ACE Engineering Academy
Leading Institute for ESE/GATE/PSUs

DEEP LEARN

HYDERABAD | DELHI | PUNE | BANGALORE | LUCKNOW | CHENNAI | VISAKHAPATNAM | VIJAYAWADA | TIRUPATHI | KOLKATA | AHMEDABAD

ESE-2021

PRELIMINARY EXAMINATION

QUESTIONS WITH DETAILED SOLUTIONS

MECHANICAL ENGINEERING

ACE Engineering Academy has taken utmost care in preparing the ESE-2021 Prelims Examination solutions. Discrepancies, if any, may please be brought to our notice. ACE Engineering Academy do not owe any responsibility for any damage or loss to any person on account of error or omission in these solutions. ACE Engineering Academy is always in the fore front of serving the students, irrespective of the examination type (GATE/ESE/PSUs/PSC/GENCO/TRANSCO etc.,).

All Queries related to ESE-2021 Prelims Solutions are to be sent to the following email address hyderabad@aceenggacademy.com

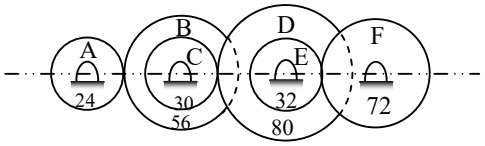
Contact Us : 040-23234418,19,20

MECHANICAL ENGINEERING

Subject wise Weightage

SUBJECT	No. of Questions
Fluid Mechanics	13
Heat Transfer	03
Machine Design	10
Strength of Material	08
Renewable Sources of Energy	12
Basic Thermodynamics	12
Refrigeration & Air Conditioning	07
IC Engines	04
Power plant	13
Turbo-machinery	12
Production Engineering	07
Material Science	12
Theory of Machines	14
IM & OR	04
Mechatronics and Robotics	13
Maintenance Engineering	01
Engineering Mechanics	05
Total	**150**

01. The compound gear train shown in the figure below consists of compound gear B-C and D-E. All gears are mounted on parallel shafts. The motor shaft rotating at 800 rpm is connected to the gear A and the output shaft to the gear F. The number of teeth on gears A, B, C, D, E and F are 24, 56, 30, 80, 32 and 72 respectively. What is the speed of the gear F ?



(a) 57.14 rpm (b) 32.51 rpm (c) 74.63 rpm (d) 69.72 rpm

01. Ans: (a)

Sol: Gear B, C and D, E are compound wheels

$\omega_A = 600\text{rpm}$

$\omega_F = ?$

$$\frac{\omega_A}{\omega_F} = \frac{\omega_A}{\omega_B}\frac{\omega_B}{\omega_C}\frac{\omega_c}{\omega_D}\frac{\omega_D}{\omega_E}\frac{\omega_E}{\omega_F}$$

$$= \left(-\frac{T_B}{T_n}\right)\left(-\frac{T_D}{T_c}\right)\left(-\frac{T_F}{T_E}\right)$$

$$= -\frac{T_B}{T_A}\frac{T_D}{T_c}\frac{T_F}{T_E}$$

$$= -\frac{56\times 80\times 72}{24\times 30\times 32} = -14$$

$$\frac{800}{\omega_F} = -14$$

$$\omega_F = \frac{-800}{14} = -57.14 \text{ rpm}$$

02. A quick-return mechanism is to be designed, where the outward stroke must consume 1.2 sec and the return stroke 0.8 sec. If the cycle time is 2.0 s/rev, what is the speed at which the mechanism should be driven ?

(a) 10 rev/s (b) 30 rev/s

(c) 10 rev/min (d) 30 rev/min

02. Ans: (d)

Sol: In 2 sec mechanism completes 1 rev

In 1 sec mechanism will complete $\frac{1}{2}$rev

In 60 sec i.e., 1 min mechanism will complete

$$= \frac{60}{2}\text{ rev} = 30\text{ rev}$$

Speed = 30 rev/min

03. The following data relate to a single cylinder reciprocating engine : mass of reciprocating parts = 40 kg, mass of revolving parts = 30 kg at crank radius, speed = 150 rpm, stroke = 350 mm. If 60% of the reciprocating parts and all the revolving parts are to be balanced, what is the balance mass required at a radius of 320 mm?

(a) 15.27 kg (b) 21.43 kg

(c) 24.96 kg (d) 29.53 kg

03. Ans: (d)

Sol: $m_{rec} = 40$ kg,

$m_{rev} = 30$ kg,

$N = 150\,\text{rpm}$

$$\Rightarrow \omega = \frac{2\pi \times 150}{60} = 5\pi\ \text{rad/s}$$

Stroke = 350 mm

$$\Rightarrow \text{Crank radius} = \frac{350}{2} = 175\text{ mm}$$

$\Rightarrow$ c = 0.6

Balancing mass radius, b = 320 mm

$\because$ B.b = c m_{rec} r + m_{rev} r

$$\Rightarrow B \times 320 = 0.6 \times 40 \times 175 + 30 \times 175$$

$$\Rightarrow B = \frac{175\left(0.6 \times 40 + 30\right)}{320}$$

$$= \frac{175 \times (54)}{320} = \frac{175 \times 54}{320}$$

$$= 29.53\text{ kg}$$

04. A leaf spring consists of seven steel plates, each 60 mm wide and 6 mm thick. What is the length of the spring if it is to carry a central load of 3 kN, without the stress exceeding 150 MPa ?

(a) 547 mm (b) 498 mm

(c) 494 mm (d) 504 mm

04. Ans: (d)

Sol: $\sigma_{max} = 150$ MPa

Central load (2F) = 3000 N $\Rightarrow$ F = 1500 N

Width (b) = 60 mm

Thickness (h) = 60 mm

No. of leafs (n) = 7

Maximum stress for laminated leaf spring

$$\sigma_{max} = \frac{6.F.L}{n.b.h^2}$$

$$\text{Half length (L)} = \frac{\sigma_{max}.n.b.h^2}{6.F}$$

Total length of leaf spring

$$(2L) = \frac{\sigma_{max}.n.b.h^2}{3.F}$$

$$= \frac{150 \times 7 \times 60 \times 6^2}{3 \times 1500}$$

2L = 504 mm

05. According to maximum shear stress theory, with comparison to yield strength in tension, the yield strength in shear is

(a) half the yield strength in tension.

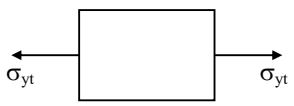
(b) same as that of yield strength in tension.

(c) double the yield strength in tension.

(d) 1.33 times that of the yield strength in tension.

05. Ans: (a)

Sol:



Simple tension

$\sigma_1 = \sigma_{yt}$ $\sigma_2 = 0$ $\sigma_3 = 0$

According to maximum shear stress theory

$$\tau_{max} = \max\left\{\frac{\sigma_1 - \sigma_2}{2}, \frac{\sigma_2 - \sigma_3}{2}, \frac{\sigma_3 - \sigma_1}{2}\right\}$$

$$\tau_{max} = \frac{\sigma_{yt}}{2}$$

When the loading is shear, $\tau_{max} = \tau_{yt}$

$$\therefore \ \tau_{yt} = \frac{\sigma_{yt}}{2}$$

06. In curved beams, normally the nature of stress distribution is

(a) linear (b) circular

(c) parabolic (d) hyperbolic

06. Ans: (d)

Sol: The stress distribution in curved beams is hyperbolic.

07. Consider the following statements regarding crack :

1. Crack is more likely to occur in the regions of discontinuity such as oil holes.
2. Crack is more likely to occur in the regions of irregularities in machining operations such as stamp mark.
3. Crack is more likely to occur in the internal cracks due to defects in materials like blow holes.

Which of the above statements are correct ?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

07. Ans: (d)

Sol: The correct statements are :

- Crack is more likely to occur in the regions of discontinuity such as oil holes.
- Crack is more likely to occur in the regions of irregularities in machining operations such as stamp mark.
- Crack is more likely to occur in the internal cracks due to defects in materials like blow holes.

ACE Engineering Academy Since 1995 Leading Institute for ESE/GATE/PSUs x DEEP LEARN

DEEP LEARN PRE-RECORDED VIDEOS

ONLINE COURSES

CE | ME | EC | EE | CSIT | IN | PI

- for **ESE | GATE | SSC | PSUs** curated by India's best minds. Access courses through Mobile/Tablet from anywhere.
- We have subscriptions options of 1 Month, 3 Months, 6 Months, 12 months, 18 months and 24 months.

RECORDED VIDEO LECTURES

- GATE + PSUs (650+ Hours*) English
- GATE + PSUs (650+ Hours*) Hinglish
- ESE : General Studies (250+ Hours*)
- SSC-JE : Technical (Civil) (400+ Hrs*)
- ESE + GATE + PSUs (1000+ Hours*)
- SSC-JE : GS (200+ Hours*)
- APPSC / TSPSC - Technical (400+Hours) (Telugu + English)
- APPSC / TSPSC - GS - (250+Hours) (Telugu + English)
- GENCO / TRANSCO -(600+Hours) (Telugu + English)
- Subject wise courses available for SSC - JE : GS & Technical (Civil).
- Subject wise courses available for GATE / ESE (Hinglish).

SALIENT FEATURES

Get **10% DISCOUNT**

USE CODE: **ESE10**

Valid Till: 30th July 2021

- Dynamic & Experienced Faculty.
- Covers Exam Preparation Strategy and Live Doubt clearing sessions.
- Facilitates Enhanced learning by incorporating 2d & 3d animations.
- Free Online Test Series (Total 117 tests, subject wise, sectional wise, and full length mock tests.
- Compose online study notes and save it for future reference.
- Comprises of weekly self assessment tests.
- Free Interview Guidance & Post GATE Guidance for subscribers.
- ASK AN EXPERT feature for doubt clarifications via emails/video (services to be availed within 12 hrs.)
- Procure Full set of Study Material (Optional)*
- EMI option available.

Scan QR Code Download the Android App (Mobile/Tab)*
www.deep-learn.in

GET IT ON Google Play

08. The yield strength of bolt material is 300 MPa and factor of safety is 2.5. What is the maximum principal stress using maximum principal stress theory ?

(a) 750 MPa (b) 120 MPa

(c) 27.38 MPa (d) 10.95 MPa

08. Ans: (b)

Sol: $\sigma_{yt} = 300$ MPa

FOS = 2.5

According to maximum principal stress theory

$$\sigma_1 = \frac{\sigma_{yt}}{FOS} = \frac{300}{2.5}$$

$\sigma_1 = 120$ MPa

09. Which one of the following theories gives satisfactory results for brittle materials ?

(a) Maximum principal stress theory

(b) Maximum shear stress theory

(c) Distortion energy theory

(d) Shear stress energy theory

09. Ans: (a)

Sol: For brittle materials, maximum principal stress theory gives satisfactory results.

10. A cast steel bar having an ultimate strength of 120 MPa is subjected to a reversed, repeated, bending load. The bar will be machined to a rectangular cross-section, 150 mm wide × 200 mm high. What is the equivalent diameter ?

(a) 14 mm (b) 30 mm

(c) 140 mm (d) 300 mm

10. Ans: (c)

Sol: For rectangular cross-section of width B and depth H, the equivalent diameters is,

$$d_e = \sqrt{\frac{0.05 \times B \times H}{0.0766}} = \left\{\frac{5 \times 150 \times 200}{7.66}\right\}^{1/2}$$

$$d_e = \left\{\frac{5 \times 300}{7.66}\right\}^{1/2} \times 10$$

(i) $\left\{\frac{5 \times 300}{7.66}\right\}^{1/2} > 10$ $\therefore$ Options (a) & (b) are wrong

(ii) $\left\{\frac{5\times 300}{7.66}\right\}^{1/2} < 30$ $\therefore$ Option (d) is wrong

$\therefore$ So, option (c) is correct.

11. Consider the following statements regarding typical analysis of bolt failure :

1. 15% failure of bolt occur at the fillet under the head.
2. 50% failure of bolt occur at the end of threads on the shank.
3. 80% failure of bolt occur in the threads that are in contact with the nut.

Which of the above statements is/are correct ?

(a) 1 only (b) 3 only

(c) 2 and 3 only (d) 1, 2 and 3

11. Ans: (a)

Sol: The analysis of bolt failures indicate that,

- 15% failures of bolt occur at the fillet under the head
- 20% failures of bolt occur at the end of threads on the shank.
- 65% failures of bolt occur in the threads that are in contact with the nut.

12. Which of the following are the functions of lubrication in a bearing unit ?

1. To protect the bearing components from corrosion.
2. To absorb heat from the bearing unit.
3. To carry heat away from the bearing unit.

Select the correct answer using the code given below :

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

12. Ans: (d)

Sol: Characteristics of lubricant:

- Minimizes friction
- Good heat absorbing capacity
- Has less variation of viscosity with temperature
- Resists oxidation at higher temperature
- Prevents corrosion of metal surfaces
- Minimizes the formation of engine deposite

13. Consider the following statements regarding clutches :

1. Dry clutch has higher coefficient of friction compared to wet clutch.
2. The torque capacity of wet clutch is high compared to dry clutch.
3. The engagement in a dry clutch is smoother than in case of wet clutch.

Which of the above statements is/are correct ?

(a) 1 only (b) 1 and 3 only

(c) 2 only (d) 1, 2 and 3

13. Ans: (a)

Sol:

Dry Clutch	Wet Clutch
1. As lubricant is not present, coefficient of friction is a bit higher	1. Presence of lubricant decreases friction
2. Because of higher friction, torque carrying capacity is more	2. As friction is less, torque carrying capacity is less
3. High friction leads to sudden engagement of clutch	3. Lesser friction results in smooth engagement of clutch.

14. Which of the following factors can cause misalignment of the teeth on the pinion relative to those on the gear ?

1. Inaccurate gear teeth
2. Misalignment of the axes of shafts carrying gears
3. Thermal distortions during operation

Select the correct answer using the code given below :

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

14. Ans: (d)

Sol: All the three factors given below cause misalignment of the teeth on the pinion relative to those on the gear are :

- Inaccurate gear teeth
- Misalignment of the axes of shafts carrying gears
- Thermal distortions during operation

15. Consider the following statements regarding welded and riveted joints :

1. Welded assemblies are tight and leak proof as compared with riveted assemblies.
2. Single-welded V-joint is less reliable than square butt joint.
3. Welding results in a thermal distortion of the parts, thereby inducing residual stresses.

Which of the above statements is/are correct ?

(a) 1 only (b) 1 and 3 only

(c) 2 only (d) 1, 2 and 3

15. Ans: (b)

Sol:

- Welded assemblies are tight and leak proof as compared with riveted assemblies.
- V-Joints are generally economical and reliable.
- Residual stresses are induced in welded parts after welding.

16. Iron at 20°C is BCC with atoms of atomic radius 0.124 nm. What is the lattice constant 'a' for the cube edge of the iron unit cell ?

(a) 0.2864 nm (b) 0.1496 nm

(c) 0.2173 nm (d) 0.1756 nm

16. Ans: (a)

Sol:

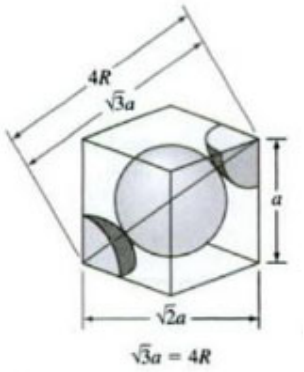


Fig: BCC unit cell showing relationship between the lattice constant a and the atomic radius R.

From Fig. it is seen that the atoms in the BCC unit cell touch across the cube diagonals. Thus, if a is the length of the cube edge, then $\sqrt{3}a = 4R$. Where R is the radius of the iron atom.

Therefore, $a = \frac{4R}{\sqrt{3}} = \frac{4(0.124\text{nm})}{\sqrt{3}} = 0.2864\,\text{nm}$

17. Copper has the FCC crystal structure and a unit cell with a lattice constant of 0.361 nm. What is the interplanar spacing 'd_{220}' ?

