ASSIGNMENT 2: GATE 2012
PI: PRODUCTION AND INDUSTRIAL ENGINEERING

AI25BTECH11034 – Sujal Chauhan

Q.1 – Q. 25 carry one mark each.

1) $\lim_{x\to 0}\left(\frac{1-\cos x}{x^2}\right)$ is (GATE 2012)
   a) 1/4
   b) 1/2
   c) 1
   d) 2

2) For the spherical surface $x^2 + y^2 + z^2 = 1$, the unit outward normal vector at the point $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0\right)$ is given by (GATE 2012)
   a) $\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}$
   b) $\frac{1}{\sqrt{2}}\hat{i} - \frac{1}{\sqrt{2}}\hat{j}$
   c) $\hat{k}$
   d) $\frac{1}{\sqrt{3}}\hat{i} + \frac{1}{\sqrt{3}}\hat{j} + \frac{1}{\sqrt{3}}\hat{k}$

3) Consider the function $f(x) = |x|$ in the interval $-1 \le x \le 1$. At the point $x = 0$, $f(x)$ is (GATE 2012)
   a) continuous and differentiable.
   b) non-continuous and differentiable.
   c) continuous and non-differentiable.
   d) neither continuous nor differentiable.

4) At $x = 0$, the function $f(x) = x^2 + 1$ has (GATE 2012)
   a) a maximum value
   b) a minimum value
   c) a singularity
   d) a point of inflection

5) The area enclosed between the straight line $y = x$ and the parabola $y = x^2$ in the xy-plane is (GATE 2012)
   a) 1/6
   b) 1/4
   c) 1/3

d) 1/2

6) For a long slender column of uniform cross section, the ratio of critical buckling load for the case with both ends clamped to the case with both ends hinged is (GATE 2012)
   a) 1
   b) 2
   c) 4
   d) 8

7) A thin walled spherical shell is subjected to an internal pressure. If the radius of the shell is increased by 1% and the thickness is reduced by 1%, with the internal pressure remaining the same, the percentage change in the circumferential (hoop) stress is (GATE 2012)
   a) 0
   b) 1
   c) 1.08
   d) 2.02

8) A cantilever beam of length L is subjected to a moment M at the free end. The moment of inertia of the beam cross section on the neutral axis is I and the young's modulus is$E$. The magnitude of the maximum deflection is (GATE 2012)
   a) $\frac{ML^2}{2EI}$
   b) $\frac{ML^2}{EI}$
   c) $\frac{2ML^2}{EI}$
   d) $\frac{4ML^2}{EI}$

9) A circular solid disc of uniform thickness 20 mm, radius 200 mm and mass 20 kg is used as a flywheel. If it rotates at 600 rpm, the kinetic energy of the flywheel, in Joules is (GATE 2012)
   a) 395
   b) 790
   c) 1580
   d) 3160

10) In the mechanism given below, if the angular velocity of the eccentric circular disc is 1 rad/s, the angular velocity (rad/s) of the follower link for the instant shown in the figure is (GATE 2012)
   Note: All dimensions are in mm.
   a) 0.05
   b) 0.1
   c) 5.0
   d) 10.0

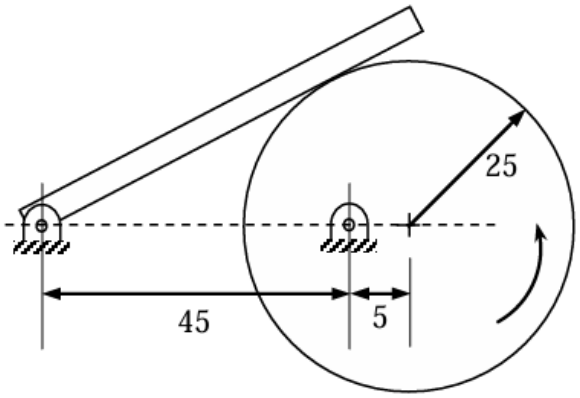

Fig. 1

11) Steam enters an adiabatic turbine operating at steady state with an enthalpy of 3251.0 kJ/kg and leaves as a saturated mixture at 15 kPa with quality (dryness fraction) 0.9. The enthalpies of the saturated liquid and vapor at 15 kPa are $h_f = 225.94\,kJ/kg$ and $h_g = 2598.3\,kJ/kg$ respectively. The mass flow rate of steam is 10 kg/s. Kinetic and potential energy changes are negligible. The power output of the turbine in MW is (GATE 2012)

a) 6.5
b) 8.9
c) 9.1
d) 27.0

12) An ideal gas of mass m and temperature T_1 undergoes a reversible isothermal process from an initial pressure P_1 to final pressure P_2. The heat loss during the process is Q. The entropy change ΔS of the gas is (GATE 2012)

a) $mR\ln\left(\frac{P_2}{P_1}\right)$
b) $mR\ln\left(\frac{P_1}{P_2}\right)$
c) $mR\ln\left(\frac{P_2}{P_1}\right) - \frac{Q}{T_1}$
d) zero

