GATE 2024

Question Paper | Answer Key

Graduate Aptitude Test in Engineering (GATE) is a prestigious national-level exam that assesses candidates for comprehensive understanding in various undergraduate-level subjects in Engineering, Technology, Science, Architecture, and Humanities.

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General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	If '→' denotes increasing order of intensity, then the meaning of the words [dry → arid → parched] is analogous to [diet → fast → _____]. Which one of the given options is appropriate to fill the blank?
(A)	starve
(B)	reject
(C)	feast
(D)	deny
Q.2	If two distinct non-zero real variables x and y are such that $(x + y)$ is proportional to $(x - y)$ then the value of $\frac{x}{y}$
(A)	depends on xy
(B)	depends only on x and not on y
(C)	depends only on y and not on x
(D)	is a constant

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Q.3	Consider the following sample of numbers: 9, 18, 11, 14, 15, 17, 10, 69, 11, 13 The median of the sample is
(A)	13.5
(B)	14
(C)	11
(D)	18.7
Q.4	The number of coins of ₹1, ₹5, and ₹10 denominations that a person has are in the ratio 5:3:13. Of the total amount, the percentage of money in ₹5 coins is
(A)	21%
(B)	$14\frac{2}{7}\%$
(C)	10%
(D)	30%

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Q.5	For positive non-zero real variables p and q, if $$\log\,(p^2+q^2) = \log p + \log q + 2\log 3\,,$$ then, the value of $\frac{p^4+q^4}{p^2q^2}$ is
(A)	79
(B)	81
(C)	9
(D)	83

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Q.6 – Q.10 Carry TWO marks Each

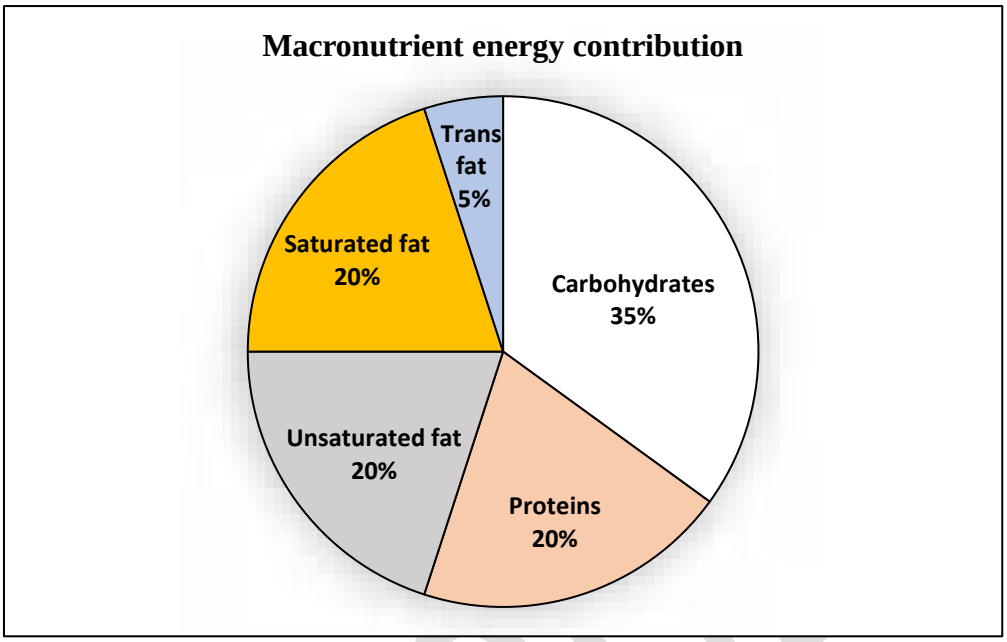
Q.6	In the given text, the blanks are numbered (i)−(iv). Select the best match for all the blanks. Steve was advised to keep his head _____(i)_____ before heading _____(ii)_____ to bat; for, while he had a head _____(iii)_____ batting, he could only do so with a cool head _____(iv)_____ his shoulders.
(A)	(i) down (ii) down (iii) on (iv) for
(B)	(i) on (ii) down (iii) for (iv) on
(C)	(i) down (ii) out (iii) for (iv) on
(D)	(i) on (ii) out (iii) on (iv) for

