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Q. No. 1 – 25 Carry One Mark Each

Q.1 If F is any vector function then $\nabla \cdot (\nabla \times F) =$

- (a) 0 (b) 1 (c) 3 (d) $\nabla^2 f$

Q.2. If $\lambda_1, \lambda_2, \lambda_3$ are the eigen values of the given matrix then

$$\begin{bmatrix} -1 & 2 & 3 \\ 1 & -4 & 2 \\ 2 & -4 & -6 \end{bmatrix}$$

then $\lambda_1 * \lambda_2 * \lambda_3$ is

- (a) 1 (b) -1 (c) 0 (d) -11

Q.3 The Temperature at a point in space is given by

$T(x,y,z) = x^2 + y^2 - z$. A mosquito located at (1,1,2) desires to fly in such a direction that it will get warm as soon as possible. The direction it should move is

- (a) $\frac{2}{3}(2i+2j+2k)$ (b) $\frac{1}{3}(2i+2j-k)$ (c) $i+j-k$ (d) $2i-2j+k$

Q.4. The given equation $5x+3y+7z=4, 3x+26y+2z=9, 7x+2y+10z=5$ has

- (a) unique solution (b) no solution (c) infinite solution (d) four solution

Q.5. If $R = x\hat{i} + y\hat{j} + z\hat{k}$ then $\nabla * R =$

- (a) 0 (b) 1 (c) 3 (d) none of these

Q.6. The equivalent evaporation (kg/hr) of a boiler producing 2000 kg/hr of steam with enthalpy content of 2426 kJ/kg from feed water at temperature 40°C (liquid enthalpy = 168 kJ/kg, enthalpy of vaporization of water at 100°C = 2258 kJ/kg) is:

- (a) 2000 (b) 2149 (c) 1682 (d) 1649

Q.7 The time variation of the position of a particle in rectilinear motion is given by $x = 2t^3 + t^2 + 2t$. If v is the velocity and a the acceleration of the particle in consistent units, the motion started with

- (a) $v=0, a=0$ (b) $v=0, a=2$ (c) $v=2, a=0$ (d) $v=2, a=2$

Q.8. For a current carrying wire of 20 mm diameter exposed to air ($h = 25 \text{ W/m}^2\text{K}$), maximum heat distribution occurs when the thickness of insulation ($k = 0.5 \text{ W/m K}$), is:

- (a) 20 mm (b) 10 mm (c) 2.5mm (d) 0 mm

Q.9 Existence of velocity potential implies that

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- (a) Fluid is in continuum (b) Fluid is irrotational
(c) Fluid is ideal (d) Fluid is compressible
- Q.10 A gas turbine cycle with infinitely large number of stages during compression and expansion leads to
- (a) Stirling cycle (b) Atkinson cycle
(c) Ericsson cycle (d) Brayton cycle
- Q.11 Two insulating materials of thermal conductivity K and $2K$ are available for lagging a pipe carrying a hot fluid. If the radial thickness of each material is the same.
- (a) material with higher thermal conductivity should be used for the inner layer and one with lower thermal conductivity for the outer.
(b) material with lower thermal conductivity should be used for the inner layer and one with higher thermal conductivity for the outer.
(c) it is immaterial in which sequence the insulating materials are used
(d) it is not possible to judge unless numerical values of dimensions are given
- Q.12 The practice to use steam on the shell side and cooling water on the tube side in condensers of steam power plant is because
- (a) to increase overall heat transfer coefficient water side velocity can be increased if water is at the tube side
(b) condenser can act as a storage unit for condensed steam
(c) rate of condensation of steam is invariably smaller than the mass flow rate of cooling water
(d) it is easier to maintain vacuum on the shell side than on the tube side
- Q.13 For a given set of operating pressure limits of a Rankine cycle, the highest efficiency occurs for
- (a) Saturated cycle (b) Superheated cycle
(c) Reheat cycle (d) Regenerative cycle
- Q.14 For a single stage impulse turbine with a rotor diameter of 2 m and a speed of 3000 rpm when the nozzle angle is 20° , the optimum velocity of steam is m/s is?

