RPSC-AEn

MECHANICAL ENGINEERING-I

Detailed Solutions

Dated : 05th December 2019

ENGINEERS ACADEMY®
Your GATEway to Professional Excellence
IES • GATE • PSUs • JTO • IAS • NET

Engineers Academy Study Centers :

Jaipur-Pratap Nagar • Jaipur Mahaveer Nagar • Jaipur Sanghi • Allahabad • Chandigarh • Delhi • Patna • Kanpur • Jalandhar Kota • Lucknow • Jodhpur • LPU Campus • Ajmer • Ranchi • Agra

www.engineersacademy.org
809 444 1777

PART - A

Note: Attempt all questions. Answer the following questions in 15 words each. Each question carries 2 marks.

1. Which heuristic scheduling rule minimuzes flow time and average number of jobs in a system?

Ans. Two heuristics that can be used to solve the flow shop scheduling problem (n Jobs, m machine) are palmer's and the one by campbell Dudek and Smith.The palmer's heuristics computes an index for job and creates a sequence by arranging the jobs in decreasing order of index.

2. What is the 'systems principle' of material handling?

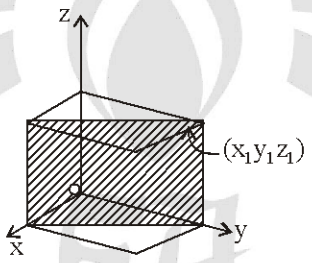
Ans. Material movement and storage activities should be fully integrated to form a co-ordinated, operational system which spans receiving, inspection, storage, production, assembly, packaging, unitizing, order selection, shipping, transportation and handling of returns.

3. What is the use of Berger's Vector in edge dislocation?

Ans. i) To determine the yield strength of a material by affecting work hardening

ii) To determine the direction of dislocation line.

4. Miller indices (x, y, z) for the hatched plane in the unit cell given in fig. Below, are represented as



Ans. Intercept on Axes : (1, 1, ,∞)

Reciprocal : (1/1, 1/1, 1/∞)

Miller indices : [1, 1, 0]

5. Which is more stable, the pearlitic or the spheroiditic microstructure? Justify

Ans. Spheroiditic microstructure are more stable than pearlitic ones because pearlite has a tendency to transform in the spheroidite.

6. *Illustrate the three stages of creep failure.*

Ans.

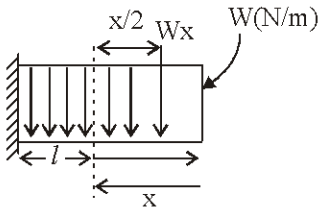
i) **Primary creep:** Region of decreasing creep rate. Creep resistance increases due to dislocation interlocking

ii) **Secondary Creep:** Constant creep rate

iii) **Tertiary Creep:** Region of increasing creep rate.

7. Given the expression for the extreme values of bending moment for a cantilever of length *l* that carries a uniformly distributed load with intensity of W/length.

Ans.



$$(B.M.)_{x-x} = (W\ x)\frac{x}{2}$$

$$(B.M.)_{free\ end} = 0$$

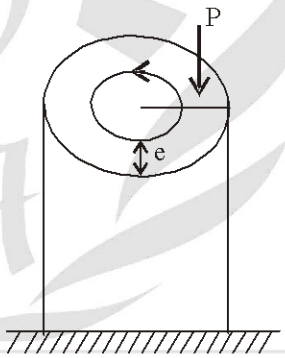
$$(B.M.)_{fixed\ end} = \frac{-Wl^2}{2}$$

8. A short column of external diameter D and internal diameter d carries an eccentric load W. Give the expression for the greatest eccentricity which the load can result on column without producing tension on its cross-section.

Ans.

$$(\sigma_a) = \frac{P}{\frac{\pi D^2}{4}(1-k^2)}$$

$$(\sigma_b) = \frac{Pe}{\frac{\pi}{32}D^3(1-k^4)}$$



$\Rightarrow$ Column with producing tension

$$(\sigma_a) = (\sigma_b)$$

$$(e) = \frac{D^2 + d^2}{8D}$$

9. State Hook's law and give the expression of Young's modulus from it.

Ans. Stress is directly proportional of strain upto proportional limit.

$$\sigma \propto \varepsilon$$

$$\sigma = \varepsilon E$$

$$E = \sigma/\varepsilon$$

10. Define the fundamental deviation in Limits. Fits and Gauges.

Ans. It is one of the two deviation (Either lower or upper deviation), which is chosen to define the position of tolerance zone

11. A leadscrew with a 7.5 mm pitch drives a worktable in an NC positioning system. The leadscrew is powered by a stepping motor which has 200 step angles. The worktable is programmed to move a distance of 120 mm form its present position at a travel speed of 300 mm/min.determine the number of pulses required to move the table to the specified distance.

Ans. 7.5 mm axial movement cover in 1 Revolution

120 mm axial movement cover in $\frac{120}{7.5}$ Revolution

No. of pulse required for $\frac{120}{7.5}$ Rev. $= \frac{120}{7.5} \times 200$

$= 3200$ pulse $\{\because$ 1 step = 1 Pulse$\}$

12. Give the expression of permeability number of sand along with notations used.

Ans. $$P_n = \frac{VH}{PAT}$$

Where p_n = Permeability No.

V = Volume of air passed through

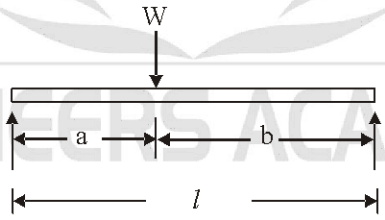
H = Height of specimen

A = Area of specimen

P = Pressure difference

T = Time required to pass air

13. Give the expression for deflection (δ) at the point load for the beam shown in the following figure.



Ans. $\left[\delta(\text{at point load}) \frac{Wa^2b^2}{3EIl}\right]$

14. What is a Globoidal Cam?

Ans. A circumferential contour is cut on the surfaces of notation of the cam to impart motion to the follower which has an oscillatory motion. It can have two types of surfaces, convex or concave.

15. In a closed coil springs of radius R, wire radius r and length L, the ratio of strain energy due to transverse shear to strain energy due to torsion will be proportional to?

