GATE 2014 – A Brief Analysis

(Based on student test experiences in the stream of ME on 16th February, 2014 - Second Session)

Section wise analysis of the paper

	1 Mark	2 Marks	Total No of Questions
Engineering Mathematics	4	4	8
Engineering Mechanics	1	3	4
Strength of Materials	2	2	4
Design of Machine Elements	1	4	5
Theory of Machines	1	1	2
Vibrations	1	1	2
Fluid Mechanics	2	2	4
Thermal Science	2	4	6
Heat Transfer	2	3	5
Manufacturing Science	6	2	8
Industrial Engineering	3	4	7
Verbal Ability	3	1	4
Numerical Ability	2	4	6
	30	35	65

Questions from the Paper

1. Which of the following options is the closest in meaning to the word underlined in the sentence below?

   In a democracy, everybody has the freedom to <u>disagree</u> with the government.

   (A) Dissent (B) descent (C) decent (D) decadent

Ans: A

2. While receiving the award the scientist said "I Feel vindicated". The meaning of the word vindicated is closed to

   (A) Punished (B) substantiated (C) appreciated

Ans: B

3. In the sequence of 12 consecutive odd numbers the sum of first 5 numbers is 425 then the sum of last 5 numbers in sequence is _________.

Ans: 495

8^{th} observation is $7 \times 2 = 14$ more than 1^{st} observation

9^{th} observation is 14 more than 2^{nd} observation

10^{th} observation is 14 more than 3^{rd} observation

11^{th} observation 14 more than 4^{th} observation

12^{th} observation 14 more than 5^{th} observation

Total $14 \times 5 = 70$

Sum of the first five numbers $= 425$

Sum of last five numbers $= 495$

4. Let $f(x, y) = x^n y^m = P$. If x is doubled and y is halved the new value of f is

(A) $2^{n-m} P$ (B) $2^{m-n} P$ (C) $2(n-m)P$ (D) $2(m-n)P$

Ans: A

$$P' = 2^n X^n \left(\frac{1}{2}\right)^m y^m$$

$$= 2^{n-m} X^n Y^m$$

$$= 2^{n-m} P$$

5. After discussion, Tom said to me, "please revert" He expect me to

(A) Retract (B) get back to him

(C) move in reverse (D) retreat

Ans: B

6. If KCLFTSB stands for best of luck and SHSWDG stands for good wishes, which of following indicates "ace the Exam'

(A) MCHTX (B) MXHTC (C) XMHCT (D) XMHTC

Ans: B

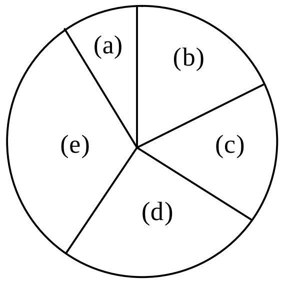
KCLFTSB: BST-Best, F-Of, LCK-Luck (Reverse order)

SHSWDG: GD-Good, WSHS-Wishes (Reverse order)

Similarly "ace the Exam'- C-Ace, T-The, XM-Exam

7. A firm producing air purifiers sold 200 units in 2012. The following Pie chart represents the share of raw material, labour cost, transportation, energy, plant and machinery cost in total manufacturing cost of firm 2012. The expenditure of labour in 2012 is Rs. 4, 50,000. The raw material expenses in

2013 are increased by 30%. All other expenses increased by 20%. What is the percentage increase in total cost for company in 2013?



a – transport (10%)
b – labour (15%)
c– raw material (20%)
d – energy (25%)
e– plant and machinery (30%)

Ans: 22

	2012	2013
Transport (10%)	300,000	360,000
Labour (15%)	450,000	540,000
Raw material (20%)	750,000	780,000
Energy (25%)	750,000	900,000
Plant and Machinery (30%)	900,000	1,080,000
Total	**3,000,000**	**3,660,000**

Percentage increase in total cost =22%

8. Industrial consumption of power doubled from 2000-2001 to 2010-2011. Assuming it to be uniform over the year find the annual rate of increase in percentage

