

# ASSIGNMENT 1: GATE 2013

## AG : Agricultural Engineering

EE25BTECH11047 - Ravula Shashank Reddy

- 1) If  $\mathbf{P} = \mathbf{A} \mathbf{B}$ , where  $\mathbf{A} = \begin{pmatrix} 2 & 1 \\ 3 & 0 \end{pmatrix}$  and  $\mathbf{B} = \begin{pmatrix} 1 & 3 & 0 \\ 2 & 1 & 2 \end{pmatrix}$ ; then  $\mathbf{P}$  is (GATE EE 2025)

a)  $\begin{pmatrix} 7 & 2 \\ 9 & 0 \end{pmatrix}$       b)  $\begin{pmatrix} 4 & 7 & 2 \\ 3 & 9 & 0 \end{pmatrix}$       c)  $\begin{pmatrix} 2 & 4 \\ 3 & 9 \end{pmatrix}$       d)  $\begin{pmatrix} 2 & 4 & 7 \\ 0 & 3 & 9 \end{pmatrix}$

- 2) If  $\mathbf{C} = \mathbf{A} \times \mathbf{B}$ , where  $\mathbf{A} = 2\mathbf{i} - \mathbf{j} + 3\mathbf{k}$  and  $\mathbf{B} = \mathbf{i} + 2\mathbf{j}$ ; then  $\mathbf{C}$  is (GATE EE 2025)

a)  $-6\mathbf{i} + 3\mathbf{j} + 5\mathbf{k}$       b)  $6\mathbf{i} + 3\mathbf{j} - 5\mathbf{k}$       c)  $-6\mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$       d)  $6\mathbf{i} + 2\mathbf{j} + 5\mathbf{k}$

- 3) The general solution of the differential equation is

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} - 4y = 0$$

(GATE EE 2025)

a)  $Ae^x + Be^{-4x}$       b)  $Ae^{-x} + Be^{4x}$       c)  $Ae^x + Be^{4x}$       d)  $Ae^{-x} + Be^{-4x}$

- 4) Eigenvalues of the matrix  $\begin{pmatrix} 2 & 1 \\ 3 & 2 \end{pmatrix}$  are (GATE EE 2025)

a)  $\pm 2i$       b)  $2i \pm \sqrt{3}$       c)  $2 \pm i\sqrt{3}$       d)  $2 \pm \sqrt{3}$

- 5) Poisson distribution having a mean of 5 will have  $\sqrt{5}$  as (GATE EE 2025)

a) median      c) standard deviation  
b) mode      d) variance

- 6) During the testing of a spike-tooth type thresher for wheat crop, the throughput and the thresher capacity were found to be  $750 \text{ kg h}^{-1}$  and  $445 \text{ kg h}^{-1}$ , respectively. The grain-straw ratio (grain:straw) of the crop is 1.5 : 1. Material other than grain (MOG) collected at the main grain outlet is 0.5%. The total grain loss in percentage from all the sources will be (GATE EE 2025)

a) 0.33      b) 0.50      c) 1.11      d) 1.61

- 7) The rear furrow wheel in a tractor mounted disc plough is provided to (GATE EE 2025)

a) reduce the frictional power loss  
b) maintain the uniform depth of cut

- c) reduce the side draft  
d) improve the penetration of the plough.
- 8) The cumulative discharge of a tractor mounted hydraulic sprayer having 7 nozzles is  $2.0 \text{ L min}^{-1}$  when the tractor is operated at  $4 \text{ km h}^{-1}$ . If the nozzle spacing is  $0.3 \text{ m}$ , the discharge in  $\text{L ha}^{-1}$  is  
(GATE EE 2025)  

a) 1000.02	b) 285.72	c) 166.67	d) 142.86
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- 9) A two-wheel drive tractor, while negotiating a terrain, indicates 100% slip of one of the rear wheels. Under such a condition, the use of differential lock causes  
(GATE EE 2025)  