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- (a) 334 (b) 356 (c) 668 (d) 711

Q.15. A stone of mass m at the end of a string of length l is whirled in a vertical circle at a constant speed. The tension in the string will be maximum when the stone is

- (a) at the top of the circle (b) half-way down from the top
(c) quarter way down from the top (d) at the bottom of the circle

Q.16 A gas turbine power plant has a specific output of 388 kJ/kg and an efficiency of 34%. A regenerator is installed and the efficiency increases to 51%. The specific output will be closest to

- (a) 582 kJ/kg (b) 519 kJ/kg (c) 388 kJ/kg (d) 776 kJ/kg

Q.17 For the data listed below for two journal bearings A and B, predict the flow conditions in the bearings

	Diameter	Radial clearance (m)	Surface speed of shaft (m/s)	Viscosity of lubricant (Pa - s)	Density of lubricant (kg/m^3)
A	0.01	10^{-5}	210	0.001	1000
B	0.05	10^{-4}	10	0.01	850

- (a) laminar in both A and B (b) turbulent in both A and B
(c) Laminar in A and turbulent in B (d) turbulent in A and laminar B

Q.18 The buckling load for a column pinned at both ends is 5 kN. If the ends are fixed, the buckling load changes to

- (a) 20 kN (b) 2.5 kN (c) 10 kN (d) 7.07 k N

Q.19 The ratio of average shear stress to the maximum shear stress in a beam with a square cross-section is:

- a) 1 (b) $\frac{2}{3}$ (c) $\frac{3}{2}$ (d) 2

Q.20 A static fluid can have

- (a) non-zero normal and shear stress
(b) negative normal stress and zero shear stress
(c) positive normal stress and zero shear stress
(d) zero normal stress and non-zero shear stress

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- Q.21 A gas having a negative Joule-Thompson coefficient ($\mu < 0$), when throttled, will
- (a) become cooler (b) become warmer
(c) remain at the same temperature
(d) either be cooler or warmer depending on the type of gas
- Q.22 Lumped heat transfer analysis of a solid object suddenly exposed to a fluid medium at a different temperature is valid when
- (a) Biot number < 0.1 (b) Biot number > 0.1
(c) Fourier number < 0.1 (d) Fourier number > 0.1
- Q.23 The Rateau turbine belongs to the category of
- (a) pressure compounded turbine (b) reaction turbine
(c) velocity compounded turbine (d) radial flow turbine
- Q.24 In ECM, the material removal is due to
- (a) corrosion (b) erosion
(c) fusion (d) ion displacement
- Q.25 The lengths of the links of a 4-bar linkage with revolute pairs only are p,q,r and s units. Given that $p < q < r < s$. which of these links should be the fixed one, for obtaining a 'double crank' mechanism?
- (a) link of length p (b) link of length q
(c) link of length r (d) link of length s

Q nos. 26 -56 carry two marks each

- Q.26 Which of the following is the Laplace transform of

$$f(t) = \begin{cases} 1, & \text{if } 0 \leq t < 2, \\ t^2 - 4t + 4, & \text{if } t \geq 2 \end{cases} ?$$

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$$(a) F(s) = \frac{2e^{-2s}}{s^3}$$

$$(b) F(s) = \frac{1 - e^{-2s}}{s} + \frac{2e^{-2s}}{s^3}$$

$$(c) F(s) = \frac{e^{-2s}}{s} + \frac{2 - 2e^{-2s}}{s^3}$$

Q.27 A suitable form of the general solution to

$$y'' - 2y' + y = e^t + t$$

$$(a) c_1te^t + c_2e^t + At^2e^t + Bt + C$$

$$(b) c_1e^t + c_2t^2 + Ate^t + Bt + C$$

$$(c) c_1te^t + c_2e^t + Ate^t + Bt + C$$

$$(d) c_1te^t + c_2e^t + Ate^t + Bt$$

Q.28 The tangent plane to the surface $x^2 + y^2 - 2z^2 = 3$ at the point $(2, 1, 1)$ can be written as

$$(a) -2(x - 2) + 2(y - 1) - (z - 1) = 0, \quad (b) 2(x - 2) + (y - 1) - 4(z - 1) = 0.$$

$$(c) (x - 1) + 9y - 1 + (z - 1) = 0, \quad (d) 2x + y + z = 3,$$

$$(e) 2(x - 2) + (y - 1) - 2(z - 1) = 0.$$

Q.29 The acceleration vector $\mathbf{r}''(t)$ of $\mathbf{r}(t) = t^3 \mathbf{i} + (\sin \pi t) \mathbf{j}$ at $t = \frac{1}{3}$ is

$$(a) 2\mathbf{i} - \frac{\sqrt{3}}{2}\pi^2\mathbf{j}, \quad (b) 2\mathbf{i} + \frac{\pi^2}{2}\mathbf{j}, \quad (c) 3\mathbf{i} + \frac{\pi^2}{2}\mathbf{j}, \quad (d) 3\mathbf{i} - \frac{1}{2}\mathbf{j}, \quad (e) \text{None of the above.}$$