Ans. Strain energy due to shear,

$$U_1 = \frac{\tau^2}{2G} \times V$$

Strain energy due to Torsion,

$$U_2 = \frac{\tau^2}{4G} \times V$$

$$\frac{U_1}{U_2} = 2$$

16. A car is moving on a curved horizontal road of radius 100 m with a speed of 20 m/s. The rotating masses of the engine have an angular speed of 100 rad/s in clockwise direction when viewed from the front of the car. The combined moment of inertia of the rotating masses is 10 kg-m². Calculate the gyroscopic moment(in N-m)

Ans. Given:- $I = 10$ kg-m²

$V = 20$ m/s

$R = 100$ m

$\omega = 100$ rad/sec

$$\omega_p = \frac{V}{R} = \frac{20}{100}$$

$\therefore$ Gyroscopic couple(T) = $T\omega\omega_p$

$$= 10\ (100)\left(\frac{20}{100}\right)$$

$T = 200$ N–m

17. Define the recrystallization temperature for a metal.

Ans. It is a process by which old stressed grain are replaced by new stress free grains.

18. A seamless spherical shell. 900 mm in diameter and 10 mm thick is being filled with a fluid under pressure until its volume increases by 150×10³ mm³. Calculate the pressure exerted by the fluid on the shell, taking modulus of elasticity for the material of the shell as 200 kN/mm² and Poisson's ratio as 0.3.

Ans.

$$\varepsilon_v = \frac{\Delta V}{V} = \frac{3Pd}{4tE}(1-\mu)$$

$$\Rightarrow \quad \frac{150 \times 10^3}{\frac{4\pi}{3} \times (450)^3} = \frac{3P \times 900}{4 \times 10 \times 200 \times 10^3} \times (1-0.3)$$

$P = 1.66$ N/mm²

19. The cutter of a broaching machine is pulled by square threaded screw with mean diameter of 50 mm and 10 mm pitch. If the operating nut takes the axial load of 400 N with total torque required as 4410 N-mm, then calculate the efficiency of the screw (in %).

Ans.

$$\eta = \frac{(W\tan\alpha)(d/2)}{T} = \frac{400 \times \left(\frac{10}{\pi \times 50}\right) \times \frac{50}{2}}{4410} = 0.143 \text{ or } 14.43\%$$

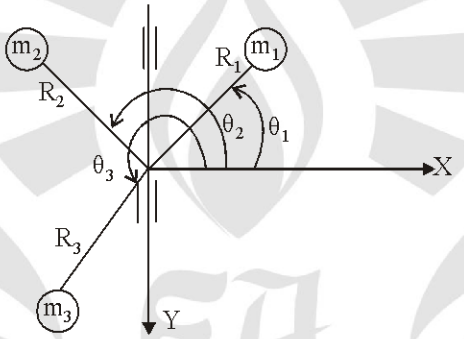
20. Explain the fly back (snap back) method of stopwatch used during work study.

Ans. Hear, the stop watch is started at the beginning of first element. At the end of the element the reading is noted in the study sheet. At the same time, the stop watch hand is snapped back to zero. This is done by pressing down the knob immediately the knob is released. The hand starts moving from zero for timing the next element. Thus the timing for each element found is called observed time.

PART - B

Note: *Answer all the following questions in 50 words each. Each question carries 5 marks.*

21. Figure below shows a rotor with the properties:



Where $\theta_1 = 45°$, $\theta_2 = 135°$, $\theta_3 = 240°$, $m_1 = 4$ kg, $m_2 = 3$ kg, $m_3 = 2.5$ kg, $R_1 = 75$ mm, $R_2 = 85$ mm and $R_3 = 50$ mm. Determine the amount and angle of the counter mass at a radial distance of 75 mm required for the static balance.

Ans.

$$\Sigma mr\cos\theta = m_1 r_1 \cos\theta_1 + m_2 r_2 \cos\theta_2 + m_3 r_3 \cos\theta_3$$
$$= 4(.075)\cos 45 + 3(0.085)\cos 135 + 2.5(0.05)\cos 240 = 0.03068$$

Similarly $\Sigma mr\sin\theta = 0.28419$

We know that : $m_B r_B = \sqrt{\{-\Sigma mr\cos\theta\}^2 + -\Sigma mr\sin\theta\}^2}$

$$= \sqrt{(0.03068)^2 + (0.28419)^2} = 0.02884$$

$$m_B = \frac{0.28584}{0.075} = 3.81\text{kg}$$

Also, $\tan\theta_B = \frac{-\Sigma mr\sin\theta}{-\Sigma mr\cos\theta} = \frac{-0.28419}{-(-0.03068)}$

$$\theta_B = -83.84° \text{ or } 276.16°$$

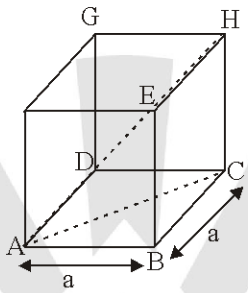
22. What is the difference between the states of phase equilibrium and states of phase equilibrium and metastability?

Ans. For the condition of phase equilibrium, the free energy is a minimum, the system completely stable meaning that over time the phase characteristics are constant for metastability, the system is not at equilibrium, and there are very slight changes of phase characteristics with time.

23. Derive the atomic packing factor for BCC and FCC crystalline materials.

Ans. Atomic packing factor for BCC and FCC:→

For BCC,



$$\text{Total no. of atoms} = \frac{1}{8}\times 8+1 = 2$$

In ΔABC $AC^2 = AB^2+BC^2$

$AC^2 = a^2+a^2$

$AC = \sqrt{2}a$

In ΔACH $AH^2 = AC^2 + CH^2$

$AH = (3a^2) = \sqrt{3}a$

$4r = \sqrt{3}a$

$$r = \frac{\sqrt{3}a}{4}$$

$$\text{Atomic Packing factor (APF)} = \frac{n \times \text{Volume of atoms}}{\text{Volume of unit cell}}$$

$$APF = \frac{n \times \frac{4}{3}\pi r^3}{a^3} = \frac{2 \times \frac{4}{3}\pi\left(\frac{\sqrt{3}a}{4}\right)^3}{a^3} = 0.68$$

For FCC, total no. of atoms, (n)

$$n = \frac{1}{8}\times 8+\frac{1}{2}\times 6 = 4$$

$$a = \frac{\sqrt{2}a}{4}$$

Online Test Series

GATE 2020

Online Test Series is the most suitable platform to enable concept building and to improve the performance. It offers flexibility such that student can appear for the test any time any where.

CE • EC • EE • IN • ME • PI • CH • CS • MT • TX • BT • FT

KEY FEATURES

- Quality papers are developed by research & development team of Engineers Academy.
- Questions are newly designed based on the trend of the examination.
- Combination of subject wise & full syllabus test helps to brush up the basics and match the standard of the competition.
- High level of accuracy is maintained in order to develop error free question papers.
- Fully explained and well – illustrated solutions to all the questions.
- Comprehensive and detailed analysis report of test performance.