(a) 0.085 nm (b) 0.174 nm

(c) 0.206 nm (d) 0.128 nm

17. Ans: (d)

Sol: $$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}} = \frac{0.361\,nm}{\sqrt{(2)^2 + (2)^2 + (0)^2}} = 0.128\ nm$$

18. Which one of the following is ***not*** a step of lever rule of determination of phase amounts ?

(a) A tie line is constructed across the two-phase region at the temperature of the alloy.

(b) The overall alloy composition is located on the tie line.

(c) Perpendiculars are dropped from these intersections to the horizontal composition axis, from which the composition of each of the respective phases is read.

(d) The fraction of one-phase is computed by taking the length of tie line from the overall alloy composition to the phase boundary for the other phase and dividing by the total tie line length.

18. Ans: (c)

Sol: **Determination of Phase Compositions:**

To compute the equilibrium concentrations of the two phases, the following procedure is used:

- A tie line is constructed across the two-phase region at the temperature of the alloy.
- The intersections of the tie line and the phase boundaries on either side are noted.
- Perpendiculars are dropped from these intersections to the horizontal composition axis, from which the composition of each of the respective phases is read.

So option (c) is not a step of lever rule of determining of phase amounts. Hence option (c) is correct.

Determination of Phase Amounts:

If the composition and temperature position is located within a two-phase region, things are more complex. The tie line must be used in conjunction with a procedure that is often called the lever rule (or the inverse lever rule), which is applied as follows:

- The tie line is constructed across the two-phase region at the temperature of the alloy.
- The overall alloy composition is located on the tie line.
- The fraction of one phase is computed by taking the length of tie line from the overall alloy composition to the phase boundary for the other phase and dividing by the total tie-line length.
- The fraction of the other phase is determined in the same manner.

- If phase percentages are desired, each phase fraction is multiplied by 100. When the composition axis is scaled in weight percent, the phase fractions computed using the lever rule are mass fractions – the mass (or weight) of a specific phase divided by the total alloy mass (or weight). The mass of each phase is computed from the product of each phase fraction and the total alloy mass.

So option (a, b and d) are the steps of lever rule of determining of phase amounts.

Hence option (a, b and d) are incorrect.

19. Consider the following statements regarding polymeric materials :

1. A plastic material that requires heat to make it formable (plastic) and upon cooling, retains its shape is known as thermosetting plastic.
2. The chemical reaction in which high molecular mass molecules are formed from two or more monomers is called chain polymerization.
3. A polymer chain consisting of two or more types of monomeric units is called copolymer.

Which of the above statements is/are CORRECT ?

(a) 1 and 2 only (b) 2 and 3 only

(c) 2 only (d) 3 only

19. Ans: (d)

Sol: **Thermoplastic (noun):** A plastic material that requires heat to make it formable (plastic) and upon cooling, retains its shape.

Polymerization: The chemical reaction in which high-molecular-mass molecules are formed from monomers.

Copolymer: A polymer chain consisting of two or more types of monomeric units.

Here statement 3 is only correct. Hence option (d) is correct.

ACE® Engineering Academy Since 1995 Leading Institute for ESE/GATE/PSUs x DEEP LEARN

EXCLUSIVE

ONLINE LIVE CLASSES

ENGLISH

CE | ME | EC | EE | CSIT

ESE | GATE | PSUs - 2022/2023

COURSE DETAILS

- For ESE+GATE+PSUs Students
  1. Online Live Classes - Technical Subjects Only.
  2. Recorded Classes - General Studies Subjects (on ACE Deep Learn Platform).
- Recorded version of the online live class will be made available through out the course (with 3 times view).
- Doubt clearing sessions and tests to be conducted regularly.
- 5 to 6 hours of live lectures per day in week days. On Sundays and Public Holidays 6-7 Hours of Live Online Lectures (6 days a week).
- Access the lectures from any where.

New Batch Start from:

24th JULY 2021

DISCOUNTS

- 25% OFF* for ACE Old Students
- 20% OFF* for IIT / NIT, Students
- 15% OFF* for IIIT & Govt. College students

APPSC / TSPSC - AEE (CE)
Batch Date: **19th July, 2021**

GENCO / TRANSCO / DISCOMs
Batch Date: **5th July, 2021**

SSC-JE (General Intelligence)
Batch Date: **2nd July, 2021**

Call: 040-23234418/19/20 | Email: hyderabad@aceenggacademy.com

20. As per mechanical properties, which one of the following microconstituents is soft and ductile ?

(a) Bainite

(b) Martensite

(c) Spheroidite

(d) Tempered martensite

20. Ans: (c)

Sol: **Table:** ***Microstructures and Mechanical Properties for Iron – Carbon Alloys***

Microconstituent	**Phases Present**	**Arrangement of Phases**	**Mechanical Properties (Relative)**
Spheroidite	α-Ferrite + Fe_3C	Relatively small Fe_3C sphere like particles in an α-ferrite matrix	Soft and ductile
Coarse pearlite	α-Ferrite + Fe_3C	Alternating layers of α-ferrite and Fe_3C that are relatively thick	Harder and stronger than spheroidite, but not as ductile as spheroidite
Fine pearlite	α-Ferrite +Fe_3C	Alternating layers of α-ferrite and Fe_3C that are relatively thin	Harder and stronger than coarse pearlite, but not as ductile as coarse pearlite
Bainite	α-Ferrite + Fe_3C	Very fine and elongated particles of Fe_3C in an α-ferrite matrix	Harder and stronger than fine pearlite; less hard than martensite; more ductile than martensite
Tempered martensite	α-Ferrite + Fe_3C	Very small Fe_3C spherelike particles in an α-ferrite matrix	Strong; not as hard as martensite, but much more ductile than martensite
Martensite	Body-centered tetragonal, single phase	Needle-shaped grains	Very hard and very brittle

21. The simultaneous compaction and shaping of a ceramic powder (and binder) by pressure applied uniformly in all directions is known as

(a) Glaze pressing (b) Porcelain pressing

(c) Slip pressing (d) Isostatic pressing

21. Ans: (d)

Sol: **Isostatic pressing:** The simultaneous compaction and shaping of a ceramic powder (and binder) by pressure applied uniformly in all directions.

22. An electric motor drives a punching press. A flywheel fitted to the press has a radius of gyration of 0.5 m and runs at 250 rpm. The press is capable of punching 800 holes per hour with each punching operation taking 1.5 seconds and requiring 12,000 N-m of work. The energy delivered by the motor during punching operation is

(a) 2000 N-m (b) 3000 N-m

(c) 4000 N-m (d) 5000 N-m

22. Ans: (c)

Sol: Radius of gyration (k) = 0.5 m

N = 250 rpm

800 holes per hour

Punching time = 1.5 sec

Energy required = 12,000 N-m

800 holes in 3600 sec

1 hole in $\frac{60\times 60}{800}$ s

Cycle time = 4.5 second

Punching time = 1.5 sec

Total energy required in punching = 1200 N-m

Total energy supplied by motor in a cycle i.e. in 4.5 seconds = 12,00 J

Power of the motor = $\frac{12000}{4.5}$ Watt

Energy supplied by motor during actual punching i.e., 1.5 sec

$\Rightarrow \frac{12000}{4.5}\times 1.5 = 4000$ Joule

23. A linkage has 11 links and 4 loops. What is the degree of freedom if it has only single turning pairs?

(a) 0 (b) 1 (c) 2 (d) 3

23. Ans: (c)

Sol: Degree of freedom (DOF) = N – (2L + 1) = 11 – (2×4 +1) = 2

24. Which one of the following is the application of first inversion of single-slider-crank chain ?

(a) Hand-pump

(b) Reciprocating engine

(c) Elliptical trammel

(d) Whitworth quick-return mechanism

24. Ans: (b)

Sol: Reciprocating engine is first inversion of single slider crank chain.

25. Consider the following statements regarding cams :

1. A cam in which the follower moves radially from the centre of rotation of the cam is known as a disc cam.
2. A globoidal cam is a double-disc cam, the two discs being keyed together and are in constant touch with the two rollers of a follower.
3. A conjugate cam can have two types of surfaces, convex or concave.
4. In a spherical cam, the follower oscillates about an axis perpendicular to the axis of rotation of the cam.

Which of the above statements are correct ?

(a) 1 and 4 only (b) 2 and 4 only

(c) 2 and 3 only (d) 1, 2, 3 and 4

25. Ans: (a)

Sol:

- Conjugate cam is a double disc cam, the two discs being keyed together and are in constant touch with the two rollers of a follower.
- Globoidal cam can have two types of surfaces, convex or concave. A circumferential contour is cut on the surface of the rotation of the cam to impart motion to the follower which has an oscillatory motion.

26. Under which of the following conditions is Coriolis component encountered in the relative acceleration of two points ?

1. The two points are coincident, but on different links.
2. The point on one link traces a path on the other link.
3. The link that contains the path rotates.

Select the correct answer using the code given below :

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

26. Ans: (d)

Sol: Coriolis component is encountered in the relative acceleration of two points when

- The two points are coincident, but on different links.
- The point on one link traces a path on the other link.
- The link that contains the path rotates.

27. A mass 'm' attached to a light spring oscillates with a period of 2 seconds. If the mass is increased by 2 kg, the period increases by 1 second. What is the value of the mass ?

(a) 0.9 kg (b) 1.6 kg (c) 2.1 kg (d) 2.7 kg

27. Ans: (b)

Sol: Time period (T) = 2 sec

$m' = m + 2$

$T' = 3s, \quad m = ?$

$$T = 2\pi\sqrt{\frac{m}{K}}$$

$$T' = 2\pi\sqrt{\frac{m'}{K}}$$

$$\frac{T}{T'} = \sqrt{\frac{m}{K}} \times \sqrt{\frac{K}{m'}}$$

$$\Rightarrow \frac{2}{3} = \sqrt{\frac{m}{m+2}}$$

$$\Rightarrow \frac{4}{9} = \frac{m}{m+2}$$

$$\Rightarrow 4m + 8 = 9m \quad \Rightarrow 5m = 8$$

$$\Rightarrow m = 1.6 \text{ kg}$$

28. What is the critical speed of the shaft if its natural frequency of transverse vibration is 2.85 Hz ?

(a) 171 rpm (b) 285 rpm

(c) 570 rpm (d) 142.5 rpm

28. Ans: (a)

Sol: $f_n = 2.85$ Hz

$\omega_n = 2\pi f_n$

$= 2 \times \pi \times 2.85 = 17.898$ rad/s

$$N = \frac{60 \times \omega_n}{2\pi}$$

$$= \frac{60 \times 17.898}{2\pi} = 171 \text{ rpm}$$

29. Consider the following statements regarding gears :

1. The ratio of number of teeth on the gear to that on the pinion is known as gear ratio.
2. The circle passing through the tips of teeth is called dedendum circle.
3. The circle passing through the roots of teeth is called addendum circle.
4. Backlash is the difference between the space width and the tooth thickness along the pitch circle.

Which of the above statements are correct ?

(a) 1, 2 and 3 only (b) 1 and 4 only

(c) 2 and 3 only (d) 1, 2, 3 and 4

29. Ans: (b)

Sol: The correct statements are :

- The circle passing through tip of teeth is called addendum circle
- The circle passing through roots of teeth is called dedendum circle.

30. The number of teeth of a spur gear is 30 and it rotates at 200 rpm. What is the pitch line velocity if it has a module of 2 mm ?

(a) 341.7 mm/s (b) 497.2 mm/s

(c) 628.3 mm/s (d) 758.5 mm/s

30. Ans: (c)

Sol: Pitch line velocity,

$$V = \frac{\pi dN}{60} = \frac{\pi \times (m \times T) \times N}{60} = \frac{\pi \times 2 \times 30 \times 200}{60} = 628.3 \text{ mm/s}$$

31. Which one of the following lubricants is used in forward hot extrusion of steel ?

(a) Molten glass

(b) Soap solution

(c) Copper sulphate

(d) Vegetable oil

31. Ans: (a)

Sol: **Forward Hot extrusion:**

The forward hot extrusion, signifying the flow of metal in the forward direction, i.e., the same as that of the ram. In forward extrusion, the problem of friction is prevalent because of the relative motion between the heated metal billet and the cylinder walls. This is particularly severe in the case of steels because of their higher extrusion temperatures. To reduce this friction, lubricants are to be used. At lower temperatures, a mixture of oil and graphite is generally used. The problem of lubrication gets compounded at the higher operating temperatures. *Molten glass is generally used for extruding steels.* This stays in liquid form at the operating temperature and provides necessary heat insulation to the hot metal billet in addition to lubrication. To reduce the damage to equipment, extrusion is finished quickly and the cylinder is cooled before further extrusion.

32. Which one of the following statements is not the correct statement regarding operating characteristics (OC) curve for sampling plan ?

(a) It shows ability to distinguish between good and bad lots.

(b) No sampling plans can give complete protection against acceptance of defectives.

(c) Larger the sample size, steeper is the slope of the curve.

(d) Acceptance number is zero for ideal sampling plan.

32. Ans: (d)

Sol: Acceptance number need not be ‘zero’ for ideal sampling plan.

ACE Engineering Academy Leading Institute for ESE/GATE/PSUs Since 1995 x DEEP LEARN

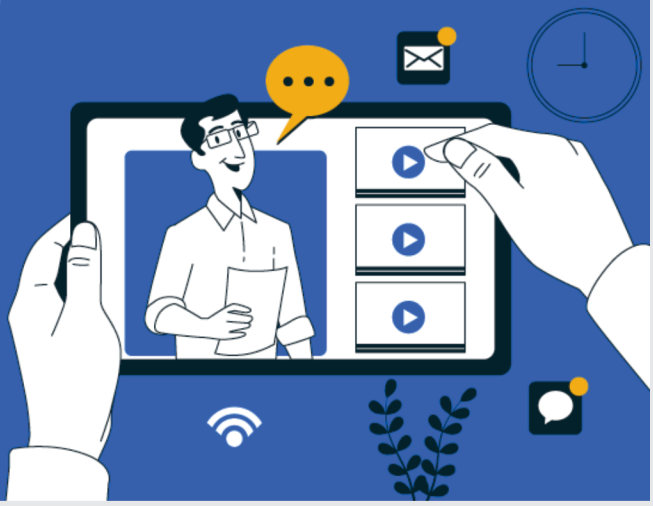
ACE | DEEP LEARN

Now Deep Learn Pre-Recorded Videos are Available in:

हिंदी + English (Hinglish)

for **GATE (ECE | EEE)** Technical

Launching Soon: GATE (ME | CE)
*Subjects are being released in sequence



ACE x DEEP LEARN

Pre-Recorded Classes*

GENCO / TRANSCO DISCOMs

** Offer price: without stuty material

REC

Pre-Recorded Classes

APPSC / TSPSC (AEE)

GENERAL STUDIES | **TECHNICAL (CIVIL)**

GET **20% DISCOUNT**

USE CODE
TSPSC20

Valid till 31st July, 2021

EEE Launching Soon

* Subjects are being released in sequence

33. Which one of the following statements is ***not*** correct for forward or direct extrusion process ?

(a) High friction forces must be overcome.

(b) High extrusion forces are required but mechanically simple and uncomplicated.

(c) Low scrap or material waste only 5 - 6% of billet weight.

(d) Simple, but the material must slide along the chamber wall.

33. Ans: (c)

Sol: Comparison between direct extrusion and indirect extrusion:

Sl.No.	Forward or direct extrusion	Backward or indirect extrusion
1.	The flow of metal is in the same direction as the movement of ram.	In this case the metal flows in the opposite direction to the movement of ram.
2.	High friction forces must be overcome.	Low friction forces are generated as the mass of material does not move.
3.	High extrusion forces required but mechanically simple and uncomplicated.	25-30% less extruding force required as com-pared to direct extrusion. But hollow ram required limited application.
4.	High scrap or material waste about 18-20% on an average.	Low scrap or material waste, only 5-6% of billet weight.

