ENTRANCE EXAMINATION FOR ADMISSION, MAY 2013.

Ph.D. (GREEN ENERGY TECHNOLOGY)

COURSE CODE : 159

Register Number :

Signature of the Invigilator
(with date)

COURSE CODE : 159

Time : 2 Hours   Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.

2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.

3. Read each of the question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.

4. Avoid blind guessing. A wrong answer will fetch you −1 mark and the correct answer will fetch 4 marks.

5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.

6. Do not open the question paper until the start signal is given.

7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.

8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.

9. Use of Calculators, Tables, etc. are prohibited.

1. $y = x^{-n}$, where n is a positive integer represents

(A) Straight line   (B) Parabola   (C) Ellipse   (D) Hyperbola

2. Rank of the matrix $\begin{pmatrix} i & 0 & 0 \\ 0 & i & 0 \\ 0 & 0 & i \end{pmatrix}$ where i is an imaginary number

(A) 1   (B) 2   (C) 3   (D) Not defined

3. When two vectors $A(i)$ and $B(j)$ are orthonormal then

(A) $A(i).B(j) = 0$ (B) $A(i).B(j) = 1$

(C) $A(i).B(j) = \delta ij$ (D) None of the above

4. Solution of the differential equation

$\dfrac{d^2 x}{dy^2} + x = 0, \quad x = 0 \quad at \quad y = 0 \quad and \quad x = 1 \quad at \quad y = \pi/2$

(A) $x = sin(y)$ (B) $x = cos(y)$

(C) $x = sin(y) + cos(y)$ (D) $x = sin^{-1}(y)$

5. The product of two numbers (0,1) and (1,0) in a complex space is

(A) 0   (B) 1   (C) $\sqrt{-1}$ (D) None of these

6. The function $f(x) = x^2 - x$, at $x = 0.5$ has

(A) Maxima   (B) Minima   (C) Saddle point   (D) Salient point

7. $\displaystyle\int_a^b x^{-1+\varepsilon} dx$ where $\varepsilon \to 0$ is

(A) $\ln (b/a)$ (B) 0   (C) $1/\varepsilon$ (D) $b^\varepsilon - a^\varepsilon$

8. Eigen value of $\dfrac{d^2}{dx^2}(sin(x))$ is

(A) 1   (B) -1

(C) $\sqrt{-1}$ (D) Not an eigen value operation

9. $\ln (-1)$ is , (ln is natural log)

(A) Not defined   (B) 1   (C) 0   (D) $i\pi$

10. For two sets A and B, $\overline{A \cup B}$ is

(A) $\overline{A} \cup \overline{B}$ (B) $A \cup B$ (C) $\overline{A} \cap \overline{B}$ (D) $A \cap B$

11. Derivative of $y = 2^x$ is

(A) $\dfrac{dy}{dx} = x\, 2^{x-1}$ (B) $\dfrac{dy}{dx} = \dfrac{2^{x-1}}{x}$

(C) $\dfrac{dy}{dx} = 2.3\log 2.\, 2^x$ (D) $\dfrac{dy}{dx} = -x2^{x-1}$

12. Which one is not true for the curve $y = a(x-n)2$

(A) Represent a parabola

(B) Vertical line $x = n$ is an axis of symmetry

(C) For $a > 0$ has a minimam $y = 0$ at $x = n$

(D) Horizondal line $y = n$ is an axis of symmetry

13. The equation of a straight line that passes through point $A(1,-1)$ and has a slope equa to -1 is

(A) $y = -x$ (B) $y = x$ (C) $y = 1/x$ (D) $y = x + 1$

14. Root of the equation $x^2 + ix + 2 = 0$, where $i = \sqrt{-1}$ is

(A) $(-1, 1)$ (B) $(i, 1)$ (C) $(-2i, i)$ (D) No root exist

15. For joint probability $P(A \cap B)$ for two events A and B

(A) $P(A \cap B) = P(A) + P(B) - P(A \cup B)$

(B) $P(A \cap B) = P(A) + P(B) + P(A \cup B)$

(C) $P(A \cap B) = P(A)P(B) - P(A \cup B)$

(D) $P(A \cap B) = P(A) + P(B)$

16. Which one list all members of the set $\{x \mid x$ is a real number such that $X^2 = 1\}$

(A) $\{\}$ (B) $\{1\}$ (C) Infinite   (D) None of these

17. The rate of conductive heat transfer across 1m² of a mild steel plate that has a constant thickness of $5x10^{-3}$ m and a thermal conductivity of 45 W/mK, when the temperature of hot and cold surfaces are $100°$C and $99.9°$C, is