TEST STRUCTURE GATE 2020

Sr. No.	Branch	No. of Test	Part + Subject	Cascaded	Full Length	Mock Test
1.	Civil Engineering	60	30	5	10	15
2.	Electronics & Comm. Engg.	60	30	5	10	15
3.	Electrical Engineering	60	30	5	10	15
4.	Instrumentation Engineering	50	30	5	10	5
5.	Mechanical Engineering	60	30	5	10	15
6.	Production Engineering	60	30	5	10	15
7.	Chemical Engineering	30	10	5	10	5
8.	Computer Science & Engg.	30	10	5	10	5
9.	Metallurgy Engineering	22	18	-	4	-
10.	Textile Engineering	22	18	-	4	-
11.	Biotechnology engineering	30	18	6	6	-

Fees ₹ 500/-

Online Registration
www.onlineengineersacademy.org
8094441999

Online Test Series

SSC-JE 2019

Online Test Series is the most suitable platform to enable concept building and to improve the performance. It offers flexibility such that student can appear for the test any time any where.

Civil Engineering | **Mechanical Engineering** | **Electrical Engineering**

KEY FEATURES

- Specially designed for SSC-JE 2019 Examinations.
- Question Papers are in Hindi and English both medium.
- Detailed Solutions of each and every question.
- Question wise and test wise Analysis & comparison with toppers on time management.
- SSC JE-2019 Online Test Series is designed to provide the real time exam experience to the aspirants.
- Most importantly these tests are designed as per revised syllabus of SSC JE-2019.
- **Test series questions classification-**
  (1) Technical Syllabus - (CE • ME • EE)
  (2) Non Technical Syllabus- (Analytical Reasoning, General Studies)

TEST STRUCTURE — SSC-JE-2019 ONLINE TEST SERIES

Sr. No.	Type of Test	No. of Test	Questions	Marks	Duration
1.	Multi Subject Test	15	100	100	1 Hrs
2.	Non-Technical Test (Full Syllabus)	10	100	100	1 Hrs
3.	Technical Test (Full Syllabus)	2	100	100	1 Hrs
4.	Basic Level Test (SSC-JE Full Syllabus)	9	200	200	2 Hrs
5.	Advance Level Test (SSC-JE Full Syllabus)	5	200	200	2 Hrs
6.	Speed Mock Level Test (SSC-JE Full Syllabus)	10	200	200	2 Hrs

51 Newly Designed Quality Tests

7500 Questions

Fees ₹ 1200/-

This offer is valid till 30 Jan., 2020

Online Registration
www.onlineengineersacademy.org
8094441999

Online Test Series

COAL INDIA LIMITED (CIL)

Online Test Series is the most suitable platform to enable concept building and to improve the performance. It offers flexibility such that student can appear for the test any time any where.

Civil Engineering | **Mechanical Engineering** | **Electrical Engineering**

KEY FEATURES

- Specially designed for CIL-MT Examinations.
- Detailed Solutions of each and every question.
- Question wise and test wise Analysis & comparison with toppers on time management.
- CIL-MT Online Test Series is designed to provide the real time exam experience to the aspirants.
- **Test series questions classification-**
  (1) Technical Syllabus - (CE • ME • EE)
  (2) Non Technical Syllabus- (Analytical Reasoning, General Studies)

TEST STRUCTURE — CIL ONLINE TEST SERIES

S. No.	Test Syllabus	No of Que.	Total Marks	Duration
1.	General Knowledge/Awareness, Reasoning, Numerical Ability and General English	100	100	90 Min.
2.	Technical (CE • EE • ME)	100	100	90 Min.
3.	General Knowledge/Awareness, Reasoning, Numerical Ability and General English	100	100	90 Min.
4.	Technical (CE • EE • ME)	100	100	90 Min.
5.	General Knowledge/Awareness, Reasoning, Numerical Ability and General English	100	100	90 Min.
6.	Technical (CE • EE • ME)	100	100	90 Min.
7.	General Knowledge/Awareness, Reasoning, Numerical Ability and General English	100	100	90 Min.
8.	Technical (CE • EE • ME)	100	100	90 Min.

Fees ₹ 400/-

Online Registration
www.onlineengineersacademy.org
8094441999

$$APF = \frac{n \times \text{volume of atom}}{\text{volume of unit cell}}$$

$$APF = \frac{4 \times \frac{4}{3}\pi r^3}{a^3} = \frac{4 \times \frac{4}{3}\pi \times \left(\frac{\sqrt{2}a}{4}\right)^3}{a^3} = 0.74$$

24. A transmission shaft is subjected to a maximum torque of 7500 N-cm and a maximum bending moment of 12000 N-cm. The loads are suddenly applied with minor shocks having shock & fatigue factors 2.0 and 1.5 for bending and torque respectively. The allowable shear stress

Ans. Maximum Torque = 7500 N – cm

Maximum B.M = 12000 N– cm

k_b = 2.0

k_t = 1.5

$\tau_{allowable}$ = 420 N/cm²

d = ?

→ Equivalent torque $(T_e) = \sqrt{M^2 + T^2}$

$$T_e = \sqrt{(2 \times 12000)^2 + (1.5 \times 7500)^2} = 265050.89 \text{ N–cm}$$

→ $$\tau = \frac{16T_e}{\pi d^3} = \frac{16 \times 26505.89}{\pi d^3}$$

$$d^3 = \frac{16 \times 2650.5.89}{\pi \times 420} \Rightarrow d = 6.84 \text{ cm}$$

25. Compare soldering with fusion -welding processes in terms of

(a) preheating of workpiece

(b) temperature requirements

(c) strength of joint

(d) post process mechanical properties of workpiece

(e) post process requirements of heat treatment

Ans.

	Soldering	Fusion-Welding
1. Preheating of workpiece	Preheating require for a high quality joint.	No preheating required
2. Temperature Required	It require 840°F	It required 6500 F
3. Strength of joint	Weak Joint	Strongest joint compare to soldering
4. Post process mechanical Properties of Work piece	Mechanical properties don't change	Mechanical properties of base metal may change at the joint due to heating and cooling
5. Post process requirement of heat treatment	Heat treatment does not require	Heat treatment are always required

26. A new medical facility is to be located in Delhi. The location factors, weights and scores (1 = poor, 5 = excellent) for two potential sites are given in the following table. Which is the best location based on total weighted scores?

