ASSIGNMENT 1: GATE 2010
ME: MECHANICAL ENGINEERING

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Q.1-Q.25 carry one mark each

1) The parabolic arc $y = \sqrt{x},\ 1 \le x \le 2$ is revolved around the x-axis. The volume of the solid of revolution is

(GATE ME 2010)

a) $\frac{\pi}{4}$ b) $\frac{\pi}{2}$ c) $\frac{3\pi}{4}$ d) $\frac{3\pi}{2}$

2) The Blasius equation, $\frac{d^3f}{d\eta^3} + \frac{f}{2}\frac{d^3f}{d\eta^3} = 0$. is a

(GATE ME 2010)

a) second order nonlinear ordinary differential equation
b) Third order nonlinear ordinary differential equation
c) Third order linear ordinary differential equation
d) Mixed order nonlinear ordinary differential equation

3) The value of the integral is

$$\int_{-1}^{\infty} \frac{dx}{1+x^2}$$

(GATE ME 2010)

a) $-\pi$ b) $-\pi/2$ c) $-\pi/2$ d) π

4) The modulus of the complex number $(\frac{3+4i}{1-2i})$ is

(GATE ME 2010)

a) 5 b) $\sqrt{5}$ c) $\frac{1}{\sqrt{5}}$ d) $\frac{1}{5}$

5) The function $y = |2 - 3x|$

(GATE ME 2010)

a) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$
b) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$ except at $x = \frac{3}{2}$
c) is continuous $\forall x \in \mathbb{R}$ and differentiable $\forall x \in \mathbb{R}$ except at $x = \frac{2}{3}$
d) is continuous $\forall x \in \mathbb{R}$ except at $x = 3$ and differentiable $\forall x \in \mathbb{R}$

6) Mobility of a statically indeterminate structure is

(GATE ME 2010)

a) ≤ -1 b) 0 c) 2 d) ≥ 2

7) Then there are 2 points P and Q in a planar body.The relative velocity between 2 points

(GATE ME 2010)

a) should always be along PQ
b) can be oriented along any direction
c) should always be perpendicular to PQ

d) should be along QP when body undergoes pure transition

8) The state of plane stress at a point is given by σ_1 = -200MPa σ_y = 100MPa τ_{xy} = 100MPa The maximum sheer stress in(MPa) is

(GATE ME 2010)

a) 111.8 b) 150.1 c) 180.3 d) 223.6

9) Which of the following statements is **INCORRECT**

(GATE ME 2010)

a) Grashof's rule states that for a planar crank-rocker four bar mechanism, the sum of the shortest and longest link lengths cannot be less than the sum of the remaining two link lengths.
b) Inversions of a mechanism are created by fixing different links one at a time.
c) Geneva mechanism is an intermittent motion device.
d) Gruebler's criterion assumes mobitity of a planar mechanism to be one

10) The natural frequency of a spring mass system on earth is ω_n.The natural frequency of the system on moon($g_{moon}=\frac{g_{moon}}{6}$) is

(GATE ME 2010)

a) ω_n b) $0.408\omega_n$ c) $0.204\omega_n$ d) $0.167\omega_n$

11) Tooth interference in an external involve spor gear pair can be reduced by

(GATE ME 2010)

a) decreasing center distance between gear pair
b) decreasing module
c) decreasing pressure angle
d) incraesing number of gear teeth

12) For the stability of a floating body,under the influence of gravity alone,which of the following is TRUE?

(GATE ME 2010)

a) Metacentre should be below centre of gravity.
b) Metacentre should be above centre of gravity.
c) Metacentre and centre of gravity must lie on the same horizontal line.
d) Metacentre and centre of gravity must lie on the same vertical line.