(A) 9 W   (B) 90 W   (C) 0.007 W   (D) 900 W

18. Which one of the following is correct for a selective surface for solar thermal applications?

(A) High absorptivity and high emissivity

(B) Low absorptivity and high emissivity

(C) High absorptivity and low emissivity

(D) Low absorptivity and low emissivity

19. The value of solar constant is

(A) 1763 W/m²   (B) 1637 W/m²   (C) 1367 W/m²   (D) 1000 W/m²

20. A signal of 10 V is applied to a 50 ohm coaxial transmission line, terminated in a 100 ohm load. The voltage reflection coefficient is

(A) 1/4   (B) 1/3   (C) 1/2   (D) 1

21. The vanes of a centrifugal pump are generally

(A) Radial   (B) Curved backward

(C) Curved forward   (D) Twisted

22. The value of the multiplier resistance for a dc voltmeter, having 50 V range with 5 $k\Omega V$ sensitivity, employing a 200 µA meter movement and having internal resistance of 100 Ω, is given by

(A) 249.9 $k\Omega$ (B) 200 Ω (C) 200 $k\Omega$ (D) 2.5 $k\Omega$

23. For calculation of heat transfer by natural convection from a horizontal cylinder, what is the characteristic length in Grass of number?

(A) Diameter of the cylinder

(B) Length of the cylinder

(C) Circumference of the base of the cylinder

(D Half of the circumference of the base of the cylinder

24. Consider the following statements : Electrets are the materials which are

1. having permanent electric moments

2. electromagnets

3. very similar to permanent magnet materials

4. similar to anti-ferroelectric materials

Which of the above statements is/are correct?

(A) 2 only   (B) 1 and 3 only   (C) 2 and 3 only   (D) 1,2,3 and 4

25. In which one of the following processes, in a closed system the thermal energy transferred to a gas is completely converted to internal energy resulting in increase in gas temperature?

   (A) Isochoric process   (B) Adiabatic process

   (C) Isothermal process   (D) Free expansion

26. If reflection coefficient for voltage be 0.6, the voltage standing wave ratio (VSWR) is

   (A) 0.66   (B) 4   (C) 1.5   (D) 2

27. The benchmarking parameter for air conditioning equipment is

   (A) kW/Ton of refrigeration

   (B) kW/kg of refrigerant handled

   (C) kCal/m³ of chilled water

   (D) Differential temperature across chiller

28. For a parallel RLC circuit, if $R = 40\,\Omega$, $L = 2\,H$ and $C = 0.5\,F$, the bandwidth and quality factor are respectively

   (A) 20 rad/s, 0.05   (B) 10 rad/s, 20   (C) 20 rad/s, 10   (D) 0.05 rad/s, 20

29. In a heat treatment furnace the material is heated up to 730°C from ambient temperature of 30°C. Considering the specific heat of material as 0.13 Kcal/kg°C, what is the energy content in one kg of material after heating?

   (A) 910 Kcal   (B) 91 Kcal   (C) 5385 kCal   (D) 700 Kcal

30. A penstock pipe of 10 cm diameter carries water under a pressure head of 100 m. If the wall thickness is 9 mm, what is the tensile stress in the pipe wall in MPa?

   (A) 2725   (B) 545   (C) 272.5   (D) 1090

31. The emissivity of conventional refractory ———————— with increase in temperature.

   (A) Decreases

   (B) Increases

   (C) Remains the same

   (D) Sometimes increases and sometimes decreases

32. For a vapour compression cycle, enthalpy at suction = 1600 kJ/kg, enthalpy at discharge from the compressor = 1800kJ/kg, enthalpy at exit from condenser = 600 kJ/kg. What is the COP for this refrigeration cycle?