a) equal speed and equal power distribution to both the drive wheels	b) equal speed and equal torque distribution to both the drive wheels	c) equal power and equal torque distribution to both the drive wheels	d) equal speed and unequal power distribution to both the drive wheels.
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- 10) A double acting hydraulic cylinder has a rod diameter equal to one-half the piston diameter. If the system pressure is maintained constant, the ratio of load carrying capacity of extension stroke to that of retraction stroke is  
(GATE EE 2025)  

a) 0.75	b) 1.00	c) 1.33	d) 4.00
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- 11) During a test, sound level was measured as 90 dB in the operator's cabin on a tractor. Taking reference sound pressure as  $5 \times 10^{-2} \text{ N m}^{-2}$ , the measured RMS sound pressure in  $\text{N m}^{-2}$  is  
(GATE EE 2025)  

a) 6.32	b) $6.32 \times 10^{-1}$	c) $1.8 \times 10^{-3}$	d) $6.32 \times 10^{-10}$
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- 12) During land leveling of agricultural land for irrigation and drainage purposes, the acceptable deviation in elevation from the design value in metre is  
(GATE EE 2025)  

a) 0.015	b) 0.025	c) 0.055	d) 0.150
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- 13) The gridiron pipe drainage system is more economical than the herringbone pipe drainage system because  
(GATE EE 2025)  

a) it is adopted in the fields which do not require complete drainage	b) the number of main or sub-main lines is reduced	c) the number of junctions and the double-drained area are reduced	d) it has only main or sub-main lines.
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- 14) If the drainable porosity of a command area is 5% and the design rate of drop of the water table is  $0.25 \text{ m day}^{-1}$ , the drainage coefficient of the command area in  $\text{mm day}^{-1}$  will be  
(GATE EE 2025)  

a) 250	b) 12.5	c) 1.25	d) 0.0125
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15) A soil has a void ratio of 0.75 and a specific gravity of 2.66. The value of critical hydraulic gradient at which quick sand condition will occur is

(GATE EE 2025)

- a) 0.95                      b) 1.05                      c) 2.09                      d) 6.64

16) The pressure that does not have any measurable influence on the void ratio or shearing resistance of the soil mass is

(GATE EE 2025)

- a) pore water pressure                      c) capillary pressure  
b) intergranular pressure                      d) surcharge pressure.

17) The Rational method is used to estimate

(GATE EE 2025)

- a) runoff volume                      c) runoff depth  
b) peak runoff rate                      d) direct surface runoff.

18) Pan evaporation data recorded at a certain location over a period of one week are 4.0, 4.3, 4.6, 4.9, 5.12, 5.18, 6.0. If irrigation scheduling based on ratio of irrigation water (IW) to cumulative pan evaporation (CPE) is practiced, the depth of irrigation at an interval of a week for  $IW/CPE = 0.9$  is

(GATE EE 2025)

- a) 3.60                      b) 4.41                      c) 5.59                      d) 30.88

19) A 16 m high wind break is constructed to protect soil from wind erosion due to wind velocity of  $18 \text{ m s}^{-1}$  at 15 m height. The minimum wind velocity at 15 m height capable of moving the soil fraction is  $8 \text{ m s}^{-1}$ . The angle of deviation of prevailing wind direction from the perpendicular to the wind break is  $30^\circ$ . The distance of full protection from the wind break in m is

(GATE EE 2025)

- a) 60.44                      b) 104.69                      c) 306.00                      d) 530.01

20) Milk enters into the heating section of a high temperature short time (HTST) pasteurization plant at a temperature of  $45^\circ\text{C}$  and leaves at  $72^\circ\text{C}$ . Hot water at temperature of  $95^\circ\text{C}$  enters counter-currently into the heat exchanger and leaves at  $77^\circ\text{C}$ . The effectiveness of the heat exchanger is

(GATE EE 2025)

- a) 0.18                      b) 0.36                      c) 0.54                      d) 0.84

21) The equation representing the heat of respiration ( $q$ ) of fruits and vegetables as a function of temperature ( $\theta$ ) with positive constants  $a$  and  $b$  is

(GATE EE 2025)

- a)  $q = ae^{b\theta}$                       c)  $q = a \ln(b\theta)$   
b)  $q = ae^{-b\theta}$                       d)  $q = a + b\theta$ .