S.No.	Location factor	Weight	Scores	
			Location1	Location2
1.	Facility Utilization	25	3	5
2.	Total patient km per month	25	4	3
3.	Average time per emergency trip	25	3	3
4.	Land and Construction Costs	15	1	2
5.	Employee preferences	10	5	3

Ans. ***

27. A factory producing only one item, which it sells for 12.50 per unit, has a fixed cost of 60,000 and variable cost of 60,000 and variable cost of 7.50 per unit. Find the number of units to be produced to earn a profit of 12000.

Ans. Let, x be the unit to be produced

Fixed cost = (FC) = 60000 Rs

Sells per unit (s) = 12.50 Rs

Variable cost per unit (v)= 7.5 Rs

Profit = 12000 Rs

$S = F + V + P$

$sx = F + vx + P$

$x(s-u) = F + P$

$x[12.50-7.50] = 60000+12000$

$x = 14400$ unit

28. A firm buys castings of P and Q type of parts and sells them as finished product after machining, boring and polishing. The purchasing cost for castings are 3 and 4 each for parts P and Q and their selling costs are 8 and 10, respectively. The per hour capacity of machines used for the machining, boring and polishing for the two products is given below:

Capacity per hour	Parts	
	P	Q
Machining	30	50
Boring	30	45
Polishing	45	30

The running cost for the machining, boring and polishing are 30, 22.5 and 22.5 per hour, respectively. Formulate the linear programming problem to find out the product mix to maximize the profit.

NIMBUS

Ye Hai Future Ki Taiyari

ESE +GATE+ PSUs 2021

ONLINE PROGRAMME (NIMBUS)

ABOUT COURSE

Nimbus is an online learning platform for Engineering graduates who are preparing for competitive exams like ESE,GATE,PSU,SSC -JE and other JE/AE exams. Nimbus is a comprehensive GATE preparation course that provides high-quality GATE training at the comfort of your home. It consists of LIVE online classes conducted by expert faculty, study material,GATE Online and Offline Tests and GD/PI sessions. Nimbus is an ideal course for working professionals and students who have no access to quality GATE training in their cities / towns.

STREAMS

- Production Engineering
- Electrical Engineering (EE)
- Civil Engineering (CE)
- Electronics & Communication (EC)
- Mechanical Engineering (ME)
- Instrumentation Engineering (IN)

FEATURES

(a) 1500 hrs of Online (Live + VOD + Pre-recorded) Classroom Sessions
(b) 24X7 access to Classes and unlimited revision
(c) Live interaction with IIT alumnus or IES faculties
(d) Systematic, focused, consistent course curriculum
(e) Faculties share shortcuts, tips and techniques to help you in master concepts
(f) Access to view missed classes under "Video on Demand" section.
(g) Chat-based interaction with faculty to clear doubt during live class
(h) Additional Doubt Clarification sessions on a fixed schedule
(i) Short quizzes after each chapter
(j) Low cost compared to coaching centers

STUDY MATERIALS

- ☑ Theory and Objective books of Technical and Non technical Subjects.
- ☑ Engineering Mathematics, Reasoning & Aptitude Book : Theory and Previous Year Solved Question Papers.
- ☑ ESE Prelims Paper-1& Paper-2 Objective Previous Year Solved Question Papers.
- ☑ ESE Mains Paper-1& Paper-2 Conventional Previous Year Solved Question Papers.
- ☑ DPP (Daily Practices Problems) Sheet for Regular Assignments.
- ☑ GATE Previous Year Solved Papers.
- ☑ Current Affairs & G. K. Books.
- ☑ Hand Book and MCQ Book of Various PSUs Exams Books.

TEST SERIES

Classroom Test : Engineers Academy provides the complete Classroom Test of each and every Technical and Non-Technical Subjects up to the level of ESE, GATE and PSUs.

Test Series (Online & Offline) : Engineers Academy provides the complete online and offline test series each and every Technical and Non-Technical Subjects up to the level of ESE, GATE and PSUs.

- ☑ GATE Online Test Series.
- ☑ ESE Prelims Examination Online / Offline Test Series.
- ☑ ESE Main Examination Offline Test Series.

INTERVIEW

Post GATE Counseling: PSUs Recruitments & Previous Year Cutoffs, IIT Previous Year Cutoffs, NITs Previous Year Cutoffs, IIITs and Other Government Colleges Admissions Curiteria, Research Institutes, Scholarships in FPM (IIM Fellowship), Placement Drive, M.S. From Foreign Universities, Teaching Jobs,

ESE Interview Guidance Programme : Engineers Academy Provides the DAF Counseling for ESE Exam Qualified Aspirants.

- ☑ How to Fill DAF (Detailed Application Form).
- ☑ Personality Development & HR Sessions.
- ☑ Hobbies, Interest, Degree Projects, Extra & Co-curricular Activities.
- ☑ Session for Technical, General Awareness and Current Affairs.
- ☑ Mock Interview with real UPSC Exam.

Fees 19,999/-

Free Demo Classes@

www.youtube.com/nimbuslearning

Online Registration

www.nimbus.org.in

Email: info@nimbus.org.in

7374000888 7374000999

Ans.

	Part P (Rs/unit)	Part Q (Rs / unit)
Machining	$\frac{30}{30}=1$	$\frac{30}{50}=0.6$
Boring	$\frac{22.5}{30}=0.75$	$\frac{22.5}{45}=0.5$
Polishing	$\frac{22.5}{45}=0.5$	$\frac{22.5}{30}=0.75$
purchasing cost for Casting(Rs.)	3	4
Total cast price (Rs.)	5.25	5.85
Selling cost(Rs.)	8	10
Profit(Rs.)	2.75	4.15

Let, No. of unit produced P $= x_1$

No. of unit produced Q $= x_2$

maximum profit (Z) = $2.75x_1 + 4.15x_2$

29. A vibrating system consists of a mass of 50 kg; a spring of stiffness 30 kN/m a damper. The damping provided is only 20% of the critical value. Determine:(i) the damping factor (ii) the critical damping coefficient and (iii) natural frequency of damped vibration

Ans. Given:-

$m = 50$ kg

$k = 30$ kN/m

$C = 20\%$ of (C_c)

i) Damping factor (ξ)

$C = 20\%$ of C_c

$C = 0.20 \times C_c$

$$\xi = \frac{C}{C_c} = 0.2$$

ii) $$C_c = 2\sqrt{km} = 2\sqrt{30 \times 10^3 \times 50}$$

iii) $$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{30 \times 10^3}{50}}$$

$\omega_n = 24.49$ rad/sec

$$\omega_d = \omega_n \sqrt{1-\xi^2} = 24.49\sqrt{1-(0.2)^2}$$

$\omega_d = 23.99$ rad/sec

30. State or mention the applications of neutral, reducing and oxidizing types of flame those are generated during oxy-acetylene gas welding.