   (A) 3.3   (B) 5.0   (C) 4   (D) 4.5

33. Two wave functions $\varphi 1$ and $\varphi 2$ are orthogonal if

   (A) $\int \phi_2^* \phi_1 d\tau = 0$ (B) $\int \phi_2^* \phi_1 d\tau = 1$ (C) $|\phi_1|^2 d\tau = 0$ (D) $|\phi_2|^2 d\tau = 0$

34. Photo-electric effect can be explained on the basis of
   (A) Wave theory of light   (B) Quantum theory of light
   (C) Corpuscular theory of light   (D) Electro-magnetic theory of light

35. A particle In a box in the lowest energy state ($n = 1$) is most likely to be at
   (A) The walls
   (B) Middle of the box
   (C) Equal chance for any point at inside the box
   (D) No where in the box

36. If a charged particle moves with velocity V in uniform magnetic field (B), the acceleration is maximum when the angle between
   (A) $\vec{V}$ and $\vec{B}$ is zero   (B) $\vec{V}$ and $\vec{B}$ is 45°
   (C) $\vec{V}$ and $\vec{B}$ is 90°   (D) $\vec{V}$ and $\vec{B}$ is 180°

37. The energy gap between successive energy levels in a hydrogen atom
   (A) Decreases as energy increases   (B) Decreases as energy decreases
   (C) Increases as energy increases   (D) Either (A) or (B) above

38. In a p-n junction diode the depletion region is
   (A) Completely neutral
   (B) Positively charged
   (C) Negatively charged
   (D) A space charge region between positive and negative ions on either side of the junction

39. Maxwell's divergence equation for the magnetic field is given by
   (A) $\nabla \times B = 0$ (B) $\nabla . B = 0$ (C) $\nabla \times B = \rho$ (D) $\nabla . B = \rho$

40. The electric field lines and equipotential lines
   (A) Are parallel to each other
   (B) Are one and the same
   (C) Cut each other orthogonally
   (D) Can be inclined to each other at any angle

41. The total energy of an electron in any stationary orbit is
    (A) Always negative   (B) Always zero
    (C) Always positive   (D) Uncertain

42. A parity check usually can detect
    (A) One-bit error   (B) Double-bit error
    (C) Three-bit error   (D) Any-bit error

43. Which of the flowing is a Boson
    (A) Electron   (B) Proton   (C) Neutron   (D) Photon

44. A current amplifier is characterized by
    (A) Low input impedance and high output impedance
    (B) High input impedance and low output impedance
    (C) Low impedance at both input and output terminals
    (D) High impedance at both input and output terminals

45. Suppose temperature of the sun goes down by a factor of two, then the total power emitted by the sun will go down by a factor of
    (A) 2   (B) 4   (C) 8   (D) 16

46. The origin of van der Waal's interaction in molecular crystal is
    (A) Nuclear   (B) Magnetic
    (C) Ionic   (D) Fluctuating dipolar

47. Field effect transistor is a
    (A) Unipolar device   (B) Bipolar device
    (C) Unijunction device   (D) Low input impedence device

48. According to Quantum Mechanics, the wavelength is inversely proportional to the
    (A) Electric potential   (B) Speed
    (C) Momentum   (D) Force

49. An amount of energy required in excess to the ground state energy for any action is called as
    (A) Activation energy   (B) Pumping energy
    (C) Depletion energy   (D) Diode energy

50. Two electrons stay together in an orbital due to the differences in their
    (A) Difference in their electronic charge
    (B) Difference in their spin
    (C) Difference in their volt
    (D) Difference in their mass

51. A solar cell is a
    (A) Voltage generator
    (B) Power generator
    (C) Light generator
    (D) Current generator

52. Wind is nothing but the moment of
    (A) Water vapour
    (B) Carbon-di-oxide
    (C) Dust
    (D) Air mass

53. A difference in the salinity of sea water generates
    (A) Sea current
    (B) Waves
    (C) Tide
    (D) Tsunami

54. Force of gravity on a mass "m" lying on the earth is
    (A) $F M m/R^2$
    (B) $G M m/R^2$
    (C) $E M m/R^2$
    (D) $W M m/R^2$

55. The bonding in crystals occur in —————— different ways.
    (A) 2
    (B) 3
    (C) 4
    (D) 5

56. As electron is accelerated from rest by 10.2 meV. The percent increase in its mass is
    (A) 20
    (B) 200
    (C) 2000
    (D) 20000