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Q.7	A rectangular paper sheet of dimensions 54 cm × 4 cm is taken. The two longer edges of the sheet are joined together to create a cylindrical tube. A cube whose surface area is equal to the area of the sheet is also taken. Then, the ratio of the volume of the cylindrical tube to the volume of the cube is
(A)	$1/\pi$
(B)	$2/\pi$
(C)	$3/\pi$
(D)	$4/\pi$

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Q.8 The pie chart presents the percentage contribution of different macronutrients to a typical 2,000 kcal diet of a person.



The typical energy density (kcal/g) of these macronutrients is given in the table.

Macronutrient	Energy density (kcal/g)
Carbohydrates	4
Proteins	4
Unsaturated fat	9
Saturated fat	9
Trans fat	9

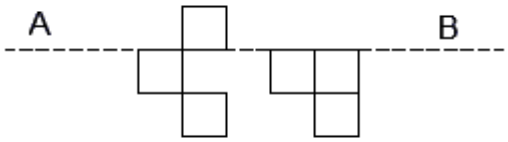
The total fat (all three types), in grams, this person consumes is

(A) 44.4

(B) 77.8

(C) 100

(D) 3,600

Q.9	A rectangular paper of 20 cm × 8 cm is folded 3 times. Each fold is made along the line of symmetry, which is perpendicular to its long edge. The perimeter of the final folded sheet (in cm) is
(A)	18
(B)	24
(C)	20
(D)	21
Q.10	The least number of squares to be added in the figure to make AB a line of symmetry is 
(A)	6
(B)	4
(C)	5
(D)	7

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Q.11 – Q.35 Carry ONE mark Each

Q.11	In adsorption chromatography, the adsorption of uncharged solute molecules onto a silica-based stationary phase is by _____.
(A)	covalent bonds
(B)	electrostatic interactions
(C)	ionic bonds
(D)	van der Waals forces
Q.12	The transfer function of a process is $G(s) = \frac{K_p}{\tau_p s+1}$, where K_p is the gain and τ_p is the time constant. This is a _____ process.
(A)	first order
(B)	multi-capacity
(C)	purely capacitive
(D)	second order

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Q.13	Which one of the following statements is correct in the context of thermodynamics?
(A)	In a closed system, neither mass nor energy is transferred across the system boundary
(B)	In a closed system, both mass and energy can be transferred across the system boundary
(C)	The total energy of the system is the sum of kinetic and potential energies
(D)	In a closed system, only energy can be transferred across the system boundary and not mass
Q.14	Which one of the following statements is correct about Reynolds Number (N_{Re}) in a stirred tank bioreactor?
(A)	N_{Re} is independent of the viscosity of the medium
(B)	In laminar flow, mixing time increases with an increase in N_{Re}
(C)	N_{Re} is inversely proportional to the impeller speed
(D)	In turbulent flow, mixing time is independent of N_{Re}

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Q.15	The relationship that involves the exchange of nutrients between two different species for their mutual growth is called _____.
(A)	antagonism
(B)	commensalism
(C)	parasitism
(D)	syntrophism
Q.16	Mendel's 'law of segregation' applies to the segregation of _____ during gamete formation.
(A)	mitochondrial genes
(B)	alleles of a gene
(C)	linked genes on the same chromosome
(D)	unlinked genes on the same chromosome
Q.17	Co-translational translocation of proteins is observed in _____.
(A)	endoplasmic reticulum
(B)	Golgi complex
(C)	mitochondria
(D)	peroxisomes

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Q.18	2-mercaptoethanol breaks the _____ covalent bond between light and heavy chains of an immunoglobulin molecule.
(A)	C-N
(B)	N-O
(C)	S-C
(D)	S-S
Q.19	During normal embryonic development of the mice paw, elimination of cells from the inter-digital space is due to _____.
(A)	apoptosis
(B)	meiosis
(C)	mutagenesis
(D)	necrosis

