ESE-2018 PRELIMS TEST SERIES

Date: 12th November, 2017

ME–Test 08 (OBJECTIVE SOLUTION)...

ANSWERS

1. (c)	31. (b)	61. (c)	91. (d)	121. (a)
2. (a)	32. (b)	62. (d)	92. (b)	122. (c)
3. (d)	33. (a)	63. (d)	93. (b)	123. (b)
4. (a)	34. (d)	64: (a)	94. (b)	124. (a)
5. (b)	35. (d)	65. (d)	95. (d)	125. (b)
6. (b)	36. (a)	66. (c)	96. (a)	126. (a)
7. (b)	37. (d)	67. (d)	97. (a)	127. (b)
8. (d)	38. (b)	68. (c)	98. (b)	128. (a)
9. (d)	39. (d)	69. (c)	99. (c)	129. (a)
10. (c)	40. (c)	70. (d)	100. (c)	130. (c)
11. (c)	41. (a)	71. (b)	101. (a)	131. (b)
12. (b)	42. (b)	72. (a)	102. (a)	132. (a)
13. (a)	43. (a)	73. (c)	103. (d)	133. (a)
14. (b)	44. (d)	74. (d)	104. (d)	134. (a)
15. (b)	45. (b)	75. (b)	105. (b)	135. (b)
16. (d)	46. (a)	76. (a)	106. (a)	136. (b)
17. (a)	47. (b)	77. (a)	107. (a)	137. (b)
18. (a)	48. (c)	78. (a)	108. (a)	138. (a)
19. (c)	49. (a)	79. (c)	109. (a)	139. (a)
20. (b)	50. (c)	80. (b)	110. (c)	140. (b)
21. (d)	51. (c)	81. (d)	111. (b)	141. (b)
22. (c)	52. (b)	82. (c)	112. (b)	142. (a)
23. (a)	53. (b)	83. (c)	113. (c)	143. (a)
24. (d)	54. (d)	84. (c)	114. (a)	144. (d)
25. (a)	55. (a)	85. (b)	115. (b)	145. (d)
26. (b)	56. (a)	86. (b)	116. (b)	146. (d)
27. (a)	57. (a)	87. (d)	117. (a)	147. (c)
28. (d)	58. (d)	88. (c)	118. (b)	148. (c)
29. (c)	59. (b)	89. (d)	119. (c)	149. (a)
30. (c)	60. (c)	90. (d)	120. (d)	150. (d)

Sol–1: (c)

Velocity of any point on a link with respect to another point (relative velocity) on the same link is always perpendicular to the line joining these points on the configuration (or space) diagram.

V_{QP} = Relative velocity between P & Q

= $V_P - V_Q$ always perpendicular to PQ.

Sol–2: (a)

According to Grashof's law "For a four bar mechanism, the sum of the shortest and longest link lengths should not be greater than the sum of remaining two link lengths if there is to be continuous relative motion between the two links.

Sol–3: (d)

When gear teeth are produced by a generating process, intereference is automatically eliminated because the cutting tool removes the interfering portion of the flank. This effect is called undercutting. By undercutting the undercut tooth can be considerably weakened. So, intereference can be reduced by using more teeth on the gear. However, if the gears are to transmit a given amount of power, more teeth can be used only by increasing the pitch diameter.

Sol–4: (a)

We know natural frequency of a spring mass system is

$$\omega_n = \sqrt{\frac{k}{m}}$$

This equation (i) does not depend on the g and weight (W = mg), So, the natural frequency of a spring mass system is unchanged on the moon.

Hence, it will remain $\omega_{moon} = \omega_n$

Sol–5: (b)

Correct pairs are P-3, Q-4, R-2, S-1

Sol–6: (b)

Sol–7: (b)

Correct pairs are, P-4, Q-3, R-2, S-1

Sol–8: (d)

Corrected pairs are, P-2, Q-6, R-5, S-1

Sol–9: (d)

Sol–10: (c)

Belt and pulley is a higher pair.

Sol–11: (c)

Transmission angle is the angle between Output link and coupler.

