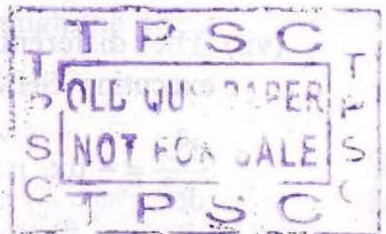
$S = \{(x_1, x_2) : x_1^2 + x_2^2 \leq 1, x_1, x_2 \geq 0\}$ are

(a) $(0,0), \left(\frac{1}{2}, 0\right)$

(b) $\left(0, \frac{1}{2}\right), (0, 1)$

(c) $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right), \left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$

(d) $\left(\frac{1}{2}, \frac{1}{2}\right), (1, 0)$



(v) The position of the moving point at time t is given by $x = a \cos t$ and $y = a \sin t$. Its acceleration is

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

(vi) A stone of mass 5 kg is attached to the end of a string of length 50m and is whirled in a horizontal circle. The string can stand a maximum tension of 4kg-wt. The maximum velocity of revolution that can be given to the stone is

(take $g = 10 \text{ m/sec}^2$)

- (a) 10 m/sec (b) 15 m/sec
(c) 20 m/sec (d) 25 m/sec

(vii) The differential equation of a particle executing SHM along x-axis, is given by

$\frac{d^2x}{dt^2} = -\mu x$, $\mu > 0$. If initially $\frac{dx}{dt} = v$, in the negative x direction at $x = a$, its solution is

(a) $x = a \cos \sqrt{\mu}t + \frac{v}{\sqrt{\mu}} \sin \sqrt{\mu}t$

(b) $x = \frac{v}{\sqrt{\mu}} \sin \sqrt{\mu}t$



$$(c) \quad x = a \cos \sqrt{\mu}t - \frac{v}{\sqrt{\mu}} \sin \sqrt{\mu}t$$

$$(d) \quad x = \frac{v}{\sqrt{\mu}} \cos \sqrt{\mu}t$$

(viii) The dimension of the vector space $R^{m \times n}$ of all $m \times n$ real matrices is

$$(a) \quad m+n$$

$$(b) \quad m - n$$

$$(c) \quad mn$$

$$(d) \quad \frac{m}{n}$$

(ix) Let W be a subspace of $\mathbb{R}^3$ such that $\dim W = 2$. Then

(a) W is a line through the origin

(b) W is a plane through the origin

(c) W is a point

(d) None of these

(x) A line makes angle α , β , γ with x -axis, y -axis and z -axis respectively, then $\cos 2\alpha + \cos 2\beta + \cos 2\gamma$ is equal to

$$(a) \quad 2$$

$$(b) \quad 1$$

$$(c) \quad -2$$

$$(d) \quad -1$$

(xi) The velocity of a particle moving in a straight line is given by the relation $v^2 = ax^2 + 2bx + c$. Its acceleration varies as the distance from the point

- (a) $x = a$ (b) $x = b$
(c) $x = c$ (d) $x = -b/a$

(xii) The vectors $(1, 2, 1)$, $(2, 1, 1)$ and $(1, 1, 2) \in \mathbb{R}^3$ are

- (a) Linearly independent
(b) Linearly dependent
(c) Spans $\mathbb{R}^3$
(d) Linearly independent and also spans $\mathbb{R}^3$.

(xiii) The solution to a transportation problem with m sources and n destinations is feasible, if the numbers of allocations are

- (a) $m + n - 1$ (b) $m + n + 1$
(c) $m + n$ (d) mn

(xiv) The polar equation $\frac{1}{r} = 8 + 5\cos \theta$ represents a

- (a) Circle (b) Parabola
(c) Ellipse (d) Hyperbola

(xv) P is a point on the line segment joining the points (3, 5, -1) and (6, 3, -2). If y-coordinate of the point P is 2, then its x-coordinate will be

- (a) 2 (b) $\frac{17}{3}$
(c) $\frac{15}{2}$ (d) -5

(xvi) A shell of mass m is ejected from a gun of mass M by an explosion which generates kinetic energy E . Then the initial velocity of the shell is

- (a) $\sqrt{\frac{ME}{(M+m)m}}$
(b) $\sqrt{\frac{mE}{(M+m)m}}$
(c) $\sqrt{\frac{2mE}{(M+m)m}}$
(d) $\sqrt{\frac{2ME}{(M+m)m}}$



(xvii) Two smooth spheres of masses m_1 and m_2 moving with velocities u_1 and u_2 respectively in the same direction along their line of centres impinge directly with the co-efficient of elasticity 1. Then the loss of K.E. due to direct impact is

