GATE 2008
AGRICULTURAL ENGINEERING (AG)
MAIN PAPER

Duration: Three Hours   **Maximum Marks:** 150
Q.1-Q.20 carry one mark each

1) If $f(x)$ is a perfect normal distribution with mean and standard deviation of 5 and 1 respectively, then the value of $f(x)$ for $x = 6$ is

   a) 0.124   b) 0.242   c) 0.482   d) 0.524

   (GATE AG 2008)

2) Eigenvalues of the matrix $\begin{pmatrix} 2 & 1 \\ 2 & 3 \end{pmatrix}$ are

   a) 1 and 2   b) 1 and 3   c) 1 and 4   d) 2 and 3

   (GATE AG 2008)

3) $\int_0^{\pi/2} \frac{\cos\theta}{\sqrt{1-\cos^2\theta}} d\theta$ is

   a) 0   b) $\frac{\pi}{2}$ c) 1   d) π

   (GATE AG 2008)

4) A function $f(x)$ is evaluated as 1, 1.5, 2.2 and 3.4 at four values of x having intervals of 0.5. The area under the curve $f(x)$ using trapezoidal rule is

   a) 1.95   b) 2.45   c) 2.95   d) 3.45

   (GATE AG 2008)

5) If $\log_e(y) = -x \log_e(x)$, then the maximum value of y is

   a) e   b) e^{x^2} c) $e^{e^{-1}}$ d) e^x

   (GATE AG 2008)

6) The cross product of $\mathbf{x} = 2\mathbf{i} + \mathbf{j}$ and $\mathbf{y} = \mathbf{i} - 2\mathbf{j} + \mathbf{k}$ is

a) $\mathbf{i} - \mathbf{j} + 2\mathbf{k}$
b) $\mathbf{i} - 2\mathbf{j} + 5\mathbf{k}$
c) $\mathbf{i} - 2\mathbf{j} - 5\mathbf{k}$
d) $2\mathbf{i} - 4\mathbf{j}$

(GATE AG 2008)

7) Inverse Laplace Transform of $\frac{1}{(s-2)^2}$ is

a) e^{2t} b) te^{2t} c) $2te^t$ d) t^2e^{2t}

(GATE AG 2008)

8) Solution of the ordinary differential equation

$$\frac{dy}{dx} = x^2 + 2y \tag{1}$$

is

a) $y = \frac{2}{3}x^2 + 4x$
b) $y = \sqrt{\frac{2}{3}x^2 + 4x + k}$
c) $y = \frac{2}{3}x^3 - 4x + k$
d) $y = \frac{2}{3}x^3 + 4x + k$

(GATE AG 2008)

9) The area of a map plotted to a scale of 1:3000 measures 9069.37 mm². The 20 m chain used for this survey was short by 0.2 m. The true land area it represents is

a) 83281 m²   b) 82449 m²   c) 80808 m²   d) 80000 m²

(GATE AG 2008)

10) To measure the difference in level precisely between two points with a leveling instrument having collimation error, the method to be used is

a) reciprocal leveling
b) check leveling
c) compound leveling
d) profile leveling

(GATE AG 2008)

11) Three catchments A, M and F each having an area of 10,000 km² are situated in an arid zone, mountainous region of a temperate zone and flat region of a temperate zone respectively. The desirable number of hydrometeorological stations for these three catchments, N_A, N_M and N_F, respectively will be such that

a) $N_M > N_F > N_A$

c) $N_A > N_M > N_F$

b) $N_A < N_M < N_F$

d) $N_M = N_F$ and $N_M > N_A$

(GATE AG 2008)

12) The following design parameters of contour bunds constructed on a land of 4% slope are given: V.I. = 1.2 m, base width = 2.5 m, top width = 0.5 m, height = 1.0 m. Assuming the length for side and lateral bunds as 30% of the length of contour bunds, the land area lost due to bunding is

a) 0.156%   b) 2.50%   c) 10.83%   d) 12.52%

(GATE AG 2008)