57. In hydrogen spectrum, the series of lines appearing in visible region of spectrum are known as
    (A) Pascheur
    (B) Balmer
    (C) Lyman
    (D) Pfund

58. Among the following compounds, strongest acid is
    (A) C_2H_2
    (B) C_2H_6
    (C) CH_3OH
    (D) C_6H_6

59. The crystal field stabilization energy (CFSE) will be the highest for
    (A) CoF_4^{3-}
    (B) $Co(CNS)_4^{2-}$
    (C) $Mn(H_2O)_6^{2}$
    (D) $CO(NH3)_6^{3+}$

60. The reagent commonly used to determine hardness of water titrimetrically is
    (A) Oxalic acid
    (B) Disodium salt of EDTA
    (C) Sodium citrate
    (D) Sodium thio sulphate

61. Properties which depend on the number of the dissolved particle in a solution are called
    (A) Isotropic
    (B) Isotonic
    (C) Colligative
    (D) Iso electronic

62. An example of buffer solution is
   (A) $HCl + CH_3 COOH$
   (B) $CH_3 COOH + CH_3COONa$
   (C) $NaOH + NH_4OH$
   (D) $NaCl + NaOH$

63. In Joule-Thomson expansion
   (A) $dS=0$
   (B) $dH=0$
   (C) $dE=0$
   (D) $dG=0$

64. The particle having a major role in binding the nucleus is
   (A) Neutrons
   (B) Electrons
   (C) Meson
   (D) Proton

65. The Tyndal effect is due to
   (A) Reflection of the light
   (B) Adsorption of light
   (C) Scattering of light
   (D) Produce of charge on colloidal particles

66. Increased concentration of CO_2 in atmosphere is responsible for
   (A) Acid rain
   (B) Lack of photosynthesis
   (C) Greenhouse effect
   (D) Death of aquatic life

67. The IUPAC name for $(CH_3)C = CHCH_2CH_2CH_2 CH(OH)CH_3$
   (A) 6 – methyl – 5– hepten– 2 – ol
   (B) 1 – methyl – 2– hepten – 5 – ol
   (C) 1 – methyl – 2– hepten– 6 – ol
   (D) 1, 1 –dimethyl – 2– hepten– 5 – ol

68. The angle strain in cyclohexane is nearly
   (A) 20°
   (B) 10°
   (C) 15°
   (D) 13.28°

69. Benzene belongs to the following point group
   (A) D_4h
   (B) D_6h
   (C) D_6d
   (D) D_3h

70. Among the following the most basic compound is
   (A) Benzylamine
   (B) Aniline
   (C) Acetaanilide
   (D) p-nitroaniline

71. Which of the following compound has one chiral carbon atom?
   (A) D-exythrose
   (B) D-threose
   (C) Glyceraldehyde
   (D) All of the above

72. A biological catalysts is
   (A) N_2
   (B) A carbohydrate
   (C) An enzyme
   (D) None of these

73. The correct equation for the reduction of nicotinamide adenine dinucleotide phosphate (NADP+) is

(A) $NADP^+ + 2H^+ \rightarrow NADPH^+ + H^+$

(B) $NADP^+ + H^+ + e^- \rightarrow NADPH$

(C) $NADP^+ + H^+ + 2e^- \rightarrow NADPH$

(D) $NADP^+ + 2H^+ + 2e^- \rightarrow NADPH_2$

74. The reactions of the Krebs cycle

(A) Take place in the cytosol of eukaryotic cells

(B) Generate ATP directly by substrate phosphorylation

(C) Are important for the metabolism of carbohydrates but not other molecules

(D) Both (A) and (B)

75. The plant growth regulator that retards senescence is

(A) Cytokinin

(B) Gibberellic acid

(C) Indoleacetic acid

(D) Ethylene glycol

76. Intact duplex DNA is a substrate for

(A) DNA pol 1   (B) DNA pol 111   (C) RNA polymerase   (D) DNA pol 11

77. Which of the following has the greatest effect on the ability of blood to transport oxygen?

(A) Capacity of the blood to dissolve oxygen

(B) Amount of hemoglobin in the blood

(C) pH of plasma

(D) CO_2 content of red blood cells

78. What is the fundamental difference between matter and energy?

(A) Matter is cycled through ecosystem; energy is not

(B) Energy is cycled through ecosystems; matter is not

(C) Energy can be converted into matter; matter cannot be converted into energy

(D) Matter can be converted into energy; energy cannot be converted into matter

79. Which one of the following statements about energy flow is incorrect?

(A) Secondary productivity declines with each trophic level

(B) Only net primary productivity is available to consumers

(C) About 90% of the energy at one trophic level does not appear at the next

(D) Eating meat is probably the most economical way of acquiring the energy of photosynthetic productivity