13) For an opaque surface, the absorptivity (α), transmissivity (τ) and reflectivity (ρ) are related by the equation: (GATE 2012)

a) $\alpha + \rho = \tau$
b) $\rho + \alpha + \tau = 0$
c) $\alpha + \rho = 1$
d) $\alpha + \rho = 0$

14) Which of the following configurations has the highest fin effectiveness? (GATE 2012)

a) Thin, closely spaced fins
b) Thin, widely spaced fins
c) Thick, widely spaced fins
d) Thick, closely spaced fins

15) Oil flows through a 200 mm diameter horizontal cast iron pipe (friction factor, $f = 0.0225$) of length 500 m. The volumetric flow rate is $0.2\,m^3/s$. The head loss (in m) due to friction is (assume $g = 9.81\,m/s^2$) (GATE 2012)

a) 116.5
b) 0.116
c) 12.2
d) 232.36

16) A solid cylinder of diameter 100 mm and height 50 mm is forged between two frictionless flat dies until the height is 25 mm. The percentage change in diameter is (GATE 2012)

a) 18.6
b) 20.0
c) 41.4
d) 52.6

17) Q.17 In an interchangeable assembly, shafts of size $25.000^{-0.010}_{+0.030}$ mm mate with holes of size $25.000^{+0.020}_{+0.020}$ mm. The maximum interference (in microns) in the assembly is (GATE 2012)

a) 40
b) 30
c) 20
d) 10

18) A CNC vertical milling machine has to cut a straight slot of 10 mm width and 2 mm depth by a cutter of 10 mm diameter between points (0, 0) and (100, 100) on the XY plane (dimensions in mm). The feed rate used for milling is 50 mm/min. Milling time for the slot (in seconds) is (GATE 2012)

a) 120
b) 170
c) 180
d) 240

19) Match the following metal forming processes with their associated stresses in the workpiece. (GATE 2012)

Metal forming process	Type of stress
1. Coining	P. Tensile
2. Wire Drawing	Q. Shear
3. Blanking	R. Tensile and compressive
4. Deep Drawing	S. Compressive

a) 1-S, 2-P, 3-Q, 4-R
b) 1-S, 2-P, 3-R, 4-Q
c) 1-P, 2-Q, 3-S, 4-R
d) 1-P, 2-R, 3-Q, 4-S

20) During *normalizing* process of steel, the specimen is heated (GATE 2012)
   a) between the upper and lower critical temperature and cooled in still air.
   b) above the upper critical temperature and cooled in furnace.
   c) above the upper critical temperature and cooled in still air.
   d) between the upper and lower critical temperature and cooled in furnace.

21) In abrasive jet machining, as the distance between the nozzle tip and the work surface increases, the material removal rate (GATE 2012)
   a) increases continuously.
   b) decreases continuously.
   c) decreases, becomes stable and then increases.
   d) increases, becomes stable and then decreases.

22) Which one of the following is NOT a decision taken during the aggregate production planning stage? (GATE 2012)
   a) Scheduling of machines
   b) Amount of labour to be committed
   c) Rate at which production should happen
   d) Inventory to be carried forward

23) Which one of the following is NOT associated with the process of new product development? (GATE 2012)
   a) QFD
   b) FEMA
   c) KANBAN
   d) DFMA

24) A process needs to be standardized for method and time. Which one of the following represents the sequence of work study experiments? (GATE 2012)
   a) Time study followed by method study
   b) Only time study
   c) Time study and method study simultaneously
   d) Method study followed by time study

25) Reduction in the variability of manufactured product characteristics will definitely result in observations close to (GATE 2012)
   a) the upper control limit in $\overline{X}$ chart.
   b) the lower control limit in $\overline{X}$ chart.
   c) the lower control limit in R chart.
   d) the center line in R chart.

