Q1: If the functions of an orthogonal set $\{\phi_n(x)\}$ have the property of $\int_a^b \phi_n^2(x)\,dx = 1$, then the functions, in the interval [a, b], are said to be:

A. Weight functions
B. Null functions
C. Orthonormal functions
D. Complete functions

Q2 The only solution of the initial value problem $y'' + x^2y = 0$ with $y(0) = 0$ and $y'(0) = 0$ is:

A. $y(x) = sinn\pi x$
B. $y(x) = e^{n\pi x}$
C. $y(x) = cosn\pi x$
D. $y(x) = 0$

Q3: The general solution of the differential equation $x^2y'' + xy' + (x^2 - 9)y = 0$ is:

A. $y(x) = C_1J_9(x) + C_2J_{-9}(x)$
B. $y(x) = C_1J_3(x) + C_2J_{-3}(x)$
C. $y(x) = C_1I_9(x) + C_2I_{-9}(x)$
D. $y(x) = C_1I_3(x) + C_2I_{-3}(x)$

Q4: The Euler Beta function $\beta(x, y)$ can be expressed in terms of Gamma function as:

A. $\beta(x,y) = \frac{\Gamma(x)+\Gamma(y)}{\Gamma(x)\Gamma(y)}$
B. $\beta(x,y) = \frac{\Gamma(x)+\Gamma(y)}{\Gamma(x)-\Gamma(x)}$
C. $\beta(x,y) = \frac{\Gamma(x)\Gamma(y)}{\Gamma(x+y)}$
D. $\beta(x,y) = \frac{\Gamma(x)\Gamma(y)}{\Gamma(x-y)}$

Q5: For solving **1D** wave equation of transverse vibrating elastic string, ($\frac{\partial^2 u}{\partial t^2} = a^2 \frac{\partial^2 u}{\partial x^2}$), based on the separation of variables method, the solution of time dependent deferential equation $\ddot{T} + \mu T = 0$, which has *periodic nature*, satisfies the boundary conditions $u(0,t) = 0$ and $u(L,t) = 0$ if:

A. $\mu < 0$
B. $\mu > 0$
C. $\mu = 0$
D. couldn't be predicted

Q6: The generating function of the Legendre's polynomial is:

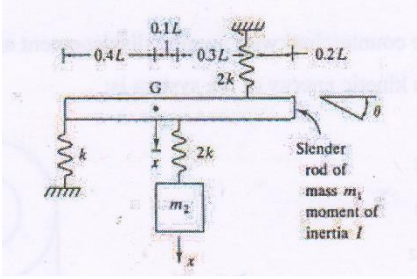
A. $\frac{e^{-xt/(1-t)}}{1-t} = \sum_{n=0}^{\infty} \frac{\mathrm{L}_n(x)t^n}{n!}$
B. $e^{-xt/(1-t)} = \sum_{n=0}^{\infty} \frac{\mathrm{H}_n(x)t^n}{n!}$
C. $\frac{1}{\sqrt{1-2xt+t^2}} = \sum_{n=0}^{\infty} P_n(x)t^n$
D. $e^{\frac{x}{2}\left(t-\frac{1}{t}\right)} = \sum_{n=0}^{\infty} \mathrm{J}_n(x)t^n$

Q7: For a partial differential equation, in a function $\phi\,(x,y)$ and two variables x, y, the form obtained after applying the separation of variables is:

A. $\phi\,(x,y) = X(x) + Y(y)$
B. $\phi\,(x,y) = X(x) - Y(y)$
C. $\phi\,(x,y) = X(x)Y(y)$
D. $\phi\,(x,y) = X(x)/Y(y)$

Q8: Which of the following is a non-homogeneous partial differential equation?

A. $u_{tt} + c^2 u_{xx} = 0$
B. $u_{xx} + (u_{xy})^2 + u_{yy} = x^2 + y^2$
C. $u_{tt} - c^2 u_{xx} = 0$
D. $u_t + c^2 u_{xx} = 0$



Q9: The system shown in the figure is:

A. one degree of freedom
B. two degrees of freedom
C. three degrees of freedom
D. four degrees of freedom

Q10: A 200 kg mass is placed at the end of 1.8 m long steel ($E = 210 \times 10^9\ N/m$) cantilever beam. The mass is observed to vibrate with a natural frequency of 2 Hz. The moment of inertia of the beam's cross-section about its neutral axis is: (Consider the system is single degree of freedom), k_{eq} of the beam $= 3EI/L^3$.