(a) $\frac{m_1 m_2}{2(m_1 + m_2)}(u_1 - u_2)^2$

(b) 1

(c) 0

(d) $\frac{m_1 m_2}{2(m_1 + m_2)}$

(xviii) The distance of the point (2,5,7) from the x-axis is

(a) 2

(b) $\sqrt{74}$

(c) $\sqrt{29}$

(d) $\sqrt{53}$

(xix) The measure of the angle between the pair of straight lines represented by

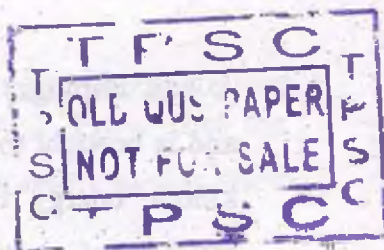
$$4x^2 - 24xy + 11y^2 = 0 \text{ is}$$

(a) $\frac{\pi}{2}$

(b) $\frac{\pi}{4}$

(c) between $\frac{\pi}{4}$ and $\frac{\pi}{3}$

(d) between $\frac{\pi}{3}$ and $\frac{\pi}{2}$



(xx) In an orbit described under a force a centre, the velocity at any point is inversely proportional to the distance of the point from the centre of force. Then the path is

(a) a parabola

(b) an ellipse

(c) a cardioide

(d) an equiangular spiral.

SECTION – B

Answer any six questions :

5×6=30

2. Show that the equation of the lines through the origin, each of which makes an angle with the line $y = x$ is

$$x^2 - 2xy \sec 2q + y^2 = 0.$$

3. The plane $lx + my = 0$ is rotated about its line of intersection with the plane $z = 0$ through an angle α . Prove that its equation in its new position is

$$lx + my \pm z \sqrt{l^2 + m^2} \tan \alpha = 0.$$

4. A ball impinges directly on another ball at rest and is brought to rest by impact. If half the initial kinetic energy is lost by impact, find the coefficient of elasticity.
5. A bullet of mass $\frac{1}{4}$ is moving with a velocity of 500 ft/sec strikes a fixed target perpendicularly and falls down. If the blow is assumed to last for $\frac{1}{100}$ th of a second, find the average value of the force of impulse between the shot and the target.
6. Prove that in E^3 the set $X = \{(x_1, x_2, x_3) : (x_1 - x_2 + x_3 \leq 3)\}$ is convex set.
7. Use Charnes Big M-method (method of penalty) to
 Maximize $z = 5x_1 - 2x_2 + 3x_3$
 Subject to $2x_1 + 2x_2 - x_3 \geq 2$
 $3x_1 - 4x_2 \leq 3$
 $x_2 + 3x_3 \leq 5$
 $x_1, x_2, x_3 \geq 0$.

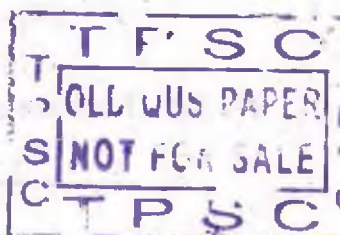
8. A particle moves along a straight line according to the law $s^2 = 5t^2 + 3t + 2$. Prove that the acceleration varies as $\frac{1}{s^3}$. (s and t having their usual meaning)
9. Test whether the set of vectors (1, 2, -1), (3, -1, 2) and (5, 3, 0) in Euclidean 3-space is linearly dependent or not.

SECTION - C

Answer any *five* questions : 10×5=50

10. Find an optimal solution and the corresponding cost of transportation in the following transporation problem :

	D ₁	D ₂	D ₃	D ₄	
O ₁	1	2	-2	3	70
O ₂	2	4	0	1	38
O ₃	1	2	-2	5	32
	40	28	30	42	



11. If one of the straight lines given by the equation $ax^2 + 2hxy + by^2 = 0$ coincide with one of those given by $a'x^2 + 2h'xy + b'y^2 = 0$ and the other lines represented by them be perpendicular, prove that

$$\frac{ha'b'}{b' - a'} = \frac{h'ab}{b - a} = \frac{1}{2} \sqrt{-aa'bb'}$$

12. Define angular velocity of a particle about a fixed point O. Two points P and Q are describing concentric circles of radii 'a' and 'b' and centre O, with velocities u and v. Find the velocity of P relative to Q when the angle POQ is θ and if the angular velocity of one relative to the other is

zero, then $\cos\theta = \frac{au + bv}{av + bu}$.

13. Write the dual of the following L.P.P :

Maximize $z = 3x_1 + 2x_2 + x_3$

subject to $x_1 + 3x_2 + 4x_3 \leq 6$

$2x_1 + 4x_2 \geq 8$

$x_1 - 4x_3 \geq -5$

and $x_1, x_2, x_3 \geq 0$.