26) The system of algebraic equations given below has

$$x + 2y + z = 42x + y + 2z = 5x - y + z = 1$$

(GATE 2012)

a) A unique solution of $x = 1, y = 1$ and $z = 1$.
b) Only two solutions of $(x = 1, y = 1, z = 1)$ and $(x = 2, y = 1, z = 0)$.
c) Infinite number of solutions.
d) No feasible solution.

27) For the matrix $A = \begin{pmatrix} 5 & 3 \\ 1 & 3 \end{pmatrix}$, ONE of the normalized eigen vectors is given as (GATE 2012)

a) $\begin{pmatrix} \frac{1}{2} \\ \frac{\sqrt{3}}{2} \end{pmatrix}$
b) $\begin{pmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{pmatrix}$
c) $\begin{pmatrix} \frac{3}{\sqrt{10}} \\ -\frac{1}{\sqrt{10}} \end{pmatrix}$
d) $\begin{pmatrix} \frac{1}{\sqrt{5}} \\ \frac{2}{\sqrt{5}} \end{pmatrix}$

28) Consider the differential equation

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

with the boundary conditions of $y(0) = 0$ and $y(1) = 1$. The complete solution of the differential equation is (GATE 2012)

a) x^2
b) $\sin\left(\frac{\pi x}{2}\right)$
c) $e^x \sin\left(\frac{\pi x}{2}\right)$
d) $e^x \sin\left(\frac{\pi x}{2}\right)$

29) The inverse Laplace transform of the function $F(s) = \frac{1}{s(s+1)}$ is given by (GATE 2012)

a) $f(t) = \sin t$
b) $f(t) = e^{-t} \sin t$
c) $f(t) = e^t$
d) $f(t) = 1 - e^{-t}$

30) A box contains 4 red balls and 6 black balls. Three balls are selected randomly from the box one after another, without replacement. The probability that the selected set contains one red ball and two black balls is (GATE 2012)

a) 1/20
b) 1/12
c) 3/10

d) 1/2

31) The state of stress at a point under plane stress condition is

$$\sigma_{xx} = 40\,\text{MPa}, \quad \sigma_{yy} = 100\,\text{MPa}, \quad \tau_{xy} = 40\,\text{MPa}.$$

The radius of the Mohra's circle representing the given state of stress in MPa is (GATE 2012)

a) 40
b) 50
c) 60
d) 100

32) A force of 400 N is applied to the brake drum of 0.5 m diameter in a band-brake system as shown in the figure, where the wrapping angle is 180°. If the coefficient of friction between the drum and the band is 0.25, the braking torque applied, in $N.m$ is (GATE 2012)

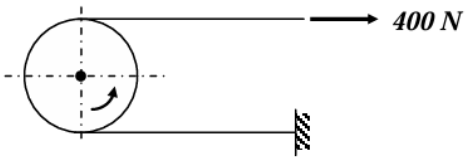

Fig. 2

a) 100.6
b) 54.4
c) 22.1
d) 15.7

33) Water ($C_p = 4.18\,kJ/kgK$) at $80°C$ enters a counterflow heat exchanger with a mass flow rate of $0.5\,kg/s$. Air ($C_p = 1\,kJ/kgK$) enters at $30°C$ with a mass flow rate of $2.09\,kg/s$. If the effectiveness of the heat exchanger is 0.8, the LMTD (in $°C$) is (GATE 2012)

a) 40
b) 20
c) 10
d) 5

34) Consider two infinitely long *thin* concentric tubes of circular cross section as shown in the figure. If D_1 and D_2 are the diameters of the inner and outer tubes respectively, then the view factor F_{22} is (GATE 2012)

a) $\left(\frac{D_2}{D_1}\right) - 1$
b) zero
c) $\frac{D_1}{D_2}$
d) $1 - \left(\frac{D_1}{D_2}\right)$

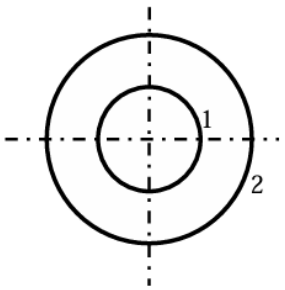

Fig. 3

35) A large tank with a nozzle attached contains three immiscible, inviscid fluids as shown. Assuming that the changes in h_1, h_2, and h_3 are negligible, the instantaneous discharge velocity is (GATE 2012)