22) For an initial spore load equal to 25 spores per container inoculated with *Clostridium botulinum* having  $D_{121} = 0.25 \text{ min}$ , the spoilage probability of the container subjected to  $F_{121} = 1.5 \text{ min}$  is

(GATE EE 2025)

- a)  $10^{-5}$                       b)  $10^{-6}$                       c)  $10^{-8}$                       d)  $10^{-9}$

23) Slope and intercept of the BET equation relating  $[a_w/(1 - a_w)]$  and  $a_w$ , where  $a_w$  is water activity and  $x$  is the moisture content on dry basis, are 18 and 2, respectively. The values of thermodynamic constant  $C$  and BET monolayer moisture content  $x_m$  (%) are respectively

(GATE EE 2025)

- a) 40 and 20                      b) 30 and 15                      c) 20 and 10                      d) 10 and 5

24) A cold storage chamber is constructed with 10 mm mortar, 200 mm brick, 100 mm insulation and 5 mm wood-board having thermal conductivities of 0.8, 1.5, 0.025 and  $0.2 \text{ W m}^{-1} \text{ K}^{-1}$ , respectively. The resistance of  $4 \text{ K m}^2 \text{ W}^{-1}$  is offered by

(GATE EE 2025)

- a) mortar                      b) brick                      c) insulation                      d) wood-board

25) The horse power of the motor running the compressor of a refrigerator having COP of 4.5 and extracting  $200 \text{ kJ kg}^{-1}$  of evaporating heat with  $1.5 \text{ kg min}^{-1}$  refrigerant flow rate is

(GATE EE 2025)

- a) 0.5                      b) 1.0                      c) 1.5                      d) 2.0

26) Given  $f(x) = e^{-x^2}$  for  $x = 1.1, 1.2, 1.3, 1.4$ , and  $1.5$ , evaluate  $\int_{1.1}^{1.5} f(x) dx$  by Simpson's 1/3rd rule is \_\_\_\_\_

(GATE EE 2025)

27) A tractor operated single acting trailing type disc harrow has 8 discs on each gang. The gang angle of both the gangs is maintained at  $35^\circ$ . The horizontal component of resultant soil reaction force on each disc is 600 N and it makes an angle of  $30^\circ$  with the gang axis. If the speed of operation is  $6 \text{ km h}^{-1}$ , the required drawbar power in kW to operate the harrow will be \_\_\_\_\_.

(GATE EE 2025)

28) A two-wheel drive tractor pulls an implement that has a draft force of 11.5 kN. The total motion resistance of the tractor is 2.5 kN. Under these circumstances, the slip of the drive wheels is 20%. If the power loss in transmission is 20%, the percentage of power lost in converting engine power into drawbar power is \_\_\_\_\_.

(GATE EE 2025)

29) An unconfined aquifer extends over an area of  $1 \text{ km}^2$  and has hydraulic conductivity, total porosity and specific retention of 20 m per day, 30% and 10%, respectively. After pumping some groundwater from this aquifer, the water table dropped to a depth of 20 m from the ground level. If the water table was initially at 14.5 m below the ground level, the change in groundwater storage in million cubic meters would be \_\_\_\_\_.

(GATE EE 2025)

30) Two parallel canals 50 m apart fully penetrate a homogeneous unconfined aquifer resting on a horizontal impermeable layer. The aquifer has a hydraulic conductivity of  $3 \text{ m day}^{-1}$  and an effective porosity of 0.25. One-dimensional steady groundwater flow occurs from the upper canal to the lower canal with the height of water levels in the canals 10 m and 8.5 m from the aquifer bottom, respectively. If a sediment layer of 4 cm thick with hydraulic conductivity of  $1.2 \times 10^{-2} \text{ m day}^{-1}$  is ultimately deposited on the inflow face, the groundwater discharge per 1000 m width between the two canals in  $\text{m}^3 \text{ day}^{-1}$  will be \_\_\_\_\_.

