AG : AGRICULTURAL ENGINEERING

Duration : Three Hours *Maximum*

Read the following instructions carefully.

1. This question paper contains **16** printed pages including pages for rough work. Please check all pages and report discrepancy, if any.

2. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **Optical Response Sheet (ORS)**.

3. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.

4. All questions in this paper are of objective type.

5. Questions must be answered on **Optical Response Sheet (ORS)** by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. **Each question has only one correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.

6. <u>There are a total of 60 questions carrying 100 marks.</u> Questions 1 through 20 are 1-mark questions, questions 21 through 60 are 2-mark questions.

7. Questions 51 through 56 (3 pairs) are common data questions and question pairs (57, 58) and (59, 60) are linked answer questions. The answer to the second question of the above 2 pairs depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is un-attempted, then the answer to the second question in the pair will not be evaluated.

8. Un-attempted questions will carry zero marks.

9. Wrong answers will carry NEGATIVE marks. For Q.1 to Q.20, ⅓ mark will be deducted for each wrong answer. For Q. 21 to Q. 56, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.57, Q.58), and (Q.59, Q.60) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair i.e. for Q.57 and Q.59, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.58 and Q.60.

10. Calculator (without data connectivity) is allowed in the examination hall.

11. Charts, graph sheets or tables are NOT allowed in the examination hall.

12. Rough work can be done on the question paper itself. Additionally, blank pages are given at the end of the question paper for rough work.

Q. 1 – Q. 20 carry one mark each.

Q.1 Inverse of the matrix $\begin{pmatrix} 2 & 3 \\ 2 & 1 \end{pmatrix}$ is

(A) $\begin{pmatrix} -0.5 & 0.75 \\ 0.5 & -0.25 \end{pmatrix}$

(B) $\begin{pmatrix} -0.25 & 0.5 \\ -0.5 & 0.75 \end{pmatrix}$

(C) $\begin{pmatrix} -0.25 & 0.75 \\ 0.5 & -0.5 \end{pmatrix}$

(D) $\begin{pmatrix} -0.25 & -0.5 \\ 0.75 & 0.5 \end{pmatrix}$

Q.2 The probability function value [f(x)] at x = 3 for Poisson distribution with mean of 2 is

(A) 0.12

(B) 0.18

(C) 0.24

(D) 0.30

Q.3 $I = \int_{0}^{\pi/2} \frac{\cos x \, dx}{(1 + \sin x)^2}$ is

(A) – 0.5

(B) 0

(C) 0.5

(D) 1

Q.4 A curve is having the equation, $r = a(1 - \cos\theta)$. The perimeter of the curve between $\theta = 0$ to 2π is

(A) 2a

(B) 4a

(C) 6a

(D) 8a

Q.5 $\frac{1}{s^2 - a^2}$ is the Laplace Transform of

(A) sin at

(B) t sin at

(C) sinh at

(D) a^{-1} sinh at

Q.6 In a diesel engine with variable compression ratio, the initial compression ratio is 16:1. The ratio of specific heats is 1.4. For the same cut-off ratio of 4.0, if the compression ratio is increased by 25%, the air standard thermal efficiency of the engine will be

(A) increased by 1.0%

(B) increased by 2.8%

(C) increased by 3.5%

(D) increased by 4.0%

Q.7   The type of gasifier which produces nearly tar free producer gas is

(A) counter current gasifier   (B) co-current gasifier

(C) cross-draught gasifier   (D) fluidized bed gasifier

Q.8   As per BIS standard, the power tests for tractor PTO includes

(A) Maximum power, varying load and varying speed tests

(B) Varying speed and maximum power tests

(C) Varying load and varying speed tests

(D) Varying load and maximum power tests

Q.9   The initial cost of a tractor is Rs. 4,00,000. The annual rate of depreciation is 15%. Following declining balance method, the value of the tractor at the end of 6th year is