From the above table it is very clear that option (c) is not correct.

34. Consider the following statements regarding defects in forgings :

1. Flakes are internal breaks or ruptures occurring in some grades of alloy steel.

2. Die shift is caused by misalignment between the top and bottom forging dies.

3. Fins and rags are small projections or loose metal driven into the surface of the forging.

Which of the above statements are CORRECT ?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

34. Ans: (d)

Sol: **Flakes:** Flakes are internal breaks or ruptures occurring in some grades of alloy steel. These are caused by too rapid a cooling from forging temperature.

Die shift: Die shift is caused by misalignment between the top and bottom forging dies. This may be caused due to loose wedges.

Fins and rags: Fin and rags are small projections or loose metal driven into the surface of the forging.

Hence given all three statements are correct . So option (d) is correct.

35. Consider the following statements regarding desirable properties of cutting fluid :

1. It should get oxidised when left in air.
2. It should react with the materials of machine tool parts.
3. It should wet the surface of cutting tool and workpiece.

Which of the above statements is/are CORRECT ?

(a) 2 only (b) 3 only

(c) 2 and 3 only (d) 1, 2 and 3

35. Ans: (b)

Sol: Essential properties of cutting fluids to enable the cutting fluid fulfill its functional requirements without harming the Machine – Fixture – Tool – Work (M-F-T-W) system and the operators, the cutting fluid should possess the following properties:

- ✓ For cooling :
  - high specific heat, thermal conductivity and film coefficient for heat transfer
  - spreading and wetting ability
- ✓ For lubrication :
  - high lubricity without gumming and foaming
  - wetting and spreading
  - high film boiling point
  - friction reduction at extreme pressure (EP) and temperature
- ✓ Chemical stability, non-corrosive to the materials of the M-F-T-W system
- ✓ less volatile and high flash point
- ✓ high resistance to bacterial growth
- ✓ Odourless and also preferably colourless
- ✓ non toxic in both liquid and gaseous stage
- ✓ easily available and low cost.

36. Consider the following statements regarding limits and fits :

1. Actual size is the standard size for the part and is the same both for the hole and its shaft.
2. Basic size is the dimension as measured on the manufactured part.
3. Deviation is the algebraic difference between a size and the corresponding basic size.

Which of the above statements is/are CORRECT ?

(a) 3 only (b) 1 and 3 only

(c) 2 only (d) 1, 2 and 3

36. Ans: (a)

Sol: **Basic size:** This is the size in relation to which all limits of size are derived. Basic or nominal size is defined as the size based on which the dimensional deviations are given. This is, in general, the same for both components.

Deviation: It is the algebraic difference between a size and its corresponding basic size. It may be positive, negative, or zero.

Normally, tolerances are specified to indicate the actual size or dimension of a feature such as a hole or a shaft. Given statement (3) is Correct. Hence option (a) is correct.

37. Which of the following statements is not correct about PERT ?

(a) Network is constructed based on the events.

(b) It does not take uncertainties involved in the estimation of times.

(c) Network deals with uncertainties and hence three time estimations are considered.

(d) As there is no certainty of time, activity duration cannot be reduced.

37. Ans: (b)

Sol: PERT deals with un-certain time phases.

38. Parallel misalignment is present when

(a) two shafts are parallel to each other but are not in the same plane.

(b) two shafts are parallel to each other and are in the same plane.

(c) the shafts are not parallel to each other.

(d) the shafts are aligned with each other.

38. Ans: (b)

Sol: Parallel vertical misalignment occurs when the motor shaft is moved vertically away from the pump shaft, but both shafts still operate in the same vertical plane and parallel.

39. The major limitation with displacement or proximity probes is

(a) Size (b) Time (c) Accuracy (d) Cost

39. Ans: (d)

Sol: The major limitation with displacement or proximity probes is cost. The typical cost for installing a single probe, including a power supply, signal conditioning, etc.

40. Which one of the following contains design data on all products, e.g., their constituent components and parts ?

(a) Engineering data master file

(b) Process data master file

(c) Inventory master file

(d) Sales master file

40. Ans: (a)

Sol: Engineering data master file (BOM) specifies design data and product structure.

41. Which one of the following is the cutter with a curved tooth outline of the same shape as the profile of the workpiece ?

(a) Plain milling cutter (b) Face milling cutter

(c) End milling cutter (d) Profile milling cutter

41. Ans: (d)

Sol: Profile milling is a common milling operation. Round inserts and concepts with radius are milling cutters used for roughing and semi-roughing while ball nose end mills are milling cutters used for finishing and super-finishing.

42. Which one of the following is a joining process that may employ acetylene, natural gas, butane in combination with oxygen to supply the heat required to melt the filler rod and diffuse it into the surface of the base metal ?

(a) Furnace brazing (b) Torch brazing

(c) Induction brazing (d) Dip brazing

42. Ans: (b)

Sol: **Torch Brazing:** A joining process that may employ acetylene, natural gas, butane or propane in combination with air or oxygen to supply the heat required to melt the filler rod and diffuse it into the surface of the base metal. This technique is not extensively used for continuous mass production. Flux used is in the form of paste or powder.

43. Consider the following statements regarding modulation :

1. The modulation is essential in communication systems, where a weak signal is transmitted by the use of a carrier signal.
2. When the frequency of the high frequency signal is varied in accordance with the intensity of the low-frequency weak signal, the modulation is said to be frequency modulation.
3. The process of recovering original baseband signal from the modulated signal is called phase modulation.

Which of the above statements are CORRECT ?

(a) 1 and 3 only

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

43. Ans: (b)

Sol:

- Modulation is a process of changing the parameters of a high frequency signal called carrier signal, with respect to the intensity of a given weak signal called original baseband signal or modulating signal. The high frequency signal is usually a sinusoidal signal. The parameters are simply the amplitude, frequency and phase. The modulation is essential in communication systems, where a weak signal is transmitted by the use of a carrier signal. So statement (1) is CORRECT.
- There are many forms of modulation such as Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM). When a high frequency signal has an amplitude varied in response to the intensity (amplitude) of a low-frequency weak signal the modulation is said to be AM. When the frequency of the high frequency signal is varied in accordance with the intensity of the low-frequency weak signal the modulation is said to be FM. So statement (2) is CORRECT.
- Similar definition can also be given for PM. The modulation processes are essentially used for broadcast communication because the high frequency carrier signal are efficient for radiation. The process of recovery of original baseband signal from the modulated signal is called demodulation. So statement (3) is INCORRECT. Hence option (b) is Correct.

ACE Engineering Academy
Leading Institute for ESE/GATE/PSUs
Since 1995
x DEEP LEARN

GATE - 2022

ONLINE TEST SERIES

AVAILABLE NOW

No. of Tests 65
+
Free 52 Practice Tests of GATE - 2021 Online Test Series
Total Tests 117

- GATE 2021 Online Test Series will be available on 15th APRIL 2021
- Offer starts from 21st June 2021 to 20th July 2021

GATE + ESE (Prelims) 2022

COMBINATION PACK

ONLINE TEST SERIES

AVAILABLE NOW

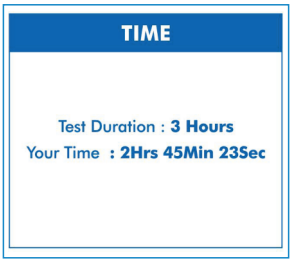
No. of Tests 65
+
Free 52 Practice Tests of GATE - 2021 Online Test Series
Total Tests 117

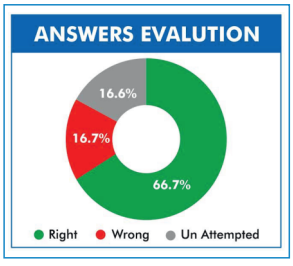
- GATE 2021 Online Test Series will be available on 15th APRIL 2021
- ESE 2022 Prelims, the number of tests and schedule will be updated once notification released
- Offer starts from 21st June 2021 to 20th July 2021

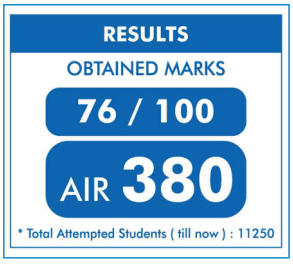
HIGHLIGHTS

- Detailed Solutions are Available.
- Video Solutions are Available for Difficult Questions.
- All India rank will be given for each test.
- Comparison with all India toppers of ACE student.

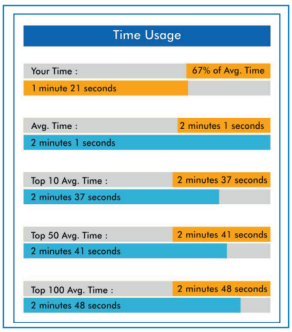
TEST WISE STATISTICS:

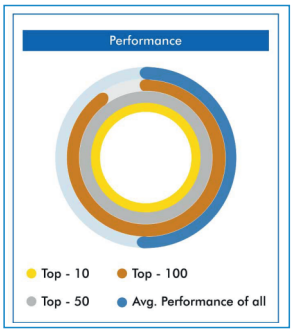


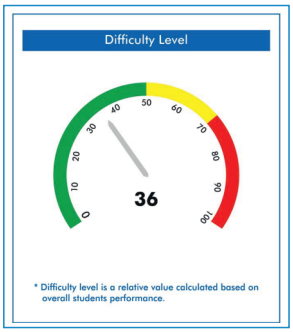




QUESTION WISE STATISTICS:







44. Consider the situation where a microprocessor gives an output of an 8-bit word. This is fed through an 8-bit digital-to-analog converter to a control valve. The control valve requires 6.0 V to be fully open. If the fully open state is indicated by 11111111, then what is the output to the valve for a change of 1 bit ?

(a) 0.033 V (b) 0.053 V (c) 0.043 V (d) 0.023 V

44. Ans: (d)

Sol: The output voltage will be divided into 2^8 intervals. Since there is to be an output of 6.0 V when the output is 2^8 of these intervals, a change of 1 bit is a change in the output voltage of $6.0/2^8 = 0.023$ V.

45. Which one of the following is ***not*** an application of Hall effect sensor ?

(a) Magnetic switch for electric transducer

(b) Measurement of current

(c) Measurement of acceleration

(d) Measurement of power

45. Ans: (c)

Sol: Applications of Hall Effect Sensor

- It is used as a magnetic switch for electric transducer.
- It is used for the measurement of the position, displacement and proximity.
- It is used for measurement of current.
- It is used for measurement of power.

46. A man whose weight is 650 N, standing on the ground, raises a load of 3000 N by means of single string system of pulleys. There are six light pulleys in each block. The thrust of the man on the ground is

(a) 120 N (b) 135 N (c) 150 N (d) 175 N

46. Ans: (c)

Sol:

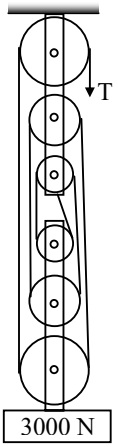
T = Force exerted by man

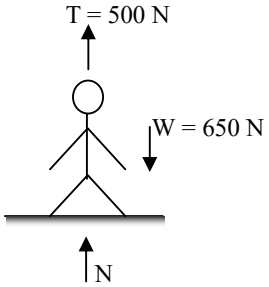
$$\therefore T = \frac{3000}{6} = 500\text{N}$$

FBD for man :

$\therefore$ N = W – T

N = 650 – 500 = 150 N





47. A particle starts with an initial velocity of 200 cm/s and moves with a uniform retardation of 10 cm/s^2. If it describes 1500 cm in time t, what is/are the possible value(s) of t ?

(a) 10 sec only (b) 10 sec and 30 sec

(c) 30 sec only (d) 5 sec and 10 sec

47. Ans: (a)

Sol: Distance travelled = 1500 cm

$$S = ut + \frac{1}{2}at^2$$

$$1500 = 200 \times t + \frac{(-10)}{2} \times t^2$$

$$\therefore 5t^2 - 200t + 1500 = 0$$

$$t^2 - 40t + 300 = 0$$

$$t^2 - 30\,t - 10\,t + 300 = 0$$

$$t\,(t - 30) - 10\,(t - 30) = 0$$

$$\Rightarrow \; t = 30 \text{ or } 10 \text{ sec}$$

Note: Since, particle stops at t = 20 sec. After 20 sec particle is at rest hence answer is t = 10 sec.

48. Consider the following statements for system of forces :

1. Two or more forces that act at the same point are called coplanar forces.
2. Two or more forces whose directed arrows lie in same plane are called concurrent forces.
3. Varignon's theorem states that 'the moment of several concurrent coplanar forces about any point O in their plane equals the moment of their resultant about the point O'.
4. Lami's theorem states that if a body is in equilibrium under the action of three forces, each force is proportional to the sine of angle between the other forces.

Which of the above statements are correct ?

(a) 1, 2 and 4 only (b) 1 and 4 only

(c) 3 and 4 only (d) 1, 2 and 3 only

48. Ans: (c)

Sol: (i). If the lines of action of all forces lie in same plane, the forces are called as coplanar forces.

$\therefore$ 1 is wrong.

Check options $\Rightarrow$ a, b & d should be wrong as they contain 1. $\therefore$ Answer is option (c)

(ii) Two or more forces act at the same point are called concurrent forces.

49. Consider the following statements related to stress and strain :

1. Shear stress is always tangential to the area over which it acts.
2. Shear stresses on the transverse pair of faces are known as complimentary shear stresses.
3. Shear strain is defined as the change in the right angle of the element measured in radians.
4. Modulus of rigidity is the ratio of shear strain to shear stress.

Which of the above statements are correct ?

(a) 1, 3 and 4 only (b) 2 and 4 only (c) 3 and 4 only (d) 1, 2 and 3 only

49. Ans: (d)

Sol: Following statements are true related to stress & strain :

- Shear stress is always tangential to the area over which it acts.
- Shear stresses on the transverse pair of faces are known as complimentary shear stresses.
- Shear strain is defined as the change in the right angle of the element measured in radians.
- Modulus of rigidity, $G = \frac{\text{shear stress}}{\text{shear strain}}$

50. Consider the following statements for stress and strain analysis :

1. The stress components on any inclined plane can easily be found with the help of a geometrical construction known as Mohr's stress circle.
2. The ratio of longitudinal strain to lateral strain is known as Poisson's ratio.
3. When a body is acted upon by three mutually perpendicular forces, there is change in the volume of the body which is referred to as dilation of the material.
4. The ratio of original volume to increase in volume is known as volumetric strain.

Which of the above statements are correct ?

(a) 1 and 3 only (b) 2 and 4 only (c) 3 and 4 only (d) 1, 2, 3 and 4

50. Ans: (a)

Sol: Following statements are true for stress and strain analysis :

- The stress components on any inclined plane can easily be found with the help of a geometrical construction known as Mohr's stress circle.
- When a body is acted upon by three mutually perpendicular forces, there is change in the volume of the body which is referred to as dilation of the material.
- Poisson's ratio $= \frac{-(\text{lateral strain})}{\text{longitudinal strain}}$
- Volumetric strain, $\varepsilon_v = \frac{\delta v}{v} = \frac{\text{Change in volume}}{\text{Original volume}}$

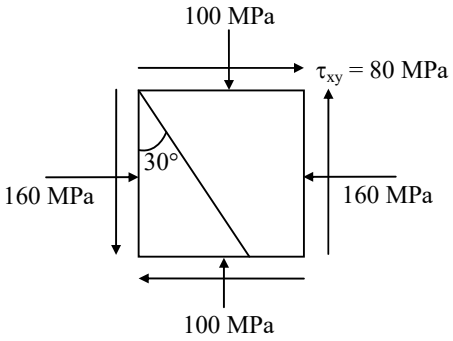
51. The stresses on two perpendicular planes through a point in a body are 160 MPa and 100 MPa, both compressive, along with a shear stress of 80 MPa. What is the normal stress on a plane inclined at 30° to the plane of 160 MPa stress ?