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Q.20	A cultured skin fibroblast cell of a goat ‘P’ was fused with an enucleated ovum of a goat ‘Q’. The resultant activated early embryo was then transplanted into a pseudopregnant (surrogate) female goat ‘R’ of the same strain as ‘Q’. On completion of gestation, a female goat ‘S’ was born. With the exception of mitochondrial DNA, ‘S’ is a clone of _____.
(A)	Only P
(B)	Only Q
(C)	Only R
(D)	Both P and R
Q.21	Which one of the following bacteriophages has a genome composed of single stranded circular DNA?
(A)	ØX174
(B)	λ
(C)	T5
(D)	P1

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Q.22	Which one of the following is an insect cell line?
(A)	HEK 293
(B)	Sf9
(C)	DH5α
(D)	CHO
Q.23	Which one of the following is the basic principle of Sanger's DNA sequencing method?
(A)	Chain termination by incorporation of dideoxynucleotides
(B)	Chain elongation by incorporation of dideoxynucleotides
(C)	Release of inorganic pyrophosphate
(D)	Chain cleavage by modification of dideoxynucleotides
Q.24	An element that is present in a nucleotide but not in a nucleoside is _____.
(A)	carbon
(B)	nitrogen
(C)	oxygen
(D)	phosphorous

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Q.25	Krebs (TCA) cycle is _____ pathway.
(A)	only an anabolic
(B)	only a catabolic
(C)	an amphibolic
(D)	a pyogenic
Q.26	If a denatured protein of human origin is injected into a rabbit, antibodies generated will recognize the _____ structure of the protein.
(A)	primary
(B)	secondary
(C)	tertiary
(D)	quaternary
Q.27	All pseudogenes **DO NOT** code for a _____.
(A)	protein with original function
(B)	protein with altered function
(C)	RNA with coding sequence
(D)	RNA with regulatory function

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Q.28	A value of k for which the linear equations $(k-1)x+3y=0$ and $2x+ky=0$ have a non-zero solution is _____.
(A)	1
(B)	2
(C)	3
(D)	4
Q.29	The value of the series $1+\sin x+\cos^2 x+\sin^3 x+\cdots$ at $x=\frac{\pi}{4}$ is _____.
(A)	$\frac{1}{\sqrt{2}+1}$
(B)	$\frac{\sqrt{2}}{\sqrt{2}+1}$
(C)	$\frac{1}{\sqrt{2}-1}$
(D)	$\frac{\sqrt{2}}{\sqrt{2}-1}$

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Q.30	The solution of the differential equation $\frac{dy}{dx} = y + e^{-x}$ that satisfies $y(0) = -\frac{1}{2}$ is _____.
(A)	$-\frac{1}{2}e^{-\frac{x}{2}}$
(B)	$-\frac{1}{2}e^{x}$
(C)	$-\frac{1}{2}e^{-x}$
(D)	$-\frac{1}{2}e^{\frac{x}{2}}$
Q.31	The six faces of a cube (die) are numbered as 1, 2, 3, 4, 5 and 6, and it is rolled once. An outcome is the observed number on the top face. If the probability of getting an odd number as an outcome is twice that of an even number, then the probability of getting a number less than 3 is _____.
(A)	$\frac{1}{9}$
(B)	$\frac{2}{9}$
(C)	$\frac{1}{3}$
(D)	$\frac{4}{9}$

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Q.32	Let $\overrightarrow{OR}$ be the vector that is perpendicular to the vectors $\overrightarrow{OP} = 2\hat{\imath} - 3\hat{\jmath} + \hat{k}$ and $\overrightarrow{OQ} = -2\hat{\imath} + \hat{\jmath} + \hat{k}$. If the length of the vector $\overrightarrow{OR}$ is $\alpha\sqrt{3}$, then α is _____.
(A)	3
(B)	4
(C)	5
(D)	6
Q.33	The degree of reduction (reductance) for oxalic acid ($C_2H_2O_4$) is _____.
Q.34	If the rate at which *E. coli* divides is 0.5 h^{-1}, then its doubling time is _____ h.
Q.35	The decimal reduction time of a microbe during sterilization at 120 °C with a first order thermal death rate constant of 1 min^{-1} will be _____ min (rounded off to 1 decimal place).