(A) Rs. 40,000   (B) Rs. 1,51,000

(C) Rs. 1,76,000   (D) Rs. 2,01,000

Q.10   The diameter of an undeflected tractor wheel fitted with 13.6 – 28, 12 PR tyre with an aspect ratio of 0.75 is

(A) 0.99 m   (B) 1.05 m

(C) 1.23 m   (D) 1.40 m

Q.11   Line of sight through the leveling instrument is called

(A) Backsight   (B) Foresight

(C) Line of collimation   (D) Sight of collimation

Q.12   In a reciprocal leveling, the level set up close to point P gave readings of 1.6 m and 0.8 m at stations P and Q respectively. The readings obtained by setting up the level close to point Q were 1.4 m and 0.5 m on stations P and Q respectively. Total error of collimation, curvature and refraction in m is

(A) 0.05   (B) 0.10

(C) 0.55   (D) 0.85

Q.13   The empirical method for computing the consumptive use of a crop using the mean monthly temperature and day light hours is

(A) Thornthwaite   (B) Blaney Criddle

(C) Hargreaves   (D) Lowry Johnson

Q.14   The nature of Hooghoudt's equation for drain spacing is

(A) Parabolic   (B) Hyperbolic

(C) Elliptic   (D) Circular

Q.15   For construction of a tubewell, the following formations were obtained from ~~~~~ unconfined aquifer between 12 m and 16 m and a confined aquifer between 30 m and 40 m b~~~~ ~evel. A horizontal centrifugal pump installed on the ground level can pump water from ~~~~~ ~ted tubewell. Probable static water level from the ground surface in m is

(A) 5   (B) 12   (C) 16   (D) 30

Q.16   If the length, breadth and thickness of a rice grain are 7 mm, 3 mm and 2 mm respectively, the sphericity of the grain is

(A) 0.33   (B) 0.50   (C) 0.67   (D) 0.75

Q.17   Wheat weighing 4900 N at moisture content of 25% on wet basis is to be dried to moisture content of 10% on dry basis. The amount of moisture evaporated from the wheat in kg is

(A) 87   (B) 103   (C) 116   (D) 156

Q.18   If bulk density of a particulate material is 600 kg m^{-3} and true density is 1000 kg m^{-3}, the porosity of the material is

(A) 20%   (B) 40%   (C) 60%   (D) 80%

Q.19   An insulating material has a thermal conductivity of 0.03 W m^{-1} K^{-1}. If 60 mm of this material is applied as insulation on a heat transfer surface, the R-value of the insulation in m^{2} K W^{-1} is

(A) 1   (B) 2   (C) 3   (D) 6

Q.20   Convective heat transfer coefficient outside an ice cream block is 10 W m^{-2} K^{-1}. Thermal conductivity of frozen ice cream is 0.3 W m^{-1} K^{-1}. Convection takes place across a layer of 10 mm of air for 5 minutes. If the density and the specific heat capacity of ice cream are respectively 600 kg m^{-3} and 2.5 kJ kg^{-1} K^{-1}, then 0.33 is

(A) Biot Number   (B) Nusselt Number

(C) Fourier Number   (D) Prandtl Number

Q. 21 to Q. 60 carry two marks each.

Q.21 A two-wheel drive tractor is pulling a load of 12 kN horizontally on a leveled surface at a speed of 5.0 km h^{-1}. The rolling radius of the traction wheel and wheel slip are 0.65 m and respectively. If the rear axle torque is 9 kN m, the tractive efficiency is

(A) 56.7%   (B) 62.1%   (C) 69.3%   (D) 78.5%

Q.22 The disc and tilt angles of a single bottom disc plough having 0.76 m disc diameter are 50° and 25°, respectively. If the depth of ploughing is 0.25 m, width of cut of the plough in m is

(A) 0.508   (B) 0.526   (C) 0.546   (D) 0.559

Q.23 The standard of a cultivator experiences a maximum bending moment of 120 Nm. It has a rectangular cross-section with sides in the ratio of 3:1. If the permissible bending stress of the material is 8×10^7 N m^{-2}, the cross-sectional area of the cultivator standard in square millimeter is