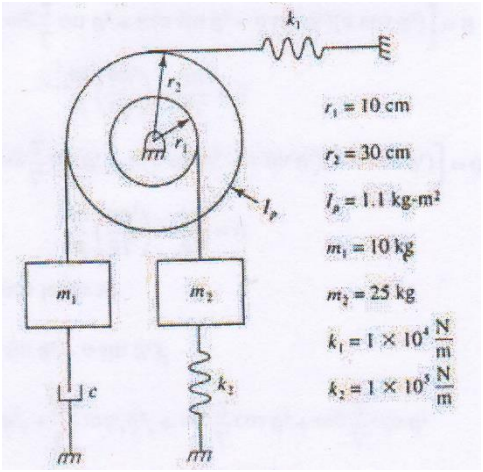
A. $2.22*10^{-5}$ m^4
B. $5.22*10^{-5}$ m^4
C. $3.22*10^{-5}$ m^4
D. $6.22*10^{-5}$ m^4

Q11: If the differential equations governing the motion of a system are:

$$\begin{bmatrix} m & 0 \\ 0 & m \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} 2k & -k \\ -k & 3k \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

Then the natural frequencies of the system are:

A. $\omega_1 = 2.23\sqrt{\frac{k}{m}}$, $\omega_2 = 4.12\sqrt{\frac{k}{m}}$
B. $\omega_1 = 1.176\sqrt{\frac{k}{m}}$, $\omega_2 = 1.902\sqrt{\frac{k}{m}}$
C. $\omega_1 = 3.76\sqrt{\frac{k}{m}}$, $\omega_2 = 5.36\sqrt{\frac{k}{m}}$
D. $\omega_1 = 5.82\sqrt{\frac{k}{m}}$, $\omega_2 = 6.97\sqrt{\frac{k}{m}}$



Q12: If θ and $\dot{\theta}$ are counterclockwise angular displacement and angular velocity of the disk in Figure. Then the kinetic energy of the system is:

A. $1.25\dot{\theta}^2$ kg. m^2

B. $2.25\dot{\theta}^2$ kg. m^2

C. $4.25\dot{\theta}^2$ kg. m^2

D. $5.25\dot{\theta}^2$ kg. m^2

Q13: If the Lagrangian of a system is

$$\frac{1}{2}m\dot{x}_1^2 + \frac{1}{2}2m\dot{x}_2^2 + \frac{1}{2}m\dot{x}_3^2 - \frac{1}{2}kx_1^2 - \frac{1}{2}2k(x_2 - x_1)^2 - \frac{1}{2}k(x_3 - x_2)^2$$

Then one of the equations of motion is:

A. $m\ddot{x}_1 + 3kx_1 - 2kx_2 = 0$

B. $m\ddot{x}_1 + 5kx_1 - 7kx_2 = 0$

C. $m\ddot{x}_1 + kx_1 - 8kx_2 = 0$

D. $2m\ddot{x}_1 + 2kx_1 - 7kx_2 = 0$

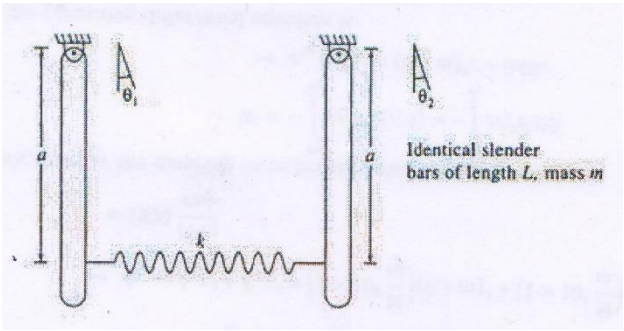
Q14: If a single degree of freedom system is excited by impulsive force at $t = 0$. Then the initial conditions of the system are:

A. $y_0 = \frac{1}{k}$ $\dot{y}_0 = 0$

B. $y_0 = 0$ $\dot{y}_0 = \frac{1}{m}$

C. $y_0 = \frac{1}{m}$ $\dot{y}_0 = 0$

D. $y_0 = 0$ $\dot{y}_0 = \frac{1}{k}$



Q15: The potential energy of the system shown in Figure at an arbitrary instant θ_1 and θ_2 is:

A. $-mg\frac{L}{2}\sin\theta_1 - mg\frac{L}{2}\sin\theta_2 + \frac{1}{2}k(a\cos\theta_2 - a\cos\theta_1)^2$

B. $-mgL\cos\theta_1 - mgL\cos\theta_2 + \frac{1}{2}k(\frac{a}{2}\sin\theta_2 - \frac{a}{2}\sin\theta_1)^2$

C. $-mg\frac{L}{2}\cos\theta_1 - mg\frac{L}{2}\cos\theta_2 + \frac{1}{2}k(a\sin\theta_2 - a\sin\theta_1)^2$

D. $-mga\cos\theta_1 - mga\cos\theta_2 + \frac{1}{2}k(L\sin\theta_2 - L\sin\theta_1)^2$

Q16: Which of the following is a basic classification of Engineering Materials?