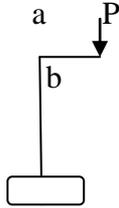
Q.30 Suppose that the angle between the vectors $\mathbf{u} = \mathbf{i} - \mathbf{k}$ and $\mathbf{v} = 2\mathbf{i} + a\mathbf{j}$ is $\frac{\pi}{3}$. Then a is equal to

$$(a) \pm\sqrt{3}, \quad (b) \frac{\pm\sqrt{3}}{2}, \quad (c) \pm 3, \quad (d) \pm 2, \quad (e) \pm 3.$$

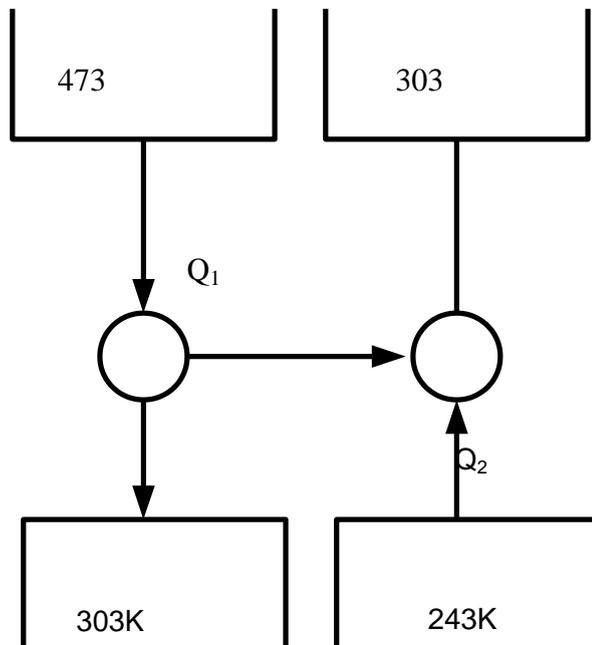
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- Q.31 The frame shown in the figure is of constant cross section area and is perfectly restrained at its lower end. The vertical deflection caused by the load P is



- (a) $Pa^2/EI (b+a/3)$ (b) $Pa^2/EI (b-a/3)$ (c) Pa^2b/EI (d) $Pa^3/3EI$
- Q.32 A car engine burns 5 kg fuel at 1500 K and rejects energy into the radiator and exhaust at an average temperature of 750 K. If the fuel provides 40000 kJ/kg, what is the maximum amount of work the engine provide?
- (a) 50MJ (b) 100MJ (c) 150MJ (d) 200MJ
- Q.33 We wish to produce refrigeration at -30°C . A reservoir, shown in fig is available at 200°C and the ambient temperature is 30°C . This, work can be done by a cyclic heat engine operating between the 200°C reservoir and the ambient. This work is used to drive the refrigerator. Determine the ratio of heat transferred from 200°C reservoir to the heat transferred from the -30°C reservoir, assuming all process are reversible.



- (a) 0.69 (b) 0.8 (c) 0.78 (d) 1.69

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Q.34 A rigid tank contains 2 kg of air at 200 KPa and ambient temperature, 20°C. An electric current now passes through a resistor inside the tank. After a total of 100 kJ of electrical work has crossed the boundary, the air temperature inside is 80°C, is this possible?