(A) 222   (B) 300   (C) 492   (D) 624

Q.24 A flywheel type chaff cutter with two cutting knives is having a feeding throat of 0.2×0.1 m^2. The mean chaff length is found to be 20 mm for a flywheel speed of 500 rpm. If the density of the dry fodder is 120 kg m^{-3}, the capacity of the chaff cutter in kg h^{-1} at full load is

(A) 920   (B) 1440   (C) 2160   (D) 2880

Q.25 In a single V-belt drive having 30° groove angle, the cross-sectional area of the belt is 250 mm^2 and the mass density of the belt material is 1200 kg m^{-3}. The maximum stress bearing capacity of the belt material is 6000 kN m^{-2}. Coefficient of friction between the belt and the pulley is 0.2 and the angle of lap on the driving pulley is 150°. The maximum power transmitted through the V-belt in kW is

(A) 5.6   (B) 10.5   (C) 17.7   (D) 35.4

Q.26   The final drive system of a tractor comprised a planetary gear drive. The ring teeth and is held stationary. Power comes into the sun gear which has 34 teeth and rotates 100 rpm. Power comes out of the gear set on the planet carrier which drives the rear axle sha of the rear axle in rpm is

(A) 32.7   (B) 47.0   (C) 54.4   (D) 71.4

Q.27   A horizontal axis wind rotor is to be designed for a tip speed ratio of 1.5, rotor diameter 3.3 m and angle of attack (the angle at which the wind will strike the blade) $5°$. If wind velocity in each part of the swept area of the rotor is reduced to one-third of its upstream wind velocity, the blade angle in degrees at the tip of the rotor will be

(A) 14   (B) 19   (C) 24   (D) 29

Q.28   A load cell employing Wheatstone bridge circuit has two fixed resistors and two strain gauges all of which have a value of 120 ohm. The gauge factor is 2.1. The strain in each of the two strain gauges, one in tension and the other in compression, is 1.65×10^{-4}. If the battery current in the initial balanced condition of the bridge is 50 mA, the sensitivity of the load cell in v/strain will be

(A) 0.001   (B) 0.002   (C) 6.3   (D) 12.6

Q.29   The high idle speed of an engine is 2240 rpm and the governor regulation is 11.5%. The peak torque of 180 N m occurs at 1450 engine rpm. If lugging ability is 28 Nm, the engine power in kW at governor's maximum position will be

(A) 31.8   (B) 35.7   (C) 37.6   (D) 42.2

Q.30   A tractor seat suspension system with a seat and operator mass of 90 kg has a seat suspension damping rate of 350 N s m^{-1}. If the spring rate of the system is 5 N mm^{-1}, the damping ratio of the system is

(A) 0.13   (B) 0.26   (C) 0.39   (D) 0.52

Q.31   A venturimeter of 75 mm diameter is fitted to a horizontal pipe of 150 mm diameter. Gauge pressure in the venturimeter in case of no flow is 2 m of water. Taking atmospheric pressure as 10 m of water, the theoretical flow through the pipeline in litres per second, when the throat point pressure is 2.60 m of water (absolute), is

(A) 15   (B) 30   (C) 60   (D) 75

Q.26 The final drive system of a tractor comprised a planetary gear drive. The rin_ _teeth and is held stationary. Power comes into the sun gear which has 34 teeth and rotates _ _100 rpm. Power comes out of the gear set on the planet carrier which drives the rear axle sha_ _of the rear axle in rpm is

(A) 32.7   (B) 47.0   (C) 54.4   (D) 71.4

Q.27 A horizontal axis wind rotor is to be designed for a tip speed ratio of 1.5, rotor diameter 3.3 m and angle of attack (the angle at which the wind will strike the blade) $5°$. If wind velocity in each part of the swept area of the rotor is reduced to one-third of its upstream wind velocity, the blade angle in degrees at the tip of the rotor will be