A. Metals

B. Non-Metals

C. Both Metals & Non-Metals

D. None of the mentioned

Q17: Which of the following is not a property of engineering materials?

A. Mechanical properties
B. Chemical properties
C. Polymorphism
D. Electrical properties

Q18: Which of the following attributes explains why pure metals are not frequently used in engineering applications?

A. Softness
B. Hardness
C. Brittleness
D. Luster

Q19: Which of the following class of engineering ceramics generally includes lubricant materials?

A. Metalloids
B. Intermetallic
C. Sulphides
D. Carbides

Q20: Which of the following is not a property of fiberglass?

A. Nonflammable
B. Reinforcement for plastics
C. Thermal insulation
D. Organic

Q21: How is the creep strength of ceramics when compared to other materials?

A. Low
B. High
C. Excellent
D. Zero

Q22: Which of the following factors affect the mechanical properties of a material under applied loads?

A. Grain size
B. Shape of Material
C. Content of alloys
D. Imperfection and defects

Q23: Thermal conductivity of non-metallic amorphous solids with a decrease in temperature will:

A. increase
B. decrease
C. remains constant
D. may increase or decrease depending on temperature

Q24: The thermal diffusivities for solids are generally:

A. less than those for gases
B. less than those for liquids
C. more than those for liquids and gases
D. more or less same as for liquids and gases

Q25: Thermal conductivity of water in general with temperature rise:

A. increase
B. decrease
C. remains constant
D. may increase or decrease depending on temperature

Q26: Thermal diffusivity of a substance is:

A. proportional to thermal conductivity
B. inversely proportional to k
C. proportional to (k)
D. doesn't affect by (k)

Q27: A non-dimensional number generally associated with natural convection heat transfer is:

A. Grashoff number
B. Nusselt number
C. Prandtl number
D. Reynold number

Q28: All radiations in a black body are:

A. reflected
B. reflected
C. transmitted
D. absorbed

Q29: Two plates spaced 150 mm apart are maintained at 1000°C and 70°C. The heat transfer will take place mainly by:

A. conduction
B. free convection
C. forced convection
D. radiation

Q30: For a material subjected to uniaxial stress, which of the following correctly describes the relationship between Young's modulus (E), Poisson's ratio (ν), and the material's response?

A. E and ν determine the material's ability to resist shear deformation.
B. E and ν together uniquely determine the material's bulk modulus
C. E represents the material's stiffness, while ν describes the volumetric change due to uniaxial stress.
D. E and ν are independent and do not influence each other.

Q31: Which of the following boundary conditions is inappropriate for a stress function in the context of plane stress problems in elasticity?

A. Specifying the displacement on the boundary.
B. Specifying the normal and shear stresses on the boundary.
C. Specifying the stress function itself on the boundary.
D. Specifying both displacement and stress simultaneously on the boundary.

Q32: In the theory of elasticity, the compatibility conditions ensure that the strain components are compatible with a continuous displacement field. Which of the following sets of conditions represent the compatibility equations for a three-dimensional stress state?

A. Six second-order partial differential equations involving the strain components ensuring that any displacement field derived from them is continuous.
B. A series of differential equations ensuring the continuous nature of the displacement field derived from the second-order strain tensor components.
C. Six coupled second-order differential equations in terms of the strain components ensuring that the strains are derived from a single-valued continuous displacement field.
D. A set of six independent partial differential equations involving the second derivatives of strain components to ensure compatibility with the continuous displacement field.

Q33: A cylindrical rod made of an unknown isotropic material is subjected to a tensile test. The rod's length increases by 0.5% when a tensile stress of 100 MPa is applied. Simultaneously, the diameter of the rod decreases. Which of the following statements best describes the relationship between the material properties and the observed behavior?

A. The Young's modulus of the material can be directly calculated from the given data, but Poisson's ratio must be known to determine the diameter change.

B. The observed diameter decrease indicates a Poisson's ratio greater than 0.5, which is typical for most engineering materials.

C. The relationship between the tensile stress and the diameter decrease is independent of the material's Poisson's ratio.

D. The material's behavior suggests a Poisson's ratio less than 0.5, which is typical for isotropic materials undergoing tensile stress.

Q34: An engineer is designing a new component using a composite material that combines two different isotropic materials with significantly different elastic moduli. When the component is subjected to a uniaxial tensile load, which of the following statements best describes the expected stress distribution within the composite material?

