Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
Mid-Semester Examination-Spring 2020

Subject: Know your environment ***Subject Code(s): AEC 1201***
Full Marks: 25 ***Time Allotted: 2 h***

Q1. Read the following passage and answer the following two questions: 2.5x2=5 5

The continuous rise in temperature of the planet is really upsetting. The root cause for this is global warming. Global warming begins when sunlight reaches the Earth. The clouds, atmospheric particles, reflective ground surfaces and surface of oceans then sends back about 30 % of sunlight back into the space, whilst the remaining is absorbed by oceans, air and land. This consequently heats up the surface of the planet and atmosphere, making life feasible. As the Earth warms up, this solar energy is radiated by thermal radiation and infrared rays, propagating directly out to space thereby cooling the Earth. However, some of the outgoing radiation is re- absorbed by carbon dioxide, water vapours, ozone, methane and other gases in the atmosphere and is radiated back to the surface of Earth. These gases are commonly known as greenhouse gases due to their heat-trapping capacity. It must be noted that this re-absorption process is actually good as the Earth's average surface temperature would be very cold if there was no existence of greenhouse gases

A. What is the natural greenhouse effect:

B. How do the anthropogenic activities contribute to global warming?

Q2. Identify the correct answer: 20x1 = 20

1. Natural heat from Earth's interior can be exploited as _____energy source

A. Hydrothermal B. Geothermal C. Wind

2 _____ energy comes from splitting atoms in a reactor to heat water into steam, turn a turbine and generate electricity

A nuclear B tidal C solar

3 Carcinogen means, that induces_____

A mutation B chromosomal changes C cancer

4 _____, a branch of ecology dealing with the individual organism or species in relation to its environment

A autecology B synecology C organismal

5 Ex situ conservation is the technique of conservation of all levels of biological diversity _____ their natural habitats through different techniques

A within B outside C of local origin

6 _____ is the process by which an oligotrophic lake accumulates nutrients, fills with organic matter and becomes more turbid

A evapotranspiration B eutrophication C succession

7. A keystone species that has a dramatic effect on an ecosystem by modifying habitat is known as _____

A umbrella species B endangered species C ecosystem engineer

8 An organism that is native to a particular region is regarded as_____

A exotic B endemic C parasitic

9 Dead plant and animal material and animal waste products that decomposed are known as _____.

A nekton B. plankton c detritus

10 The amount of oxygen that would be consumed if all organic substances in a given volume of water were oxidized by bacteria and other organisms, known as_____

A. biochemical oxygen demand B chemical oxygen demand C oxygen demand

11 Bhopal gas tragedy, was a gas leak incident of India occurred in the year 1984 in Bhopal, Madhya Pradesh, India, and the gas was

A methyl isocyanate B Chloroflurocarbon C methane

12 Manas National Park is located in

A Uttarakhand B Arunachal Pradesh C Assam

13 World Wetlands Day is celebrated Internationally each year on

A 2 February B 22nd April C 5th June

14 Which of the following is not a type of ex situ conservation

A Genebank and seed bank B National Park C Zoological garden

15 To control flood, which of the following strategy will be taken?

A flood warning system should be improved

B wetlands should be filled and new constructions will be made

C natural flow of river should be changed

16 The average annual rainfall in the Earth surface is
A 10 cm B 100 cm C 1000 cm

17 Average age of life on the planet Earth is

A 4 5 billion years B 3 5 billion years C 4 5 million years

18 The average temperature in the surface of the Earth is

A 15 F B 15 C C 35 C

19 Earth's atmosphere and oceans were originated from

A meteoritic gases and vapor showered on earth B interior of the earth C condensation of gases & vapor from space

20 The layer of atmosphere closest to Earth's surface is
A Stratosphere B Troposphere C hydrosphere

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Integrated Bachelor's-Master's Program

Mid-Semester (Sem-II) Examination-Spring 2020

Subject:Liner Algebra and Multivariable Calculus

Subject Code: MCS 1201 A

Full marks: 25 ***Time Alloted: 2 hrs***

1. Suppose $T : \mathbb{R}^3 \to \mathbb{R}^2$ and $S : \mathbb{R}^2 \to \mathbb{R}^3$ are two linear transformations. Show that the linear transformation $ST : \mathbb{R}^3 \to \mathbb{R}^3$ is not invertible. [6]

2. Suppose $T \in \mathcal{L}(V)$ is injective and suppose the set $\{v_1, v_2, \cdots, v_n\}$ is linearly independent. Show that the set $\{T(v_1), T(v_2), \cdots\cdots, T(v_n)\}$ is linearly independent. [6]

3. Suppose V is a complex vector space and suppose $S, T \in \mathcal{L}(V)$ are such that $ST = TS$. Show that $\ker(T - \lambda I)$ is invariant under S for every $\lambda \in \mathbb{C}$. [6]

4. Let D be the linear operator on $\mathcal{P}_n(\mathbb{R})$ given by $D(p) = p'$.

(i) Find the matrix representation of D with respect to the ordered basis $\{1, x, x^2, \cdots, x^n\}$.