(A) 14   (B) 19   (C) 24   (D) 29

Q.28 A load cell employing Wheatstone bridge circuit has two fixed resistors and two strain gauges all of which have a value of 120 ohm. The gauge factor is 2.1. The strain in each of the two strain gauges, one in tension and the other in compression, is 1.65×10^{-4}. If the battery current in the initial balanced condition of the bridge is 50 mA, the sensitivity of the load cell in v/strain will be

(A) 0.001   (B) 0.002   (C) 6.3   (D) 12.6

Q.29 The high idle speed of an engine is 2240 rpm and the governor regulation is 11.5%. The peak torque of 180 N m occurs at 1450 engine rpm. If lugging ability is 28 Nm, the engine power in kW at governor's maximum position will be

(A) 31.8   (B) 35.7   (C) 37.6   (D) 42.2

Q.30 A tractor seat suspension system with a seat and operator mass of 90 kg has a seat suspension damping rate of 350 N s m^{-1}. If the spring rate of the system is 5 N mm^{-1}, the damping ratio of the system is

(A) 0.13   (B) 0.26   (C) 0.39   (D) 0.52

Q.31 A venturimeter of 75 mm diameter is fitted to a horizontal pipe of 150 mm diameter. Gauge pressure in the venturimeter in case of no flow is 2 m of water. Taking atmospheric pressure as 10 m of water, the theoretical flow through the pipeline in litres per second, when the throat point pressure is 2.60 m of water (absolute), is

(A) 15   (B) 30   (C) 60   (D) 75

Q.32 The intensity of active earth pressure in kPa at a depth of 10 m in dry cohesionless ~~angle~~ of internal friction of 25^0 and specific weight of 15 kN m^{-3} is

(A) 39   (B) 61   (C) 79   (D) 129

Q.33 If the probability of occurrence of rainfall on any day during June to September is 0.15, the probability that 4 out of 20 days in the month of August to remain dry will be

(A) 0.162   (B) 0.182   (C) 0.192   (D) 0.228

Q.34 A 10 ha watershed received 100 mm uniformly distributed rainfall. Land use pattern consists of 25% residential area with soil group C and curve number 82, good meadow condition in 50% of the area with soil group D and curve number 78. There is also good open space condition in 25% of the area with soil group D and curve number 80. Assuming AMC-II condition, the volume of runoff in m^3 from the watershed will be

(A) 4955   (B) 5705

(C) 5755   (D) 6555

Q.35 The peak runoff volume from the catchment between two contour bunds constructed on a 2.5% slope is 972.5 m^3. The contour bunds have top width of 500 mm, height 600 mm, side slope 2:1, vertical interval 1.0 m and length 250 m. If the crest of the overflow weir is at a height of 300 mm from the ground and time available for the excess water to flow through the weir is 20 minutes, discharge in m^3 per minute through the weir is

(A) 15.0   (B) 20.0

(C) 25.0   (D) 48.6

Q.36 An earthen embankment with a pipe spillway is constructed to create temporary storage in a gully. The pipe of 10 m length has to carry a peak discharge of 1 m^3 s^{-1} at an available head of 4 m. Entrance loss coefficient for the square entrance is 0.50 and the friction loss coefficient is 0.15. Required diameter of the pipe in m is

(A) 0.50   (B) 0.60

(C) 0.75   (D) 1.00

Q.37   Contour bund is constructed on a land with S per cent slope. If the length of each [ ] is L and vertical interval is D, then the number of contour bunds per hectare of land area is

(A) $\dfrac{S}{LD}$

(B) $\dfrac{LD}{S}$

(C) $\dfrac{100S}{LD}$

(D) $\dfrac{10^4 S}{LD}$

Q.38   A hydraulically efficient trapezoidal drainage channel with a side slope of 2:1 has been designed in a sandy loam soil for a catchment of 600 ha. Taking a drainage coefficient of 16 mm, the flow velocity in mm s^{-1} in the drainage channel with a flow depth of 1 m is