Sol–12: (b)

Rotary engine is an inversion of Single slider crank chain

Sol–13: (a)

Kutzbach criterion for determining the number of degrees of freedom (n) is n = 3(*l*-1)-2j-h

Sol–14: (b)

Since grassof's law is satisfied $\Rightarrow$ $s + \ell \le p + q$

$\because$ Drag - crank mechanism (also known as double-crank mechanism) will be obtained by fixing shortest link.

Sol–15: (b)

When input and output link are parallel , then

$V_C = V_B = 2$ m/s

Sol–16: (d)

For pure rolling all the points will have different velocity i.e. $\vec{V} = \vec{V}_{cm} + r\vec{\omega}$, where $\vec{V}cm$ is the velocity of the centre of the disk, $\vec{\omega}$ is the angular velocity of the disk hence, centre of disk will have zero acceleration.

Sol–17: (a)

Sol–18: (a)

Centripetal acceleration, $a_c = r\omega^2$

Tangential acceleration, $a_t = r\alpha$

$\therefore$ Net acceleration, $a_N = \sqrt{a_c^2 + a_l^2}$

$$\Rightarrow a = \sqrt{\left(r\omega^2\right)^2 + \left(r\alpha\right)^2}$$

Sol–19: (c)

Sol–20: (b)

Sol–21: (d)

Sol–22: (c)

Smaller pressure angle reduces the axial thrust on the bearing. Also since power transmission = Torque transmitted × angular velocity.

But Torque transmitted = $F_{tangential} \times r$;

$= F\cos\phi \times r$;

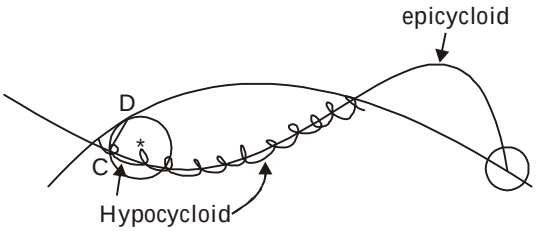
$r \rightarrow$ pitch circle radius

$\phi \rightarrow$ pressure angle

$\Rightarrow$ By decreasing pressure angle, power transmission increases.

Sol–23: (a)

Sol–24: (d)



Sol–25: (a)

$$\text{Train value} = \frac{1}{\text{speed ratio}}$$

$$= \frac{\text{Product of number of teeth on driver}}{\text{product of number of teeth on follower}}$$

Sol–26: (b)

$r_{sun} + 2r_{planet} = r_{annular}$

But $r = \frac{mT}{2}$:

$m \rightarrow$ module of rushing gear

$T \rightarrow$ number of teeth

$\Rightarrow T_{sun} + 2.T_{planet} = T_{annular}$

$\Rightarrow T_{sun} + 2(16) = 80$

$\Rightarrow T_{sun} = 48$ teeth

Sol–27: (a)

Sol–28: (d)

$\Delta P \rightarrow$ maximum fluctuation of energy

$$\Delta E = \frac{1}{2} I\omega_1^2 - \frac{1}{2} I\omega_2^2 = \frac{1}{2} I\left(\omega_1^2 - \omega_2^2\right)$$

$$= I\left(\frac{\omega_1 + \omega_2}{2}\right)\cdot\left(\omega_1 - \omega_2\right)$$

$$\Rightarrow \Delta E = I\omega\cdot\left(\omega_1 - \omega_2\right) = I\omega^2\left(\frac{\omega_1 - \omega_2}{\omega}\right)$$

$$\Rightarrow \Delta E = I\omega^2 K = \left(\frac{1}{2} I\omega^2\right)(2k)$$

$\Rightarrow \Delta E = 2$K.E.

Sol–29: (c)

Sol–30: (c)

Sol–31: (b)

Sol–32: (b)

$\therefore$ Critical damping coefficient,

$C_c = 2\sqrt{km}$

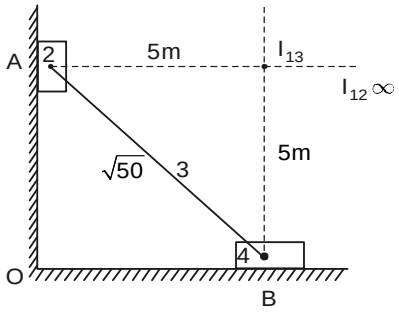
$$\Rightarrow C_c = 2\sqrt{(0.9\times 1000)\times(1)} = 60 \text{ N/m/s}$$

Sol–33: (a)

Sol–34: (d)

Sol–35: (d)

Sol–36: (a)



Now $\omega_{AB} = \frac{V_A}{I_{13}A} = \frac{V_B}{I_{13}B}$

$= \frac{10}{5} = 2$ rad/sec

Sol–37: (d)

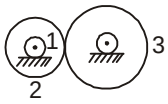
Sol–38: (b)

Sol–39: (d)

Coriollis acceleration arises when a slider slides on rotating link.