(ii) Find all eigenvalues and eigenvectors of D. [5+5=10]

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Mid-Semester (Sem-II) Examination-Spring 2020

Subject: Object-Oriented Programming with Java ***Subject Code(s): MCS1201B***
Full Marks: 25 ***Time Allotted: 2 h***

[Answer any five questions]

[5*5=25]

1. What is an interface? Discuss the utility of interface with suitable example.

[1+4]

2. What is multithreading? Explain the steps for creating thread in Java. Also explain the predefined thread priorities in Java.

[1+3+1]

3. What are class and objects? Explain how an object is created in Java? Also explain the role of constructor in Java using Java code.

[1+2+2]

4. What is Polymorphism? Explain the difference between method overloading and method overriding with the help of example.

[1+4]

5. What is Exception? Write down the difference between checked and unchecked Exception

[1+4]

6. What is Encapsulation? Write a Java program, to find factorial of a given number.

[1+4]

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Mid-Semester Examination-Spring 2020

Subject: Structure & Spectroscopy ***Subject Code(s): CHS1201***
Full Marks: 25 ***Time Allotted: 2 h***

Part-A

1. In the mid-infrared spectrum, the O-H stretching vibrational fundamental of methanol (CH_3O–H) appears at 3690 cm^{-1}.

   (a) Assuming that the force constant of a chemical bond does not change upon deuteration, find the frequency of the O-D stretching fundamental of CH_3O–D.

   [Hints: Assume harmonic behaviour, and to work out the reduced mass, assume CH_3O as one unit and H atom the other]

   (b) The first overtone of the O-H stretching vibration of methanol appears at 7210 cm^{-1}. Calculate ν_e and x_e the *anharmonicity* parameters considering Morse Oscillator as the vibrational potential.

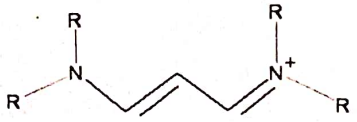
   (c) At what frequency the first hot-band from v = 1 level is expected?

   (d) What is the expected intensity ratio of the fundamental to hot band at 300 K?

   2+2+1+1

2. Shown below the representative structure of a cyanine dye molecule. Considering particles in a one-dimensional box model, estimate the lowest energy electronic excitation wavelength of the dye. Consider the lengths of C-C single and double bonds are 1.54 and 1.34 Å, and C-N single and double bonds as 1.47 and 1.28 Å, respectively. Note, there is a lone pair of electrons on the N atom.

   2



3. What is Franck-Condon Factor in electronic transitions? How does it influence the vibrational band intensities in an electronic spectrum of a diatomic molecule if the bond length in the excited state is elongated significantly? 1+2

4. What is the term-symbol for the ground electronic state of O_2^+ cation? Explain. 2

Part-B (12 marks)

Answer all the questions

2X6 = 12

(a) How many alkenes do you expect to get if you heat the alcohol, $(CH_3)_3C\text{-}CH_2\text{-}CH_2\text{-}OH$, with concentrated H_2SO_4? Show the route of their formation indicating the major one with reason.

(b) The C-H bond dissociation energy of the following ~~unsaturated~~ hydrocarbon molecules are in the order: acetylene > ethylene >ethane, ~~where~~ the acetylenic hydrogen is the most acidic among them. Explain.

(c) Draw all possible canonical forms of diazomethane (CH_2N_2) indicating the most and the least stable ones with reasons.

(d) Among all possible alkenes having the molecular formula C_6H_{12}, draw the structures of two isomers that have the highest and the lowest values of heat of hydrogenation. Reasons :-

(e) Arrange the following molecules in order of their increasing dipole moment giving your justification: $CH_3\text{-}CH_2\text{-}Cl$, $CH_2{=}CH\text{-}Cl$ and $CH \equiv C\text{-}Cl$.

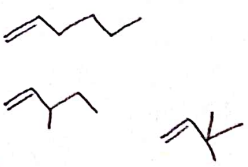
(f) Give the order of relative stability of the carbocations: $(CH_3)_3C^+$, $Ph\text{-}CH_2^+$ and cyclopropylmethyl carbocation. Rationalize your answer.