(A) 5.6 (B) 7.2 (C) 10 (D) 12.2

Ans: B

$$A = P\left(1+\frac{r}{100}\right)^n \quad n = 10 \text{ years } A = 2P \Rightarrow \left(1+\frac{r}{100}\right)^{10} = 2$$

$r = 7.2$

9. Find the next term in the sequence 13M, 17Q, 19S, _____.

(A) 21W (B) 21V (C) 23 W (D) 23 V

Ans: C

10. A five digit is formed using the digits 1, 3, 5, 7 & 9 without repeating any one of them. What is the sum of all such possible five digit numbers?

(A) 6666660 (B) 6666600 (C) 6666666 (D) 6666606

Ans: B

The digit in unit place is selected in 4! Ways

The digit in tens place is selected in 4! Ways

The digit in hundreds place is selected in 4! Ways

The digit in thousands place is selected in 4! Ways

The digit in ten thousands place is selected in 4! Ways

Sum of all values for 1

$$4!\times 1\times\left(10^0+10^1+10^2+10^3+10^4\right)$$

$$=4!\times 11111\times 1$$

Similarly for '3' $4!\times(11111)\times 3$

Similarly for '5' $4!\times(11111)\times 5$

Similarly for '7' $4!\times(11111)\times 7$

Similarly for '9' $4!\times(11111)\times 9$

$$\therefore \text{sum of all such numbers} = 4!\times(11111)\times(1+3+5+7+9)$$

$$=24\times(11111)\times 25$$

$$=6666600$$

11. Ball bearings are rated by a manufacturer for a life of 10^6 revolutions. The catalogue rating of particular bearing is 16 KN. If the design load is 2kN then the life of the bearing will be $P\times10^6$ revolutions where P is equal to _______

Ans: P=512

$$L=\left(\frac{c}{w}\right)^k\times10^6 \quad k=3\,(\text{Ball bearing})$$

$$=\left(\frac{16}{2}\right)^3\times10^6$$

$$=8^3\times10^6=P\times10^6$$

$$\boxed{P=512}$$

12. In a statically determinate plane truss, no of joints (J), the number of members (M) is represented by

(A) j=2m-3 (B) m=2j+1 (C) m=2j-3 (D) m=2j-1

Ans: C

13. The number of independent elastic constant required to define the stress-strain relationship for isotropic elastic solid is ______.

Ans: 9

14. If μ of elastic material is 0.4. The ratio of modulus of rigidity to young's modulus is _____.

Ans: 0.357

$E = 2G(1+\mu)$

$$\frac{G}{E} = \frac{1}{2(1+\mu)} = \frac{1}{2(1+0.4)} = 0.357$$

15. Total number of decision variables in objective function of an assignment problem of size n×n is

(A) n^2 (B) 2n (C) 2n-1 (D) n

Ans: D

16. Which of the following is used to convert rotational motion into a translation motion?

(A) Bevel gear (B) Double helical gears

(C) Worm gear (D) Rack and pinion gear

Ans: D

17. A Point mass in executing SHM on with amplitude of 10 mm and frequency of 4 Hz, The maximum acceleration (m/s^2) of the mass is____.

Ans: 6.32

Exp. Given A=10 mm=0.01 m

F=4Hz, $x = A\cos\omega t$

$$v = \frac{dx}{dt} = -A\omega\sin\omega t, \qquad \frac{d^2x}{dt^2} = a = -A\omega^2\cos\omega t$$

For maximum, t=0

$$\therefore a = A\omega^2 \quad = 0.01(2\pi f)^2$$

$$\because \omega = 2\pi f \quad = 0.01(2\times\pi\times 4)^2 \qquad = 6.32\,m/s^2$$

18. A bolt of major diameter 12 mm is required to clamp two steel plates. Cross-sectional area of the threaded portion of the bolt is 84.3 mm^2, length of threaded portion in grip is 30 mm while the length of unthreaded portion in grip is 8 mm. E= 200 GPa. The effective stiffness in (MN/m) of the bolt clamped zone is ________.