13) The percentage of husk, bran and bran oil received from rice milling are respectively

a) 20, 5 and 25

c) 20, 5 and 40

b) 5, 10 and 30

d) 20, 10 and 20

(GATE AG 2008)

14) In order to freeze a fruit juice its thermodynamic temperature is
   a) higher than the freezing point of water
   b) below the freezing point of water
   c) equal to the freezing point of water
   d) dependent upon the water content of the fruit juice

(GATE AG 2008)

15) When a suspension of microorganism is heated at constant temperature, the reaction kinetics of decrease in the number of the organism is

a) linear   b) exponential   c) parabolic   d) hyperbolic

(GATE AG 2008)

16) Water activity (a_w) is a ratio of
   a) vapour pressure of water to partial pressure of water in the product
   b) partial pressure of water in air to partial pressure of air at saturation
   c) vapour pressure of water in equilibrium with the food to vapour pressure of pure water at the same temperature
   d) vapour pressure of pure water to vapour pressure of water in equilibrium with food

17) Two links OA and OB are connected by a pin joint at O such that $\angle AOB$ is $144°$. If the diameter of pin joint is d and the angular velocity of each link is ω, then the velocity of rubbing at the pin joint O when the links move in opposite directions is

a) 0   b) ωd c) $\frac{2}{5}\pi\omega d$ d) $\frac{1}{2}\omega d$

18) The essential requirement for turning in a power tiller is accomplished by having
   a) both the wheels as towed wheels
   b) only one wheel driven by the engine, while the other wheel is always free to rotate
   c) one of the wheels disconnected from the engine at the time of turning
   d) the same mechanism as used in a rear wheel driven tractor

19) The function of a differential lock used in a rear wheel driven tractor is
   a) to operate both the rear wheels at the same speed
   b) to operate both the rear wheels at differential speeds
   c) to operate both the rear wheels at the same torque
   d) to evenly distribute the power to both the wheels

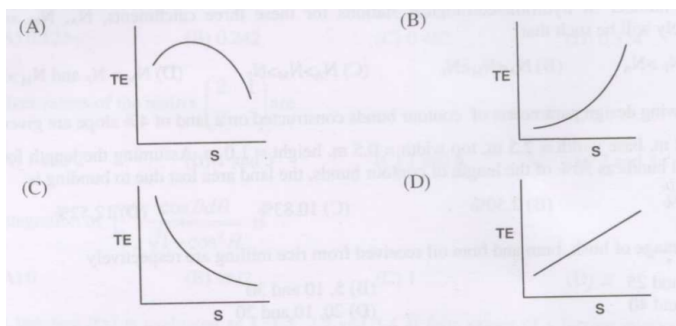20) The nature of variation of tractive efficiency (TE) with wheel slip (S) in a rear wheel driven tractor is

Fig. 1

Q. 21 to Q. 75 carry two marks each.

21) The correlation analysis between X and Y variables assuming the parabolic relation-ship revealed a nonlinear correlation coefficient of 0.98. The percentage of the total variation that remains unexplained by assuming a parabolic relationship between X and Y is

a) 2.0　　　　　　　b) 96.0　　　　　　　c) 3.96　　　　　　　d) 10.0

22) Cycloid is formed by $x = a(\theta - \sin\theta)$ and $y = a(1 - \cos\theta)$. The surface area of the curved plane obtained from the rotation of the cycloid around x axis is

a) $16\pi a^2$　　　　b) $\frac{32\pi a^2}{3}$　　　　c) $\frac{64\pi a^2}{3}$　　　　d) $\frac{128\pi a^2}{3}$