Sol–40: (c)

Sol–41: (a)



Degree of freedom,

$F = 3(\ell - 1) - 2j - h$

$= 3(3-1) - 2 \times 2 - 1$

$= 1$

where ℓ – no. of links

j – no. of lower pairs

h – no. of higher pairs

Sol–42: (b)

Sol–43: (a)

Sol–44: (d)

Sol–45: (b)

Follower velocity in various cases,

1. Cycloidal motion, $V = \frac{2h\omega}{\phi}$
2. SHM, $V = \frac{\pi\omega h}{2\phi} = 1.570\frac{\omega h}{\phi}$
3. Uniform velocity motion.

$$V = \frac{h\omega}{\phi}$$

$\therefore$ So the cycloidal motion has maximum velocity, then SHM and the least velocity is in uniform velocity motion.

Sol–46: (a)

Sol–47: (b)

Sol–48: (c)

Sol–49: (a)

Sol–50: (c)

Sol–51: (c)

(FCC, HCP have the highest APF = 0.74. That is why these 2 structures are called as close packed structures)

Sol–52: (b)

Sol–53: (b)

Sol–54: (d)

Sol–55: (a)

Sol–56: (a)

Sol–57: (a)

Sol–58: (d)

Steel : Si -Deoxidisation agent

cl : si - Graphitisation agent is i.e.

(i) Graphitisation occurs it much lesser % of C

(ii) i.e. addition of Si in liquid Fe shifts the iron carbon diagram towards left.

Sol–59: (b)

Sol–60: (c)

Sol–61: (c)

Sol–62: (d)

Sol–63: (d)

Sol–64: (a)

Sol–65: (d)

Sol–66: (c)

Sol–67: (d)

Sol–68: (c)

Sol–69: (c)

In vertical hyperbolic profile there is an advantage of superior strength and greatest resistance to outside wind loading compared to other shape.

Sol–70: (d)

Sol–71: (b)

A dry cooling tower is one in which the circulating water is passed through finned tubes over which the cooling air is passed. As a result, all the heat rejected from the circulating water is thus in the form of sensible heat to cooling air. The main disadvantage is less efficient than wet type, work at high back pressure.

Sol–72: (a)

Sol–73: (c)

Sol–74: (d)

Sol–75: (b)

$$\rho = \frac{\cos\alpha}{2}$$

Sol–76: (a)

$$\eta_{polytropic} = \left(\frac{\gamma-1}{\gamma}\right)\times\left(\frac{n}{n-1}\right)$$

Sol–77: (a)

The main function of boiler drum is to seperate the steam from liquid and seperated steam is sent to superheater side and water is recircularted through the corner untill it converts into vapour.

Sol–78: (a)

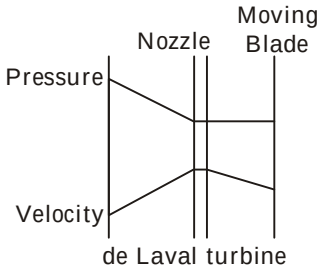
Sol–79: (c)

Sol–80: (b)

FAD is delivered volume reduced to 1 bar and 15°C, only when volume is compared at a given pressure and temperature, it shows the true handling capacity of a compressor.

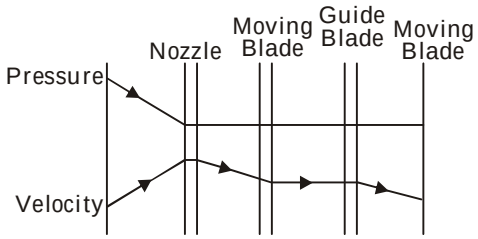
Sol–81: (d)

De Laval turbine consists of a single rotor to which impulse blades are attached. The steam is fed through one or several convergent-divergent nozzles which do not extend completely around the circumference of the rotor so that only part of the blades are impinged upon by the steam at any one time.