13) The maximum velocity of a one-dimensional incompressible fully developed viscous flow, between two fixed parallel plates, is 6 ms^{-1}. The mean velocity $\left(ms^{-1}\right)$ of the flow is

(GATE ME 2010)

a) 2 b) 3 c) 4 d) 5

14) A phenomenon is modeled using n dimensional variables with k primary dimensions. The number of non-dimensional variables is

(GATE ME 2010)

a) k b) n c) n-k d) n+k

15) A turbo-charged four-stroke direct injection diesel engine has a displacement volume of 0.0259 m^3 ($25.9liters$). The engine has an output of 950KW at 2200 rpm. The mean effective pressure (*in MPa*) is closest to

(GATE ME 2010)

a) 2 b) 1 c) 0.2 d) 0.1

16) One kilogram of water at room temperature is brought into contact with a high temperature thermal reservoir. The entropy change of the universe is

(GATE ME 2010)

a) equal to entropy change of the reservoir
b) equal to entropy change of water
c) equal to zero
d) always positive

17) A hydraulic turbine develops 1000KW power for a head of 40m. If the head is reduced to 20m, the power developed (in KW)is

(GATE ME 2010)

a) 177 b) 354 c) 500 d) 707

18) The material property which depends only on the basic crystal structure is

(GATE ME 2010)

a) fatigue strength
b) work hardening
c) fracture strength
d) elastic constant

19) In a gating system, the ratio 1:2:4 represents

(GATE ME 2010)

a) sprue base area: runner area: ingate area
b) pouring basin area: ingate area: runner area
c) sprue base area: ingate area : casting area
d) runner area: ingate area: casting area

20) A shaft has a dimension, $\phi 35^{-0.025}$ The respective values of fundamental deviation and tolerance are

(GATE ME 2010)

a) -0.025, ±0.08
b) -0.025, 0.016
c) -0.009, ±0.008
d) -0.009, 0.016

21) In a CNC program block, N002 G02 G91 X40 ZA0 , G02 and G91 refer to

(GATE ME 2010)

a) circular interpolation in counterclockwise direction and incremental dimension
b) circular interpolation in counterclockwise direction and absolute dimension
c) circular interpolation in clockwise direction and incremental dimension
d) circular interpolation in clockwise direction and absolute dimension

22) The demand and forecast for February are 12000 and 10275, respectively. using single exponential smoothening method ($smoothening\ coefficient$ = 0.25), forecast for the month of March is

(GATE ME 2010)

a) 431 b) 9587 c) 10706 d) 11000

23) Little's law is a relationship between

(GATE ME 2010)

a) stock level and lead time in an inventory system
b) waiting time and length of the queue in a queuing system

c) number of machines and job due dates in a scheduling problem
d) uncertainty in the activity time and project completion time

24) vechile manufacturing assembly line is an example of

(GATE ME 2010)

a) product layot
b) process layot
c) manufacture layot
d) fixed layot

25) Simplex method of solving linear programming problem uses

(GATE ME 2010)

a) all the points in the feasible region
b) only the comer points of the feasible region
c) intermediate points within the infeasible region
d) only the interior points in the feasible region

Q.26-Q.55 carry two marks each

26) Torque exerted on a flywheel over a cycle is listed in the table. Flywheel energy (*inJperunitcycle*) using Simpson's rule is

Angle (degree)	0	60	120	180	240	300	360
Torque (N m)	0	1066	−323	0	323	−355	0

(GATE ME 2010)

a) 542 b) 993 c) 1444 d) 1983

27) One of the eigenvectors of the matrix $A = \begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$ is

(GATE ME 2010)

a) $\begin{pmatrix} 2 \\ -1 \end{pmatrix}$ b) $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$ c) $\begin{pmatrix} 4 \\ 1 \end{pmatrix}$ d) $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$

28) Velocity vector of a flow field is given as $\left(V\right) = 2xy\,\hat{i} - x^2\,\hat{j}$. The velocity vector at $(1, 1, 1)$ is

(GATE ME 2010)

a) $4\hat{i} - \hat{j}$
b) $4\hat{i} - \hat{k}$
c) $\hat{i} - 4\hat{j}$
d) $\hat{i} - 4\hat{j}$

29) The Laplace transform of a function $f(t)$ is $\frac{1}{(s^2)(s+1)}$.The function $f(t)$ is

(GATE ME 2010)

a) t-1+e^t b) t+1+e^{-t} c) -1+e^{-t} d) 2t+e^{-t}

30) A box contains 2 washers, 3 nuts and 4 bolis. Items are drawn from the box at random one at a time without replacement. The probability of drawing 2 washers first followed by 3 nuts and subsequently the 4 bolis is