23) If one bucket contains 8 red balls and 2 black balls and another bucket contains 7 red balls and 3 black balls, the probability of having at least one red ball from drawings of one ball from each of the two buckets is

a) 0.94　　　　　　　b) 0.84　　　　　　　c) 0.56　　　　　　　d) 0.38

24) In a factory 30% of the machines are assembled by robots and 70% are assembled by manual labour. Reliability of the first type of machines is 0.9 and that of the second type of machines is 0.8. One piece of machine was found to be reliable. The probability of the machine having been assembled by robot is

a) 0.325　　　　　　b) 0.565　　　　　　c) 0.675　　　　　　d) 0.835

25) If $\sum_{i=1}^{n}(x - a_i)^2$ has a minima at A, then A is the arithmetic mean of the series

a) $a_1 - a_2 + a_3 - \ldots + (-1)^{n+1}a^n$　　　　c) $\frac{1}{a_1} - \frac{1}{a_2} + \frac{1}{a_3} - \ldots + (-1)^{n+1}\frac{1}{a_n}$

b) $\frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + \ldots + \frac{1}{a_n}$　　　　d) $a_1 + a_2 + a_3 + \ldots + a_n$

26) Solution of the differential equation

$$\frac{dy}{dx} - 7y = e^x \quad \text{is}$$

a) $e^x(Ce^{6x} - 6^{-1})$ c) $e^x(Ce^{-6x} - 6^{-1})$

b) $e^{7x}(e^{-6x} - C)^{-1}$ d) $e^x[Ce^x + (6e^x)^{-1}]$

<div align="right">(GATE AG 2008)</div>

27) A clayey soil has a field capacity of 0.38 m^3/m^3 and wilting point of 0.24 m^3/m^3. If the specific weight of the soil is 12.75 kN/m^3 and the effective root-zone depth is 0.8 m, the available moisture holding capacity is

a) 15.6 cm   b) 11.2 cm   c) 1.12 cm   d) 20.8 cm

<div align="right">(GATE AG 2008)</div>

28) A flow of 150 L s^{-1} was supplied for 8 hours from a tank to irrigate 2 ha of land. It was found that the actual delivery rate at the farm was less than 150 L s^{-1}. If the conveyance loss was 864 m^3 and percolation and runoff losses in the field were 240 and 760 m^3 respectively, the water application efficiency of this system is

a) 80%   b) 61%   c) 77%   d) 71%

<div align="right">(GATE AG 2008)</div>

29) The following data were obtained from an agricultural land requiring a pipe drainage system for groundwater control:
- Hydraulic conductivity = 8.3 cm/h
- Drainable porosity = 5%
- Reaction factor = 0.31 per day
- Equivalent depth to the impermeable layer = 2.8 m

The drain spacing computed by the Glover-Dumm formula will be

a) 60 m   b) 190 m   c) 50 m   d) 6 m

<div align="right">(GATE AG 2008)</div>

30) A tile drainage system draining 12 ha flows at the design capacity for two days in response to a storm. If the system is designed using a drainage coefficient of 1.25 cm, the amount of water removed from the drainage area during two days is

a) 150 m^3 b) 1500 m^3 c) 30 m^3 d) 3000 m^3

<div align="right">(GATE AG 2008)</div>

31) The analysis of maximum one-day rainfall in a city indicated that a depth of 280 mm has a return period of 50 years. The probability of a one-day rainfall depth equal to or greater than 280 mm in the city occurring two times in 15 successive years is

a) 0.032   b) 0.323   c) 0.042   d) 0.272

32) A catchment with an area of 756 km^2 has a 6 h unit hydrograph which is triangular with a base of 70 h. The peak discharge of direct runoff hydrograph due to 5 cm of rainfall excess in 6 h from the catchment is

a) 60 m^3/s   b) 535 m^3/s   c) 300 m^3/s   d) 756 m^3/s

33) A 50 g L^{-1} solution of a tracer was discharged into a stream at a constant rate of 20 mL s^{-1}. At a downstream section, the tracer was completely mixed and the concentration was measured as 10 parts per billion. Assuming the background concentration as zero, the stream discharge is

a) 100 m^3/s   b) 200 m^3/s   c) 800 m^3/s   d) 1000 m^3/s

34) The velocity of flow of water through a drop inlet pipe spillway is 4 m s^{-1} and the friction loss coefficient is 0.12. Maximum slope that can be provided to the pipe to maintain pipe flow condition is

a) 8.9%   b) 9.8%   c) 10.3%   d) 10.8%

35) If W is the width of a bench terrace constructed on a land of slope S, then the drop (D) between two consecutive bench terraces for a riser slope of $1/2 : 1$ is given by

a) $D = \frac{WS}{100-S}$ b) $D = \frac{WS}{200-S}$ c) $D = \frac{2WS}{200-S}$ d) $D = \frac{2WS}{100-S}$