(GATE EE 2025)

- 31) The overall heat transfer coefficient based on the outside surface area of a tubular heat exchanger decreased due to fouling during operation from  $1000 \text{ W m}^{-2} \text{ K}^{-1}$  to  $800 \text{ W m}^{-2} \text{ K}^{-1}$ . The fouling film coefficient of the heat exchanger in  $\text{W m}^{-2} \text{ K}^{-1}$  is \_\_\_\_\_.

(GATE EE 2025)

- 32) A high pressure dairy homogenizer operates under upstream and downstream pressures of 200 and 40 bar respectively homogenizing 30 L of whole milk per hour. Density and specific heat capacity of whole milk are  $1030 \text{ kg m}^{-3}$  and  $3.8 \text{ kJ kg}^{-1} \text{ K}^{-1}$ , respectively. Assuming complete energy conservation, the temperature rise of whole milk in  $^{\circ}\text{C}$  is \_\_\_\_\_.

(GATE EE 2025)

- 33) A fish fillet of 5 mm thickness having 85% moisture (wet basis) is to be frozen using a plate freezer. The plates are at  $-35^{\circ}\text{C}$  and the heat transfer coefficient between the fillet and the freezer plates can be assumed to be  $2.0 \text{ W m}^{-2} \text{ K}^{-1}$ . The initial freezing temperature of fish is  $-2.5^{\circ}\text{C}$ , latent heat of fusion is  $330 \text{ kJ kg}^{-1}$ , density of fish is  $1100 \text{ kg m}^{-3}$  and thermal conductivity of frozen fish is  $1.5 \text{ W m}^{-1} \text{ K}^{-1}$ . The time required to freeze the fillet from the initial freezing temperature in hour(s) is \_\_\_\_\_.

(GATE EE 2025)

- 34) Box 1 contains 15 balls out of which 3 are red. Box 2 contains 12 balls out of which 4 are red. If one ball is drawn at random from each box simultaneously, the probability of getting at least one red ball is

(GATE EE 2025)

- a) 0.07                      b) 0.47                      c) 0.53                      d) 0.75

- 35) A hemispherical vessel of 300 mm diameter is completely filled with oil and water. If the oil layer is 50 mm deep on the top, the volume of water in the vessel in litres is

(GATE EE 2025)

- a) 1.27                      b) 3.73                      c) 7.07                      d) 14.14

- 36) A tractor mounted off-set type reciprocating mower is driven by the PTO shaft. The maximum inertia force of 3.2 kN occurs along the pitman at  $32^{\circ}$  crank angle and  $27^{\circ}$  pitman angle with the horizontal plane. The knives of the cutterbar are riveted to the slider. If each of the allowable tensile and compressive stresses of the slider material is 50 MPa, the minimum cross-sectional area of the slider in  $\text{mm}^2$  is

(GATE EE 2025)

- a) 29.05                      b) 33.91                      c) 54.27                      d) 57.02

- 37) The flywheel of a hand operated chaff cutter with two cutting knives is rotated at 30 rpm and is connected to a worm gear assembly for driving the feed rollers. The number of teeth of the worm gear is 24 and number of starts (threads) of the worm is 2. If diameter of each of the feed rollers is 15 cm, the chaff length in mm will be

(GATE EE 2025)

- a) 9.8                      b) 12.8                      c) 19.6                      d) 39.2

- 38) A piston pump is driven by a 5 m diameter horizontal axis wind turbine for supplying water from a borehole with a total pump head of 10 m. The mean velocity of air is  $18 \text{ km h}^{-1}$  and the density

of air is  $1.29 \text{ kg m}^{-3}$ . The actual power coefficient of the wind turbine is 0.30 and the overall pump efficiency is 60%. Neglecting the transmission losses, the expected pump discharge in  $\text{L s}^{-1}$  will be  
(GATE EE 2025)