(GATE ME 2010)

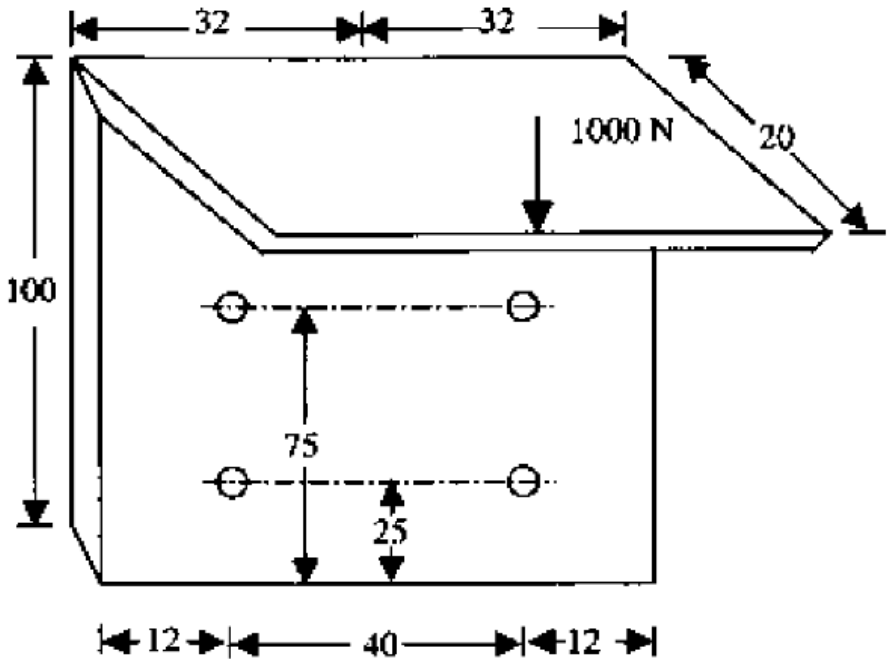
a) $\frac{2}{315}$ b) $\frac{1}{630}$ c) $\frac{1}{1260}$ d) $\frac{1}{2520}$

31) A band brake having band-width of 80 mm, drum diameter of 250 mm, coefficient of friction of 0.25 and angle of wrap of 270 degrees is required to exert a friction torque of 1000 N m. The maximum tension (*in kN*)developed in the band is

(GATE ME 2010)

a) 1.88 b) 3.56 c) 6.12 d) 11.56

32) A bracket (*shown in figure*) is rigidly mounted on wall using four rivets. Each rivet is 6mm in diameter and has an effective length of 12mm.

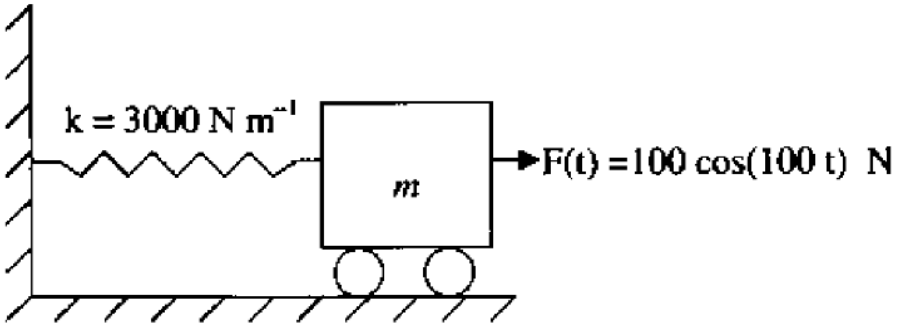


Direct shear stress (*in MPa*) in the most heavily loaded rivet is

(GATE ME 2010)

a) 4.4 b) 8.8 c) 17.6 d) 35.2

33) A mass m attached to a spring is subjected to a harmonic force as shown in figure. The amplitude of the forced motion is observed to be 50 mm. The value of m (in kg) is