C_p of air 1005 J/Kg/K and $C_v=705$ J/kg/K

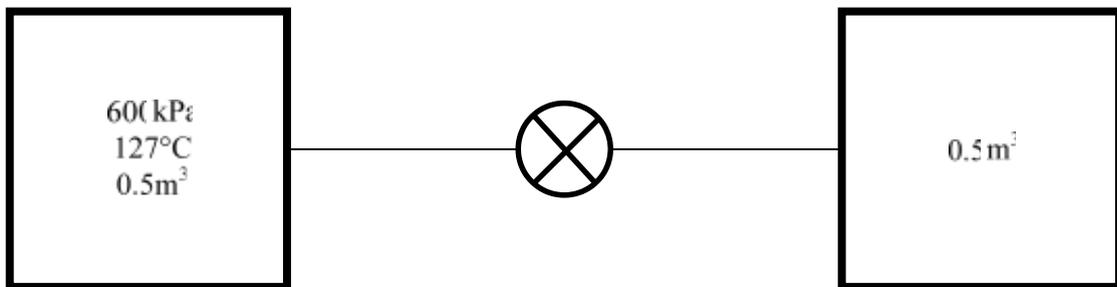
- (a) Yes (b) no (c) data insufficient

Q.35. Nitrogen at 600 kPa, 127°C is in a 0.5 m³-insulated tank connected to pipe with a valve to a second insulated initially empty tank 0.5 m³. The valve is opened and nitrogen fills both the tanks. Find the final pressure and temperature

- (a) 600 kPa, 400 K (b) 300 kPa, 400 K (c) 600 kPa, 200 K (d) 300 kPa, 800 K

Q.36 The entropy generated in this process is

- (a) 514.5 J/K (b) 0 (c) 0.514 J/K (d) 913 J/K



Q.37 A piece of granite floats at the interface of mercury and water contained in a beaker (Fig.). If the densities of granite, water and mercury are ρ , ρ_1 and ρ_2 respectively, the ratio of the volume of granite in water to the volume in mercury is

- (a) $(\rho_2 - \rho) / (\rho - \rho_1)$
(b) $(\rho_2 + \rho) / (\rho + \rho_1)$
(c) $\rho_1 \rho_2 / \rho$
(d) ρ_1 / ρ_2
(e) ρ_2 / ρ_1

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Q.38 The disk has a mass of 10kg and radius 1m. If it is released from rest, determine its angular velocity in $t = 3s$.

- (a) 19.62 (b) 0 (c) 9.81 (d) 29.43

Q.39 A project consists of three parallel paths with mean durations and variances of (10,4), (12,4) and (12,9) respectively. According to the standard PERT assumptions, the distribution of the project duration is

- (a) Beta with mean 10 and standard deviation 2
(b) Beta with mean 12 and standard deviation 2
(c) Normal with mean 10 and standard deviation 3
(d) Normal with mean 12 and standard deviation 3

Q.40 If the length of the Cantilever beam is doubled, the natural frequency of the mass M at the end of this Cantilever beam of negligible mass is decreased by a factor of

- (a) 2 (b) 4 (c) 8 (d) $\sqrt{8}$

Q.41 In a blanking operation, the Clearance is provided on

- (a) the die (b) both the die and the punch equally
(c) the punch (d) neither the punch nor the die

Q.42 Time taken to drill a hole through a 50 mm thick plate with the drill rotating at 150 rpm and moving at a feed rate of 0.25 mm/revolution is

- (a) 80 sec (b) 40 sec (c) 160 sec (d) 100 sec

Q.43 Suppose X is a normal random variable with mean 0 and variance 4. Then the mean of the absolute value of X is

- (a) $\frac{1}{\sqrt{2\pi}}$ (b) $\frac{2\sqrt{2}}{\sqrt{\pi}}$ (c) $\frac{2\sqrt{2}}{\pi}$ (d) $\frac{2}{\sqrt{\pi}}$

Q.44 In a time series forecasting model, the demand for five time periods was 10, 13, 15, 18 and 22. A linear regression fit resulted in an equation $F = 6.9 + 2.9 t$ where F is the forecast for period t . The sum of absolute deviations for the five data is:

- (a) 2.2 (b) 0.2 (c) -1.2 (d) 24.3

A fit is specified as 25 H8/e8. The tolerance value for a nominal diameter of 25 mm in IT8 is 33 microns and fundamental deviation for the shaft is -40 microns. The maximum clearance of the fit in microns is

- (a) -7 (b) 7 (c) 73 (d) 106

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Uncut thickness = 0.5 mm Cutting speed = 20 m/min Width of cut = 5 mm
Chip thickness = 0.7 mm Thrust force = 200 N Cutting force = 1200 N
Rake angle = 15°

Assume Merchant's theory.