Ans. **i) Reducing or carburizing flame :** Excess acetylene. The ratio of oxygen to acetylene is generally in the range of (0.9 to 1)

Application: High carbon steels, Alloy steels.

ii) Oxidizing flame: Excess oxygen quantity the ratio of oxygen to acetylene is generally in the range of 1.15 to 1.5.

Application : Brass, Bronze etc.

iii) Neutral flame : equal acetylene and oxygen

Application : low carbon steel, mild carbon steel.

31. A manufacturing company purchase 10000 units of a raw material for its annual requirements. The ordering cost per order is Rs. 150 and carrying cost per unit is Rs.75 Calculate the economic ordering quantity, total annual inventory cost and the number of orders per year.

Ans. i) $$Q^* = \sqrt{\frac{2DC_o}{C_c}} = \sqrt{\frac{2\times10^4\times150}{75}}$$

(EOQ) $Q^* = 200$ unit

ii) Total annual inventory cost = $\sqrt{2DC_oC_c} = 15000$

iii) No. of order = $\frac{D}{Q^*} = \frac{10000}{200} = 50$

32. State the assumptions of simple bending theory for beams.

Ans. 1) The material of the beam is perfectly homogenous and isotropic

2) The beam material obeys Hooke's law.

3) The transverse section which are plane before bending, remain plane after bending also.

4) The value of young's modulus for material of beam is same in tension and compression.

5) Only pure bending in beam material.

PART - C

Note: ***Answer the following questions in 100 words each. Each. Each question carries 20 marks.***

33. A hydraulic circuit utilizes a spherical pressure tank, which is connected to a piston cylinder to move the piston, pressure inside the tank is maintained at 28 N/cm². Assume efficiency as 100%. Determine:

(a) The thickness of the wall-plate of the tank, if diameter of tank is 80 cm. The allowable tensile strength of the steel wall-plate used is 525 N/cm².

(b) Assuming a pressure drop of 2.1 N/cm² between tank and piston-cylinder, determine the piston diameter required to produce an operating Force of 2250 N. Assume an allowance for friction in the cylinder is equal to 10 percent of the force.

(c) Determine the thickness of cylinder wall. If the safe tress is 280 N/cm².

POSTAL PACKAGE FOR SSC-JE

Postal study package is the distance learning program designed to meet the needs of the college going students and working professionals who are unable to join our classroom courses and wish to do self study. The study material is compact, effective and easy to understand. Engineers academy has made all efforts to provide an error free material introducing smart and shortcut techniques for better understanding of the subjects.

Civil Engineering | **Mechanical Engineering** | **Electrical Engineering**

Covers Tech & Non-Tech (for Paper I & Paper II)

COMPLETE POSTAL PACKAGE INCLUDES

- Theory and Objective books of Technical Subjects.
- General Studies Book : History, Economics, Polity, Life Science, Geography.
- Reasoning: Theory and Previous Year Solved Question Papers.
- SSC JE Objective Previous Year Solved Papers
- SSC JE Conventional Previous Year Solved Papers
- Current Affairs & G. K. Books.
- MCQ Book of Various PSUs Exams Books.

Fees ₹ 5500/-

PSUS & MCQ BOOKS

Mechanical Engineering

Electrical Engineering

Civil Engineering

Electronics Engineering

SSC-JE BOOKS

CE-Objective Previous Year Solved Papers

ME-Objective Previous Year Solved Papers

EE-Objective Previous Year Solved Papers

General Intelligence Reasoning

Theory & Objective General Studies -1

Theory & Objective General Studies -2

CE-Conventional Previous Year Solved Papers

EE-Conventional Previous Year Solved Papers

ME-Conventional Previous Year Solved Paper

Exclusive Practice Book for RPSC-AEn, JPSC-AE, BPSC-AE, RRB-JE, DMRC-JE, UPPCL-JE and other Competitive exams

for more details :

www.eapublications.org

POSTAL PACKAGE FOR ESE+GATE

Postal study package is the distance learning program designed to meet the needs of the college going students and working professionals who are unable to join our classroom courses and wish to do self study. The study material is compact, effective and easy to understand. Engineers academy has made all efforts to provide an error free material introducing smart and shortcut techniques for better understanding of the subjects.

CE • EC • EE • IN • ME • PI • CH • CS • MT • TX • BT • FT

COMPLETE POSTAL PACKAGE INCLUDES

- Theory and Objective books of Technical and Non technical Subjects.
- Engineering Mathematics, Reasoning & Aptitude Book : Theory and Previous Year Solved Question Papers.
- ESE Prelims Paper-1& Paper-2 Objective Previous Year Solved Question Papers.
- ESE Mains Paper-1& Paper-2 Conventional Previous Year Solved Question Papers.
- DPP (Daily Practices Problems) Sheet for Regular Assignments.
- GATE Previous Year Solved Papers.
- Current Affairs & G. K. Books.
- Hand Book and MCQ Book of Various PSUs Exams Books.

Electrical Engineering
Previous Year Solved Papers
ISBN : 9789389149081
MRP: ₹ 800/-

Civil Engineering
Previous Year Solved Papers
ISBN : 9789389149180
MRP: ₹ 800/-

Mechanical Engineering
Previous Year Solved Papers
ISBN : 9789389149074
MRP: ₹ 800/-

Electronics & Comm. Engineering
Previous Year Solved Papers
ISBN : 9789389149098
MRP: ₹ 800/-

Bio-Technology Engineering
Previous Year Solved Papers
ISBN : 9789389149159
MRP: ₹ 800/-

Instrumentation Engineering
Previous Year Solved Papers
ISBN : 9789389149142
MRP: ₹ 800/-

Chemical Engineering
Previous Year Solved Papers
ISBN : 9789389149111
MRP: ₹ 800/-

Textil Engineering
Previous Year Solved Papers
ISBN : 9789389149128
MRP: ₹ 800/-

Computer Science Engineering
Previous Year Solved Papers
ISBN : 9789389149104
MRP: ₹ 800/-

Metallurgy Engineering
Previous Year Solved Papers
ISBN : 9789389149166
MRP: ₹ 800/-

ESE + GATE

Fees ₹ 11000/-

GATE

Fees ₹ 8500/-

To purchase Postal study package visit :
www.eapublications.org • 7737040911

Ans. $P = 28\ N/cm^2$

$\eta = 100\%$

a) diameter of tank (d) $= 80$ cm.