36) A centrifugal pump delivers 0.03 m^3/s of water through a 100 mm diameter pipe to a vertical height of 14 m from the centerline of the pump. The pump is installed 6.0 m above water level in the sump and the head loss in the pipeline is found to be 5 m of water. If the overall efficiency is 72%, the power required to run the pump will be

a) 7.36 kW   b) 10.22 kW   c) 8.18 kW   d) 5.89 kW

<div align="right">(GATE AG 2008)</div>

37) A double acting single cylinder reciprocating pump has a cylinder diameter of 150 mm and stroke 300 mm. Suction and delivery heads for the pump are 3.0 and 30 m respectively. If the pump delivers 0.01033 m^3/s of water at 60 rpm, the percentage slip is

a) 97.43   b) 1.57   c) 2.57   d) 0.0257

<div align="right">(GATE AG 2008)</div>

38) In the Moody diagram, the third parameter is ε/D. Here, ε is
   a) the equivalent uniform sand grain roughness
   b) an arbitrarily chosen roughness magnitude
   c) median size in a non-uniform sand grain roughness
   d) mean height of the actual roughness of commercial pipes

<div align="right">(GATE AG 2008)</div>

39) Atmospheric pressure at a place is equal to 10 m of water. A liquid has a specific weight of 12 kN/m^3. The absolute pressure at a point 2 m below the free surface of liquid in kPa is

a) 2.4   b) 12.4   c) 24.0   d) 122.1

<div align="right">(GATE AG 2008)</div>

40) The weight of a hollow sphere is 100 N. If it floats in water just fully submerged, the external diameter of the sphere is

a) 112 mm   b) 213 mm   c) 269 mm   d) 315 mm

<div align="right">(GATE AG 2008)</div>

41) The thermal conductivity of a common metal used in fabrication of food processing equipment is given as 120 BTU ft^{-1} h^{-1} $°$F^{-1}. This value in J m^{-1} s^{-1} K^{-1} will be

a) 2.08   b) 208   c) 280   d) 280

<div align="right">(GATE AG 2008)</div>

42) For foods whose composition is known, the following equation holds good:

$$c_p = 1.424m_c + 1.594m_p + 1.675m_f + 0.837m_a + 4.187m_w \qquad (2)$$

where c_p is specific heat in kJ kg^{-1} K^{-1}, and m_c, m_p, m_f, m_a, m_w are mass fractions of carbohydrates, proteins, fats, ash, and moisture, respectively.
The specific heat of a food containing 40% carbohydrates, 20% protein, 10% fat, 5% ash and 25% moisture will be

a) 1.42   b) 2.14   c) 4.21   d) 6.41

(GATE AG 2008)

43) Potatoes are dried from 14% to 93% total solids. Considering 8% peeling losses, the product yield from one tonne of raw potato will be

a) 10.56%   b) 13.85%   c) 15.25%   d) 20.58%

(GATE AG 2008)

44) Heated air at 50°C and 10% relative humidity is used to dry rice in a bin dryer. The air leaves the bin under saturated condition. The corresponding data for humidity ratio as read from the psychometric chart are 0.0078 and 0.019 kg water per kg dry air. The amount of water removed per kg of dry air will be

a) 0.0112 kg   b) 0.021 kg   c) 0.112 kg   d) 0.121 kg

(GATE AG 2008)

45) One hundred kilogram of a food grain is dried from 18% wb to 13% wb moisture content. The total amount of water removed from the grain is

a) 6.82 kg   b) 6.28 kg   c) 5.75 kg   d) 5.57 kg

(GATE AG 2008)