14. (a) Find the shortest distance between the lines

$\frac{x-1}{2} = \frac{y-2}{4} = \frac{z-3}{1}$ and $y - mx = z = 0$. For

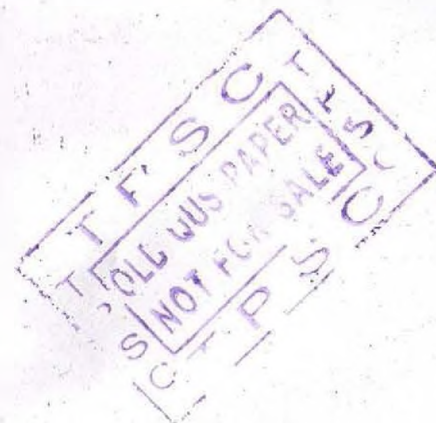
what value of m will the two lines intersect ?

- (b) Find the centre, radius and area of the circle in which the sphere $x^2 + y^2 + z^2 + 2x - 2y - 4z - 19 = 0$ is cut by the plane $x + 2y + 2z + 7 = 0$.

15. A particle moves from rest at a distance c from the centre of force which repels at a distance x with a force $\frac{\mu}{x^2}$ per unit mass. Find its velocity, when it is at a distance 2c from the centre of force.

16. Let $W = \{(x, y, z) \in \mathbb{R}^3 : x - 4y + 3z = 0\}$

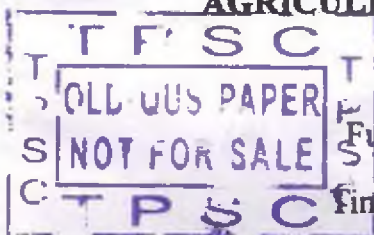
Show that W is a sub space of $\mathbb{R}^3$. find the dimension of W.



Total No. of printed pages = 9

TR/FST/AE/I/21

AGRICULTURAL ENGINEERING



Paper – I

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks
for the questions.

Instructions :

1. Answer to Question No. 1 (i to xx) i.e., MCQ type questions under Section-A must be written in English only.

Example : The capital of India is –

- (a) Delhi (b) New Delhi
(c) Indraprastha (d) None of these

Answer : (b) New Delhi.

2. Answers to other questions except mathematical part must be written either in English or in Bengali. It must not be answered partly in English and partly in Bengali. This instruction must be followed scrupulously.
3. Candidates are required to give their answers in their own words as far as practicable.

[Turn over

SECTION – A

Answer *all* questions :

1×20=20

1. Choose the correct answer and write it down on the answer script.

(i) Grade given to a graded bund is in the range of

- (a) 0.2 – 0.4% (b) 2 – 4%
(c) 20 – 40% (d) 8%

(ii) The transportation of medium size soil particles in soil erosion is related to

- (a) Suspension (b) Surface creep
(c) Saltation (d) Abrasion

(iii) Rainfall erosivity factor in USLE depends on

- (a) Soil aggregation
(b) Rainfall intensity
(c) Type of vegetative cover
(d) All of the above

(iv) For a trapezoidal section contour bund, if bottom width is 120 cm, top width is 30 cm, bund height is 30 cm; find the side slope in terms of horizontal : vertical

- (a) 15 : 1 cm (b) 1 : 1.5 cm
(c) 2 : 1 cm (d) 0.5 : 1 cm

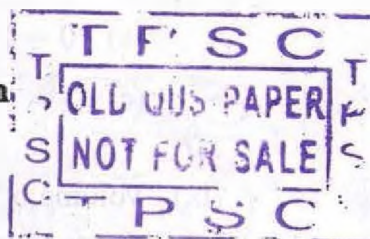
(v) A moderate rainfall has its intensity

(a) 2.5 mm/h

(b) 2.5 to 7.5 mm/h

(c) Less than 7.5 mm/h

(d) 6.25 mm/h



(vi) Runoff volume of L m wide strip between two contour bunds with horizontal interval H, and effective rainfall R_e can be computed by

(a) $R_e \cdot H \cdot L / 100$ (b) $R_e \cdot H / 100 \cdot L$

(c) $R_e \cdot 100 / H \cdot L$ (d) $R_e / L \cdot H$

(vii) To convert the point of rainfall value at various stations into an average value over a catchment area is possible by :

(a) Arithmetical-mean method

(b) Thiessen-Polygon method

(c) Isohyetal method

(d) All the above are correct

(viii) Contour farming is recommended for lands (with the slope range of

- (a) 0 – 1 % (b) 2 – 7 %
- (c) 7 – 12 % (d) 12 – 24 %

(ix) Volume of water stored below outlet level in a water harvesting structure is called

- (a) Effective storage
- (b) Dead storage
- (c) Highest flood level
- (d) None of the above

(x) Which shape of watershed of a given area is likely to generate more runoff ?