$\sigma_{allouble} = 525\ N/cm^2$

$$\sigma = \frac{Pd}{4t} \qquad \{\text{spherical Pressure tank}\}$$

$$525 = \frac{28 \times 80}{4t}$$

$t = 1.066$ cm

b) Pressure drop $= 2.1\ N/cm^2$

Force = 2250 N

Friction in cylinder = 10% of force

$$\text{Total force required} = 2250 + \left(2250 \times \frac{10}{100}\right)$$

$= 2475$ N

Pressure = 28–2.1 = 25.9 N/cm^2

$$P = \frac{F}{A} = \frac{2475}{\frac{\pi}{4}d^2}$$

$$\Rightarrow \quad 25.9 = \frac{2475 \times 4}{25.9 \times \pi}$$

$$d^2 = \frac{2475 \times 4}{25.9 \times \pi}$$

$d = 11.03$ cm

c) Thickness of cylinder wall

$$\sigma = \frac{pd}{2t}$$

$$280 = \frac{25.9 \times 11.03}{2t}$$

$$t = \frac{25.9 \times 11.3}{2 \times 280}$$

$$\Rightarrow \quad t = 0.51 \text{ cm}$$

$t = 5.1$ mm

SCHOLARSHIP & CONCESSIONS

EAST
Engineers Academy Scholarship Test

ESE - 2021-22
GATE - 2021-22

100% Scholarship Classroom Coaching

SCHOLARSHIP CRITERIA ACCORDING TO EAST MARKS

Marks Range (Out of 100)	Category	% Scholarship (Scholarship Only on Tuition Fee)
91-100	A	100%
81-90	B	75%
71-80	C	50%
51-70	D	25%
30-50	E	10%

GATE-2020 EAST Exam Pattern

Total Questions : 65	Total Marks : 100	Total Time : 3Hrs
Technical Section 70 Marks	General Aptitude 15 Marks	Engineering Mathematics 15 Marks

HOW TO TAKE PARTICIPATE:

- Visit www.onlineengineersacademy.org/east
- Registration form will be appeared. Fill the same form with your complete detail and also select your nearby Exam center & Exam Date.
- After Submission of Registration form your Roll No. will be generated.
- By help of Roll No. You can download Your EAST Exam Admit Card from Download Admit Card Link; it is available on home page of EAST Website.

DIRECT SCHOLARSHIP

- **MERIT CATEGROY :** Previously Qualified for ESE interview : 90% (Discount)
- **OLD STUDENT CATEGROY :** For Old students (Taken Coaching for ESE/GATE/PSUs/SSC-JE/AE/JE) : 50% (Discount)
- **INSTITUTIONAL CATEGROY :** For IIT B.Tech students : 50% (Discount) for NITs & BITs and other Engineering Colleges (B.Tech/M.Tech) 30% (Discount)
- **SOCIAL CATEGROY :** Physically Challenged Student • Armed Forces Children • Father Expired students • Orphan Students • Defence Personnel Disabled in War : 50% (Discount)

34. A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm². Calculate the axial load which the spring can carry and the deflection per active turn by considering:

(a) neglecting effect of curvature.

(b) the effect of curvature.

Ans. Given:- Diameter of wire = 6 mm

Outside diameter of coil = 75 mm

Permissible shear stress(τ) = 350 MPa

Module of Rigidity (G) = 84 kN/mm²

Mean coil diameter = 75 – 6 = 69 mm

Spring index (C) = $\frac{D}{d}=\frac{69}{6}=11.5$

Let, W = Axial load

1) Neglect effect of curvature

$$\tau = k_s \frac{8WD}{\pi d^3}$$

Shear stress factor(k_s) = $1+\frac{1}{2C}=1+\frac{1}{2\times 11.5}=1.043$

$$\tau = 350 = 1.043 \times \frac{8W \times 69}{\pi \times 6^3}$$

$$W = 412.7 \text{ N}$$

deflection of spring, $\delta = \frac{8WD^3}{Gd^4} \times n$

$$\frac{\delta}{n} = \frac{8WD^3}{Gd^4} \frac{8 \times 412.7 \times (69)^3}{84 \times 10^3 \times (6)^4} = 9.96 \text{ mm}$$

(2) considering effect of curvature

$$\tau = k \times \frac{8WD}{\pi d^3}$$

Wahl's Stress factor $= \frac{4C-1}{4C-4}+\frac{0.615}{C}$

$$= \frac{4\times 11.5-1}{4\times 11.5-4}+\frac{.615}{11.5} = 1.123$$

$$\tau = 1.123 \times \frac{8W \times 11.5}{\pi \times 6^2}$$

$$W = \frac{350}{0.913} = 383.4\text{N}$$

$$\delta = \frac{8WD^3n}{Gd^4} = \frac{8 \times 383.4 \times (69)^3}{84 \times 10^3 \times 6^4}$$

δ/n = 9.26 mm

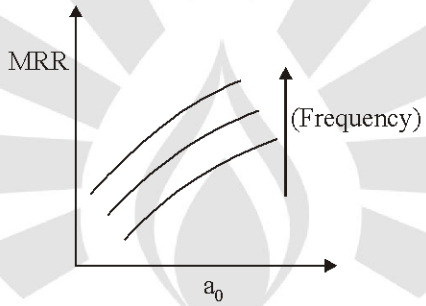
35. Explain the Ultra-Sonic Machining process. Discuss the effect of process parameters on Material Removal Rate (MRR).

Ans. Ultrasonic Machining (USM) also called as ultrasonic vibration machining is a machining process in which material is removed from the surface of a part by low amplitude and high frequency of tool against surface of material in the presence of abrasive particle. Slurry is formed by mixing the abrasive grains in the water. This slurry is made to flow across the workpiece and tip of tool during machining process. The abrasive gain particle in the surface of workpiece surface finish of workpiece depends on the grain size of abrasive.If grain size is smaller then the surface finish of workpiece will be high. This machining process is usually used to machine brittle materials and materials that have high hardness.