(A) 427

(B) 450

(C) 497

(D) 527

Q.39   A three stage centrifugal pump discharges water at a rate of 2400 litre per minute at a total head of 36 m. If the pump is directly connected to an electric motor operating at 1440 revolutions per minute, its specific speed will be

(A) 41.92

(B) 44.67

(C) 51.16

(D) 54.65

Q.40   The inside diameter and stroke length of a single acting reciprocating pump are 120 mm and 400 mm respectively. The speed of the piston is 50 strokes per minute. The suction and delivery heads are 5 m and 10 m respectively. If the efficiency of both suction and delivery strokes is 60%, the actual power required in kW by the pump is

(A) 0.55

(B) 0.65

(C) 0.94

(D) 1.12

Q.41   Bulk density of paddy with 28% moisture content on wet basis is 650 kg m^{-3}. The dry solid bulk density of paddy in kg m^{-3} is

(A) 468

(B) 508

(C) 832

(D) 904

Q.42 If absolute humidity at saturation and percentage humidity of air are 0.075 kg ... our (kg dry air)$^{-1}$ and 60% respectively, the relative humidity of air is

(A) 57.4%

(B) 60.0%

(C) 62.7%

(D) 74.5%

Q.43 Milk weighing 98000 N having specific heat capacity 3.8 kJ kg^{-1} K^{-1} is to be chilled from 40 °C to 5 °C in one hour in a chilling plant using a refrigerant whose coefficient of performance is 4.7. The total compressor power consumption assuming 100% efficiency is

(A) 79 kW

(B) 105 kW

(C) 79 hp

(D) 105 hp

Q.44 In a tray drying experiment of mango pulp, the constant rate of drying was found to be 6.18×10^{-5} kg water m^{-2} s^{-1}. The humidity ratio and saturation humidity ratio of the air were 0.02 kg water vapour (kg dry air)$^{-1}$ and 0.075 kg water vapour (kg dry air)$^{-1}$ respectively at 1 atm pressure and 65 °C temperature. Assuming the distance of travel for water vapour in drying air to be 10 mm, the mass diffusivity of water in m^2 s^{-1} is

(A) 10^{-4}

(B) 10^{-5}

(C) 10^{-6}

(D) 10^{-7}

Q.45 Fruit juice flowing at the rate of 600 kg h^{-1} is to be heated using same flow rate of hot fruit juice in a countercurrent regenerator. The specific heat capacity of the fruit juice is 3.9 kJ kg^{-1} K^{-1}. The overall heat transfer coefficient of the regenerator is 512 W m^{-2} K^{-1} and the area of the regenerator is 3.5 m^2. The effectiveness of the regenerator is

(A) 0.547

(B) 0.734

(C) 0.837

(D) 0.943

Q.46 The diameter of a grain storage bin is 4 m and the depth is 16 m. It is completely filled with wheat having bulk density of 800 kg m^{-3}. The angle of friction between wheat and wall is 24°. The ratio of lateral and vertical pressure intensity is 0.4. The lateral pressure intensity of wheat in kPa on the bin wall at 2 m depth is

(A) 2.85

(B) 5.28

(C) 8.25

(D) 8.52

Q.47 Particles having average diameter of 20 μ m and particle density of 1000 ~~~ a cyclone of 500 mm diameter at a linear velocity of 20 m s^{-1}. The separation factor of the cy~~

(A) 136

(B) 163

(C) 316

(D) 613

Q.48 Vegetable seeds are stored at absolute temperature of 320 K and relative humidity of 20%. Henderson equation for equilibrium relationship is valid for this case where the values of constants C and n are 6.5×10^{-6} and 1.8 respectively, the equilibrium moisture content of the seeds will be

(A) 5.6%

(B) 10.2%

(C) 13.4%

(D) 20.5%

Q.49 The theoretical volumetric flow rate of a horizontal screw conveyor is 1500 m^3 h^{-1}. The conveyor screw diameter is 1.2 m and the shaft diameter is 0.6 m. The rotational speed of the screw conveyor is 50 rpm. The pitch of the screw in mm is