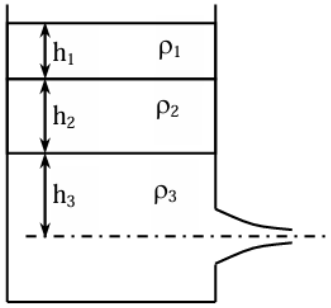

Fig. 4

a) $\sqrt{2gh_1\left(1+\frac{\rho_1}{\rho_3}\frac{h_1}{h_3}+\frac{\rho_2}{\rho_3}\frac{h_2}{h_3}\right)}$
b) $\sqrt{2g(h_1+h_2+h_3)}$
c) $\sqrt{2g\left(\frac{\rho_1h_1+\rho_2h_2+\rho_3h_3}{\rho_1+\rho_2+\rho_3}\right)}$
d) $\sqrt{2g\left(\frac{\rho_1h_1h_2+\rho_2h_2h_3+\rho_3h_3h_1}{\rho_1h_1+\rho_2h_2+\rho_3h_3}\right)}$

36) In a DC arc welding operation, the voltage-arc length characteristic was obtained as $V_{arc} = 20 + 5l$ where the arc length l was varied between $5\,mm$ and $7\,mm$. Here V_{arc} denotes the arc voltage in $Volts$. The arc current was varied from $400\,A$ to $500\,A$. Assuming linear power source characteristic, the *open circuit voltage* and the *short circuit current* for the welding operation are (GATE 2012)
a) 45 V, 450 A
b) 75 V, 750 A
c) 95 V, 950 A
d) 150 V, 1500 A

37) In a single pass rolling process using $410\,mm$ diameter steel rollers, a strip of width $140\,mm$ and thickness $8\,mm$ undergoes 10% reduction of thickness. The *angle of bite* in radians is (GATE 2012)
a) 0.006
b) 0.031

c) 0.062
d) 0.600

38) A mould having dimensions $100\,mm \times 90\,mm \times 20\,mm$ is filled with molten metal through a gate as shown in the figure. For height h and cross-sectional area A, the mould filling time is t_1. The height is now quadrupled and the cross-sectional area is halved. The corresponding filling time is t_2. The ratio t_2/t_1 is (GATE 2012)

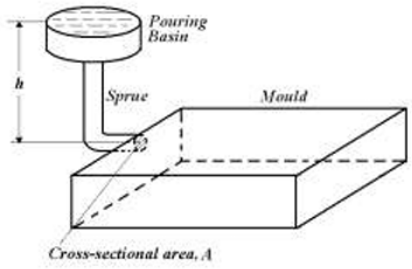

Fig. 5

a) $\frac{1}{\sqrt{2}}$
b) 1
c) $\sqrt{2}$
d) 2

39) A thin square plate $ABCD$ with side of unit length is kept in the X-Y plane as shown in the figure. The plate is first rotated by 30° in the anti-clockwise direction about the Z-axis with A fixed at the origin. The plate is then rotated by 90° in the anti-clockwise direction about the X-axis with A fixed at the origin. The final co-ordinates of C are (GATE 2012)

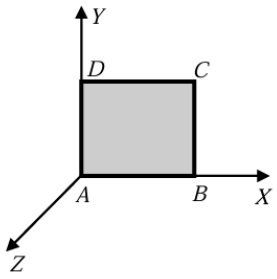

Fig. 6

a) (1.366, 0.366, 0.0)
b) (0.0, 1.366, 0.366)
c) (1.366, 0.0, 0.366)
d) (0.366, 0.0, 1.366)

40) A sine bar has a length of $250\,mm$. Each roller has a diameter of $20\,mm$. During taper angle measurement of a component, the height from the surface plate to the centre of a roller is $100\,mm$. The calculated taper angle (in degrees) is (GATE 2012)

a) 21.1
b) 22.8
c) 23.6
d) 68.9

41) Match the following plastic products with their most appropriate materials. (GATE 2012)

Products	Materials
1. Gears	P. Polymethylmethacrylate (PMMA)
2. Helmets	Q. Polyamides (PA)
3. Lenses	R. Polyethylene (PE)
4. Food packaging	S. Acrylonitrile-butadiene-styrene (ABS)

a) 1-Q, 2-R, 3-S, 4-P
b) 1-S, 2-P, 3-Q, 4-R
c) 1-P, 2-Q, 3-R, 4-S
d) 1-Q, 2-S, 3-P, 4-R

42) In a shaping process, the number of double strokes per minute is 30 and the quick return ratio is 0.6. If the length of the stroke is $250\,mm$, the average cutting velocity in m/min is (GATE 2012)
a) 3.0
b) 4.5
c) 7.5
d) 12.0

43) For a linear programming problem, the set of constraints $x + y \leq 2,\ 3x + 5y \geq 15,\ x \geq 0$ and $y \geq 0$ leads to (GATE 2012)
a) an infeasible solution.
b) a unique optimal solution.
c) multiple but finite optimal solutions.
d) infinite optimal solutions.