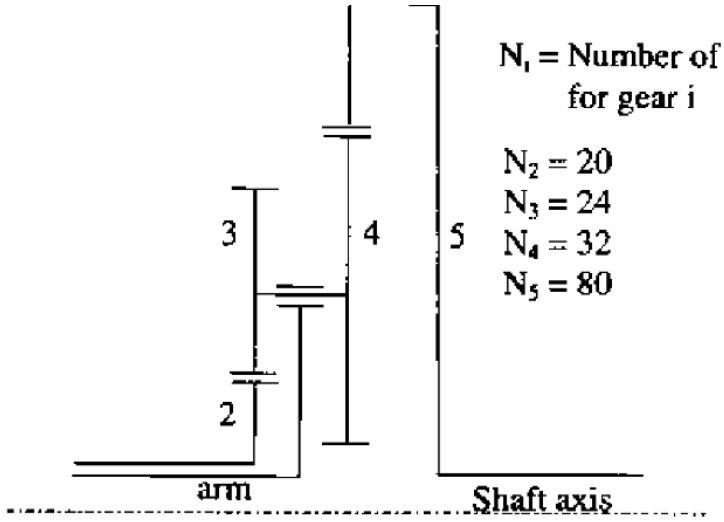


(GATE ME 2010)

a) 0.1 b) 1.0 c) 0.3 d) 0.5

34) For the epicyclic gear arrangement shown in the figure, w_2 = 100 clockwise (CW) and w_{arod}= 80 rad/s counter clockwise (CCW). The angular velocity ($in\ rad/s$) is

(GATE ME 2010)



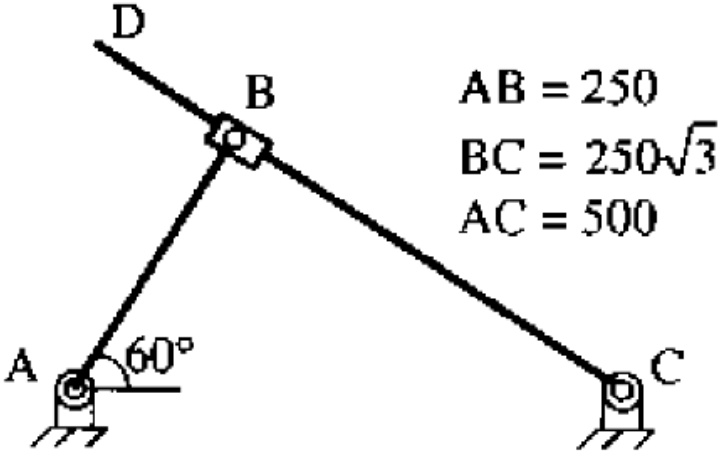
a) 0 b) 70CW c) 140CCW d) 140CW

35) A lightly loaded full journal bearing has journal diameter of 50 mm, bush bore of 50.05 mm and bush length of 20 mm. If rotational speed of journal is 1200 rpm and average viscosity of liquid lubricant is 0.03 Pa s. the power loss (in W) will be

(GATE ME 2010)

a) 37 b) 74 c) 118 d) 237

36) For the configuration shown, the angular velocity of link AB is 10 rad/s countorclockwise. The magnitude of the relative sliding velocity (in ms"') of slider B with respect to rigid link CD is



(GATE ME 2010)

a) 0 b) 0.86 c) 1.25 d) 0.25

37) A smooth pipe of diameter 200 mm carries water. The pressure in the pipe at section SI (elevation:10m) is 50 kPa . At section S2 (elevation: 12m) the pressure is 20 kPa and velocity is 2 ms^{-1} Density of water is 1000 kgm^{-3} and acceleration due to gravity is 9.8ms^{-2} Which of the following is TRUE
(GATE ME 2010)

a) flow is from S1 to S2 and head toss is 0.53 m
b) flow is from S2 to S1 and head loss is 0.53 m
c) flow is from SI to S2 and head loss is 1.06 m
d) flow is from S2 to SI and head loss is 1.06 m

38) Match the following

P: Compressible flow	U: Reynolds number
Q: Free surface flow	V: Nusselt number
R: Boundary layer flow	W: Weber number
S: Pipe flow	X: Froude number
T: Heat convection	Y: Mach number
	Z: Skin friction coefficient