Ans: 468.9

Exp. $d_1 = 12\text{ mm}$

$l_1 = 8\text{mm}$

$A_2 = 84.33\text{mm}^2$

$A_1 = \frac{\pi}{4}(d_1)^2$

$A_2 = 84.33\text{ mm}^2$

$l_2 = 30\text{mm}$

$$K_1 = \frac{A_1E_1}{l_1};\ K_2 = \frac{A_2E_2}{l_2} = \frac{84.33\times 200}{30} = 562.2$$

$$= \frac{\frac{\pi}{4}(12)^2\times 200}{8}$$

$= 2827.4$

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$= \frac{1}{2827.4} + \frac{1}{562.2}$$

$\Rightarrow K = 468.9\text{ MN/m}$

19. A single degree of freedom system has a mass of 8 kg, stiffness 8 N/m and viscous damping ratio is 0.02. The dynamic magnification factor at an excitation frequency of 1.5 rad/sec is ____.

Ans: 0.799

$$\text{Damping ratio} = 0.02 = \frac{C}{2m\omega_n} = \frac{C}{2\times 8\times\sqrt{\frac{S}{m}}}$$

$$\Rightarrow C = 0.02\times 2\times 8\times\sqrt{\frac{8}{8}} = 0.32$$

$$\text{Dynamic magnification factor} = \frac{1}{\sqrt{\frac{c^2\omega^2}{s^2} + \left(1-\frac{\omega^2}{\omega_n^2}\right)^2}}$$

$$= \frac{1}{\sqrt{\frac{(0.32)^2\times(1.5)^2}{(8)^2} + \left[1-\frac{(1.5)^2}{(1)^2}\right]}} = 0.799$$

20. A butt weld joint is developed on steel plates having yield and ultimate tensile strength 500 MPa and 700 MPa respectively. The thickness of plates is 8 mm and width is 20 mm. In proper selection of welding parameters caused an undercut of 3 mm depth along the weld. The maximum transverse tensile load (in KN) carrying capacity of the developed weld joint is ____.

Ans: 73.5

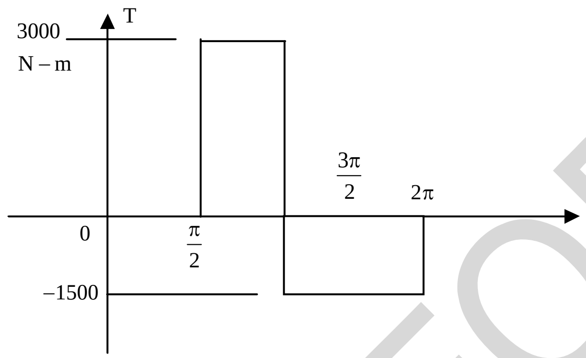
$$\text{Yield strength } = \frac{\text{Force}}{\text{Area}}$$

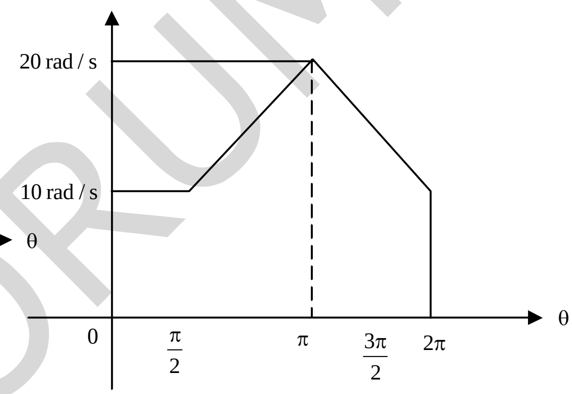
$$b = 20 + 2 \times 3 = 26\,\text{mm}$$

$$A = \frac{bt}{\sqrt{2}} = \frac{26 \times 8}{\sqrt{2}} = 147.07\ \text{mm}^2$$

$$F = \sigma_y A \quad = 500 \times 147.07 \quad = 73.53\,\text{KN}$$

21. Torque and angular speed data over one cycle of shaft carrying a flywheel are shown in the figures. The Moment of Inertia (kg-m^2) of fly wheel is ________.