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Q.36 – Q.65 Carry TWO marks Each

<table>
<tr><td>Q.36</td><td>Match the disease (Column I) with its biological vector (Column II).

Column I — Column II

P. Chagas disease — 1. Tsetse flies

Q. Trypanosomiasis — 2. Mosquitoes

R. Leishmaniasis — 3. Sandflies

S. Yellow Fever — 4. Reduviid bugs</td></tr>
<tr><td>(A)</td><td>P-4; Q-1; R-3; S-2</td></tr>
<tr><td>(B)</td><td>P-2; Q-3; R-4; S-1</td></tr>
<tr><td>(C)</td><td>P-1; Q-4; R-3; S-2</td></tr>
<tr><td>(D)</td><td>P-3; Q-1; R-2; S-4</td></tr>
<tr><td></td><td></td></tr>
</table>

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Q.37	Match the industrial enzyme (**Column I**) with its application (**Column II**). **Column I** — **Column II** P. Lipase — 1. Maltose syrup production Q. Ficin — 2. Oil degradation R. Amylase — 3. Oligosaccharide/monosaccharide production S. Glucosidase — 4. Meat tenderization
(A)	P-3; Q-4; R-2; S-1
(B)	P-2; Q-4; R-1; S-3
(C)	P-2; Q-3; R-1; S-4
(D)	P-1; Q-2; R-4; S-3

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Q.38	Match the enzyme (**Column I**) with its corresponding function (**Column II**). **Column I** — **Column II** P. Primase — 1. RNA dependent RNA synthesis Q. Reverse transcriptase — 2. DNA dependent DNA synthesis R. RNA Replicase — 3. RNA dependent DNA synthesis S. DNA Polymerase III — 4. DNA dependent RNA synthesis
(A)	P-4; Q-1; R-3; S-2
(B)	P-2; Q-1; R-3; S-4
(C)	P-3; Q-4; R-2; S-1
(D)	P-4; Q-3; R-1; S-2

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Q.39	Match the item (**Column I**) with its corresponding use (**Column II**). **Column I** — **Column II** P. Glutamine — 1. Detachment of adherent cells Q. Trypsin — 2. Selection of transfected mammalian cell lines R. Hypoxanthine — 3. Source of carbon and nitrogen in animal cell culture media S. Neomycin — 4. A component of medium for selection of hybridoma in monoclonal antibody production
(A)	P-3; Q-1; R-4; S-2
(B)	P-1; Q-2; R-4; S-3
(C)	P-3; Q-1; R-2; S-4
(D)	P-2; Q-3; R-1; S-4

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Q.40 Match the chemical (**Column I**) with its use (**Column II**).

Column I	**Column II**
P. Diethylpyrocarbonate	1. Chelation of magnesium ion during DNA purification
Q. Cesium chloride	2. Prevention of RNA degradation in aqueous environment
R. Ethidium bromide	3. Separation of DNA by density gradient centrifugation
S. Ethylenediaminetetraacetic acid	4. Staining of RNA in agarose gel

(A) P-4; Q-1; R-3; S-2

(B) P-4; Q-3; R-2; S-1

(C) P-2; Q-1; R-4; S-3

(D) P-2; Q-3; R-4; S-1

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Q.41	Match the item in **Column I** with the corresponding technique in **Column II**. **Column I** — **Column II** P. Blue laser — 1. Electron microscopy Q. Tungsten filament — 2. Fluorescence activated cell sorting R. ^{15}N labelled protein — 3. Electrophoresis S. Polyacrylamide — 4. Nuclear magnetic resonance spectroscopy
(A)	P-2; Q-3; R-1; S-4
(B)	P-2; Q-1; R-4; S-3
(C)	P-3; Q-1; R-4; S-2
(D)	P-1; Q-2; R-4; S-3