Q.48. The values of shear angle and shear strain, respectively, are

- (A) 30.3° and 1.98 (B) 30.3° and 4.23
(C) 40.2° and 2.97 (D) 40.2° and 1.65

Q.49 The coefficient of friction at the tool-chip interface is:

- (A) 0.2 (B) 0.46 (C) 0.85 (D) 0.95

Q.50 The percentage of total energy dissipated due to friction at the tool-chip interface is:

- (A) 30% (B) 42% (C) 58% (D) 70%

Linked Answer Questions: Q.51 to Q54 Carry Two Marks Each

Statement for Linked Answer Questions 51 & 52:

A simply supported beam of span length 6 m and 75 mm diameter carries a uniformly distributed load of 2.0kN/m.

Q.51 What is the maximum value of bending moment?

- (A) 12kNm (B) 9 kNm (C) 18 kNm (D) 16 kNm

Q.52 What is the maximum value of bending stress?

- (A) 217.30 MPa (B) 434.6 MPa (C) 834 MPa (D) 869.2 MPa

Statement for Linked Answer Questions 53 & 54:

A vibratory system consists of a mass 25 kg, a spring of stiffness 1600 N/m, and a dashpot with damping coefficient of 15 Ns/m.

Q.53 The value of critical damping of the system is:

- (A) 0.2 Ns/m (B) 8 Ns/m (C) 0.4 Ns/m (D) 400 Ns/m

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Q.54 The value of logarithmic decrement is:

- (A) 0.075 (B) 0.235 (C) 0.68 (D) 0.0375

Q.55 A mould has a downsprue whose length is 20 cm and the cross sectional area at the base of the downsprue is 1 cm^2 . The downsprue feeds a horizontal runner leading into the mould cavity of volume 1000 cm^3 . The time required to fill the mould cavity will be

- (a) 4.05 s (b) 5.05 s (c) 6.05 s (d) 7.25 s

Q. No. 56– 60 Carry One Mark Each

56 A train raveling at 42 km/hr passes a cyclist going in the same direction in 9 secs.; if the cyclist had been going in the opposite direction, the train would have passed him in 5 secs, Find the length of the train.

- a) 75 metres b) 60 metres c) 90 meters d) 80 meters

57 The pipes P and Q can fill the tank in 20 and 30 hours respectively. Pipe R can empty it in 10 hours. If all the three are opened together, how many hours will the tank take to be filled?

(Assume the tank was empty initially).

- a) 20 hours b) 25 hour c) 60 hours d) It will never be filled.

Q.58 FIRE: ASHES:: (A) accident: delay (B) wood: splinters
(C) water: waves (D) regret: melancholy (E) event: memories

59 Choose the word nearest to meaning of SUBJUGAT

surrender (b)conquer(c) vanquish (d)vanish

o

Q.60 Normally an individual thunderstorm lasts about 45 minutes, but under certain conditions the storm may, becoming ever more severe, for as long as four hours.

- A) wane B) moderate C) persist D) vacillate E) disperse

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Q. 61 to 65 carry 2 marks each

Q.61 Measurement is, like any other human endeavor, a complex activity, subject to error, not always used, and frequently misinterpreted and

- A) mistakenly ... derided B) erratically ... analyzed
C) systematically ... organized D) innovatively refined E)
properly...misunderstood

62 Abra is Rambo's daughter, Shinto is Rambo's sister . Shintu's daughter is called Cabra and son is called Dabra. Limba is Cabra's maternal aunt.

- Abra is Limba's;
(a) aunt (b)nephew (c)uncle (d)none of these

Q.63 A can do a work in 6 days and B in 8 days. With the help of a boy, the three complete the work in 3 days and get Rs. 200. What is the boy's share, if the money is distributed in the ratio of the work done?

- a) Rs. 75 b) Rs. 45 c) Rs. 30 d) Rs. 25

Q.64 In a certain code SIKKIM is coded as THLJL. How is training written in that code

- (a)SQBHOOH (B)UQBHOHOF (C)UQBJOHOH (d)UQBJOHOH

Q.65 Global financial markets froze in the morning New York trade on Wednesday as projections of a republican sweep the White House and congress came unstuck over a recount in the pivotal state of Florida, leaving the presidential result in balance. The dollar firmed but pared earlier gains against the Euro after the white house race was put on hold. In the event of a clear republican win in America, which of the following predictions about the dollar are most likely to come true

- (a)it will be at an advantage against euro.
(b)It will rise to some stable advantage but will eventually slide.
(c) it will be stable
(d)It will continue to volatile and unstable

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