Ans:

$$\omega = \frac{\omega_{max} + \omega_{min}}{2} = \frac{20 + 0}{2} = 10$$

$$C_s = \frac{\omega_{max} - \omega_{min}}{\omega} = \frac{20 - 0}{10} = 2$$

$$\Delta E = \text{Area of } T - \theta\,\text{diagram} = \frac{\pi}{2} \times 3000 + 1500 \times \pi \quad = 3000\pi$$

$$\Delta E = I\omega^2 C_s \Rightarrow 3000\pi = I(10)^2 \times 2 \Rightarrow I = 47.12$$

22. If Laplace transform of $\cos\omega t = \frac{S}{S^2 + \omega^2}$ then Laplace transform of $e^{-2t}\cos 4t$ is

(A) $\frac{S - 2}{(S-2)^2 + 16}$ (B) $\frac{S + 2}{(S+2)^2 + 16}$ (C) $\frac{S + 2}{(S-2)^2 + 16}$ (D) $\frac{S - 2}{(S+2)^2 + 16}$

Ans: B

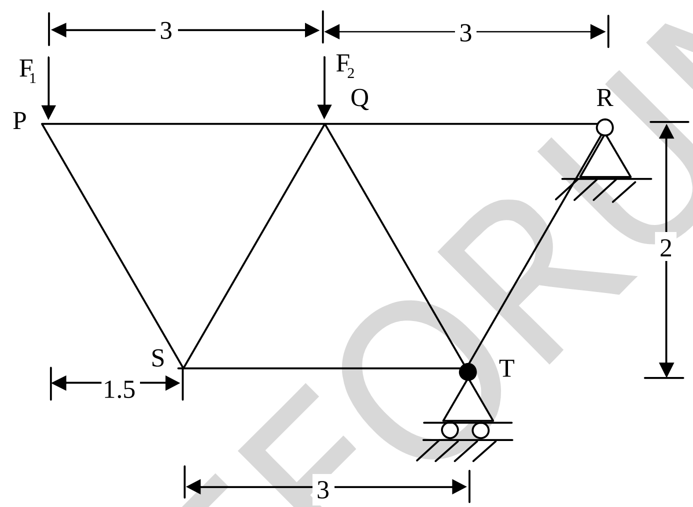
23. It is desired to avoid interference in a pair of spur gears having a 20° pressure angle with increase in pinion to gear ratio, the minimum number of teeth on the pinion

(A) Increases (B) Decreases

(C) First increases then decreases (D) Remain unchanged

Ans: B

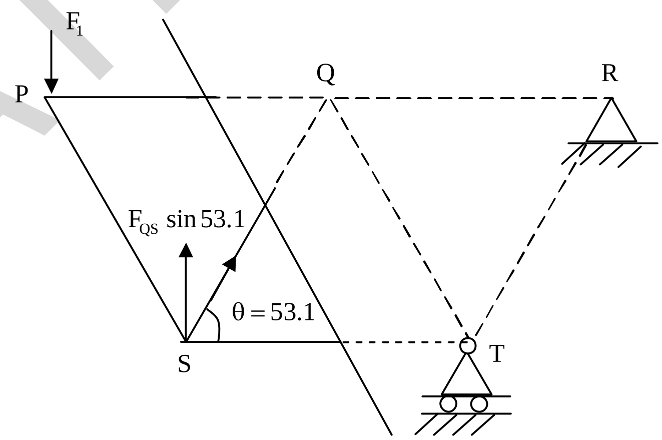
24. The truss shown in figure has the forces $F_1 \& F_2$ are 9kN & 3kN respectively Force (in kN) in QS is