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Q.42	Match the genetic disorder (**Column I**) with its molecular basis (**Column II**) **Column I** — **Column II** P. Sickle-cell anemia — 1. Mutation in nucleotide excision repair Q. Xeroderma pigmentosum — 2. Trisomy of chromosome 21 R. Tay-Sachs disease — 3. Mutation in β-globin gene S. Down Syndrome — 4. Mutation in hexosaminidase A gene
(A)	P-1; Q-4; R-2; S-3
(B)	P-3; Q-4; R-1; S-2
(C)	P-3; Q-1; R-4; S-2
(D)	P-4; Q-2; R-3; S-1
Q.43	The evolution of wings in bats and insects is an example of _____ evolution.
(A)	convergent
(B)	divergent
(C)	neutral
(D)	parallel

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Q.44	Which of the following statements is/are correct about an uncompetitive inhibitor of an enzyme?
(A)	It binds to the substrate binding site of the enzyme only
(B)	It binds to the enzyme-substrate complex only
(C)	It reduces the V_{max} of the enzyme
(D)	It binds to both free enzyme and enzyme-substrate complex
Q.45	Which of the following plant-based secondary metabolites belong(s) to the class of alkaloids?
(A)	Ajmalicine ($C_{21}H_{24}N_2O_3$)
(B)	Azadirachtin ($C_{35}H_{44}O_{16}$)
(C)	Camptothecin ($C_{20}H_{16}N_2O_4$)
(D)	Vinblastine ($C_{46}H_{58}N_4O_9$)
Q.46	Which of the following features help(s) in distinguishing alleles using restriction fragment length polymorphism (RFLP)?
(A)	Differences in the number of recognition sites for a given restriction enzyme
(B)	Differences in the ability of alleles to undergo recombination
(C)	Differences in the ability of alleles to undergo segregation
(D)	Differences in the number of tandem repeats

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Q.47	Which of the following is/are considered as biotic elicitor(s) in plant cell culture?
(A)	Cellulase
(B)	Chitin
(C)	Chitosan
(D)	Mercuric chloride
Q.48	Under which of the following conditions, a mammalian somatic cell fails to undergo mitosis during cell cycle?
(A)	Initiation of cell plate formation
(B)	Incomplete DNA replication
(C)	Chiasmata formation
(D)	Irreparable DNA damage
Q.49	Which of the following is/are synthetic auxin(s) that does/do **NOT** occur naturally?
(A)	2,4-Dichlorophenoxyacetic acid
(B)	Indole-3-acetic acid
(C)	Indole-3-butyric acid
(D)	1-Naphthaleneacetic acid

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Q.50	Which of the following statements regarding the below mentioned mRNA sequence is/are TRUE? 5`-UGAUGAGCCUUAACCGGGAACGAAUUUAAG-3`
(A)	It contains nine codons in the reading frame
(B)	It contains ten codons in the reading frame
(C)	It codes for eight amino acids
(D)	It codes for nine amino acids
Q.51	Which of the following conditions induce(s) the expression of β-galactosidase gene in the *lac* operon?
(A)	Absence of glucose
(B)	Absence of lactose
(C)	Presence of glucose
(D)	Presence of lactose

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Q.52	Which of the following factors can affect the growth of a microbial culture in a batch cultivation process?
(A)	pH of the medium
(B)	Osmolarity of the medium
(C)	Substrate concentration in the medium
(D)	Substrate feed rate
Q.53	Under complete cell washout condition in a chemostat with sterile feed, which of the following statements is/are correct?
(A)	Biomass concentration in the reactor is maximum
(B)	Substrate concentration in the exit stream is less than that in the inlet stream
(C)	Substrate concentration in the exit stream is equal to that in the inlet stream
(D)	Substrate concentration in the exit stream is zero
Q.54	Fermentation medium is cooled from 121 °C to 30 °C in a double pipe heat exchanger. If cold water is flowing in the counter-current direction and is heated from 10 °C to 70 °C, then the Log-Mean Temperature Difference (LMTD) is _____ °C (rounded off to the nearest integer).