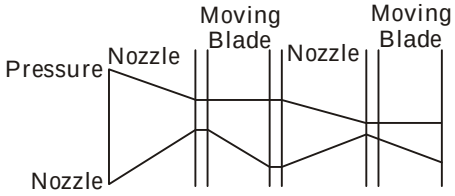


de Laval turbine

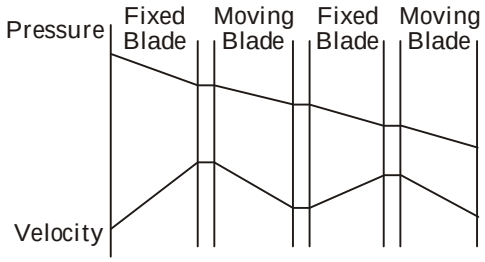
In curtis or velocity compounded turbine, one stage of nozzles is followed by two rows of moving blades instead of one. These two rows are seperated by one row of fixed blades attached to turbine stator, which has the function of redirecting the steam leaving the first row of moving blades to the second row of moving blades.



Rateau turbine



Parson turbine



Sol–82: (c)

In case of impulse turbines, the inlet area of moving blades is equal to the outlet area, while the outlet area of moving blades is smaller than the inlet area in case of reaction turbine.

Blades are symmetrical in case of impulse turbine, while in case of reaction turbines they are not symmetrical.

In case of impulse turbine, relative velocity of steam at inlet and outlet of moving blades are equal, while in case of reaction turbines, the relative velocity of steam at outlet is higher to get the reactive force.

Sol–83: (c)

$$\eta = 1-\frac{1}{r_p^{\frac{\gamma-1}{\gamma}}}$$

Thus, efficiency of air standard Brayton cycle depends only on pressure ratio.

Sol–84: (c)

The effect of supersaturation is to reduce the enthalpy drop slightly during the expansion and consequently a corresponding reduction in final velocity. The final dryness fraction and entropy are also increased and the

measured discharge is greater than that theoretically calculated.

Thus, velocity coefficient will be less than unity while the mass flow coefficient will be greater than unity. Since supersaturation leads to increase of entropy, hence the availability would decreases. Irreversibility or destruction of availability is proportional to the entropy generated.

Sol–85: (b)

Sol–86: (b)

Stirling: Bent water tube

Cochran: Vertical fire tube

Lancashire: Horizontal fire tube

Benson: Once through flow

Sol–87: (d)

Temperature control is accomplished by use of an attemperator or desuperheater that injects a controlled amount of cooling water into the superheated steam flow.

Sol–88: (c)

Positive contact clutches. Once coupled can transmit large torque with no slip.

In general, positive clutches are rarely used as compared with friction clutches. However they have some important application where synchrnous operation is required like power presses and rolling mills.

Sol–89: (d)

Sol–90: (d)

Although needle bearings are considered as a variety of cylinderical roller bearings. They are essentially not the same.

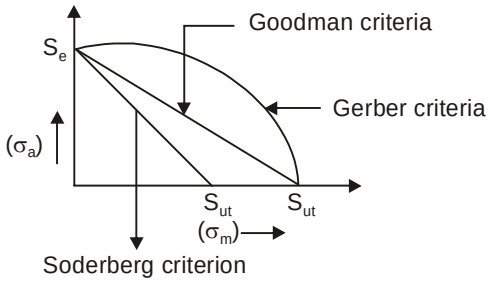
The needles, which are considerably longer than their diameter, cannot be manufactured with the same degree of accuracy, this results in high friction in needle bearings.

Sol–91: (d)

Sol–92: (b)

Insufficient tightness of the outer race in the housing seat may cause 'creep'. In bearing terminology, creep is slow rotation of the outer race relative to its seating.

Sol–93: (b) Soderberg criteria is correct answer

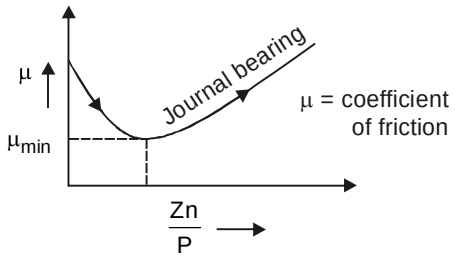


Sol-94: (b)

Axles do not used for power transmission like shaft. So it is designed using simple bending moment only.