46) The velocity of a fluid in a pipe A of diameter D is v m/s. This pipe is connected with another pipe B of diameter 2D. Reynolds's number in pipe A in relation to pipe B is

a) same   b) half   c) double   d) triple

(GATE AG 2008)

47) Milk and rapeseed oil are flowing in pipes of 5 cm diameter with the same flow velocity of 3 m/s. The densities of milk and rapeseed oil are 1030 and 900 kg/m³, respectively. The viscosity of milk is 2.1×10^{-3} N s m⁻² and that of rapeseed oil is 118×10^{-3} N s m⁻². The values of Reynolds' number for milk and rapeseed oil will be respectively

a) 73571 and 1144

b) 1144 and 73571

c) 73175 and 1144

d) 144 and 73571

48) The higher and lower temperatures in a refrigerator working on reverse Carnot cycle are 35°C and -15°C respectively. The capacity of the machine is 35.16 kW. The power required will be

a) 81.6 kW   b) 68.1 kW   c) 8.61 kW   d) 6.81 kW

49) The results of sieve analysis of a food powder are presented in the following two tables. **Table 1.**

Sieve aperture (μm)	Mass retained (%)
12.5	13.8
7.25	13.6
3.25	35.6
2.00	21.4
1.00	12.8
0.75	2.8

Table 2.

Average diameter of particles, d (μm)	Mass retained on the sieve (%)	$(d) \times (x)$
0.375	2.8	1.05
1.625	12.8	20.80
2.625	21.4	56.15
3.250	35.6	115.4
7.375	13.6	100.4
10.000	13.8	138.0
Total	100	468.125

The mass mean diameter of the sample will be

a) 8.46 μm   b) 6.48 μm   c) 4.46 μm   d) 6.48 μm

50) A spherical tank of 2 m diameter is filled with an edible oil of specific gravity 0.92. If the pressure measured at the highest point in the tank is 70 kPa, the total pressure (kPa) in the tank will be

   a) 80.5   b) 85.3   c) 88.1   d) 92.2

51) Peas which have an average diameter of 6 mm are blanched to give a temperature of 85°C at the centre. The initial temperature of the pea is 15°C and temperature of the hot water blancher is 95°C. The thermal conductivity, specific heat and density of peas are 0.35 $W\,m^{-1}\,K^{-1}$, 3.3 $kJ\,kg^{-1}\,K^{-1}$ and 980 $kg\,m^{-3}$ respectively. The heat transfer coefficient is 1200 $W\,m^{-2}\,K^{-1}$. If the value of Fourier number (Fo) is 0.32, the time of blanching will be

   a) 26.6 s   b) 26.0 s   c) 20.6 s   d) 20.0 s

52) The viscosity of milk at 21°C is 2.1×10^{-3} Pa s and its density at this temperature is 1029 $kg\,m^{-3}$. Milk flows at the rate of 0.12 $m^3\,min^{-1}$ in a 2.5 cm diameter pipe. At 21°C, the flow of milk will be

   a) stream line   c) transition
   b) laminar   d) turbulent

53) A cork slab of 100 mm thickness has one face at -12°C and the other face at 21°C. If the mean thermal conductivity (k) of the cork is 0.042 $J\,m^{-1}\,s^{-1}\,K^{-1}$, the rate of heat transfer $(J\,s^{-1})$ through 1 m^2 of the wall will be

   a) 13.9   b) 9.3   c) 5.0   d) 2.5

54) Mechanical separation is divided into

   a) cleaning, sorting, sieving and filtration   and sieving
   b) grading, weighing, sieving and filtration d) sedimentation, centrifugation, cleaning
   c) sedimentation, centrifugation, filtration   and sieving

55) Following two groups of equipment and their working principles or purpose are given

Group - I		Group - II
(i) pneumatic conveyor		(a) air blowing or suction
(ii) hammer mill		(b) feed grinding
(iii) cyclone separator		(c) centrifugal force
(iv) pycnometer		(d) stress / strain measurement

Identify the incorrect pair

(A) i-a   (B) ii-b   (C) iii-c   (D) iv-d   (GATE AG 2008)