(a) – 42.4 MPa (b) –75.7 MPa

(c) – 59.1 MPa (d) – 86.3 MPa

51. Ans: (b)

Sol:



$\sigma_x = -160$ MPa, $\sigma_y = -100$ MPa, $\tau_{xy} = 80$ MPa , $\theta = 30°$

$$\sigma_{30^\circ} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$= \frac{-160 - 100}{2} + \frac{-160 + 100}{2}\cos 60^\circ + 80\sin 60^\circ$$

$$= -130 - 15 + 69.28$$

$\sigma_{30^\circ} = -75.717$ MPa

52. Consider the following statements regarding types of supports and beams :

1. When both supports of beams are roller supports, the beam is known as simply supported beam.
2. A beam with one end fixed and the other end free is known as fixed beam.
3. A beam with both ends fixed is known as cantilever beam.
4. A beam with one end fixed and the other simply supported is known as propped cantilever.

Which of the above statements is/are correct ?

(a) 1 only

(b) 1 and 4 only

(c) 1, 3 and 4 only

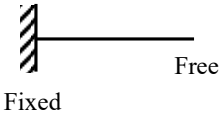
(d) 2, 3 and 4 only

52. Ans: (b)

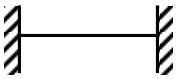
Sol:

- Simply supported beam

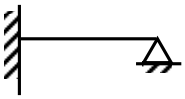
- Cantilever beam



- Fixed beam



- Propped cantilever



53. Consider the following statements regarding stress in beam :

1. If a member is subjected to equal and opposite couples acting in the same longitudinal planes, the member is said to be in pure bending.
2. The internal stresses developed in the beam are known as flexural stresses.
3. There is an intermediate surface known as neutral surface, at which the stress is zero.
4. An axis obtained by intersection of the neutral surface and a cross-section is known as neutral axis.

Which of the above statements are correct ?

(a) 2 and 3 only (b) 1 and 4 only

(c) 3 and 4 only (d) 1, 2, 3 and 4

53. Ans: (d)

Sol: Following statements are correct regarding stress in beam :

- If a member is subjected to equal and opposite couples acting in the same longitudinal planes, the member is said to be in pure bending.
- The internal stresses developed in the beam are known as flexural stresses.
- There is an intermediate surface known as neutral surface, at which the stress is zero.
- An axis obtained by intersection of the neutral surface and a cross-section is known as neutral axis.

54. Consider the following statements for the symmetric beam under pure bending :

1. In the elastic range, the normal stress varies linearly with the distance from the neutral surface.
2. As long as the stresses remain in the elastic range, the neutral axis passes through the centroid of the section.
3. If stresses are in the plastic range, the neutral axis passes through the centroid of the section.

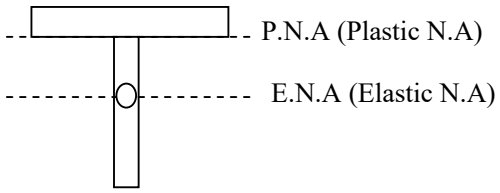
Which of the above statements is/are correct ?

(a) 1 only (b) 2 only

(c) 1 and 2 only (d) 2 and 3 only

54. Ans: (c)

Sol: Plastic neutral axis may not pass through centroid of the section.



55. The volume of FCC unit cell in terms of the atomic radius R is

(a) $V_c = 16R^3\sqrt{3}$ (b) $V_c = 8R^3\sqrt{2}$

(c) $V_c = 16R^3\sqrt{2}$ (d) $V_c = 8R^3\sqrt{3}$

55. Ans: (c)

Sol: In the FCC unit cell (figure) illustrated, the atoms touch one another across a face-diagonal, the length of which is 4R. Because the unit cell is a cube, its volume is a^3, where a is the cell edge length. From the right triangle on the face,

$$a^2 + a^2 = (4R)^2$$

Or, solving for a,

$$a = 2R\sqrt{2}$$

The FCC unit cell volume V_C may be computed from

$$V_C = a^3 = \left(2R\sqrt{2}\right)^3 = 16R^3\sqrt{2}$$

56. Which one of the following alloying ingredients increases the harden ability and forms carbides for wear resistance?

(a) Chromium (b) Molybdenum

(c) Nickel (d) Manganese

56. Ans: (b)

Sol: **Chromium** (Cr) improves strength, hardness, wear resistance, and hot hardness. It is one of the most effective alloying ingredients for increasing hardenability. In significant proportions, Cr improves corrosion resistance. So option (a) is incorrect.

Molybdenum (Mo) increases toughness and hot hardness. It also improves harden ability and forms carbides for wear resistance. So option (b) is correct.

Nickel (Ni) improves strength and toughness. It increases hardenability but not as much as some of the other alloying elements in steel. In significant amounts it improves corrosion resistance and is the other major ingredient (besides chromium) in certain types of stainless steel. So option (c) is incorrect.

Manganese (Mn) improves the strength and hardness of steel. When the steel is heat treated, hardenability is improved with increased manganese. Because of these benefits, manganese is a widely used alloying ingredient in steel. . So option (b) is incorrect.

Vanadium (V) inhibits grain growth during elevated temperature processing and heat treatment, which enhances strength and toughness of steel. It also forms carbides that increase wear resistance.

57. Which one of the following related to the most stable arrangement of atoms in a crystal is ***not*** correct?

(a) Preserves electrical neutrality

(b) Maximizes strong ion-ion repulsion

(c) Satisfies discreteness of all covalent bonds

(d) Packs the atoms as closely as possible

57. Ans: (d)

Sol: Stable arrangement of atoms in a crystal may not give close packing of atoms.

Ex: In diamond, carbon atoms are arranged in stable but packing fraction is 0.34 only

58. The dielectric constant of rubber varies between

(a) 0.5 and 1.0

(b) 1.0 and 1.5

(c) 1.5 and 2.0

(d) 2.5 and 5.0

58. Ans: (d)

Sol: **Rubber:** These are organic polymers and may be natural or synthetic. The natural rubber obtained from rubber tree has limited applications due to its resistance to low and high temperatures. The

synthetic rubbers are produced artificially by copolymerisation of isobutylene and isoprene. These have good electrical and thermal properties. *The dielectric constant of rubber varies between 2.5 and 5*, and loss tangent between 0.01 and 0.03. Rubber's are used as an insulating material for electric wires, tapes, cables, coatings, motor windings, transformers, etc.

Gaseous dielectrics, e.g. nitrogen, hydrogen, etc. have dielectric constant 1.0. The best dielectrics are polystyrene, polycarbonate, polyethylene, polymide, mineral oil, pure alumina and pure silica.

59. Consider the following statements for ductile fracture:

1. The material undergoes substantial plastic deformation with high energy absorption before fracture.
2. Presence of cracks on the surface of material initiates this type of failure.
3. Fracture occurs due to necking.

Which of the above statements is/are CORRECT?

(a) 1 only (b) 1 and 2 only

(c) 2 and 3 only (d) 1 and 3 only

59. Ans: (d)

Sol: *Ductile fracture:* In ductile fracture the material undergoes substantial plastic deformation with high energy absorption before fracture and so the toughness value of ductile materials is high. Fracture occurs in these materials due to necking. Examples are metals and alloys.

60. The TTT diagram shows the times required for isothermal transition from

(a) austenite to pearlite.

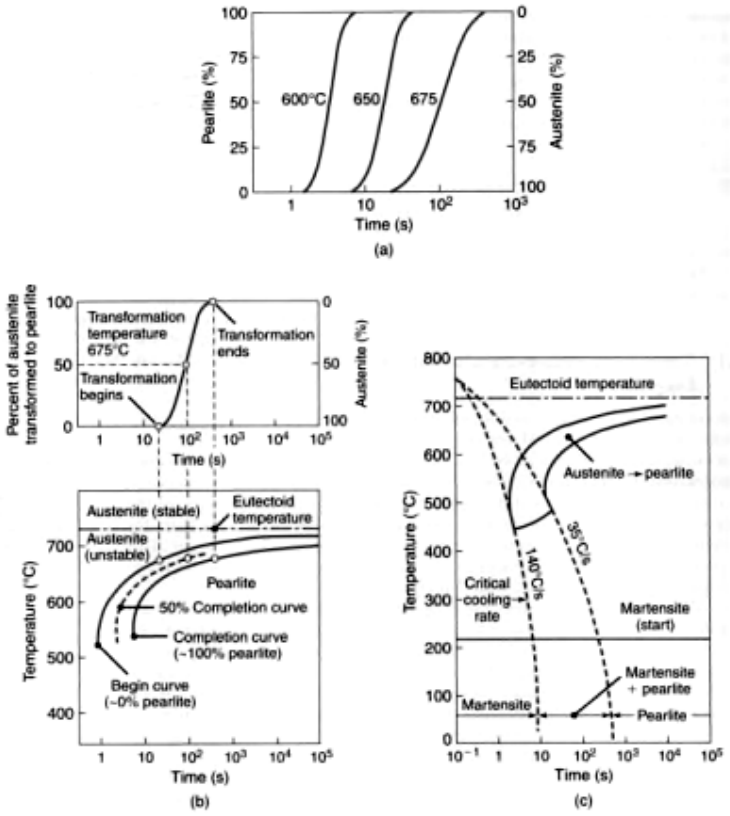
(b) austenite to ferrite.

(c) ferrite to pearlite.

(d) martensite to pearlite.

60. Ans: (a)

Sol: The percentage of austenite transformed into pearlite is a function of temperature and time (Fig. a). This transformation is best illustrated by Figs. b and c in diagrams called isothermal transformation (IT) diagrams, or time–temperature–transformation (TTT) diagrams, constructed from the data given in Fig. a



(a) Austenite-to-pearlite transformation of iron–carbon alloy as a function of time and temperature.

(b) Isothermal transformation diagram obtained from (a) for a transformation temperature of 675°C.

61. Consider the following statements regarding mechatronics systems:

1. The anti-lock brakes on a car are a simple example of a real time computing systems
2. The completion of an operation after its deadline is considered useless in soft real time system.
3. The hard real time system tolerates lateness and may respond with decreased service quality.

Which of the above statements is/are CORRECT ?

(a) 1 only (b) 2 and 3 only

(c) 3 only (d) 1, 2 and 3

61. Ans: (a)

Sol: Real-Time Mechatronics Systems

Real time control and computing is the study of hardware and software systems which are subject to a "real-time constraint". A real-time system is one for which there is an operational deadline from event to system response.

A system is said to be a real-time system if there is total correctness of an operation. This depends upon not only the operation's logical correctness, but also the time in which it is performed and used. It may be the point where the operation's application can be considered (within context) to be mission critical. The anti-lock brakes on a car are a simple example of a real-time computing system - the real-time constraint in this system is the short time in which the brakes must be released to prevent the wheel from locking.

There are two types of real-time systems:

1. **Hard Real-time System:** In this the completion of an operation after its deadline is considered useless. (e.g., car engine control system as a delayed signal may cause engine failure or damage).
2. **Soft Real-time System:** It tolerates such lateness, and may respond with decreased service quality. (e.g., dropping frames while displaying a video).

62. Which one of the following materials has least piezoelectric charge sensitivity ?

(a) Quartz (b) Barium Titanate

(c) PZT (d) PVDF

62. Ans: (a)

Sol: The charge sensitivity depends on the material concerned and the orientation of its crystals. Quartz has a charge sensitivity of 2.2 pC/N when the crystal is cut in one particular direction and the forces applied in a specific direction; barium titanate has a much higher charge sensitivity of the order of 130 pC/N and lead zirconate-titanate about 265 pC/N.

63. The ideal hydraulic rotary actuator provides shaft torque, T, which is

(a) equal to displaced volume measured.

(b) inversely proportional to the displaced volume measured.

(c) proportional to the differential pressure.

(d) inversely proportional to the differential pressure.

63. Ans: (c)

Sol: The ideal hydraulic rotary actuator provides shaft torque, T, which is proportional to the differential pressure, ΔP, across the servo valve.

$$T = k D \Delta P$$

where, k = proportionality constant relating torque and differential pressure

D = displaced volume measured in mm^3

TSPSC

ASSISTANT EXECUTIVE ENGINEERS

ACE Engineering Academy (Since 1995) Leading Institute for ESE/GATE/PSUs x DEEP LEARN

ONLINE TEST SERIES

No. of Tests: 30
Subject wise : **22**
Full Length Mock Tests : **8**

ACE Engineering Academy (Since 1995) Leading Institute for ESE/GATE/PSUs x DEEP LEARN

ESE - 2021 MAINS TEST SERIES

No. of Tests: 10
(Subject wise:6, Mock Tests: 4)

Free for all ESE 2021 Prelims Qualified Students

Commencing from
28th August, 2021

All Tests will be conducted in **QCAB format**

Call: 040-48539866 / 40136222
Email: testseries@aceenggacademy.com

64. An ammeter requires a change of 3 A in its coil to produce a change in deflection of the pointer by 12 mm. What is the static sensitivity ?

(a) 36 mm/A (b) 9 mm/A

(c) 4 mm/A (d) 15 mm/A

64. Ans: (c)

Sol: Static sensitivity, $K = \frac{\text{Change of output signal}}{\text{Change of input signal}} = \frac{12}{3} = 4 \text{ mm/A}$

65. What is the force needed to apply to a piston of 2 cm radius in order to result a force of 6000 N at the working piston of radius 6 cm ?

(a) 1334 N (b) 333 N

(c) 1050 N (d) 667 N

65. Ans: (d)

Sol: Given data,

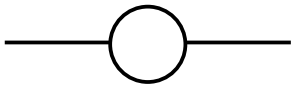
$F = 6000 \text{ N}, \ d_1 = 2 \text{ cm}, d_2 = 6 \text{ cm}$

We know, $F_2 = F_1 \times \frac{d_2^2}{d_1^2}$

The force needed to apply to the forcing piston,

$$F_1 = F_2 \times \frac{d_1^2}{d_2^2} = 6000 \times \frac{2^2}{6^2} = 667 \text{ N}$$

66. The following symbol in the ladder logic represents :



(a) Normally open contacts

(b) Normally closed contacts

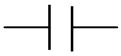
(c) Output loads

(d) Special instruction

66. Ans: (c)

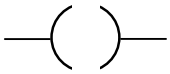
Sol:

Ladder symbols



Input as contacts not closed until input

Input as contacts which are closed until input



Output

Special instruction

67. The settling time for a unit step response of a second-order system is

(a) proportional to the natural frequency.

(b) inversely proportional to the natural frequency.

(c) equal to the damping ratio.

(d) proportional to the damping ratio.

67. Ans: (b)

Sol: Settling time of a system is inversely proportional to natural frequency.

68. A typical wrist mechanism with three rotational joints would be indicated by

(a) TRL (b) TRT

(c) LLL (d) TRR

68. Ans: (d)

Sol: The notation system can be expanded to include wrist motions by designating the two or three (or more) types of wrist joint. The notation starts with the joint closest to the arm interface, and proceeds to the mounting plate for the end effector. Wrist joints are predominantly rotating joints of type R and T. Hence, a typical wrist mechanism with three rotational joints would be indicated by TRR. This notation is simply added to the notation for the arm and body configuration. For example, a polar coordinate robot with a three-axis wrist might be designated as TRL: TRT.

69. The Analog-to-Digital conversion process involves :

1. Quantizing
2. Sampling
3. Encoding

What is the correct sequence ?

(a) 2-1-3 (b) 2-3-1 (c) 3-1-2 (d) 3-2-1

69. Ans: (a)

Sol: A/D conversion consists of three phases: sampling, quantization, and encoding.