(GATE ME 2010)

a) P-U; Q-X; R-V; S-Z; T-W
b) P-W; Q-X; R-Z: S-U; T-V
c) P-Y: Q-W: R-Z: S-U: T-X
d) P-Y; Q-W; R-Z: S-U; T-V

39) A mono-atomic ideal gas (y=1.67, molecular weight = 40) is compressed adiabatically from 0.1 MPa, 300K to 0.2 MPa. The universal gas constant is 8.314 kJ kmol"' K-1. The work of compression of the gas (in kJ kg"') is

(GATE ME 2010)

a) 29.7 b) 19.9 c) 13.3 d) 0

40) Consider the following two processes; a. A heat source at 1200K loses 2500kJ of heat to a sink al 800K b. A heat souree at 800K loses 2000kJ of heat to a sink at 500K Which of the following statements is true?

(GATE ME 2010)

a) Process I is more irreversible than Process II
b) Process II is more irreversible than Process I
c) Icreversibility associated in both the processes are equal
d) Both the processes are reversible

41) A fin has 5 mm diameter and 100 mm length. The thermal conductivity of fin material is 400Wm-'K-1, One end of the fin is maintained at 130°C and its remaining surface is exposed to ambient air at 30C. If the convective heat transfer coefficient is 40Wm- K-', the heal loss (in W) from the fin is
(GATE ME 2010)

a) 0.08 b) 5.00 c) 7.00 d) 7.80

42) A inoist air sample has dry bulb temperature of 30°C and specific humidity of 11.5 g water vapour per kg dry ajr. Assume molecular weight of air as 28.93. If the saturation vapour pressure of water at 30"C is 4.24 kPa and the total pressure is 90 kPa, then the relative humidity (in sample is
(GATE ME 2010)

a) 50.5 b) 38.5 c) 56.5 d) 68.5

43) Two pipes of inner diamerer 100 mm and outer diameter 110 mm each are joined by nlash-butz welding using 30 V power supply. At the interface, 1 mm of malcrial melts from each pipe which bas a resistance of 42.4Q. If the unit melt energy is 64.4MJ m"1, then time required for welding (in s) is

(GATE ME 2010)

a) 1 b) 5 c) 10 d) 20

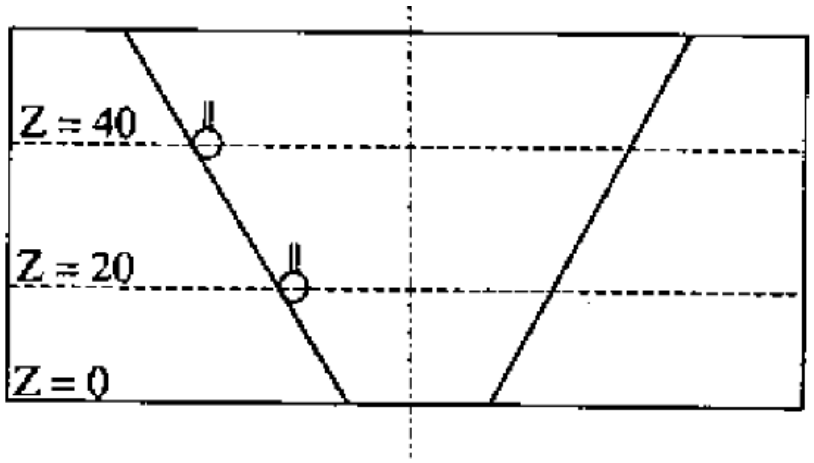
44) For tool A, Taylor's tool life exponent (n) is 0.45 and constant (K) is 90. Similarly for tool B, n = 0.3 and K= 60. The cutting speed (inm/min) above which tool A will have a higher tool life than tool B is

(GATE ME 2010)

a) 26.7 b) 42.5 c) 80.7 d) 142.9

45) A taper hole is inspected using a CMM, with a probe of 2 mm diameter. At a height, Z = 10 mm from the bottom, 5 points are touched and a diameter of circle (*not compensated for size*) is obtained as 20 mm. Similarly, a 40 mm diameter is obtained at a height Z = 40 mm. The smaller diameter ($inmm$) of hole at Z = 0 is