56) A single plate dry type clutch is to be designed for a tractor engine to transmit its maximum torque with the following data. The torque developed by the engine at governor's maximum = 125 Nm; the engine torque reserve capacity = 20 percent; coefficient of friction = 0.3; maximum facing pressure = 0.1 MPa. Considering uniform pressure, if the outer diameter of the plate is 1.5 times the inner diameter, the outer diameter of the plate will be

a) 165.38 mm   b) 224.46 mm   c) 238.50 mm   d) 300.52 mm

(GATE AG 2008)

57) A 20 kW four stroke cycle diesel engine is running at 2400 rpm and maintaining an ignition delay of $18°$ during combustion. When the engine speed is reduced by 25 percent, the ignition delay increases by $4°$. If the specific fuel consumption is 0.20 $kg\,kW^{-1}\,h^{-1}$, then the percent increase in the fuel consumption during the above condition of combustion will be

a) 37.0   b) 38.64   c) 61.36   d) 62.96

(GATE AG 2008)

58) The following data correspond to the height-weight ratio (H/W) in mm kg^{-1} of a population of six agricultural workers employed in the operation of a manually operated weeder.

S. No.	1	2	3	4	5	6
H/W (mm/kg)	23.9	23.7	21.3	22.1	25.3	23.3

The dimension of the operator corresponding to the fifth-percentile of the population is

a) 19.26   b) 20.49   c) 21.99   d) 23.25

(GATE AG 2008)

59) One kilogram of air is subjected to polytropic compression from a volume of 28 m^3 and a pressure of 101 kPa to a volume of 2 m^3 and pressure of 2 MPa. The external work required to make this compression possible is

a) 1.66 MJ   b) 2.93 MJ   c) 3.04 MJ   d) 8.92 MJ

<div align="right">(GATE AG 2008)</div>

60) A flail mower is operated using the PTO power of a tractor through a bevel gear drive. The tractor forward speed is 10.8 km h^{-1}. The velocity of the flail tip with respect to the ground is 18 m s^{-1}. The length of each flail is 400 mm and the diameter of the shaft carrying the flails is 100 mm. If the tractor PTO speed is 800 rpm, the required bevel gear reduction ratio is

a) 1.13   b) 2.00   c) 2.25   d) 2.51

<div align="right">(GATE AG 2008)</div>

61) The torque exerted on the crankshaft of a two stroke engine is given by the equation

$$T\,(\mathrm{N\,m}) = 450 + 30\sin 2\theta - 90\cos 2\theta$$

where θ is the crank angle displacement from the inner dead centre. If the resisting torque is constant, the power developed by the engine at a speed of 1500 rpm is

a) 22.50 kW   b) 35.30 kW   c) 70.69 kW   d) 135.00 kW

<div align="right">(GATE AG 2008)</div>

62) In an epicyclic gear train, an arm carries two wheels A and B having 24 teeth and 30 teeth respectively. If the arm rotates at 100 rpm in the clockwise direction about the centre of the wheel A which is fixed, the speed of wheel B on its own axis is

a) 20 rpm, anti-clockwise   c) 180 rpm, clockwise
b) 25 rpm, anti-clockwise   d) 225 rpm, clockwise

<div align="right">(GATE AG 2008)</div>

63) A tractor drawn seed broadcaster is operated at 10.8 km h^{-1}. The broadcaster has a horizontal seed plate located inside the hopper above the ground level. The diameter of the plate is 300 mm and its angular velocity is 80 s^{-1}. If the air resistance is neglected, the resultant velocity with which the seed mass is approaching the furrow 3 seconds after it starts release from the edge of the wheel

a) 29.40 m s^{-1} b) 30.52 m s^{-1} c) 31.75 m s^{-1} d) 44.10 m s^{-1}

<div align="right">(GATE AG 2008)</div>

64) The differential equation of motion for a single degree of freedom mass-spring damped system is

$$\frac{d^2x}{dt^2} + \frac{dx}{dt} + 12x = 0$$

If the units of mass, length and time are kg, m, and s respectively, the natural frequency of vibration is