Directions: *Each of the next six (06) items consists of two statements, one labelled as 'Statement (I)' and the other labelled as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :*

Codes :

(a) Both Statement (1) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

(b) Both Statement (I) and Statement (II) are individually true, but Statement (II) is not the correct explanation of Statement (I).

(c) Statement (I) is true, but Statement (II) is false.

(d) Statement (I) is false, but Statement (II) is true.

70. **Statement (I):** Gravity is the driving force behind flows through open channels.

Statement (II): Gravity stands to reason that the ratio of inertial to gravitational forces will play a major role in open channel flow analysis.

70. Ans: (b)

Sol: Both Statement (I) and Statement (II) are individually true, but Statement (II) is not the correct explanation of Statement (I).

71. **Statement (I):** The viscosity of liquids decreases with the increase of temperature while the viscosity of gases increases with the increase of temperature.

Statement (II): The viscous forces in a fluid are due to cohesive forces and molecular momentum transfer.

71. Ans: (b)

Sol: Both Statement (I) and Statement (II) are individually true, but Statement (II) is not the correct explanation of Statement (I).

72. **Statement (I):** If two systems are in thermal equilibrium with a third system, then they are not in thermal equilibrium with each other.

Statement (II): Zeroth law of thermodynamics is the basis for temperature.

72. Ans: (d)

Sol: Statement (I) is violation of zeroth law.

73. **Statement (I):** A thermal energy reservoir is a system that always remains at constant temperature even though the heat is added to or removed from it.

Statement (II): A thermal reservoir that supplies heat energy is called sink and one that absorbs the heat energy is called source.

73. Ans: (c)

Sol: Statement (II) is false as reservoir which supplies heat energy is called source.

74. **Statement (I):** Wear is an issue whenever two components operate with relative motion between them or when liquids or solids impinge on a surface at high velocity.

Statement (II): Wear is often cumulative and can eventually render the components incapable of delivering their expected performance.

74. Ans: (b)

Sol: Definition of wear by ASTM: 'Damage to a solid surface, generally involving progressive loss of material due to relative motion between the surfaces and a contacting substance or substances'.

75. **Statement (I):** Increased productivity, reduced cost of labour and improved quality can be achieved by automation.

Statement (II): Due to automation in process inventory, dependence on operator skills may be increased.

75. Ans: (c)

Sol: Due to automation, dependence on operator skills never be increased.

76. In various solar energy storage systems, pumped hydro-electric storage system falls under which one of the following categories ?

(a) Thermal energy storage

(b) Electrical energy storage

(c) Mechanical energy storage

(d) Electromagnetic energy storage

76. Ans: (c)

Sol: Pumped hydro-electric storage system falls under mechanical energy storage.

77. What is the standard value of solar constant adopted by World Radiation Centre ?

(a) 1192 W/m^2 (b) 1084 W/m^2

(c) 1927 W/m^2 (d) 1367 W/m^2

77. Ans: (d)

Sol: The standard value of solar constant adopted by World Radiation Centre is 1367 W/m^2.

78. What is the tip speed ratio of Savonius wind turbine rotor ?

(a) 1 (b) 3 (c) 5 (d) 7

78. Ans: (a)

Sol: The tip speed ratio of Savonius wind turbine rotor is 1.

79. What is the solidity of American multi-blade wind turbine rotor ?

(a) 0.4 (b) 0.7 (c) 0.9 (d) 1

79. Ans: (c)

Sol: The solidity of American multi-blade wind turbine rotor is 0.9.

80. The energy density of Bio-ethanol is

(a) 8.3 MJ/kg (b) 14.6 MJ/kg (c) 26.9 MJ/kg (d) 34.7 MJ/kg

80. Ans: (c)

Sol: The energy density of Bio-ethanol is 26.9 MJ/kg.

81. The percentage of hydrogen in producer gas is

(a) 34% (b) 27% (c) 18% (d) 8%

81. Ans: (*)

Sol: Producer gas is $CH_4 \rightarrow C = 12,\ H = 1$

CH_4 :

Molecular weight = 16

Molecular weight $H_2 = 4$

Producer gas is predominantly CH_4

% of H_2 in $CH_4 = \frac{4}{16} \times 100 = 25\%$ *(Nearest answer is option (b))*

82. In single basin, double effect scheme, power is generated

(a) during filling. (b) during emptying.

(c) on ebb only. (d) on both flood and ebb.

82. Ans: (d)

Sol: In single basin, double effect scheme, power is generated on both flood and ebb.

83. The operating temperature of alkaline fuel cell is

(a) 39°C (b) 90°C (c) 127°C (d) 192°C

83. Ans: (b)

Sol: The operating temperature of alkaline fuel cell is 90°C.

84. The ideal emf produced by polymer electrolyte membrane fuel cell at 25°C is

(a) 3.57 VJ (b) 2.94 V

(c) 1.23 V (d) 0.73 V

84. Ans: (c)

Sol: The ideal emf produced by polymer electrolyte membrane fuel cell at 25°C is 1.23 V.

85. Which one of the following fuel cells has highest efficiency ?

(a) PAFC (b) MCFC

(c) PEMFC (d) AFC

85. Ans: (d)

Sol: **Alkaline Fuel Cells** (AFCs) are among the most efficient type of fuel cells, reaching up to 60% efficiency and up to 87% combined heat and power.

86. How many kilograms of steam per day is produced by 15 m diameter community solar cooker developed by Centre for Scientific Research, Auroville (Puducherry) ?

(a) 100 kg (b) 300 kg

(c) 600 kg (d) 1000 kg

86. Ans: (c)

Sol: A 15 m diameter community solar cooker has been developed at the Centre for Scientific Research (CSR), Auroville. Around 600 kg of steam per day could be generated from this bowl.

87. In a solar passive space heating system, the south-facing thick wall is called

(a) Vent wall (b) Trombe wall

(c) Damper wall (d) Ventilation wall

87. Ans: (b)

Sol: A Trombe wall is a massive Equator-facing wall that is painted a dark color in order to absorb thermal energy from incident sunlight and covered with a glass on the outside with an insulating air-gap between the wall and the glaze.

In a solar passive space heating system, the south-facing thick wall is called Trombe wall.

88. All power plants use superheated steam due to which of the following advantages ?

1. Superheating is mostly done from waste heat of boiler without additional cost of fuel.
2. The plant efficiency increases due to higher temperature of steam.
3. There is less corrosion and erosion of equipment due to absence of moisture in the steam.

Select the correct answer using the code given below :

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

88. Ans: (d)

Sol:

- Super heater is kept after evaporator where the heat exchange takes place between the steam and combust gases.
- The plant with superheated steam can maintain higher mean temperature of heat addition, causing increase in the thermal efficiency of the plant.
- The amount of moisture formed with superheated steam while it is expanding over steam turbine blades thermal power plant is less compared to either dry steam expansion or wet steam expansion.

89. What are the effects of regenerative feed water heating for the same turbine output ?

1. It significantly increases the cycle efficiency and reduces the heat rate.
2. It increases the steam flow rate.
3. It increases the steam flow to the condenser.
4. If there is no change of boiler output, the turbine output drops.

Select the correct answer using the code given below:

(a) 1, 2 and 3 only (b) 1, 2 and 4 only

(c) 1, 3 and 4 only (d) 2, 3 and 4 only

89. Ans: (b)

Sol:

- Regeneration (feed water) increases the thermal efficiency

$$\text{Heat rate}\downarrow = \frac{1}{\eta_{th}\uparrow}$$

- For getting the same turbine work output, the amount of steam supplied to turbine should be more. Therefore, specific steam consumption increases.

$$\text{Specific steam consumption, SSC}\uparrow = \frac{m_s\uparrow}{W_{net}}$$

- If the boiler gives the same rate of steam, the amount of steam expansion is less after the bled steam passage. Therefore, the turbine work output decreases.

90. Which of the following are the advantages of pulverized coal firing ?

1. Higher boiler efficiency.
2. Fast response for no load changes.
3. Ability to use low preheated air reducing internal losses.
4. Ability to release large amounts of heat enabling it to generate about 2000 t/h of steam in one boiler.

Select the correct answer using the code given below:

(a) 1 and 2 only (b) 1 and 3 only

(c) 1 and 4 only (d) 2, 3 and 4 only

90. Ans: (c)

Sol: Pulverized coal firing can cause for better boiler efficiency and also increases the steam generating rate.

91. A turbine develops 8000 kW when running at 1000 rpm. The head on the turbine is 30 m. If the head is reduced to 18 m, what is the speed developed by the turbine ?

(a) 67.46 rpm (b) 95.24 rpm

(c) 54.67 rpm (d) 77.46 rpm

91. Ans: (d)

Sol: From similarity analysis,

$$ND \propto \sqrt{H}$$

i.e., $N \propto \sqrt{H}$ [$\because$ D = constant]

$$\therefore \frac{N_2}{N_1} = \sqrt{\frac{H_2}{H_1}}$$

$$N_2 = 1000 \times \sqrt{\frac{18}{30}} = 774.6 \text{ rpm} \quad (\text{for } N_1 = 1000 \text{ rpm})$$

$$N_2 = 100 \times \sqrt{\frac{18}{30}} = 77.46 \text{ rpm} \quad (\text{for } N_1 = 100 \text{ rpm})$$

Note: There may be typing mistake in the question. Speed may be 100 rpm instead of 1000 rpm.

92. The steam turbine can be governed by the following methods except

(a) Reaction governing

(b) Throttle governing only

(c) Nozzle control governing only

(d) Combination of throttle and nozzle control governing

92. Ans: (a)

Sol: The methods of governing of steam turbines are :

- nozzle control governing
- throttle governing
- combination of nozzle and throttle governing
- by-pass governing

Thus, steam turbine can not be governed by reaction governing.

93. In a gas turbine plant, heat supplied is 667.2 kJ/kg, and heat rejected is 391.43 kJ/kg.

(a) 57.29% (b) 72.51%

(c) 41.33% (d) 32.83%

93. Ans: (c)

Sol: Given data,

$Q_S = 667.2$ kJ/kg , $Q_R = 391.43$ kJ/kg

Thermal efficiency of the plant is given by :

$$\eta_{th} = \left(1 - \frac{Q_R}{Q_S}\right) \times 100$$

$$= \left(1 - \frac{391.43}{667.2}\right) \times 100 = 41.33\ \%$$

ACE Engineering Academy
Leading Institute for ESE/GATE/PSUs
Since 1995

x DEEP LEARN

KPSC

KARNATAKA PUBLIC SERVICE COMMISSION

WATER RESOURCE DEPARTMENT

ASSISTANT EXECUTIVE ENGINEER/
ASSISTANT ENGINEER

ONLINE TEST SERIES | **5 FULL LENGTH MOCK TESTS** | **STARTS FROM: 5TH JULY 2021**

All tests will be available till **KWRD Examination** | Call: 040-48539866. 4013 6222 | Email: testseries@aceenggacademy.com

---

GETCO

GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

Vidyut Sahayak (Junior Engineer)
Electrical

ONLINE TEST SERIES

6 Full Length Mock Tests

Starts from 3rd July 2021

Call: 040-48539866. 4013 6222
Email: testseries@aceenggacademy.com

All tests will be available till GETCO Examination.
Note: Gujarati language and grammar questions are not included in the full length mock tests.

ACE IAS ACADEMY

TSPSC | APPSC

GROUP-I (PRELIMS) & **GROUP-II** (PAPER-I)

ONLINE TEST SERIES

TOTAL NO. OF TESTS: 30
SYLLABUS AND SCHEDULE IS ENCLOSED

STARTS FROM: **9TH JULY, 2021**

NOTE: Tests will be conducted in Telugu Medium.

94. The constant pressure gas turbine works on

(a) Stirling Cycle (b) Atkinson Cycle

(c) Rankine Cycle (d) Brayton Cycle

94. Ans: (d)

Sol: Constant pressure gas turbine works on Brayton cycle also called as constant pressure cycle (or) 2P cycle (or) Joule cycle.

95. In hydraulic turbines, if the energy available at inlet is only kinetic energy, then that type of turbine is

(a) Reaction turbine

(b) Impulse turbine

(c) Francis turbine

(d) Kaplan turbine

95. Ans: (b)

Sol: In impulse turbine, the energy at the inlet of turbine is present in the form of kinetic energy.

96. A centrifugal pump has an impeller of 30 cm outer diameter. The vane tips are radial at the outlet. For a rotative speed of 1450 rpm, what is the manometric head developed ? (Assume a manometric efficiency of 82% and take g = 9.81 m/s^2)

(a) 37.24 m (b) 43.38 m

(c) 29.46 m (d) 32.88 m

96. Ans: (b)

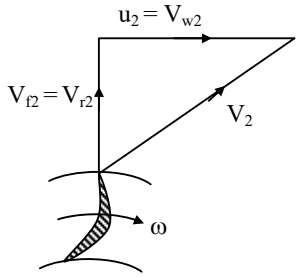
Sol: $\eta_{mano} = \dfrac{gH_m}{u_2 V_{w2}}$

$$H_m = \frac{u_2 V_{w2}}{g} \times \eta_{mano}$$

$$= \frac{u_2^2}{g} \times \eta_{mano} \qquad \text{(Radial flow at exit, } V_{w2} = u_2\text{)}$$

$$= \frac{1}{9.81} \times \left(\frac{\pi \times 0.3 \times 1450}{60}\right)^2 \times 0.82$$

$H_m = 43.38$ m



97. Lenoir cycle is used for

(a) Gas turbines (b) Pulse jet engines

(c) S.I. engines (d) C.I. engines

97. Ans: (b)

Sol:

- Ideal cycle for pulse jet engines is Lenoir cycle.
- Gas turbine works on Brayton cycle
- CI engine works on diesel cycle
- SI engine works on Otto cycle.

98. A diesel engine has a compression ratio of 20 and cut-off takes place at 5% of the stroke. What is the cut-off ratio ?

(a) 1.21 (b) 1.47 (c) 1.73 (d) 1.95

98. Ans: (d)

Sol: Diesel Engine, $r = 20$

Cut-off = 5% Stroke

$V_{cutoff} = 0.05\ V_s$

$V_3 - V_2 = 0.05\ (V_1 - V_2)$

$$V_2\left(\frac{V_3}{V_2} - 1\right) = 0.05\ V_2\left(\frac{V_1}{V_2} - 1\right)$$

$(r_c - 1) = 0.05\ (r - 1)$

$r_c - 1 = 0.05\ (20 - 1)$

$\therefore \quad r = 1.95$

99. The cubic capacity of a four-stroke over-square spark-ignition engine is 275 cc. The clearance volume is 25 cc. What is the compression ratio of the engine ?

(a) 8 (b) 10 (c) 12 (d) 14

99. Ans: (c)

Sol: $V_s = 275$ cc

$V_c = 25$ cc

The compression ratio is, $r = \frac{V_s}{V_c} + 1$

$$r = \frac{275}{25} + 1 = 12$$

100. The mechanical efficiency of a single-cylinder four-stroke engine is 60%. The frictional power is estimated to be 30 kW. What is the indicated power ?

(a) 120 kW (b) 75 kW

(c) 150 kW (d) 130 kW

100. Ans: (b)

Sol: $\eta_{mech} = 60\%$

F.P = 30 kW

I.P (kW) = ?

$$\eta_m = 0.6 = \frac{BP}{BP + FP} = \frac{BP}{BP + 30}$$

0.6 BP + 18 = BP

0.4 BP = 18

$$BP = \frac{180}{4} = 45\,kW$$

IP = BP + FP = 45 + 30 = 75 kW

101. A four-stroke petrol engine at full load delivers 100 kW. It requires 10 kW to rotate it without load at same speed. What is the mechanical efficiency at half load ?