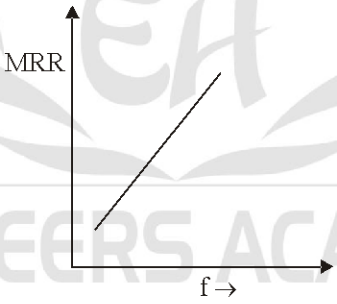
An electric current at high frequency (in Ultrasonic range i.e 18 kHz to 40 kHz) is used to generate mechanical vibration of 10 W amplitude and high frequency. The mechanical vibration generated is used for machining the surface of a part in the presence of abrasive grain particle in the form of slurry The slurry flows across the tool and workpiece when the tool presses against the workpiece, the slurry containing abrasive particle chips off the material from surface.

effect of process parameter on MRR:–

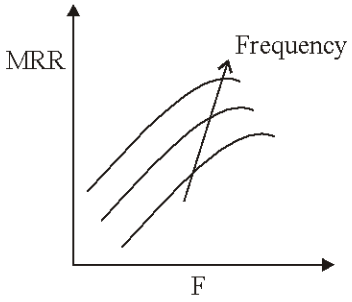
1) Amplitude of vibration (a_0) $\Rightarrow$ 15–50μm



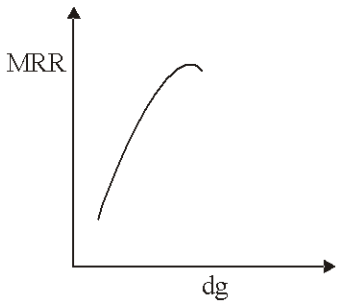
2) Frequency of vibration (f) $\Rightarrow$ 19–25 kHz



3) Feed force (F)$\Rightarrow$

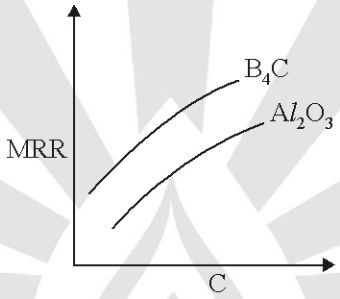


4) Abrasive size ⇒ 15–150μm



5) Volume concentration of abrasive in slurry

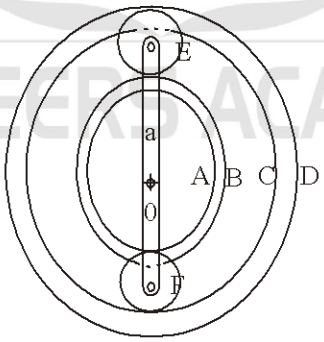
6) Abrasive material – Aluminium oxide, Boron



36. In an epicyclic gear train the compounded wheels A and B as well as internal wheels C & D rotate independently about axis O. The wheels E and F rotate on pins fixed on arm 'a' All wheels are of same module. The number of teeth on the wheels are T_A = 52, T_B = 56, T_E = T_F = 36, Determine speed of C when,

(a) Wheel D is fixed and arm 'a' rotates at 200 rpm clockwise.

(b) Wheel D rotates at 200 rpm counter-clockwise and arm 'a' rotates at 20 rpm counter clockwise.



Ans. Given:– T_A = 52

T_B = 56

T_E = T_F = 36

COMPUTER BASED TEST

Appear in Real Time Exam for GATE & SSC-JE

GATE-2020
SSC-JE-2019

70
Test Center Across India

GATE-2020 CBT Exam Pattern

Total Questions : 65	Total Marks : 100	Total Time : 3Hrs
Technical Section 70 Marks	General Aptitude 15 Marks	Engineering Mathematics 15 Marks

GATE-2020 CBT Streams — CE• ME • EE • EC• IN • CSE• CH• PI • BT• TF • MT

SSC-JE-2019 CBT Exam Pattern

Total Questions : 200	Total Marks : 200	Total Time : 2Hrs
Technical Section 100 Marks	General Intelligence & Reasoning 50 Marks	General Awareness 50 Marks

SSC-JE 2019 CBT Streams — Civil Engineering , Mechanical Engineering & Electrical Engineering.

CBT Registration Details : GATE-2020

Registration Start Date	:	1 September 2019
Registration End Date	:	19 January 2020
Download Admit Card	:	21 January 2020
GATE 2020 Mock Test Date	:	25 January 2020
GATE 2020 CBT Result Date	:	27 January 2020

CBT Registration Details : SSC-JE 2019

Registration Start Date	:	1 September 2019
Registration End Date	:	1 March 2020
Download Admit Card	:	12 March 2020
SSC-JE Mock Test Date	:	15 March 2020
SSC -JE CBT Result Date	:	17 March 2020

CBT Key Futures

1. Appear in Real Time CBT Exam.
2. Compare with Aspirants of all Over India.
3. Test Papers Designed by Senior Faculties.
4. Questions Pattern as Per GATE-2020 & SSC-JE Exams.
5. Know Your Week Areas & Subjects.
6. Detailed Solutions of Every Questions.
7. All India Ranks.
8. Rewards for GATE 2020 & SSC-JE Toppers
9. Post GATE Counselling Programme.

CBT Fee Structure

Early Bird Offer

GATE-2020 CBT	SSC-JE CBT	GATE + SSC-JE CBT
500/-	500/-	900/-

Online Registration :
www.cbt.engineersacademy.org • www.engineersacademy.org

We known that :

$$r_c = r_A + 2r_F$$

$$\frac{mT_c}{2} = \frac{mT_A}{2} + 2\left(\frac{mT_F}{2}\right) = 52 + 2(36)$$

$$T_C = 124$$

Similarly $T_D = T_B + 2T_E = 56 + 2(36)$

$$T_D = 128$$

Am	A/B	F	C	E	D
	(52) (56)	(36)	(124)	(36)	(128)
0	X	$-x\left(\frac{52}{36}\right)$	$\frac{-13x}{9}\left(\frac{36}{124}\right)$	$-x\left(\frac{56}{36}\right)$	$-x\left(\frac{56}{36}\right)\left(\frac{36}{128}\right)$
0	X	$\frac{-13x}{9}$	$\frac{-13x}{31}$	$\frac{-A}{9}x$	$\frac{-7x}{16}$
Y	Y	Y	Y	Y	Y
Y	Xy	$y-\frac{13x}{9}$	$y-\frac{13x}{31}$	$y-\frac{14x}{9}$	$y-\frac{7x}{16}$

Part(a)

$N_D = 0$ ($\because$ D fixed)

$y = 200$ (given

$\because$ $y-\frac{7x}{16}=0$

$x = 457.1$

$\therefore$ $N_c = y-\frac{13x}{31} = 8.313$

$\therefore$ $N_c = 8.313$ rpm

Part(b)

$N_D = 200$

$N_{arm} = 20 = y$

$y-\frac{7x}{16} = 200$ (1)

$y = 20$ (2)

$\therefore$ $x = 411.428$ (CW)

$\therefore$ Speed of C,

$$N_C = y-\frac{13x}{31}$$

$$= 20-\frac{13}{31}(-411.428)$$

$N_C = 192.53$ (CCW)

37. A project consists of 7 jobs. A and F can be started and completed independently. Jobs B and C can start only after job A has been completed. Jobs D, E and G can start only after jobs B, (C and D) and (E and F) are completed, respectively. Time estimates of all the jobs are given in the following table