a) 0.42 rad s^{-1} b) 0.52 rad s^{-1} c) 1.22 rad s^{-1} d) 1.83 rad s^{-1}

65) A four stroke cycle engine has the following valve events: inlet valve opens at 8° before HDC; inlet valve closes at 55° after CDC; exhaust valve opens at 60° before CDC; exhaust valve closes at 12° after HDC. If the engine runs at 2000 rpm, the time in milli-seconds during which inlet and exhaust valves remain closed simultaneously is

a) 19.67   b) 21.50   c) 40.58   d) 80.67

66) At an engine throttle position of 75 percent, the high idle speed of the engine is shifted by 200 rpm towards the maximum torque position. If the engine is maintaining a uniform speed of 2475 rpm at a given load, the governor regulation is

a) 8.42%   b) 8.10%   c) 7.77%   d) 3.88%

67) A double acting hydraulic cylinder has a piston diameter of 40 mm and the rod diameter equal to one-half the piston diameter. For a constant pressure of 4 MPa, the difference in load carrying capacity between extension and retraction is

a) 0 kN   b) 1.26 kN   c) 3.77 kN   d) 6.29 kN

68) A hydraulic motor receives a flow rate of 72 L min^{-1} at a pressure of 12 MPa. The motor speed is 800 rpm. If the motor has a power loss of 3 kW, the actual torque delivered by the motor is

a) 136.08 N m   b) 171.89 N m   c) 204.62 N m   d) 262.84 N m

(GATE AG 2008)

69) A multi-crop thresher was tested utilizing power from a tractor PTO shaft and the fuel consumption recorded was $4.5 \, \text{L h}^{-1}$. The brake thermal efficiency of the engine is 32 percent and density of the fuel used having a heating value of $40 \, \text{MJ kg}^{-1}$ is $825 \, \text{kg m}^{-3}$. If the transmission loss from the engine to PTO drive is 5 percent, the power consumed by the thresher is

a) 8.66 kW   b) 12.54 kW   c) 13.20 kW   d) 41.25 kW

(GATE AG 2008)

70) A farmer wishes to construct a $5 \, \text{m}^3$ capacity biogas plant with a cylindrical digester. The depth of the digester below the ground level is restricted to 5 m. Assume that 1.0 kg of cow dung produces $0.04 \, \text{m}^3$ of gas per day and that the bulk density of wet cow dung is $1100 \, \text{kg m}^{-3}$. If equal amount of water on volume basis is added to the dung for slurry preparation and the retention period is taken as 40 days, the diameter of the digester tank will be

a) 0.24 m   b) 1.08 m   c) 1.52 m   d) 2.31 m

(GATE AG 2008)

Common Data Questions
Common Data for Questions 71, 72 and 73:
A material consisting of 20 mm particles is crushed to an average size of 5 mm and requires $18 \, \text{kJ kg}^{-1}$ energy for this size reduction. If other conditions are similar, the energy required (kJ kg^{-1}) to crush the material from 25 mm to 3 mm needs to be calculated.

71) The energy requirement calculated using Rittinger's law will be

a) 61.53   b) 35.16   c) 16.43   d) 5.82

(GATE AG 2008)

72) The energy requirement calculated using Kick's law will be

a) 72.39   b) 52.76   c) 27.55   d) 14.85

(GATE AG 2008)

73) The energy requirement calculated using Bond's law will be

a) 57.34   b) 30.57   c) 15.79   d) 11.25

Common Data for Questions 74 and 75:
A tractor sprayer boom is fitted with 20 hollow cone nozzles to achieve an application rate of 200 L ha^{-1}. During a calibration test the nozzle flow rate was found to be 1.25 L min^{-1}, whereas the rated nozzle flow rate of 0.473 L min^{-1} was available at 275 kPa.