A. The stress will be uniformly distributed throughout the composite, independent of the differences in elastic moduli.

B. The material with the higher elastic modulus will carry a larger share of the applied load, resulting in a non-uniform stress distribution.

C. The component's stress distribution will be entirely dependent on the average properties of the two materials, creating a uniform stress field.

D. The composite material's response will be dominated by the material with the lower elastic modulus, leading to a uniform stress distribution.

Q35: During a stress analysis of a bridge, it is observed that the maximum tensile stress occurs at the bottom of the bridge deck, while the maximum compressive stress is at the top. What concept in elasticity and stress theory can be used to explain this phenomenon?

A. The observed stress distribution is due to the bridge materials' anisotropic properties, which cause differing responses to tensile and compressive forces.

B. The phenomenon is a result of the bridge deck's non-uniform thickness, leading to varying stress concentrations.

C. The bridge deck experiences bending moments, causing tensile stresses at the bottom fibers and compressive stresses at the top fibers.

D. The stress distribution is due to shear forces, which create tensile stresses at the bottom and compressive stresses at the top.

Q36: Three strain gauges are placed at 0°, 45°, and 90° angles on the surface of a rectangular steel plate. The plate is subjected to uniaxial tensile stress along the 0° direction. Which of the following correctly describes the expected readings from the strain gauges?

A. The 0° gauge will show the maximum tensile strain, the 45° gauge will show zero strain, and the 90° gauge will show compressive strain.

B. The 0° gauge will show the maximum tensile strain, the 45° gauge will show half the tensile strain, and the 90° gauge will show zero strain.

C. The 0° gauge will show the maximum tensile strain, the 45° gauge will show both tensile and compressive strain, and the 90° gauge will show compressive strain.

D. The 0° gauge will show tensile strain, the 45° gauge will show shear strain, and the 90° gauge will show compressive strain.

Q37: After solidification, the double surface films act as

A. Point defects
B. Dislocations defects
C. Cracks
D. Planner defects

Q38: Surface films that form on molten surfaces become harmful if

A. Stay on the molten surface
B. Entrainment throw the molten during solidification
C. Removal from molten surface after pouring and before Solidification
D. Reaction with gases

Q39: Inert molds are

A. Molds used for steel casting
B. Molds used for Al alloy casting
C. Molds have no reactions with molten metal
D. Sand molds

Q40: Sound casting means:

A. Sand casting
B. Bimetal casting
C. Squeeze casting
D. Free defects casting

Q41: Castings without defects can be produced when

A. Rapid flotation of bubbles
B. Rapid flotation of droplets
C. Rapid flotation of bifilms
D. Slow flotation of bubbles

Q42: If oxidation index (I) value is positive means

A. No gasses porosity forming
B. No shrinkage porosity forming
C. No both of two types forming
D. Both of two types forming

Q43: surface trouble phenomena have effect of

A. Increasing of molten flow
B. decreasing of molten flow
C. Increasing solidification time
D. decreasing solidification time

Q44: The degree of disorder of a mixture of two gases

A. is always less than the degrees of disorder of individual gases
B. is always greater than the degrees of disorder of individual gases
C. is always equals the degrees of disorder of individual gases
D. depends on the system temperature

Q45: The Carnot cycle contains two reversible adiabatic processes and

A. two reversible isentropic processes
B. two reversible isobaric processes
C. two reversible isochoric processes
D. two reversible isothermal processes

Q46: How is the entropy of a closed system increased?

A. by the interaction of heat
B. by internal reversibility
C. by the interaction of work
D. A and C

Q47: The source of exergy in steam turbine is:

A. the heat transferred to the turbine from the environment
B. The enthalpy of the steam entering the turbine
C. the heat transferred out of the turbine
D. the work done by the turbine

Q48: People use electric energy to heat and light homes. What does it indicate?

A. People are destroying energy
B. People are creating energy
C. People are converting energy from more exergy value to less exergy value
D. People are converting energy from less exergy value to more exergy value

Q49: For polytropic process with index n=1, that the reversible specific work,

A. $w_{rev} = -RT \ln \frac{v_2}{v_1}$
B. $w_{rev} = -RT \ln \frac{P_2}{P_1}$
C. $w_{rev} = RT \ln \frac{P_2}{P_1}$
D. $w_{rev} = -RT \ln \frac{T_2}{T_1}$

Q50: the entropy transfer associated with work is

A. positive entropy transfer
B. negative entropy transfer
C. no entropy transfer
D. depends on the direction

Good Luck

Examination Committee