(a) 67.82% (b) 70.24%

(c) 77.32% (d) 83.33%

101. Ans: (d)

Sol: $(BP)_{FL} = 100$ kW

FP = 10 kW

$$(BP)_{\frac{FL}{2}} = \frac{100}{2} = 50 \text{ kW}$$

$$\eta_{mech} = \frac{(BP)_{FL/2}}{(BP)_{FL/2} + FP} = \frac{50}{50 + 10} = 0.833 \approx 83.3\ \%$$

102. Freon-12 is used in a simple saturation cycle, with suction saturation temperature of –10°C and condensing saturation temperature of 30°C. If the clearance volume is 6% of the stroke volume, what is the volumetric efficiency ? (Consider specific volume at suction and discharge to be 0.07815 m^3/kg and 0.025 m^3/kg respectively)

(a) 87.24% (b) 71.31%

(c) 64.85% (d) 55.43%

102. Ans: (a)

Sol: $\eta_{vol} = 1 + c - c\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$

$P_1V_1^n = P_2V_2^n$

$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^n$

$\frac{V_1}{V_2} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$

$\eta_{vol} = 1 + c - c\left(\frac{V_1}{V_2}\right)$

$c = \frac{V_c}{V_s} = \frac{0.06\,V_s}{V_s} = 0.06$

$\frac{V_1}{V_2} = \frac{0.07815}{0.025}$

$\eta_{vol} = 1 + 0.06 - 0.06\left(\frac{0.07815}{0.025}\right)$

$= 1.06 - 0.18756$

$= 0.8724 \approx 87.24\%$

103. Relative ozone destruction efficiency of R-12 is

(a) 0.29 (b) 0.86

(c) 0.05 (d) 0.57

103. Ans: (b)

Sol: Relative ozone destruction efficiency for the following refrigerants is :

Refrigerant	Relative efficiency
R -11	1.00
R -12	0.86
R -113	0.80
R -22	0.05

104. An air cooled condenser has 6 m^2 of surface with a removal of 50 $kJ.hr^{-1}.m^{-2}°C^{-1}$. What is the refrigerant temperature to dissipate 5235 kJ/hr, if the room temperature is 25°C ?

(a) 24.31°C (b) 35.82°C

(c) 42.45°C (d) 56.94°C

104. Ans: (c)

Sol: Given data :

Surface area of air cooled condenser, $A = 6\ m^2$

Room temperature, $T_2 = 25°C$

Refrigerant temperature, $T_1 = ?$

Heat dissipate = 5235 kJ/hr

$$5235 = 50 \times 6\ (T_1 - 25)$$

$$T_1 - 25 = 17.45$$

$$\Rightarrow \quad T_1 = 42.45°C$$

105. The actual and theoretical COP of rolling piston compressor are 3.6 and 4.7 respectively. What is the relative COP ?

(a) 8.3 (b) 16.92

(c) 1.3 (d) 0.76

105. Ans: (d)

Sol: Relative COP $= \dfrac{(COP)_{actual}}{(COP)_{theoritical}} = \dfrac{3.6}{4.7} = 0.76$

106. A fuel consists of 92% carbon, 7% hydrogen and remaining residual matter by mass. Working from first principles, the higher calorific value of the fuel is

(a) 40176 kJ/kg (b) 41176 kJ/kg (c) 40876 kJ/kg (d) 41678 kJ/kg

106. Ans: (b)

Sol: C = 0.92 = 92 %

H = 7 % = 0.07

Higher Calorific Value,

$$H.C.V = 33800\ C + 144000\left(H - \frac{0}{8}\right) + 9720\ S$$

$$H.C.V = (33800 \times 0.92) + 144000\ (0.07 - 0) + 0 = 41176\ kJ/kg$$

107. In order to burn a fuel completely, which of the following basic conditions must be fulfilled ?

1. Supply enough air for complete combustion of fuel.
2. Secure low turbulence for thorough mixing of fuel and air.
3. Maintain a furnace temperature high enough to ignite the incoming fuel air mixture.
4. Provide a furnace volume large enough to allow time for combustion to be completed.

Select the correct answer using the code given below :

(a) 1, 2 and 3 only

(b) 1, 2 and 4 only

(c) 1, 3 and 4 only

(d) 2, 3 and 4 only

107. Ans: (c)

Sol: The basic conditions to be fulfilled for burning a fuel completely are :

- Supply enough air for complete combustion of fuel.
- Maintain a furnace temperature high enough to ignite the incoming fuel air mixture.
- Provide a furnace volume large enough to allow time for combustion to be completed.

108. The efficiency of any cycle increases with

(a) the decrease of maximum pressure and the constant of exhaust pressure.

(b) the decrease of maximum pressure and the decrease of exhaust pressure.

(c) the increase of maximum pressure and the decrease of exhaust pressure.

(d) the increase of maximum pressure and the constant of exhaust pressure.

108. Ans: (c)

Sol: The cycle efficiency, $= 1 - \frac{(T_m)_{HR}}{(T_m)_{HS}}$

where, $(T_m)_{HR}$ = mean temperature of heat rejection,

$(T_m)_{HS}$ = mean temperature of heat supplied.

Increase in maximum pressure indicates the high mean temperature of heat addition. Decrease in exhaust pressure indicates the low mean temperature of heat rejection. The cycle efficiency can be increased by decreasing the mean temperature of heat rejection and by increasing the mean temperature of heat supplied.

ACE® Engineering Academy Since 1995 Leading Institute for ESE/GATE/PSUs x DEEP LEARN

GATE + PSUs 2022

Exclusive Online Live

Rank Improvement Batch

Start from:

10th JULY, 2021

Discount of Rs.5,000/-
for IIT/NIT/IIIT students,
below 5,000 GATE rankers, ESE Prelims cleared students
ESE Mains cleared students and ACE old students.

109. In a power plant, the efficiencies of the electric generator, turbine (mechanical), boiler, cycle and the overall plant are 0.97, 0.95, 0.92, 0.42 and 0.33, respectively. What is the efficiency of auxiliaries ?

(a) 98.14% (b) 92.68%

(c) 83.41% (d) 75.14%

109. Ans: (b)

Sol: Given data :

$\eta_{generator} = 0.97$

$\eta_{turb} = 0.95$

$\eta_{boiler} = 0.92$

$\eta_{cycle} = 0.42$

$\eta_{overall} = 0.33$

$$\eta_{overall} = \eta_{boiler} \times \eta_{turb} \times \eta_{generator} \times \eta_{cycle} \times \eta_{auxiliaries}$$

$$\eta_{auxiliaires} = \frac{\eta_{overall}}{\eta_{boiler} \times \eta_{turb} \times \eta_{generator} \times \eta_{cycle}}$$

$$= \frac{0.33}{0.97 \times 0.95 \times 0.92 \times 0.42} = 0.9268 = 92.68\%$$

110. Consider the following statements for analysis of steam cycles:

1. A steam power plant continuously converts the energy stored in fossil fuels or fissile fuels into shaft work.
2. Steam power plants work on Brayton cycle.
3. In supercritical steam cycle, steam is generated in a 'once-through' boiler at a pressure above the critical point of 27.5 bar.
4. Deaerator is used for the purpose of deaerating the feedwater.

Which of the above statements are correct ?

(a) 2 and 3 only (b) 1 and 3 only

(c) 1 and 4 only (d) 2 and 4 only

110. Ans: (c)

Sol: Deaerator is used for eliminating the dissolved gases present in the feed water.

111. Consider the following statements for solid fuels :

1. Peat is the first stage in the formation of coal from wood.
2. The average calorific value of bituminous coal is 1524 kJ/kg.
3. Anthracite is very hard coal and has a shining black lustre.
4. Wood charcoal is obtained by destructive distillation of wood.

Which of the above statements are correct ?

(a) 1, 2 and 3 only (b) 1, 3 and 4 only

(c) 2 and 3 only (d) 1, 2 and 4 only

111. Ans: (b)

Sol: Calorific value of bituminous coal is 30000 kJ/kg. Hence, statement (2) is not correct eliminate all options which have statement (2).

112. Consider the following statements for fluidized bed boilers :

1. Fluidized bed boilers produce steam from fossil and waste fuels by using a technique called fluidized bed combustion.
2. Cyclone separators are gas cleaning devices that utilize the centrifugal force created by a spinning gas stream to separate particles from a gas.
3. In a pressurized fluidized bed boiler, the combustion process takes place in a pressurized environment resulting in a compact furnace and improved combustion efficiency.

Which of the above statements are correct ?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

112. Ans: (d)

Sol:

- Fluidized bed boilers produce steam from fossil and waste fuels by using a technique called fluidized bed combustion. Statement (1) is correct.
- Cyclone separators are gas cleaning devices that utilize the centrifugal force created by a spinning gas stream to separate particles from a gas. Statement (2) is correct.
- In a pressurized fluidized bed boiler, the combustion process takes place in a pressurized environment resulting in a compact furnace and improved combustion efficiency. Statement (3) is correct.

Note: The given statements are features of fluidized bed combustion.

113. Consider the following statements for steam turbine.

1. The ratio of actual enthalpy drop to isentropic enthalpy drop is known as mechanical efficiency.
2. The ratio of enthalpy drop in moving blades to enthalpy drop in the stage is known as degree of reaction.
3. Rateau turbine is the example of reaction turbine.
4. Curtis turbine is the example of impulse turbine.

Which of the above statements are correct?

(a) 2 and 4 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2, 3 and 4

113. Ans: (a)

Sol:

- The ratio of actual enthalpy drop to isentropic enthalpy drop is known as mechanical efficiency.
- Degree of reaction , $\frac{(\Delta h)_{MB}}{(\Delta h)_{stage}} = \frac{(\Delta h)_{MB}}{(\Delta h)_{MB} + (\Delta h)_{FB}}$
- Rateau turbine is pressure compounding impulse turbine.
- Curtis turbine is velocity compounding impulse turbine.

114. Consider tower following statements for cooling towers:

1. Cooling tower is an artificial device used to cool the hot cooling water coming out of condenser more effectively.
2. The amount of water usually lost with induced draft cooling tower ranges from 5% to 6% by evaporation.
3. The amount of water usually lost with induced draft cooling tower ranges from 7% to 8% by drift losses.
4. The rate of evaporation of water and its cooling effect on the remaining water depends upon the relative humidity of air passing through the tower.

Which of the above statements are correct?

(a) 1 and 4 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2, 3 and 4

114. Ans: (a)

Sol: Evaporation loss is approximately 1 % of water.

Drift losses are approximately 0.1 to 0.3 % of water.

115. A single-acting reciprocating pump, running at 50 rpm delivers 0.00736 m^3/s of water. The diameter of the piston is 200 mm and stroke length is 300 mm. What is the percentage slip of the pump?

(a) 5.29 % (b) 6.29% (c) 7.29 % (d) 8.29 %

115. Ans: (b)

Sol: $$Q_{th} = \frac{A_p L N}{60}$$

$$= \frac{\pi}{4} \times 0.2^2 \times 0.3 \times \frac{50}{60}$$

$$= 0.00785 \ m^3/s$$

$$\%slip = \frac{Q_{th} - Q}{Q_{th}} \times 100$$, where Q is the actual discharge.

$$= \left(1 - \frac{0.0736}{0.00785}\right) \times 100 = 6.24 \ \%$$

Nearest option is (b).

116. A pump discharges a liquid into a tank at the rate of 0.032 m^3/s. The tank, 1.5 m in diameter and 4.20 m in height, can hold 3500 kg of liquid. The density of the liquid and mass flow rate of the liquid handled by the pump are respectively.

(a) 471.57 kg/m^3 and 16 kg/s

(b) 471.57 kg/m^3 and 15 kg/s

(c) 481.57 kg/m^3 and 16 kg/s

(d) 481.57 kg/m^3 and 15 kg/s

116. Ans: (b)

Sol: $$\rho = \frac{Mass}{Volume}$$

$$= \frac{3500}{\left(\frac{\pi}{4} \times 1.5^2 \times 4.2\right)} = 471.6 \ kg/m^3$$

$$\dot{m} = \rho Q$$

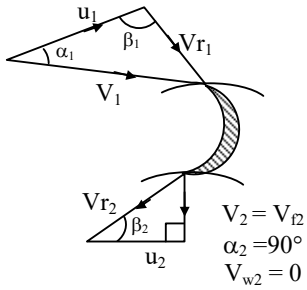
$$= 471.6 \times 0.032 = 15.1 \ kg/s$$

117. In Francis turbine, as the water discharge is radial at the outlet, the velocity whirl at the outlet becomes.

(a) 1 (b) 0 (c) ∞ (d) 0.5

117. Ans: (b)

Sol: For Francis turbine absolute velocity at exit is radial. Hence velocity of whirl at exit is zero. Refer to the velocity triangles at inlet and exit of the Francis turbine drawn below.



118. A pump impeller is 375 mm in diameter and it discharges water with velocity components of 2 m/s and 12 m/s in the radial and tangential directions respectively. The impeller is surrounded by a concentrical cylindrical chamber with parallel sides, the outer diameter being 450 mm. If the flow in the chamber is a free spiral vortex, what are the tangential velocity and radial velocity at the outlet of the changer respectively.

(a) 12 m/s and 1.67 m/s (b) 10 m/s and 1.67 m/s

(c) 12 m/s and 1.76 m/s (d) 10 m/s and 1.76 m/s

118. Ans: (b)

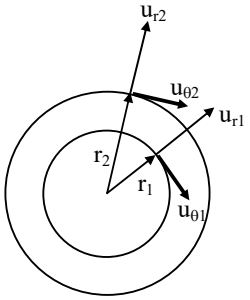
Sol: Let u_θ and u_r be the tangential and radial velocities at any radius r, then

For free vortex,

$$u_\theta \propto \frac{1}{r}$$

$$u_{\theta 1}\, r_1 = u_{\theta 2}\, r_2$$

$$u_{\theta 2} = \frac{r_1}{r_2} \times u_{\theta 1} = \frac{D_1}{D_2} \times u_{\theta 1} = \frac{375}{450} \times 12 = 10 \text{ m/s}$$



By continuity equation in radial direction,

$A_1 u_{r1} = A_2\, u_{r2}$

$$u_{r2} = \frac{A_1}{A_2} \times u_{r1} = \frac{\pi D_1 h}{\pi D_2 h} \times u_{r1} = \frac{374}{450} \times 2 = 1.67 \text{ m/s}$$

119. Which one of the following types of impellers is used to handle highly solid-laden liquids like concrete and slurry?

(a) Fully Open Impeller (b) Semi-Enclosed impeller

(c) Fully-Enclosed impeller (d) Quarter Open Impeller

119. Ans: (a)

Sol: Fully open impellers are suitable to handle highly solid laden liquids like concrete and slurry.

120. In a single reciprocating pump without air vessel, the ratio of the average frictional head to the maximum frictional head in the delivery pipe is

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

120. Ans: (c)

Sol: In reciprocating pump the frictional head varies parabolically with piston displacement. For parabolic variation, average value is found to be $\frac{2}{3}$ rd of the maximum.

$$\frac{h_{f\,da}}{h_{f\,dm}} = \frac{2}{3}$$

121. Water is flowing through a pipe of diameter 200 mm with a velocity of 3 m/s. What is the head loss due to friction for a length of 5 m if the coefficient of friction is given by $f = 0.02 + \frac{0.09}{Re^{0.3}}$, where Re is Reynolds number ?