(A) 11.25 T (B) 11.25 C (C) 13.5 T (D) 13.5C

Ans: A

By method of sections

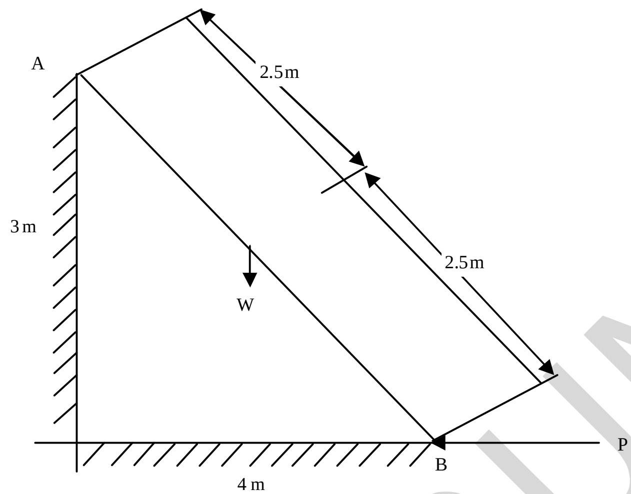


$$\sum V = 0$$

$$F_1 = F_{QS} \sin 53.1$$

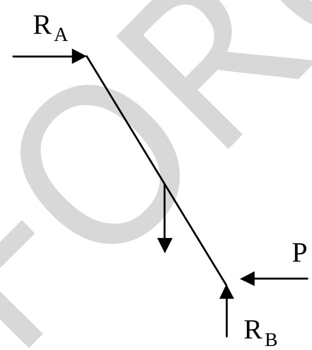
$$\Rightarrow F_{QS} = 11.25(T)$$

25. A ladder AB of length 5 m & weight 600 N is resting against a wall. Assuming frictionless contact at the floor B & wall A the magnitude of force P (in N) required N maintain equilibrium ladder is _____.



Ans: 400 N

From free body diagram



$$\sum M_B = 0$$

$$\Rightarrow W \times 2 = R_A \times 3$$

$$\Rightarrow R_A = \frac{600 \times 2}{3} = 400$$

$$\sum H = 0 \Rightarrow R_A = P = 400 \text{ N}$$

26. The thin glass cylinder with an internal radius $100\,\text{mm}$ subjected to internal pressure of 10MPa. The maximum permissible working stress is restricted to 100MPa. The minimum cylinder wall thickness (in mm) for safe design must be _____ .

Ans: 10

$$\sigma_1 = \frac{pd}{2t} \Rightarrow 100 = \frac{10 \times 2 \times 100}{2 \times t} \Rightarrow t = 10\,\text{mm}$$

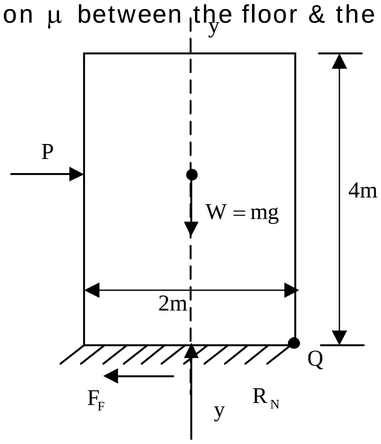
27. A shaft is subjected to the torsional moment and the maximum shear stress developed in the shaft is 100MPa. The yield and ultimate strength of the shaft in tension are 300MPa and 450MPa respectively. The factor of safety using maximum distortion energy theory (von-misses) is ____.

Ans: 1.5

$$\tau_{max} = \frac{\sigma_s}{2Fos}$$

$$\Rightarrow FOS = \frac{300}{2 \times 100} = 1.5$$

28. A wardrobe (mass 100 kg, height 4 m width 2 m depth 1m) symmetric about the Y-Y axis stands on a rough level floor as shown in the figure. A force P is applied at mid height on the wardrobe so as to tip it about point Q without slipping. What are the minimum values of force (in N) and the static coefficient of friction μ between the floor & the wardrobe is ________.