Job	Time Estimates (Days)		
	Optimistic	Pessimistic	Most Likely
A	3	7	5
B	7	11	9
C	4	18	14
D	4	12	8
E	4	8	6
F	5	19	12
G	2	6	4

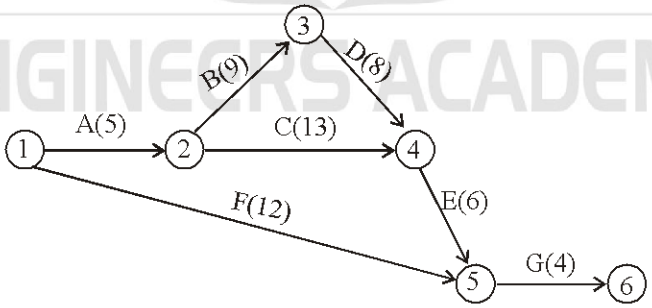
Draw the network and determine the critical path, and its expected duration (T_e). What is the probability of completing the project in 32 days? Also. Determine the total and free slacks of all the jobs.

Ans.

Job	estimated time(Te)
A	5
B	9
C	13
D	8
E	6
F	12
G	4

$$Te = \frac{T_o + 4T_m + T_p}{6}$$

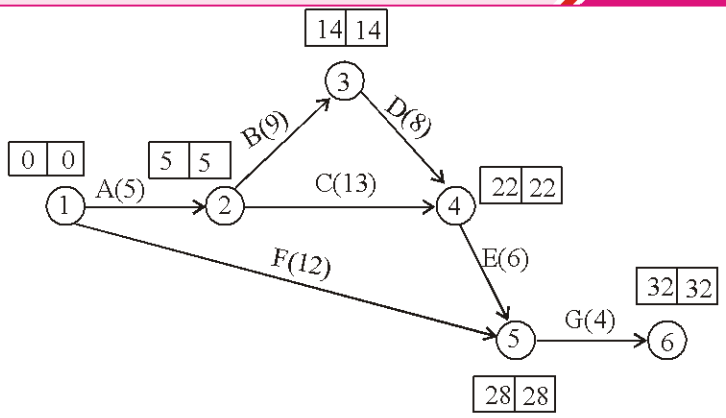
Network diagram

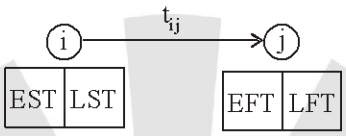


Critical path : A – B – D – E – G ⇒ 32 days

$$\text{Probability factor } (Z) = \frac{T_s - T_e}{\sigma_c} = \frac{32-32}{\sigma_c} = 0$$

Probability = 50% = 0.5 {∴ Z = 0}





EST = Earliest start time

LST = Latest start time

EFT = Earliest finish time

LFT = Latest finish time

(T.F) Total float = LFT– EST – t_{ij}

(FF) Free float = EFT – EST–t_{ij}

Job	T.F.	F.F.
A	0	0
B	0	0
C	4	4
D	0	0
E	0	0
F	16	16
G	0	0

○○○

ENGINEERS ACADEMY

Your GATEway to Professional Excellence

IES • GATE • PSUs • JTO • IAS • NET

EA Study Centers

JAIPUR- SANGHI CENTER EA Campus, Sanghi School, Gopalpura, Tonk Road, Jaipur-302018 (Rajasthan) • Tel # 098875 82200	**DELHI MUKHERJEE NAGAR CENTER** H N- 712, Ground Floor, Opp. Batra Cinema Dr. Mukherjee Nagar, Delhi-110009 • Tel # 0723 999 2 777
JAIPUR- MAHAVEER NAGAR CENTER S-52-53, Mahaveer Nagar, Behind Jaipur Hospital, Gopalpura Tonk Road, Jaipur-302018 (Rajasthan) • Tel # 077370 40910	**DELHI SAKET CENTER** Khasra 262, Westend Marg, Near Garden of Five Senses, Saket, New Delhi 110030 Tel # +91-7239993777
JAIPUR – PRATAP NAGAR CENTER 100-102, Ram Nagar, Bambala Puliya, Toll Tax, Pratap Nagar, Tonk Road, Jaipur-302033 (Rajasthan) • Tel # 07737 040 911	**PATIALA CENTER** SCB-7, IIIrd Floor, Choti Baradari, Patiala (Punjab)• Tel # 09855273076
AJMER CENTER Shiksha Tower, Behind MRF Showroom, Adarsh Nagar, Ajmer - 305002 (Rajasthan) • Tel # 097994 94491	**KANPUR CENTER** Basement, Trilok Plaza, Lakhanpur, Behind Gurdev Place, Kanpur-208024 (U.P.) • Tel # 0723 999 2222
KOTA CENTER P.No.-7A, 18 Second Floor, Near Mahaveer Nagar-3 Circle, Rangbari Road, Kota-324005 • Tel # 082902 56340	**LUCKNOW CENTER** 1st Floor, Corporation Bank, Sector-E, Aliganj, Lucknow-226024 (U.P.) •Tel # 081 888 41777
JODHPUR CENTER B-4 1st Floor,Mahaveer Colony, Shivam Hospital, Bhaskar Circle, Ratanada, Jodhpur • Tel # 76655 06 888	**CHANDIGARH CENTER** SCO 94-95, Basement & Ground floor, Sec-34/A, Chandigarh (Punjab) • Tel # 09815411737
AGRA CENTER Millennium Complex, Nehru Nagar , Just Behind Bhagwan Talkies , Agra -282003 (U.P.) • Tel # 0723 999 3 555	**PATNA CENTER** 4th Floor, Magadh Naresh, Opp KFC & SBI Bank, Main Road Kankarbagh, Patna- 800020 (Bihar) • Tel # 0843 444 1777
JALANDHAR CENTER Prestige Chamber, 4th Floor, CHR Group, GT Road, Bus Stand, Jalandhar- 144001 (Punjab) •Tel # 07589 44 1777	**ALLAHABAD CENTER** EA Campus, Opp. Ishwar Sharan College, Salori, Allahabad, UP -211004 • Tel # 0723 999 1 444
RANCHI CENTER Sri Sai Tower, 5th Floor, Debuka Nursing Lane, Lalpur, Ranchi, Jharkhand - 834001 • Tel # 07239990222, 07239990333	**LPU CAMPUS CENTER** Lovely Professional University Campus, Block-13, Room-206, G.T. Road, Phagwara-144411 (Punjab) • Tel # 09465 22 00 33