[Take the kinematic viscosity of water as 0.01 stoke, g = 9.81 m/s^2 and $(6\times10^5)^{0.3} = 54.13$]

(a) 0.993 m of water (b) 0.783 m of water

(c) 0.685 m of water (d) 0.552 m of water

121. Ans: (a)

Sol: $Re = \frac{VD}{\nu} = \frac{3\times0.2}{0.01\times10^{-4}} = 6\times10^5$

From the given relation for the coefficient of friction (f') :

$$f' = 0.02 + \frac{0.09}{\left(6\times10^5\right)^{0.3}} = 0.0217$$

Head loss due to friction is,

$$h_f = \frac{4f'LV^2}{2gD} = \frac{4\times0.0217\times5\times3^2}{2\times9.81\times0.2} = 0.995 \text{ m}$$

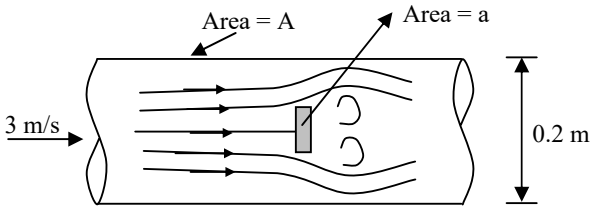
122. Water is flowing through a horizontal pipe of diameter 200 mm at a velocity of 3 m/s. A circular solid plate of diameter 150 mm is placed in the pipe to obstruct the flow. What is the loss of head due to obstruction in the pipe if $C_c = 0.62$? (Take $g = 9.81\ m/s^2$)

(a) 3.311 m (b) 4.211 m

(c) 5.211 m (d) 6.211 m

122. Ans: (a)

Sol:



Loss of head due to obstruction placed in the pipe is,

$$h_L = \frac{V^2}{2g}\left(\frac{A}{A-a}\times\frac{1}{C_c}-1\right)^2$$

where, V = velocity in pipe,

A = area of the pipe,

a = maximum area of the obstruction,

C_c = coefficient of contraction

$$h_L = \frac{3^2}{2\times 9.81}\times\left(\frac{200^2}{200^2-150^2}\times\frac{1}{0.62}-1\right)^2 \quad [\because \text{area} \propto D^2]$$

$h_L = 3.311$ m

123. Three pipes of length 800 m, 500 m and 400 m and of diameters 500 mm, 400 mm and 300 mm respectively are connected in series. These pipes are to be replaced by a single pipe of length 1700 m. What is the diameter of the single pipe?

(a) $(0.007188)^{0.2}$ m (b) $(0.003609)^{0.3}$ m

(c) $(0.003609)^{0.2}$ m (d) $(0.007118)^{0.3}$ m

123. Ans: (a)

Sol: The relation for equivalent pipe for pipes connected in series combination is given by,

$$\frac{L}{D^5} = \frac{L_1}{D_1^5} + \frac{L_2}{D_2^5} + \frac{L_3}{D_3^5}$$

where L is the equivalent length and D is the equivalent diameter.

$$\frac{1700}{D^5} = \frac{800}{0.5^5} + \frac{500}{0.4^5} + \frac{400}{0.3^5}$$

$D^5 = 0.00711$

$D = (0.00711)^{1/5} = (0.00711)^{0.2}$ m

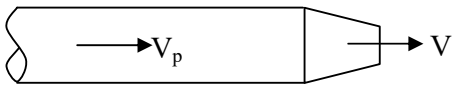
124. The head of water at the inlet of a pipe 200 m long and 500 mm diameter is 60 m. A nozzle of diameter 100 mm at its outlet is fitted to the pipe. What is the velocity of water at the outlet of the nozzle if f = 0.01 for the pipe ? (Take g = 9.81 m/s^2)

(a) 30.61 m/s (b) 34.81 m/s

(c) 36.52 m/s (d) 38.36 m/s

124. Ans: (*)

Sol:



(Head at inlet) = (Head lost in pipe) + (K.E head at exit of nozzle)

$$H = \frac{f L_p V_p^2}{2gD_p} + \frac{V^2}{2g} \quad \text{----(1)}$$

But, $A_p V_p = A \times V$

$$V_p = \frac{A}{A_p} \times V = \frac{100^2}{500^2} \times V$$

$$V_p = \frac{V}{25} \quad \text{-----(2)}$$

From (1) & (2)

$$H = \frac{V^2}{2g}\left(\frac{f L_p}{25^2 D_p} + 1\right)$$

$$60 = \frac{V^2}{2 \times 9.81} \times \left(\frac{0.01 \times 2000}{625 \times 0.5} + 1\right)$$

$\Rightarrow V = 33.26$ m/s

However, if the value of f given is considered as coefficient of friction, then V = 30.61 m/s. Which is option (a).

ACE® Engineering Academy
Leading Institute for ESE/GATE/PSUs
Since 1995
x DEEP LEARN

ACE SCHOLARSHIP TEST

APPSC / TSPSC / SSC

Exam Date : 8th AUGUST 2021
Timing: 11:00 am to 12:00 pm

No. of Questions	: 50 Q
50 Q	: 1 Mark
Total Marks	: 50 Marks
Duration	: 60 Mins.

ONLINE MODE

- AI based proctoring examination
- candidates can take the online test from any location using a laptop/ PC with a connected webcam and good internet connection.
- Audio and video must be turned on through out the duration of the test.

EXAM SYLLABUS

1. Biology
2. Science & Technology
3. Physics.
4. Chemistry
5. Polity
6. Geography
7. Indian Economy

PAPER **GENERAL SCIENCE**

Applicable for:

DEEP LEARN | **LIVE CLASSES**

CLASSROOM COACHING

Last Date to Apply
6TH August 2021
Fee: Rs.100/- Only

Allocation of Scholarships

75% Fee Waiver* 1st Position | **60% Fee Waiver* 2nd Position** | **50% Fee Waiver* 3rd Position**

♦ 30% Fee Waiver* 4th Position ♦ 20% Fee Waiver* 5th Position

For attaining scholarships, the above positions have to achieve a minimum of **40% marks.**

Registrations start from: 20th July, 2021

Call: 040-23234418/19/20 | **aceenggacademy.com**

125. Water is flowing with a velocity of 1.5 m/s in a pipe of length 2500 m and of diameter 500 mm. At the end of the pipe, a valve is provided. What is the rise in pressure if the valve is closed in 25 seconds? (Take the value of C as 1460 m/s)

(a) 12 N/cm^2 (b) 15 N/cm^2 (c) 16 N/cm^2 (d) 18 N/cm^2

125. Ans: (b)

Sol: The critical closure time is

$$T_c = \frac{2L}{C} = \frac{2\times 2500}{1460} = 3.425 \text{ sec}$$

As the actual closure time (T = 25 sec) is more than the critical closure time, the valve closure can be considered gradual. The rise in pressure in this case in given by :

$$\Delta P = \frac{\rho L V}{T}$$

$$= \frac{1000\times 2500\times 1.5}{25}$$

$$= 15 \times 10^4 \text{ N/m}^2 = 15 \text{ N/cm}^2$$

126. If a submerged body is in unstable equilibrium, then

(a) the centre of buoyancy is below the centre of gravity.

(b) the centre of buoyancy is above the centre of gravity

(c) meta-centre is below the centre of buoyancy

(d) meta-centre is above the centre of buoyancy

126. Ans: (a)

Sol: For stability of completely submerged body centre of buoyancy must be above centre of gravity. But the body in the question is unstable. Hence, answer is (a).

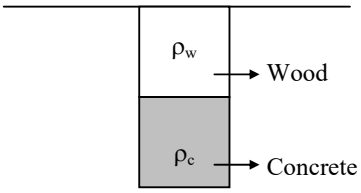
127. How much of concrete with γ = 25 kN/m^3 must be attached to a beam having a volume of 0.1 m^3 and specific gravity 0.6 to cause both to sink in water? (Take g = 9.81 m/s^2)

(a) 0.825 kN (b) 0.745 kN

(c) 0.525 kN (d) 0.645 kN

127. Ans: (d)

Sol:



As the combined mass is just about to sink,

$F_B = W$ (Total weight)

$\rho\, g\, \forall_w + \rho\, g\, \forall_c = \rho_w\, g\, \forall_w + \rho_c\, g\, \forall_c$

(where ρ is the density of water. Suffix c stands for concrete whereas suffix w stands for wood).

$$\forall_c (\rho_c - \rho) = (\rho - \rho_w)\, \forall_w$$

$$\forall_c = \left(\frac{\rho - \rho_w}{\rho_c - \rho}\right) \times \forall_w$$

$$= \left(\frac{1 - \frac{\rho_w}{\rho}}{\frac{\rho_c}{\rho} - 1}\right) \times \forall_w$$

$$W_c = \gamma_c\, \forall_c$$

$$= \gamma_c \times \left(\frac{1 - s_w}{s_c - 1}\right) \times \forall_w$$

but, $s_c = \frac{\gamma_c}{\gamma} = \frac{25}{9.81} = 2.548$

$$W_c = 25 \times \left(\frac{1 - 0.6}{2.548 - 1}\right) \times 0.1 = 0.646 \text{ kN}$$

128. A liquid has a specific gravity of 1.9 and a kinematic viscosity of 6 stokes. What is the dynamic viscosity ?

(a) 1.14 Ns/m^2 (b) 2.44 Ns/m^2

(c) 3.40 Ns/m^2 (d) 11.40 Ns/m^2

128. Ans: (a)

Sol: Kinematic viscosity is given as, $\nu = \frac{\mu}{\rho}$

Thus, the dynamic viscosity is,

$\mu = \rho\, \nu$

$= 1900 \times 6 \times 10^{-4}$

$= 1.14$ N.s/m^2

129. Oil of specific gravity 0.8 flows through a 0.2 m diameter pipe under a pressure of 100 kN/m^2. If the datum is 5 m below the centerline of the pipe and the total energy with respect to the datum is 35 Nm/N, the discharge is (Take g = 9.81 m/s^2)

(a) 0.58 m^3/sec (b) 0.47 m^3/sec

(c) 0.31 m^3/sec (d) 0.22 m^3/sec

129. Ans: (a)

Sol: The total energy head (or Bernoulli's head B) is given by the sum of pressure energy head, potential energy head and kinetic energy head. i.e.,

$$B = \frac{P}{\rho g} + \frac{V^2}{2g} + Z$$

$$35 = \frac{100 \times 10^3}{800 \times 9.81} + \frac{V^2}{2 \times 9.81} + 5$$

$$\Rightarrow V = 18.4 \text{ m/s}$$

$$Q = A\,V$$

$$= \frac{\pi}{4} \times 0.2^2 \times 18.4 = 0.58 \text{ m}^3/\text{s}$$

130. Bernoulli's equation is obtained by

(a) integrating the Euler's equation of motion.

(b) differentiating the Euler's equation of motion.

(c) differentiating the Navier – Stokes equations

(d) integrating energy equation.

130. Ans: (a)

Sol: Bernoulli's equation is obtained by integrating the Euler's equation along streamline.

131. Which one of the following is not the methodology of control separation of flow from boundary in the application of aerofoils?

(a) Streamlining of blunt body shapes

(b) Fluid ejection from the boundary layer

(c) Suction of fluid from the boundary layer

(d) Creating of motion of the boundary wall

131. Ans: (d)

Sol: Boundary layer separation can be controlled by modifying shape (i.e., streamlining), by blowing high speed liquid tangentially to surface in the direction of flow or by removing low energy fluid near to the surface by suction.

Creating a motion of the boundary wall is not the methodology of controlling separation of flow from boundary in the application of aerofoils.

132. What is the value of mass of the air in a room of size 4 m × 5 m × 6 m at 100 kPa and 25°C ? (Take R = 0.287 kPa m^3. kg^{-1} K^{-1})

(a) 150 kg (b) 180 kg

(c) 140 kg (d) 130 kg

132. Ans: (c)

Sol: Given data,

$V = 4 \times 5 \times 6(m) = 120 m^3$

P = 100 kPa

T = 25°C

R = 0.287 kJ/kg

PV = mRT

$100 \times 120 = m \times 0.287 \times (25 + 273)$

m = 140 kg

133. A body of weight 100 N is placed on a rough horizontal plane. What is the coefficient of friction if a horizontal force of 60 N just causes the body to slide over the horizontal plane?

(a) 0.4 (b) 0.5

(c) 0.6 (d) 0.9

133. Ans: (c)

Sol:

$f_{max} = 60$ N [∵ Body is just moving so limiting friction will act]

$\mu \times 100 = 60$

$\therefore \mu = 0.6$

134. A body is moving with a velocity of 2 m/s. After 4 seconds, the velocity of the body becomes 5 m/s. The acceleration of the body is

(a) 0.55 m/s^2 (b) 0.65 m/s^2

(c) 0.75 m/s^2 (d) 0.45 m/s^2

134. Ans: (c)

Sol: $V = u + at$

$5 = 2 + a \times 4$

$a = 0.75\ m/s^2$

135. The principal stresses at a point in an elastic material are 60 N/mm^2 tensile, 20 N/mm^2 tensile and 50 N/mm^2 compressive. What is the volumetric strain by considering Young's Modulus as 100×10^3 N/mm^2 and $\mu = 0.3$?

(a) 1.20×10^{-4} (b) 1.06×10^{-5}

(c) 1.30×10^{-3} (d) 1.12×10^{-2}

135. Ans: (a)

Sol: $\sigma_1 = 60\frac{N}{mm^2}(\text{Tensile})$

$\sigma_2 = 20\frac{N}{mm^2}(\text{Tensile})$

$\sigma_3 = 50\frac{N}{mm^2}(\text{compressive})$

$E = 100\times10^3\frac{N}{mm^2}\quad \mu = 0.3$

$$\text{Volumetric strain} = \epsilon_v = \frac{\Delta v}{v} = \frac{\sigma_1+\sigma_2+\sigma_3}{E}(1-2\mu)$$

$$= \frac{60+20-50}{100\times10^3}[1-2(0.3)]$$

$$= \frac{30}{100\times10^3}\times0.4$$

$$= 1.20 \times 10^{-4}$$

136. In an absorption type refrigeration system, heating in generator, refrigeration in evaporator and cooling by cooling water in condenser, take place at 95°C, –5°C and 30°C respectively. What is the maximum COP of the system?

(a) 1.17 (b) 1.35

(c) 1.52 (d) 1.78

136. Ans: (b)

Sol: $T_1 = 95°C, T_2 = 30°C, T_3 = -5°C$

$$(COP) = \eta_E \times (COP)_R$$

$$= \frac{T_1 - T_2}{T_1} \times \frac{T_3}{T_2 - T_3}$$

$$= \frac{95 - 30}{273 + 95} \times \frac{268}{30 - (-5)}$$

$$= \frac{65}{368} \times \frac{268}{35} = 1.352$$

137. Consider the following statements for sensible heat factor:

1. Sensible heat factor will be negative if sensible heat and latent heat are both negative.
2. Sensible heat factor will be negative if sensible heat is negative and latent heat is positive.
3. Sensible heat factor will be negative if sensible heat is positive and latent heat is negative.
4. Sensible heat factor will be negative if sensible heat and latent heat are both sensitive.

Which of the above statements are correct?

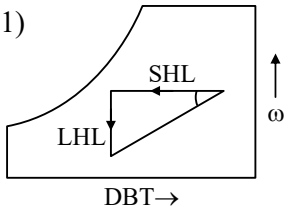
(a) 2 and 3 only (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 4 only

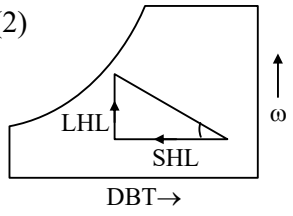
137. Ans: (c)

Sol:

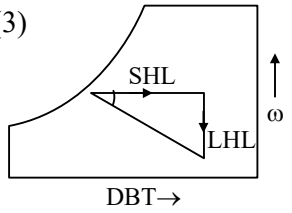
(1)



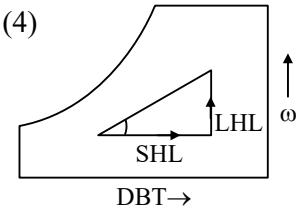
(2)



(3)



(4)



Correct statements are (1) and (3).