(A) 150

(B) 340

(C) 590

(D) 950

Q.50 A ball mill of 1.8 m diameter is charged with balls each having diameter of 40 mm for grinding solid material. The rotational speed of the balls is 80% of the critical speed. The operating speed of rotation in revolution per minute is

(A) 18

(B) 22

(C) 26

(D) 30

Common Data Questions

Common Data for Questions 51 and 52:

A vertical conveyor reaper is to be used for harvesting wheat crop at a height of 30 mm above the ground. The ultimate tensile strength and diameter of the crop stem are 35 N mm^{-2} and 3 mm respectively. The friction coefficient of knife edge for wheat crop is 0.346 and the maximum oblique angle of the counter shear is 17°. The crop stem is of homogenous solid with a uniform circular section.

Q.51 The horizontal force in N that would cause bending failure of the crop stem is

(A) 1.55

(B) 3.09

(C) 4.64

(D) 6.19

Q.52 The maximum clip angle in degrees between the knife and the counter shear is

(A) 2

(B) 17

(C) 19

(D) 36

Common Data for Questions 53 and 54:

Water is recharged to an aquifer through a well of 200 mm diameter penetrating up to the base of the aquifer. The hydraulic conductivity of the aquifer is 19 m d^{-1}. During recharge, the water level in the well is 32 m from the base of the aquifer. A constant height of 27 m above the same base is obtained at a distance of 200 m from the well.

Q.53 If the aquifer is confined with a thickness of 20 m, the theoretical recharge rate in litre per second is

(A) 18.2

(B) 25.2

(C) 28.8

(D) 30.5

Q.54 If the aquifer is unconfined, the theoretical recharge rate in litre per second is

(A) 10.5

(B) 17.7

(C) 26.8

(D) 30.5

Common Data for Questions 55 and 56:

Apple is to be stored at 30 °C in modified atmosphere package of laminated films made of 150 μ m thick polyethylene and 100 μ m thick nylon. The partial pressures of oxygen outside and inside of the package are 0.21 atm and 0.01 atm respectively. The permeability values of polyethylene and nylon in m^3 solute (STP) m^{-2} s^{-1} atm^{-1} per m thickness are 4.17×10^{-12} and 1.52×10^{-14} respectively.

Q.55 Ratio of resistance to permeation between Nylon and Polyethylene films is

(A) 138

(B) 183

(C) 381

(D) 813

Q.56 The molar flux of oxygen across the laminate in kg mole m^{-2} s^{-1} at steady state will be

(A) 1.35×10^{-12}

(B) 2.47×10^{-12}

(C) 3.59×10^{-12}

(D) 5.41×10^{-12}

Linked Answer Questions

Statement for Linked Answer Questions 57 and 58:

A tractor drawn vertical rotor planter is operated in the field at a forward speed of 5 km h^{-1}. The effective diameter of the ground wheel of the planter is 0.5 m and the transmission ratio between the ground wheel and the rotor shaft is 1:1.

Q.57   If the skid of the ground wheel of the planter is 10 %, the speed of rotor in rpm will be

      (A) 26   (B) 39

      (C) 48   (D) 58

Q.58   If the number of cells on the vertical rotor is 20, the plant to plant distance in a row in mm will be

      (A) 87   (B) 128

      (C) 157   (D) 174

Statement for Linked Answer Questions 59 and 60:

A check basin of size 15 m × 12 m is to be irrigated using a stream of 26 litre per second. The depth of crop root zone is 1.3 m and the apparent specific gravity of the root zone soil is 1.6. The water holding capacity of the soil is 16 %. Irrigation is to be applied when the soil moisture content in the crop root zone attains 12%. Deep percolation loss is neglected.

Q.59   The net irrigation requirement in mm is

      (A) 43.2   (B) 63.2

      (C) 73.2   (D) 83.2

Q.60   The duration of irrigation in minutes to replenish up to field capacity is

      (A) 4.8   (B) 9.6

      (C) 16.6   (D) 24.6

END OF THE QUESTION PAPER