Sol–95: (d)

For journal bearing



Sol–96: (a)

It is known as pitting action which is a kind of surface fatigue failure. It occurs when loading exceeds the surface endurance strength. Surface fatigue in case of ball bearing is known pitting.

Sol–97: (a)

Maximum principle stress theory is used for designing a brittle material as these material fails under tensile stress / Normal loading condition.

Sol–98: (b)

Sol–99: (c)

When nut is tightened on the bolt then bolt will have tensile load and also shearing at portion of nut and bolt contacting surface.

Sol–100: (c)

In case of bolt of uniform strength we do

(i) Drill a bolt i.e. shank area is reduced to root area.

(ii) Reduce the diameter of shank of bolt corresponding to that of minor diameter.

Sol–101: (a)

Wahl correction factor taken to take into account both direct shear as well as curvature of the wire.

Sol–102: (a)

For ductile material stress concentration effect is serious if there is dynamic loading condition as compare to static condition.

Sol–103: (d)

Tapered roller can bear axial as well as radial load.

But, $\frac{F_r}{F_a} > 1$. So option (d) is correct.

Sol–104: (d)

Power transmission = $(T \times \omega)$

So, Torque = $\frac{\pi}{16} \times \tau \times (d)^3$

So, constant torsional stresses but varying bending stresses due to gear loading.

Sol–105: (b)

In case of assembly design of shaft key should be weakest member as it should fail first to give notice that loading has exceeded the safe limit, to save the shaft and mechanical elements of the assembly.

Sol–106: (a)

Spiral gears are used for connecting non-parallel and non-intersecting shafts for power transmission.

Sol–107: (a)

There are antifriction ball bearing as it has low friction at starting condition compared to sliding contact bearing.

Sol–108: (a)

It is due to wedge shape film of oil which case bearing function in a hydrodynamic slider bearings.

Sol–109: (a)

It is advantageous to use hydro-dynamic journal bearing as they have high load carrying capacity at high speed due to hydrodynamic pressure developed by the film.

Sol–110: (c)

A little variation in centre distance of gears does not affect the velocity ratio if the teeth profile of gears are involute where as in cycloidal profile of teeth, exact centre distance should be maintained.

Sol–111: (b)

Given equation :

$$16\ddot{X} + 5\dot{X} + 4X = 0$$

$$\ddot{X} + \frac{5}{16}\dot{X} + \frac{X}{4} = 0$$

by comparing with $m\ddot{X} + c\dot{X} + KX = 0$

$m = 1,\ C = 5/16,\ K = \frac{1}{4}$

So, damping ratio = $\frac{C}{C_c}$

$$C_c = 2\sqrt{km}$$

$$= 2\sqrt{\frac{1}{4} \times 1}$$

$$= 1$$

$$\frac{C}{C_c} = \frac{5}{16}$$

Sol–112: (b)

Disturbing force, $F = (1 - C)mr(\omega)^2 \cos(\theta)$

$$= (1 - 0.4)(6 \times 0.10 \times (15)^2)\cos(60)$$

= 40.5 N

Sol–113: (c)

Formula for torque, $T = I\alpha$

$1500 = 2500 \times \alpha$

$\Rightarrow \quad \boxed{\alpha = 0.6}$

After 10 sec, speed $\omega_2 = \omega_1 + \alpha(t)$

$\omega_2 = 0 + 0.6 \times 10$

$\boxed{\omega_2 = 6\,\text{rad/sec}}$

$\Rightarrow$ Kinetic energy, $KE = \frac{1}{2} I(\omega)^2$

$= \frac{1}{2} 2500 \times (6)^2$

= 45 KNm

Sol–114: (a)

Sol–115: (b)

Sol–116: (b)

Cooling efficiency,

$$= \frac{(\text{Incoming water temp}) - (\text{Exiting water temp})}{(\text{Incoming water temp}) - (\text{WBT of ambient air})}$$

$$\Rightarrow \quad \eta = \left[\frac{35-27}{35-21}\right] = \frac{8}{14} = 0.5714 = 57.14\%$$

Sol–117: (a)

Sol–118: (b) As mass flow rate,

$m = \rho V = 1.2 \times \frac{600}{60} = 12\ \text{kg/s}$

Power, $P_{th} = m \times \phi_s \times u_2^2$

= 12 × 0.5 × $(400)^2$ = 960000 = 960 kW

Sol–119: (c)

Sol–120: (d)

In turboprop engine propeller is coupled to the turbine through a reduction gear that converts the high rpm and low torque into low rpm and high torque.