- (a) Long and narrow
- (b) Square / compact
- (c) Rectangular with larger side along the slope
- (d) None of the above

(xi) Size of coarse sand varies from

- (a) 2 to 0.02 mm (b) 2 to 0.2 mm
- (c) 0.2 to 0.02 mm (d) None of the above

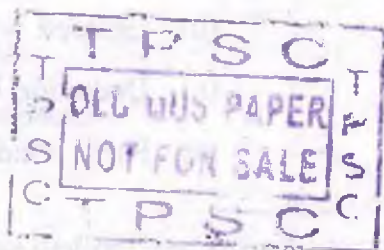
(xii) The relationship between duty and delta is

(a) $\Delta = 864 \frac{B}{D}$

(b) $\Delta = 860 \frac{B}{D}$

(c) $\Delta = 864 \frac{D}{B}$

(d) None of the above



(xiii) Total number of class in land capability classification scheme is

(a) 4

(b) 6

(c) 8

(d) 10

(xiv) Drainage density is defined as ratio of

(a) Total length of all stream and catchments area

(b) Total number of all stream and catchments area

(c) Total number of all stream and total length of all stream

(d) None of these

(xv) Excess water drained through graded bund is directly joining to

- (a) Next graded bund through pipe outlet
- (b) Grassed waterways
- (c) Diversion drains
- (d) Farm pond

(xvi) The Cipolletti weir is a contracted trapezoidal weir having side slope

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

(xvii) How can tile drainage help to increase crop yields ?

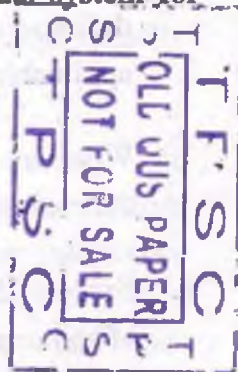
- (a) Increases free gravity water
- (b) Increases volume of soil
- (c) Decreases air circulation
- (d) Increases water table level

(xviii) Confined aquifer is also called as

- (a) Artesian aquifer
- (b) Free aquifer
- (c) Water table aquifer
- (d) None of these

(xix) Which type of alternate layouts system for tile drainage has two mains ?

- (a) Grid iron system
- (b) Natural system
- (c) Double main system
- (d) Herring bone system



(xx) In what chemical ways does tile drainage help in plant growth ?

- (a) Decreases alkalinity of soils
- (b) Increases salinity of soils
- (c) Increases nitrogen
- (d) Reduces and removes toxic substances.

SECTION – B

Answer any *six* questions from question Nos. 2 to 9 :

5×6=30

2. Write short note on Universal soil loss equation.
3. Write short note on Catchment area treatment.
4. Differentiate between the ; Crop water use efficiency and Field water use efficiency.
5. What is the specific application of pressure plate apparatus in soil moisture measurement ?

6. Discuss Darcy's law of soil water flow with a definition sketch. In what flow conditions is it applicable ?
7. What are the different types of farm ponds and their essential design requirements ?
8. Explain different types of engineering measures of soil erosion control. Mention the design criteria of contour bund.
9. What are the causes of waterlogging and soil salinity in an irrigated agriculture / agricultural field ?

SECTION – C

Answer any *five* questions from question Nos. 10 to 16 :

10×5=50

10. Define water harvesting. Write the components and sequential steps for runoff water harvesting systems in the dry regions of India with suitable sketches. Also write the limitations of water harvesting systems.
11. What are the basic components of weirs and flumes used in flow measurement under varying flows in earth channels ?

12. Discuss the different methods of Gully Control. Explain the steps followed in the design of gully control structures.
13. Design a contour bund on a land surface with loamy soil and slope of 3%. The maximum expected rainfall based on a 10-year recurrence interval is 12 cm, of which about 30% is lost to abstraction. The horizontal spacing between bunds 60 cm. Assume the slope of the seepage line in the type of soil to be 4:1.
14. Explain the procedure to conduct a topographical survey of a watershed by direct contour method.
15. Discuss the pumping test of wells. Explain the step wise procedure adopted for conducting pumping tests of wells.
16. Discuss the purposes, benefits and types of sub-surface drainage systems. Explain the design of pipe drainage systems for large irrigation projects.