- a) 2.90                      b) 5.80                      c) 28.50                      d) 32.27

39) A 4-cylinder, 4-stroke compression ignition engine has piston stroke of 10.5 cm and cylinder bore of 11 cm. At a mean piston speed of  $7 \text{ m s}^{-1}$ , the developed brake mean effective pressure is 650 kPa. The brake power in kW developed by the engine is  
(GATE EE 2025)

- a) 39.40                      b) 43.24                      c) 86.48                      d) 172.96

40) A centrifugal pump having an overall efficiency of 75% requires 6 kW power at 1450 rpm to deliver water against a suction head of 5 m and a delivery head of 12 m. If the pump runs at 1650 rpm and frictional head losses are negligible, the total head developed by the pump in metres will be  
(GATE EE 2025)

- a) 22.01                      b) 25.05                      c) 29.35                      d) 31.72

41) A 100 ha watershed received rainfall at a rate of  $5 \text{ cm h}^{-1}$  for 2 hours. If the runoff generated by the storm was at the rate of  $1 \text{ m}^3 \text{ s}^{-1}$  for 10 hours, the runoff coefficient for the watershed would be  
(GATE EE 2025)

- a)  $3.6 \times 10^{-3}$                       b)  $6.0 \times 10^{-2}$                       c) 0.36                      d) 36

42) A 10 ha field has 1.2 m deep layer of sandy loam soil underlain by sandy soil up to a depth of 5 m. A pre-irrigation rainfall brings moisture content of the top 0.3 m layer to its field capacity. The moisture content of rest of the sandy loam layer remains at permanent wilting point. The volumetric moisture content at field capacity and permanent wilting point are 32 and 16%, respectively for the sandy loam soil. The field is irrigated with a stream size of  $240 \text{ L s}^{-1}$  for 24 hours. Considering the drainage from the sandy loam soil as deep percolation, application efficiency and deep percolation ratio in percent respectively are  
(GATE EE 2025)

- a) 56.40 and 43.60                      b) 69.44 and 30.56                      c) 75.18 and 24.82                      d) 92.60 and 7.40

43) A watershed, with an area of  $360 \text{ km}^2$ , has a triangular shaped 4-h unit hydrograph with a base of 50 hours. The peak discharge of direct runoff hydrograph due to 3 cm of rainfall-excess in 4 hours from the watershed in  $\text{m}^3 \text{ s}^{-1}$  is  
(GATE EE 2025)

- a) 13.33                      b) 40.00                      c) 120.00                      d) 160.00

44) A rotary dryer is used to dry  $1200 \text{ kg h}^{-1}$  of paddy containing 30% moisture (wet basis) to give a product containing 15% moisture (wet basis). Alternately, a portion of the dry product may be recycled and mixed with the fresh feed such that the mixed feed enters the dryer with moisture content of 20% (wet basis). The moisture evaporation rate without recycle and the paddy recycle rate in  $\text{kg h}^{-1}$  respectively in the dryer are  
(GATE EE 2025)



51) The absolute humidity of the exhaust air from the spray chamber in kg water (kg dry air)<sup>-1</sup> is  
(GATE EE 2025)

- a) 0.027                      b) 0.029                      c) 0.031                      d) 0.033

A two-wheel drive tractor weighing 21 kN has a wheel base of 2.1 m. The CG of the tractor is 0.7 m ahead of rear axle centre. The tractor is pulling a single-axle trailer with gross trailer weight of 50 kN on a leveled concrete road while maintaining the line of pull parallel to the ground surface. The tractor hitch point is 42 cm behind the rear axle centre and 52.5 cm above the ground surface. During operation, 20% of the gross trailer weight is transferred to the tractor hitch point. If the coefficient of rolling resistance for each of the tractor and trailer wheels is taken as 0.04, and their ground reactions are assumed to pass through their respective wheel centres,