Useful information

Planck constant, $h = 6.626 \times 10^{-34}$ J s

Boltzmann constant, $k_B = 1.38 \times 10^{-23}$ J K^{-1}

1 kcal/mol = 350 cm^{-1}



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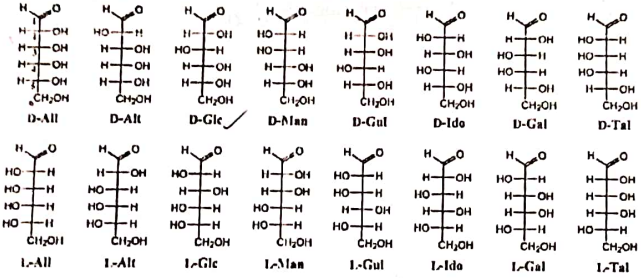
Integrated Bachelor's-Master's Program
Mid-Semester (Sem-II) Examination-Spring 2020

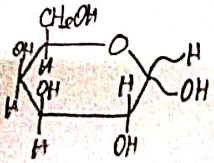
Subject: ***Subject Code(s):*** BIS 1201
Full Marks: 25 ***Time Allotted: 2 h***

1. Calculate how much of the α and β anomers of glucose are present in equilibrium mixture with a specific rotation of 52.6 degrees. (pure α D- glucose has specific rotation = + 112.2 degrees and that of β- D-glucose has specific rotation + 19 degrees) **4**
2. Draw the relative position of a) α and β anomers of glucose and b) α and β anomers of galactose in the same energy profile diagram. **3**
3. Chondroitin sulfate and Keratin Sulfate often prescribed as a drug for arthritis. Justify with proper reason. **3**
4. Glucose and fructose both are hexoses, then in glycolysis why Glucose to Fructose conversion is required ~~to~~, give proper justification. **3**
5. How many of the following aldohexoses will provide the same alditol as D glucose does upon reduction, identify them? **3**



6. In a police station, two couples claim their parenthood for a single baby. DNA matching is time consuming expensive process. So the biochemist, who has been called by the police did the simple blood group test and the results reveal as follows,
Couple 1 Male AB + Female O+ **Couple 2** Male AB+ Female A+ **Baby** AB+
From this result can the biochemist predict the false parent? Explain. **3**

7. A patient has been detected Non-Alcoholic fatty liver. And the dietitian suggests him to avoid few things. Can you guess what are those? Justify. **3**
8. Cellulose and Maltose both are homopolymer of glucose, but we can digest one. which one and why **3**



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Integrated Bachelor's-Master's Program in Science

Mid-Semester Examination-2020 (Spring Semester)

Paper: Electricity, Magnetism & Optics **Paper Code: PHS1201**
Full Marks: 50 **Time Allotted: 2hr**

Answer all questions

1. Show that the electric field inside the cavity of a closed hollow charged conducting sphere is zero . **(5 marks)**

2. Find the capacitance of two concentric spheres of radii a and b ($b > a$). Assume that the outer sphere is earthed and the region between the two spheres is filled with a dielectric medium of dielectric constant ϵ. **(5 marks)**

3. If the net charge in a charge distribution is zero, show by multipole expansion that the leading order electrical potential varries as $1/r^2$. **(5 marks)**

4. Find the force on a small electric dipole of dipole moment $\vec{\mu}$ placed in an external electrostatic field $\vec{E}$. **(5 marks)**

5. Will Gauss's theorem for electric field hold for a field which is not inverse square in nature ? Justify your answer. Using Gauss's theorem find the electric field at a distance r from an infinite conducting plane with charge density σ .

(5 marks)

6. From the condition $\vec{\nabla}.\vec{D} = 0$ and $\vec{\nabla} \times \vec{E} = 0$, show that at the boundary of two dielectrics , the normal component of D and tangential component of E are continuous. **(5 marks)**

7. Consider a point charge q placed at a distance r from the centre of an earthed conducting sphere of radius a. Using the method of image charge, show that the effect of entire charge distribution induced on the surface of the sphere in calculating the electric field outside the sphere can be replaced by that of an image charge of magnitude $-qa/r$, kept at a distance a^2/r from the centre. Mention the role of Uniqeness theorem in your argument. **(5 marks)**

8. Show that

$$\rho_P = -\vec{\nabla}.\vec{P}$$

where $\vec{P}$ is the dipole moment per unit volume and ρ_P is the density of polarised charge in a dielectric medium.
From this define susceptibility and dielectric constant of the medium. **(5 marks)**

9. State Biot-Savart's law of magnetism for a steady current distribution given by the current density $\vec{J}$. From this show that the magnetic monopole can not exist. **(5 marks)**

10. Calculate the magnetic field at a perpendicular distance r from the centre of a current carrying wire of length L carrying a steady current I **(5 marks)**