(GATE ME 2010)



a) 13.334 b) 15.334 c) 15.442 d) 15.542

46) Annual demand for window frames is 10000. Each frame costs Rs. 200 and ordering cost is Rs. 300 per order. Inventory holding cost is Rs. 40 per frame per year. The supplier is willing to offer 2

(GATE ME 2010)

a) order 200 frames every time
b) accept 2
c) accept 4
d) order Economic Order Quantity

47) The project activities, precedence relationships and durations are described in the table. The critical path of the project is

Activity	Precedence	Duration (in days)
P	–	3
Q	–	4
R	P	5
S	Q	5
T	R, S	7
U	R, S	5
V	T	2
W	U	10

(GATE ME 2010)

a) P-R-T-V
b) Q-S-T-Y
c) P-R-U-W
d) Q-S-U-W

(GATE ME 2010)

Common Data Questions

Common Data for Questions 48 and 49

In a steam power plant operating on the Rankine cycle, steam enters the turbine at 4MPa, 350 C and exits at a pressure of 15 kPa. Then it enters the condenser and exits as saturated water. Next, a pump feeds back the water to the boiler. The adiabatic efficiency of the turbine is 90%. The thermodynamic states of water and steam are given in the table.

State	h **(kJ/kg)**	s **(kJ/kg·K)**	v **(m³/kg)**
Steam: 4 MPa, 350°C	3092.5	6.5821	0.06645
Water: 15 kPa	h_f = 225.94 h_g = 2599.1	s_f = 0.7549 s_g = 8.0085	v_f = 0.001014 v_g = 10.02

TABLE 47: Thermodynamic properties of steam and water at specified states.

h is specific enthalpy, s is specific entropy and v the specific volume; subscripts f and g denote saturated liquid state and saturated vapour state.

48) The network ($KJKg^{-1}$) output of the cycle

(GATE ME 2010)

a) 498
b) 775
c) 860
d) 957

49) Heat supplied ($kJkg^{-1}$) to the cycle is

(GATE ME 2010)

a) 2372
b) 2576
c) 2863
d) 3092

Common Data for Questions 50 and 51:

Four jobs are to be processed on a machine as per data listed in the table

50) If the Earliest Due Date (EED) rule is used to sequence the jobs, the number of jobs delayed is

(GATE ME 2010)

Job	Processing limit (in days)	Due date
1	4	6
2	7	9
3	2	19
4	8	17

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

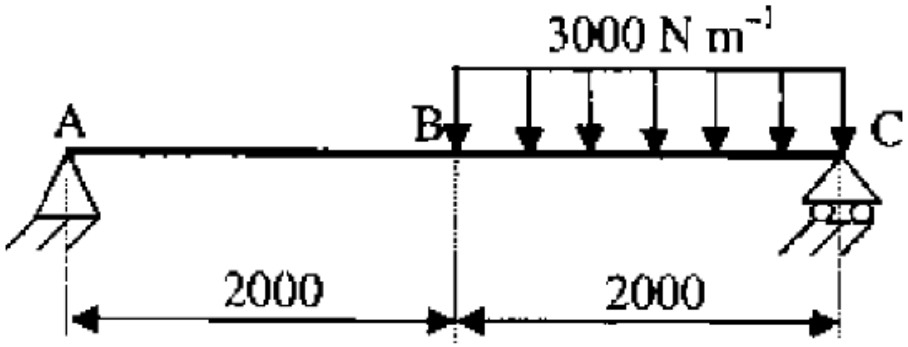
51) Using the Shortest Processing Time (SPT) rule, 1o1al tardiness is

(GATE ME 2010)

a) 0 b) 2 c) 6 d) 8

Linked Answer Questions Statement for Linked Answer Questions 52 and 53:

A massless beam has a loading pattern as shown in the figure. The beam is of rectangular cross-section with a width of 30 mm and height of 100 mm.