52) the dynamic ground reaction against the tractor rear wheels in kN is

(GATE EE 2025)

- a) 14.0                      b) 24.0                      c) 24.5                      d) 26.4

53) the gross traction ratio developed by the tractor is

(GATE EE 2025)

- a) 0.061                      b) 0.082                      c) 0.108                      d) 0.123

In an experimental setup, the discharge through a triangular notch is  $0.0074 \text{ m}^3 \text{ s}^{-1}$  at an operating head of 0.1 m. The coefficient of discharge for the notch is 0.7. If the required discharge is  $0.1 \text{ m}^3 \text{ s}^{-1}$ ,

54) the corresponding head in m is

(GATE EE 2025)

- a) 0.00015                      b) 0.035                      c) 0.283                      d) 67.13

55) the corresponding width of water surface in m is

(GATE EE 2025)

- a) 0.80                      b) 0.099                      c) 0.00043                      d) 0.00086

56) If  $3 \leq X \leq 5$  and  $8 \leq Y \leq 11$  then which of the following options is TRUE?

(GATE EE 2025)

- a)  $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{5}$   
 b)  $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{8}{5}$   
 c)  $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{8}{5}$   
 d)  $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{11}$

57) The Headmaster \_\_\_\_\_ to speak to you.

Which of the following options is incorrect to complete the above sentence?

(GATE EE 2025)

- a) is wanting  
 b) wants  
 c) want  
 d) was wanting

58) Mahatma Gandhi was known for his humility as

(GATE EE 2025)

- a) he played an important role in humiliating exit of British from India.  
 b) he worked for humanitarian causes.



- c) he displayed modesty in his interactions.  
d) he was a fine human being.

59) All engineering students should learn mechanics, mathematics and how to do computation. *I*  
*II*            *III*            *IV*

Which of the above underlined parts of the sentence is not appropriate?

(GATE EE 2025)

- a) I                                      b) II                                      c) III                                      d) IV

60) Select the pair that best expresses a relationship similar to that expressed in the pair:  
*water: pipe::*

(GATE EE 2025)

- a) cart: road                                      c) sea: beach  
b) electricity: wire                                      d) music: instrument

61) Velocity of an object fired directly in upward direction is given by  $V = 80 - 32t$ , where  $t$  (time) is in seconds. When will the velocity be between  $32 \text{ m s}^{-1}$  and  $64 \text{ m s}^{-1}$ ?

(GATE EE 2025)

- a)  $(1, 3/2)$                                       c)  $(1/2, 3/2)$   
b)  $(1/2, 1)$                                       d)  $(1, 3)$

62) In a factory, two machines  $M_1$  and  $M_2$  manufacture 60% and 40% of the autocomponents respectively. Out of the total production, 2% of  $M_1$  and 3% of  $M_2$  are found to be defective. If a randomly drawn autocomponent from the combined lot is found defective, what is the probability that it was manufactured by  $M_2$ ?

(GATE EE 2025)

- a) 0.35                                      b) 0.45                                      c) 0.5                                      d) 0.4

63) Following table gives data on tourists from different countries visiting India in the year 2011.

Country	Number of Tourists
USA	2000
England	3500
Germany	1200
Italy	1100
Japan	2400
Australia	2300
France	1000

Which two countries contributed to the one third of the total number of tourists who visited India in 2011?

(GATE EE 2025)

- a) USA and Japan  
b) USA and Australia  
c) England and France  
d) Japan and Australia

64) If  $|-2X + 9| = 3$  then the possible value of  $|-X| - X^2$  would be:

(GATE EE 2025)

- a) 30                      b) -30                      c) -42                      d) 42

65) All professors are researchers  
Some scientists are professors

Which of the given conclusions is logically valid and is inferred from the above arguments:

(GATE EE 2025)

- a) All scientists are researchers  
b) All professors are scientists  
c) Some researchers are scientists  
d) No conclusion follows

**END OF THE QUESTION PAPER**