Sol–121: (a)

Sol–122: (c)

Sol–123: (b)

Sol–124: (a)

Sol–125: (b)

Sol–126: (a)

Sol–127: (b)

Sol–128: (a)

With increase in planar density satisfied atomic bands increases which increases the stability of crystal structure and decreases the surface energy.

Sol–129: (a)

Sol–130: (c)

Sol–131: (b)

Sol–132: (a)

Sol–133: (a)

Sol–134: (a)

In ideal cycle, internal friction and irreversibilities are assumed to be zero, therefore any heat rejection will definitely decrease the entropy.

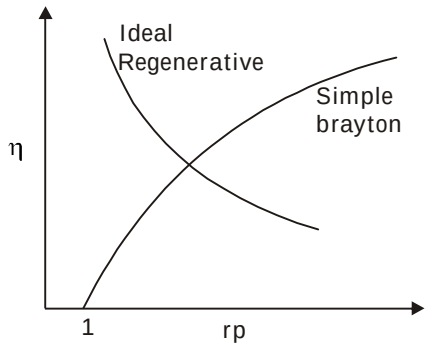
Sol–135: (b)

Sol–136: (b)

$\left(\eta_{\text{brayton cycle}}\right)_{max} = \eta_{carnot}$ but $W_{net} = 0$

Sol–137: (b)

Beyond certain pressure ratio use of regenerator become ineffective because the compressor outlet temperature becomes more than turbine exit temperature



Sol–138: (a)

$T_{MP} \Rightarrow$ Mean temperature of heat addition

$T_{MR} \Rightarrow$ Mean temperature of heat rejection

$\eta \uparrow$ when $T_{MA} \uparrow$ or $T_{MR} \downarrow$

$\therefore \quad \eta \qquad \alpha \left(T_{MA} - T_{MR}\right)$

Intercooling: $T_{MA} \downarrow\downarrow \quad T_{MR} \downarrow$

$\therefore \quad \left(T_{MA} - T_{MR}\right) \downarrow$

Rehating: $T_{MA} \uparrow T_{MR} \uparrow\uparrow$

$\left(T_{MA} - T_{MR}\right) \downarrow$

Sol–139: (a)

The state of a fluid obtained when it is isentropically deccelerated to zero velocity state is refered as stagnation state. It is taken as a reference point to denote total energy of fluid at a point, in energy transformation as total energy of fluid is constant stagnation enthalpy remain constant while it decreases for turbine and increases for compressor accordingly to change in energy content of fluid.

Sol–140: (b)

Sol–141: (b)

Sol–142: (a)

When the lining is put into service, wear occurs. Therefore a major portion of life of clutch comes under the uniform wear criterion.

Sol–143: (a)

Due to point contact between the balls and races, frictional loss and resultant temperature rise is less in this bearing. The maximum permissible speed of the shaft depends upon the temperature rise of the bearing. Therefore, Deep groove ball bearing gives high performance especially in high speed application.

Sol–144: (d)

Sol–145: (d)

In hydrodynamic journal bearing, lifting support pressure to journal generated using hydrodynamic action of shaft / journal on lubricant.

Sol–146: (d)

Endurance limit is not a property of a material like ultimate tensile strength of a material.

Sol–147: (c)

Damping force = $C\dot{x}$

where C is damping coefficient

So, $\boxed{\text{Damping force} \alpha \text{ velocity}}$

Sol–148: (c)

A pantograph is a bar linkage used to produce paths exactly similar to the ones traced out by point on the linkage. The paths so produced are usually, on an enlarged or reduced scale.

Sol–149: (a)

As gears for skew shafts have point contact, so they are not used for high power transmission.

Sol–150: (d) Unstable flow in axial compressors can be due to two reasons.

(1) Separation of flow from blade surfaces called stalling.

(2) Complete breakdown of steady flow called surging.