52) The maximum bending moment occurs at

(GATE ME 2010)

a) Location B
b) 2675 mm lo the right of A
c) 2500 mm to the right of A
d) 3225 mm to the right of A

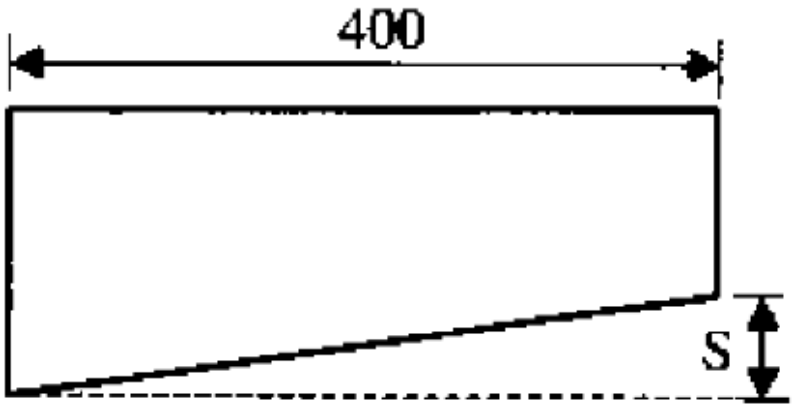
53) The maximum magnitude of bending stress (in MPa) is given by

(GATE ME 2010)

a) 60.0 b) 67.5 c) 200.0 d) 225.0

Statement for Linked Answer Questions 54 and 55:

In shear cutting operation, a sheet of 5 mm thickness is cut along a length of 200 mm. The cutting blade is 400 mm long (see figure) and zero-shear (S = 0) is provided on the edge. The ultimate shear strength of the sheet is 100 MPa and penetration to thickness ratio is 0.2. Neglect friction.



54) Assuming force vs displacement curve is regular then the work done is
(GATE ME 2010)

a) 100 b) 200 c) 250 d) 300

55) A shear of 20 mm (S = 20 mm) is now provided on the blade. Assuming force vs displacement curve to be trapezoidal, the maximum force (in kN) exerted is
(GATE ME 2010)

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

General Aptitude (GA) Questions Q.56 - Q.60 carry one mark each.

56) 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:
(GATE ME 2010)

a) 2 b) 17 c) 13 d) 3

57) *Choose the most appropriate word from the options given below to complete the following sentence:*
If we manage to our natural resources,we would live a better planet for our children.
(GATE ME 2010)

a) uphold b) restrain c) cherish d) conserve

58) *The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.* **Unemployed : Worker**
(GATE ME 2010)

a) fallow : land
b) unaware : sleeper
c) wit : jester

d) renovated : house

59) Which of the following options is the closest in meaning to the word below: **Circuitous**
(GATE ME 2010)

a) cyclie
b) indirect
c) confusing
d) crooked

60) Choose the most uppropriate word from the oprions given below to complete the following sentence:
His rather casual remarks on politics bis lack of seriousness about the subject.
(GATE ME 2010)

a) masked b) belied c) betrayed d) suppressed

Q.61 -Q.65 carry two marks each.

61) Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1" January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facls:
i. Hari's age + Gita's age > Irfan's age + Saira's age.
ii. The age difference between Gita and Saira is 1 year. However, Gita is not the oldest and Saira is not the youngest.
iii. There are no twins. In what order were they born (oldest first)?

a) SGEI
b) HSIG
c) IGSH
d) IHSG

62) 5 skilled workers can build a wall in 20 days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers. how long will it take to build the wall?
(GATE ME 2010)

a) 20 days b) 18 days c) 16 days d) 15 days

63) **Modern warfare has changed from large scale clashes of armies to suppressioo of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.**
Which of the following statements best sums up the meaning of the above passage:
(GATE ME 2010)

a) Modem warfare has resulted in civil strife.
b) Chemical agents are useful in modern warfare.
c) Use of chemical agents in warfare would be undesirable.
d) People in military establishments like to use chemical agents in war.

64) Given digits 2, 2. 3, 3, 3, 4, 4, 4, 4 how many distinct 4 digit numbers greater than 3000 can be formed?

(GATE ME 2010)

a) 50 b) 51 c) 52 d) 54

65) If 137+276=435 how much is 731+672?

(GATE ME 2010)

a) 534 b) 1403 c) 1623 d) 1513