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Q.55	*Aspergillus niger* is grown in a 10,000 L stirred batch bioreactor under aerated conditions to produce citric acid. At steady state oxygen transfer conditions, the specific oxygen uptake rate of the organism and the volumetric mass transfer coefficient are 1×10^{-4} $\frac{g\ oxygen\ consumed}{g\ biomass}$ s^{-1} and 60 min^{-1}, respectively. If the oxygen solubility is 8×10^{-3} kg m^{-3} under the operating conditions, based only on oxygen dynamics, the maximum possible cell concentration is _____kg m^{-3} (Answer in integer).
Q.56	Ethanol is produced in a 10,000 L stirred bioreactor using an impeller of diameter 1 m. The density and viscosity of fermentation broth are 1000 kg m^{-3} and 1 cp, respectively. The data relating the Power number and Impeller Reynolds number is given below: Reynolds number 1-5 5-500 > 10^5 Power number 70 10 5 Using the above data, the power required for the stirrer to operate at 300 rpm is _____ kW (Answer in integer).
Q.57	The free energy change of ATP hydrolysis at 25 °C is -32.2 kJ mol^{-1}. The free energy change for hydrolysis of α-glycerophosphate to glycerol is -8.2 kJ mol^{-1} at 25 °C. Using the above information, the free energy change for the formation of α-glycerophosphate from glycerol and ATP is _____ kJ mol^{-1} (Answer in integer).
Q.58	*E. coli* is inoculated in a shake flask containing nutrient rich medium. The initial number of viable cells in the medium is 10^2. After few hours, the number of viable cells is 10^6. Assuming cell divides by binary fission, the number of generations that have taken place is _____ (rounded off to the nearest integer).

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Q.59	A fermentor is filled with medium at a rate of 1 L min^{-1}. A leak develops at the bottom of the fermentor when the medium in the fermentor reaches 200 L. The rate of medium leakage is $2t$ L min^{-1}, where 't' is the time at which the leak begins. The volume of medium in the fermentor after 10 min of leakage is _____ L (Answer in integer).
Q.60	A fed batch process is running at quasi-steady state with respect to substrate and biomass concentration. At 2 h, the culture volume is 500 L with a constant sterile inlet feed at 50 L h^{-1} of glucose. The culture kinetic parameters μ_m and K_S are 0.2 h^{-1} and 0.1 g L^{-1}, respectively. The substrate concentration in the reactor will be _____ g L^{-1} (rounded off to one decimal place).
Q.61	Consider scale-up of fungal fermentation from a 20 L model-type to 20,000 L prototype stirred tank reactor. The model-type and prototype have the same aspect ratio during scale-up. The impeller speed in the model-type is 500 rpm and the scale-up criterion is constant shear. The impeller speed in the prototype reactor will be _____ rpm (Answer in integer).
Q.62	If $\vec{v} = \begin{pmatrix} 2 \\ 2 \\ 2 \end{pmatrix}$ is an eigenvector of the matrix $\begin{pmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \\ 1 & 2 & 3 \end{pmatrix}$ corresponding to the non-zero eigenvalue, λ, then the value of λ is _____.
Q.63	The value of the limit $\lim_{x \to \infty} \frac{x}{2} \ln(1 + \frac{2024}{x})$ is _____.

Q.64	Let $y(x) = x^2 \ln x$ for $x > 0$, be a solution of $x^2 \frac{d^2y}{dx^2} + 4y = \alpha x \frac{dy}{dx}$. Then the value of α is _____.
Q.65	The absolute relative error in evaluating the integral $\int_0^1 x^2 dx$ by the trapezoidal rule with the step size 0.25 is _____ % (rounded off to 2 decimal places).

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