44) A milk vendor incurs an overstocking cost of Rs. 2 per litre and a shortage cost of Rs. 0.5 per litre. The demand is uniformly distributed between $1\,litre$ and $6\,litres$. Using the Newsvendor Model, the maximum quantity of milk in litre(s) the vendor should order is (GATE 2012)
a) 2
b) 6
c) 1
d) 3

45) The specification limits for the weight of a product are $13.1\,kg$ and $15\,kg$. If the process has a variance of weight $0.05\,kg^2$, then the process capability index is (GATE 2012)
a) 6.3
b) 1.9
c) 1.4

d) 8.6

46) On an average, there are 30 customers in a queue. If the arrival rate of customers into the system is 16 customers per hour and on average 32 customers leave the system per hour, then the average number of customers in the system is (GATE 2012)

a) 16.5
b) 30.5
c) 32.0
d) 46.0

47) Data for four jobs that need to be processed on a single machine are given below. (GATE 2012)

Job	Processing time (days)	Due date (days)
P	12	20
Q	9	40
R	21	30
S	10	19

All the four jobs are available at time zero. If the jobs are scheduled using the Earliest Due Date (EDD) algorithm, then the job with maximum tardiness is

a) P
b) Q
c) R
d) S

Common Data Questions

Common Data for Questions 48 and 49:

Two steel truss members, AC and BC, each having cross sectional area of $100\,mm^2$, are subjected to a horizontal force F as shown in figure. All the joints are hinged.

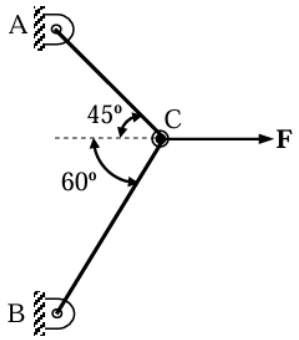

Fig. 7

48) The maximum force F in kN that can be applied at C such that the axial stress in any of the truss members DOES NOT exceed $100\,MPa$ is (GATE 2012)

a) 8.17
b) 11.15
c) 14.14

d) 22.30

49) IF $F = 1\,kN$, the magnitude of the vertical reaction force developed at the point B in kN is (GATE 2012)

a) 0.63
b) 0.32
c) 1.26
d) 1.46

Common Data for Questions 50 and 51:

Data for a plain milling operation are given below.

Length of workpiece	$200\,mm$
Cutter diameter	$100\,mm$
No. of teeth	4
Cutter speed	$100\,rpm$
Feed	$200\,mm/min$
Depth of cut	$2\,mm$
Total clearance (entry and exit)	$5\,mm$

50) Mean undeformed chip thickness (in microns) is (GATE 2012)

a) 142
b) 100
c) 71
d) 50

51) Machining time for a single pass (in seconds) is (GATE 2012)

a) 60
b) 66
c) 126
d) 150

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

In an EDM process using RC relaxation circuit, a $12\,mm$ diameter through hole is made in a steel plate of $50\,mm$ thickness using a graphite tool and kerosene as dielectric. Assume discharge time to be negligible. Machining is carried out under the following conditions:

- Resistance: $40\,\Omega$
- Capacitance: $20\,\mu F$
- Supply voltage: $220\,V$
- Discharge voltage: $110\,V$

52) The time for one cycle, in milliseconds, is (GATE 2012)

a) 0.55
b) 0.32
c) 0.89
d) 0.24

53) Average power input (in kW) is (GATE 2012)

a) 0.373
b) 0.137
c) 0.218
d) 0.500

Statement for Linked Answer Questions 54 and 55:

In a particular year, an organization earns cash revenues of Rs. 2,00,000. Total material and labour expenses are Rs. 1,09,000. The depreciation claimed on the equipment is Rs. 25,000. The tax rate is 20%.

54) The profit after tax (PAT) is (GATE 2012)

a) Rs. 92,800
b) Rs. 66,200
c) Rs. 72,800
d) Rs. 52,800

55) The net cash flow is (GATE 2012)

a) Rs. 97,800
b) Rs. 77,800
c) Rs. 66,000
d) Rs. 72,800