74) If the nozzle produces droplets with a volume median diameter of 200 micron at 1 MPa, the droplet size in micron at the desired flow rate is

a) 140   b) 167.5   c) 199.5   d) 250.9

75) If the forward speed of the tractor is 7.5 km h^{-1}, the field capacity of the sprayer in ha h^{-1} is

a) 2.84   b) 5.92   c) 6.04   d) 7.00

Linked Answer Questions: Q.76 to Q.85 carry two marks each.
Statement for Linked Answer Questions 76 and 77:
A sandy loam soil has a water holding capacity of 140 mm depth between field capacity and wilting point. The area to be irrigated is 60 ha and the depth of effective root zone is 0.30 m. The management allowed soil moisture depletion is 60% and the consumptive use is 6 mm per day. The conveyance and application efficiencies are expected to be 80 and 50% respectively. There are no leaching requirements as well as no rainfall and groundwater contributions to the crop water requirement.

76) The frequency of irrigation will be

a) 1 day   b) 3 days   c) 7 days   d) 5 days

77) The field irrigation requirement will be

a) 21600 m^3 b) 10800 m^3 c) 2.16×10^4 m^3 d) 27000 m^3

Statement for Linked Answer Questions 78 and 79:

Contour bunds are constructed on a land slope of 5% at a vertical interval of 1.35 m to store a 24 hour excess rainfall of 0.1 m. Minor effects due to side slopes of the bund are neglected in the calculation of storage volume of water behind the bund.

78) The depth of impounding immediately behind the contour bund is

a) 0.32 m   b) 0.42 m   c) 0.52 m   d) 0.62 m

(GATE AG 2008)

79) The water spread length behind the bund is

a) 12.4 m   b) 10.4 m   c) 8.4 m   d) 6.4 m

(GATE AG 2008)

Statement for Linked Answer Questions 80 and 81:

The following data were collected from two piezometers P and Q located adjacent to each other in a groundwater basin.

Description	P	Q
R.L. of the ground surface, m	220	220
Depth of piezometer, m	60	50
Depth to groundwater level from ground surface, m	60	50

80) Hydraulic heads in m at P and Q respectively will be

a) 100, 130   c) 60, 40
b) 160, 170   d) 170, 160

(GATE AG 2008)

81) Hydraulic gradient between the piezometers is

a) 0.33   b) 3.00   c) 0.94   d) 1.06

(GATE AG 2008)

Statement for Linked Answer Questions 82 & 83:

A food material having initial moisture content of 400 g/100 g (dry weight basis) is poured into 10 mm layers in a tray of freeze dryer which operates at 40 Pa. It is to be dried to 8% moisture (dry weight basis) at a maximum surface temperature of 55 $^\circ$C. The dried food has a thermal conductivity of 0.03 W m^{-1} K^{-1}, a density of 470 kg m^{-3}, a permeability of 2.4×10^{-4} kg s^{-1} m^{-1} and latent heat of sublimation of 2.95×10^6 J kg^{-1}. It is assumed that the pressure at the ice front remains constant at 78 Pa.

82) The temperature at the sublimation front will be

a) -73.5°C   b) -35.7°C   c) -25.28°C   d) -15.72°C

(GATE AG 2008)

83) The drying time will be

a) 1.7 h   b) 2.3 h   c) 3.2 h   d) 7.1 h

(GATE AG 2008)

Statement for Linked Answer Questions 84 & 85:
A rear wheel driven tractor weighing 20 kN has 40 percent of its weight supported by the front wheels. The tractor is pulling a trailed plough with a forward speed of 5 km h^{-1} on flat land. The plough exerts a drawbar pull of 8.0 kN with the line of pull making an angle of 15° with the horizontal in the vertical plane. The drawbar hitch height is 500 mm.

84) The coefficient of traction developed by the tractor for this operation is

a) 0.15   b) 0.49   c) 0.50   d) 0.56

(GATE AG 2008)

85) If the wheel slip is 20 percent and the coefficient of rolling resistance is 0.04, the tractive efficiency of the tractor is

a) 92.39%   b) 87.17%   c) 73.96%   d) 21.79%

(GATE AG 2008)

END OF THE QUESTION PAPER