(A) 490.5 & 0.5 (B) 981 & 0.5 (C) 1000.5 & 0.15 (D) 1000.5 & 0.25

Ans: B

$$\sum M_Q = 0$$

$$\Rightarrow W \times 1m = P \times 2m$$

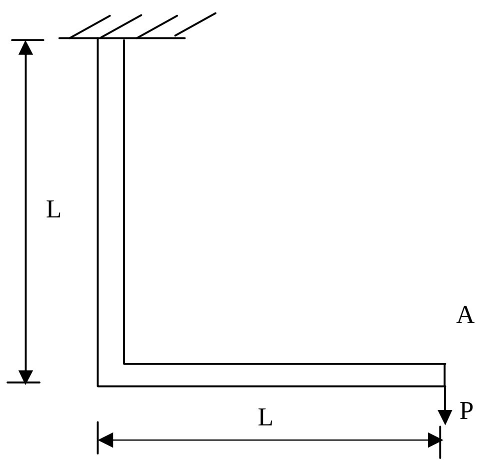
$$\Rightarrow P = \frac{100 \times 9.81}{2} = 490.5\,N, \sum H = 0$$

$$\Rightarrow F_F = P = 490.5\,N, \sum V = 0$$

$$\Rightarrow R_N = mg = 981\,N$$

$$\text{Friction Force} = \mu R_N = \frac{490.5}{981} = 0.5$$

29. A frame is subjected to a load P as shown in figure. The frame has a constant flexural rigidity EI. The effect of axial load is neglected. The deflection at pt A due to applied load P is



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(A) $\frac{1}{3}\frac{PL^3}{EI}$ (B) $\frac{2}{3}\frac{PL^3}{EI}$ (C) $\frac{PL^3}{EI}$ (D) $\frac{4}{3}\frac{PL^3}{EI}$

Ans: D

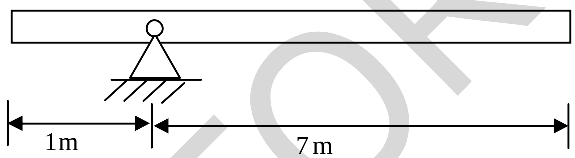
$$SE = \int_0^L \frac{M_x^2 dx}{2EI} + \int_0^L \frac{M_y^2 dx}{2EI}$$

$$M_X = PX \quad M_Y = P \times L$$

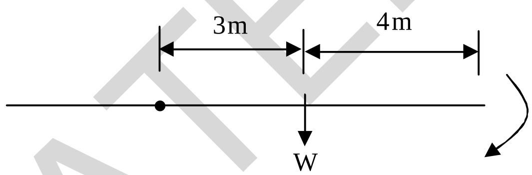
$$\frac{1}{2}P\delta = \int_0^L \frac{(PX)^2 dx}{2EI} + \int_0^L \frac{(PL)^2 dx}{2EI} = \frac{P^2\left[\frac{X^3}{6}\right]_0^L}{EI} + \frac{P^2L^2}{2EI}[X]_0^L = \frac{2}{3}\frac{P^2L^3}{EI} = \frac{1}{2}\times P \times \frac{4}{3}\frac{PL^3}{EI}$$

$$\delta = \frac{4}{3}\frac{PL^3}{EI}$$

30. A uniform slender rod (8m length, 3 kg mass) rotates in vertical plane about a horizontal axis 1 m from its end as shown in figure. The magnitude of angular acceleration (in rad/sec^2) of the rod at the position shown is



Ans: 1.37



$$\Sigma M_A = 0$$

$$\Rightarrow W \times 3 = I\alpha$$

$$3 \times 9.81 \times 3 = \frac{ML^2}{3} \times \alpha$$

$$\Rightarrow 3 \times 9.81 \times 3 = \frac{3 \times 8^2}{3} \times \alpha$$

$$\alpha = 1.37 \text{ rad/sec}^2$$