80. The biomass of one trophic level getting incorporated into the biomass of the next trophic level is the
   (A) Relative ratio of energy flow
   (B) Energy flow efficiency
   (C) Ecological efficiency
   (D) Ecological gradient.

81. Epigenetic relates to
   (A) Base pair mismatch due to mutation
   (B) Cytosine deletion causing genetic disease
   (C) Transformation of cytosine to Uracil
   (D) Methylation of cytosine regulating gene expression

82. Which of the following is not an Antigen Presenting Cell ?
   (A) Monocytes
   (B) T cell
   (C) Macrophage
   (D) Thymus epithelial cells

83. Activity of proteins *caspaces* in the cell leads to
   (A) Proliferation
   (B) Migration
   (C) Death
   (D) Structural remodeling

84. Enzyme that releases the tornsional stress built in DNA is
   (A) Endonuclease   (B) Topoisomerase   (C) DNA polymerase   (D) Rec A.

85. Genes of different species but possessing a clear sequence and functional relationship to each other are called
   (A) Analogues   (B) Paralogs   (C) Orthologs   (D) Polymorphs

86. Cholecalciferol is
   (A) Vitamin B_{12} (B) Vitamin C   (C) Vitamin D_3 (D) Vitamin K_1

87. Gluconeogenesis is the conversion of
   (A) Pyruvate to glucose
   (B) Glucose to pyruvate
   (C) Glucose to starch
   (D) Glucose to CO_2 and water

88. Pineapple is an example of
   (A) Aggregate fruit
   (B) Accessory fruit
   (C) Multiple fruit
   (D) Simple fruit

89. The ratio of emissive power of a black body to the emissive power of a perfectly black body is called
   (A) Absorptivity   (B) Emissivity   (C) Diffusivity   (D) Conductivity

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90. Which one of the following refrigerants has the lowest freezing point temperature?
   (A) Freon – 11   (B) Freon – 12   (C) Freon – 22   (D) Ammonia

91. Property of a fluid by which its own molecules are attracted is called
   (A) Adhesion   (B) Cohesion
   (C) Viscosity   (D) Compressibility

92. Among the following, which is periodic property?
   (A) Atomic radii   (B) Inonization potential
   (C) Electronaffinity   (D) All

93. Zero point energy of a harmonic oscillator is
   (A) hv   (B) Zero   (C) $\frac{1}{2}$ hv   (D) $\frac{3}{2}$ hv

94. The most convenient spectroscopic technique to establish the presence of inter-molecular hydrogen bonding in hydroxy compounds is
   (A) UV   (B) IR   (C) EPR   (D) Mass

95. A Carnot engine operates between 30 and 300° C. Its maximum efficiency is
   (A) Data insufficient to estimate   (B) 36.24%
   (C) 46.24%   (D) 56.24%

96. Point group of CS2 is
   (A) $C_{\infty v}$ (B) $D_{\infty v}$ (C) C_s (D) C_i

97. For an equilibrium process, the following is NOT true
   (A) $\Delta G = 0$ (B) $K = 1$ (C) $\Delta S = +$ ve   (D) $k_{re} = k_{ir}$

98. The lowest energy of an electron confined in a 1-dimensional box of length, a, is
   (A) $h^2/(2\pi^2 ma^2)$ (B) $h^2/(4\pi^2 ma^2)$ (C) $h^2/(8\pi^2 ma^2)$ (D) $h^2/(16\pi^2 ma^2)$

99. An heterocylic compound is
   (A) Contains both polar and non-polar groups
   (B) Is a reactive compound due to ring strain
   (C) Is a cyclic compound soluble in both water and organic solvents
   (D) Has a ring of atoms at least one of which is not carbon

100. Phenol and formaldehyde are polymerized to produce
   (A) Polester   (B) Backlite   (C) PVC   (D) Nylon