Hearty Congratulations to our

GATE 2021 TOP RANKERS

AIR 1ST IN
PRATIK PRAKASH SHINDE

AIR 1ST EE
AAKASH DHILL

AIR 1ST ME
SUYASH SHARMA

AIR 1ST PI
GANESH ADIGAUR

AIR 1ST XE
VARUN KAUSHIK

AIR 2nd ME
JAY CHAVDA

AIR 2nd PI
GOWTHAM GUDIMELLA

AIR 2nd EC
M POOJASREE

AIR 2nd ES
ANUSH VERMA

AIR 3rd ME
MUNISH KUMAR

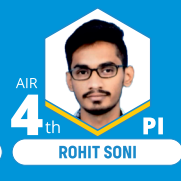
AIR 3rd ME
NUKULA VISWA TEJA

AIR 3rd PI
REHAN ANWAR DESAI

AIR 3rd EC
MANOJ KUMAR

AIR 3rd CE
SHASHIKANT KUMAR

AIR 3rd EE
JAYMAL KHUNTI



AIR 4th PI
ROHIT SONI

AIR 4th EC
P AKHIL

AIR 4th IN
DIVAKAR CH.

AIR 4th IN
SAURABH JAISWAL

AIR 4th XE
JATIN BHANDARI

AIR 4th ES
HEMANTH TIWARI

AIR 5th ME
ABHISHEKA

AIR 5th EC
VAISHNAV KV

AIR 5th CE
PRASHANT DWIVEDI

AIR 5th CS
PANKAJ LAHKAR

AIR 5th CS
S BHATTACHARJEE

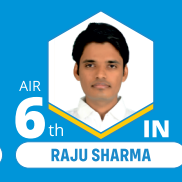
AIR 5th PI
SUBHANSHU TIWARI

AIR 6th ME
ABHISHEK MEWAR

AIR 6th PI
AKASH JAISWAL

AIR 6th EC
PARAG SAROHA

AIR 6th IN
HARSHIT GUPTA



AIR 6th IN
RAJU SHARMA

AIR 6th CE
TANMAY MAHAJAN

AIR 6th XE
MANISH YADAV

AIR 7th ME
VATSAL PANCHAL

AIR 7th PI
SACHIN DUBOLIYA

AIR 7th PI
ATULYA JYOTHI

AIR 8th ME
RAJAT GUPTA

AIR 8th ME
ROHIT S PATIL

AIR 8th EC
ANKUR LAL MEENA

AIR 8th IN
KUNAL SAURAV

AIR 8th CE
PRANSHU JANGID

AIR 8th CE
RAHUL PATI

AIR 8th EE
UJJWAL KUMAR

AIR 8th EE
HEMANT JINDAL

AIR 9th EC
ABHISHEK SINGH

AIR 9th EC
ALEESHA ROSE

AIR 9th EC
SAI VAMSI DOSAPATI

AIR 9th IN
RAMESH KUMAR

AIR 9th CS
NIRANJAN NITIN DHOOT

AIR 9th XE
RACHIT KUMAR

AIR 10th ME
DEEPESH AGARWAL

AIR 10th PI
VYOM SHARMA

AIR 10th IN
PRAGYA KAUSHIK

AIR 10th CE
GOVIND PRASAD B

AIR 10th XE
D KUMAR PATIL

AIR 10th XE
R SHIVAJI NALE

and many more...

Total 57 Ranks in Top 10

ME : 10	PI : 09	CE : 08	EE : 4	EC : 09	CS : 03	IN : 08	XE : 06

138. If the air is initially at dry bulb temperature 35°C and wet bulb temperature 26.1°C as it enters an air washer which has a humidifying efficiency of 85% then what is the final dry bulb temperature of air washed with recirculated spray water?

(a) 26.81 °C (b) 27.43 °C (c) 32.83 °C (d) 30.49 °C

138. Ans: (b)

Sol: $T_1 = DBT = 35°C$

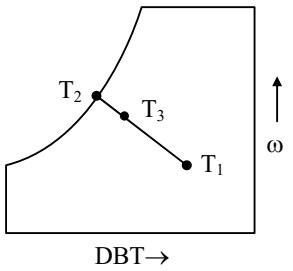
$T_2 = WBT = 26.1°C$

$$\eta = \frac{T_1 - T_3}{T_1 - T_2} = 0.85$$

$T_1 - T_3 = \eta\,(T_1 - T_2)$

$T_3 = T_1 - \eta\,(T_1 - T_2)$

$= 35 - 0.85\,(35 - 26.1) = 27.43°C$



139. Consider the following statements for Nucleate boiling:

1. For water, the critical heat flux does not exceed 1 MW/m^2
2. Nucleate boiling is the most desirable boiling regime in practice because of high heat transfer rates.
3. Heat flux increases at a higher rate with increase in temperature.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only

(c) 1 and 3 only (d) 2 and 3 only

139. Ans: (d)

Sol:

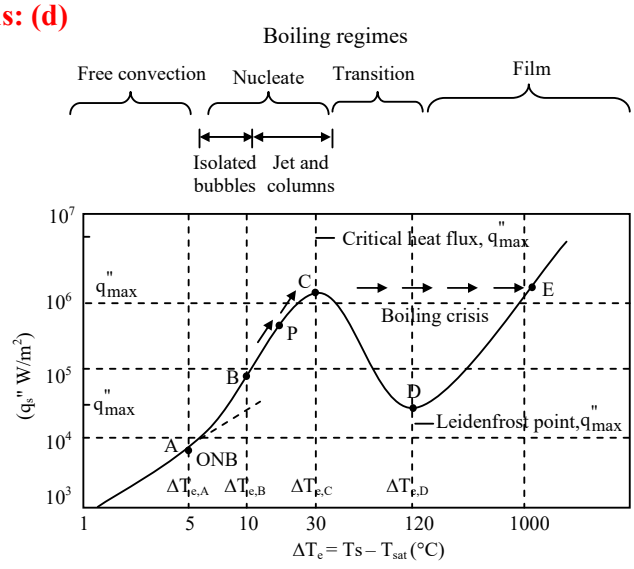


Fig: *Typical boiling curve for water at 1 atm: surface heat flux q_s'' as a function of excess temperature, $\Delta T_e \equiv T_s - T_{sat}$*

- As we can observe in figure, in water at atmospheric pressure critical heat flux exceeds 1 MW/m^2. So, 1 is not correct answer.
- It is desirable to operate many engineering devices in the nucleate boiling regime, because high heat transfer rates and convection coefficient area associated with small values of the excess temperature. So , 2 is correct
- As we can observe in figure, heat flux increases at a high rate with increase in temperature. So, 3 is also correct

140. In drop-wise condensation, the heat transfer rate is
(a) 5 times less than that in film-wise condensation.
(b) 15 times less than that in film-wise condensation.
(c) 25 times more than that in film-wise condensation.
(d) 10 times more than that in film-wise condensation.

140. Ans: (d)

Sol: For non metal vapors, dropwise condensation gives much higher heat transfer coefficient than those found with film condensation. For instance, heat transfer coefficient for dropwise condensation of steam is around 10 times that for film condensation.

141. 1 kg of water falls from an altitude of 1000 m above ground level. What is the change in the temperature of water at the foot of the fall, if there are not losses during the fall?
(Take specific heat of water as 1 kcal.$kg^{-1}.K^{-1}$ and g = 9.81 m/s^2)
(a) 3.35 °C (b) 2.35 °C
(c) 3.32 °C (d) 4.12 °C

141. Ans: (b)

Sol: $m_w = 1$ kg, $z = 1000$ m, $\Delta T(°C) = ?$, $c_w = 1$ kcal/kg.K

$g = 9.81$ m/s^2

K.E = P.E = dU [No Losses]

P.E = m g z

$P.E = 1 \times 9.81 \times 1000$

P.E = 9810 J/kg = 9.810 kJ/kg

P.E = dU

$9.810 = m_w \times c_w \times dT$

$9.810 = 1 \times 4.18 \times dT$

$\therefore$ dT = 2.35 °C

142. A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 MPa to a final state of 0.15 m^3 and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 40 kJ of heat from the gas during the process. How much does the internal energy of the gas change?

(a) –24.25 kJ (b) –19.62 kJ

(c) –15.91 kJ (d) –12.72 kJ

142. Ans: (a)

Sol: Given data,

$V_1 = 0.3\ m^3$, $P_1 = 105$ kPa,

$V_2 = 0.15\ m^3$, $P_2 = P_1 = 105$ kPa,

$Q = -40$ kJ

Work done,

$W_D = P(V_2 - V_1)$

$= 105\ (0.15 - 0.3)$

$= -15.75$ kJ

$Q = W + dU$

$dU = Q - W = -40 + 15.75 = -24.25$ kJ

143. The state of a simple compressible pure substance can be fixed by specifying

(a) one independent property

(b) two independent properties

(c) three independent properties

(d) four independent properties

143. Ans: (b)

Sol: Two independent properties are sufficient to find the thermodynamic state of a compressible gas.

144. In a thermoelectric thermometer for t °C temperature, the emf is given as:

$$E = 0.003t - 5 \times 10^{-7}\ t^2 + 0.5 \times 10^{-3} \text{ volts.}$$

Thermometer is having reference junction at ice point and is calibrated at ice point and steam point. What is the temperature shown by the thermometer for a substance at 30 °C?

(a) 33.23 °C (b) 36.28 °C

(c) 41.23 °C (d) 46.28 °C

144. Ans: (a)

Sol: $E = 0.003\ t - 5\times10^{-7}\ t^2 + 0.5 \times 10^{-3}$

$t = 0°C$,

$$E = 0.003 \times 0 - 5\times10^{-7}\times0^2 + 0.5 \times 10^{-3}$$

$$E_0 = 0.5 \times 10^{-3}\ V$$

$t = 100°C$,

$$E_{100} = 0.003 \times 100 - 5\times10^{-7}\times100^2 + 0.5 \times 10^{-3}$$

$$E_{100} = 0.2955\ V$$

$t = 30°C$,

$$E_{30} = 0.003 \times 30 - 5\times10^{-7}\times30^2 + 0.5 \times 10^{-3}$$

$$E_{30} = 0.0905\ V$$

$$t = \frac{E_{30} - E_0}{E_{100} - E_0} \times 100$$

$$= \left(\frac{0.0905 - 0.5\times10^{-3}}{0.2955 - 0.5\times10^{-3}}\right) \times 100$$

$$= 30.5°C$$

145. Consider the following statements for comparison of heat and work:

1. Both heat and work are transient phenomena.
2. Both heat and work are boundary phenomena.
3. Both heat and work are path functions and inexact differentials.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1, 2 and 3

(c) 2 and 3 only

(d) 1 and 3 only

145. Ans: (b)

Sol: The correct statements regarding heat and work are :

- Both heat and work are transient phenomena.
- Both heat and work are boundary phenomena.
- Both heat and work are path functions and inexact differentials.

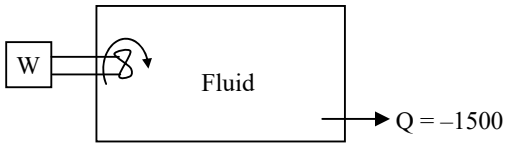
146. A tank containing a fluid is stirred by a paddle wheel. The work input to the paddle wheel is 5090 kJ. The heat transfer form the tank is 1500 kJ. What is the change in internal energy of this control mass? (Consider the tank and the fluid inside a control surface)

(a) – 3590 kJ (b) + 3590 kJ

(c) + 4590 kJ (d) – 4590 kJ

146. Ans: (b)

Sol:



W = –5090 kJ, Q = –1500 kJ

Q = dU + W

–1500 = dU – 5090

dU = 3590 kJ

147. During the charging of a storage battery, the current is 20 A and the voltage is 12.8 V. The rate of heat transfer from the battery is 10 W. At what rate is the internal energy increasing?

(a) –256 J/s (b) + 246 J/s

(c) + 256 J/s (d) – 246 J/s

147. Ans: (b)

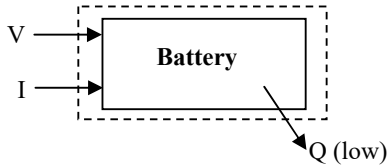
Sol: I = 20 (A)

V = 12.8 (V)

$W = V \times I(W)$

$W = 12.8 \times 20$

$W = 256\,\text{Watt}$



Q = dU + W

–10 = dU – 256

$dU = 246\ W\ (\text{or})\ (J/s)$

148. A refrigerator operates on Reversed Carnot cycle. What is the power required to drive the refrigerator between temperatures of 42°C and 4 °C, if heat at the rate of 2 kJ/s is extracted from the low temperature region?

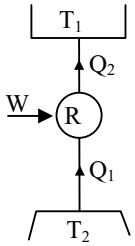
(a) 0.174 kW (b) 0.374 kW (c) 0.274 kW (d) 0.474 kW

148. Ans: (c)

Sol: Reversed Carnot cycle,

$T_1 = 42°C = 315\ K$

$T_2 = 4°C = 277\ K$



$$\frac{T_2}{T_1 - T_2} = \frac{\dot{Q}_2}{\dot{W}}$$

$$\frac{277}{315 - 277} = \frac{2}{\dot{W}}$$

$$\dot{W} = 0.274\,(kW)$$

149. Entropy generated (S_{gen}) can be taken as a criterion to indicated feasibility of process. Which of the following conditions are correct?

1. If $S_{gen} = 0$, then the process is a reversible process.
2. If $S_{gen} > 0$, then the process is an irreversible process
3. If $S_{gen} < 0$, then the process is impossible.

Select the correct answer using the code given below:

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

149. Ans: (d)

Sol: For a process to occur,

$$S_{gen} \geq 0$$

If $S_{gen} = 0$, then process is reversible.

150. What is the critical radius of insulation for asbestos (thermal conductivity = 0.17 $W.m^{-1}.\ °C^{-1}$) surrounding a circular pipe and exposed to room air at 20 °C with heat transfer coefficient 3 $Wm^{-2}.°C^{-1}$?

(a) 7.21 cm (b) 6.37 cm

(c) 5.67 cm (d) 6.93 cm

150. Ans: (c)

Sol: Given, $k = 0.17\ W/m°C$, $h = 3\ W/m^2\ °C$

For cylinder, $r_{critical} = \frac{k}{h} = \frac{0.17}{3} = \frac{17}{3 \times 100} = \frac{5.67\,m}{100} = 5.67\,cm$

Hearty Congratulations to our

ESE - 2020 TOP RANKERS

AIR 1  CHARUDATTA S ME

AIR 1  SHASHANK GAUR EE

AIR 1  PRAKASH JHA E&T

AIR 1  GAURAV KUMAR CE

AIR 2  K S SHARADRAO ME

AIR 2  ABHISHEK SINGH EE

AIR 2  PARTH BATRA E&T

AIR 2  PRASHANT SINGH CE

AIR 3  SURAJ KUMAR S ME

AIR 3  VIKASH SHANKAR EE

AIR 3  RAHUL NAREDI E&T

AIR 3  KULDEEP JANGRA CE

AIR 4  SHUBHAM B ME

AIR 4  ANUPAM S EE

AIR 4  SHUBHAM E&T

AIR 4  ANISH BAGGA CE

AIR 5  KAMLESH PARWAR ME

AIR 5  MANOJ KUMAR E&T

AIR 5  PAVITRA GOYAL CE

AIR 6  MD ZUHAIB ME

AIR 6  VISHWA SIMHAA EE

AIR 6  SAURAV KUMAR S E&T

AIR 7  PRATEEK S ME

AIR 7  DINESH KUMAR S EE

AIR 7  RAGHAV PURWAR E&T

AIR 8  V SAIKRISHNA REDDY ME

AIR 8  GAGAN GHUNAWAT EE

AIR 8  RAM KRISHNA E&T

AIR 9  GANESH KUMAR A ME

AIR 9  AKSHAY KUMAR T EE

AIR 9  CHHAVI JAIN E&T

AIR 9  ARPIT JAIN CE

AIR 10  HEMABH TRIVEDI ME

AIR 10  RAJAT DIXIT EE

AIR 10  L KUMARI JAISWAL E&T

AIR 10  AMIT SHARMA CE

and many more...

TOTAL 36 RANKS IN TOP 10

ME 10 | EE 09 | E&T 10 | CE 07