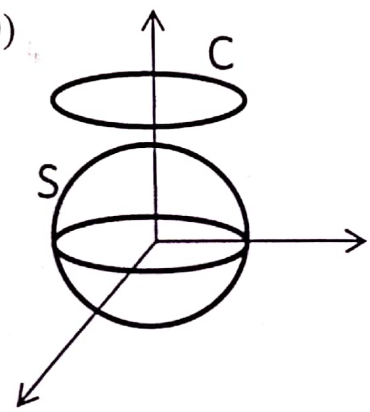
Answer all Questions

1. The electrostatic potential in a region is given by $V(x,y,z) = Ax + Bx^2/2$ for $x > 0$ and $V(x,y,z) = -Ax + Bx^2/2$ for $x < 0$, with A and B positive constants. A) Calculate the electric field B) Calculate the volume charge density. C) Using (A) and invoking the boundary conditions, calculate the surface charge density D) Calculate the total charge inside a sphere S of radius R centred at the origin. Please take into account that the total charge inside the sphere equals to the sum of volume charge and surface charge. E) What is the electric flux through the surface of the same sphere. **(10)**

2. A sphere of radius R is charged with a volume charge density given by $\rho = kr^2$ A) Determine the electric field outside and inside the sphere. B) Using the results at A) calculate divergence of the electric field inside the sphere and check Gauss' law in differential form. C) Check divergence theorem for a sphere of radius $r < R$. D) Calculate the curl of the electric field inside the sphere E) What is the line integral of the electric field for the loop shown in the figure. **(10)**

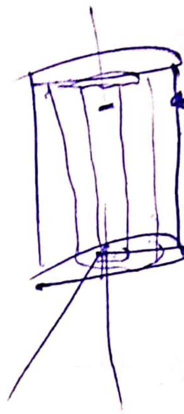


$\nabla \cdot E = \frac{\rho}{\varepsilon_0}$

$E \, 4\pi r^2$

3. A long co-axial cable carries a positive uniform surface charge density σ_a on the inner cylinder of radius 'a' and a negative uniform surface charge density σ_b on the outer cylindrical shell of radius 'b'. A) What should be the relation between σ_a and σ_b such that the cable is electrically neutral? B) Using Gauss's law calculate the electric field in the three regions $s < a$, $a < s < b$ and $b < s$. C) Calculate the potential difference between a point of cylindrical coordinates (s, 0, 10) with $s > b$ and a point on the axis of the cylinder of cylindrical coordinates (0, 0, 0). D) Calculate the electrostatic energy stored in a cable of length L.

(3+3+2+2)



Gradient: $$\nabla t = \frac{\partial t}{\partial r}\hat{\mathbf{r}} + \frac{1}{r}\frac{\partial t}{\partial \theta}\hat{\boldsymbol{\theta}} + \frac{1}{r\sin\theta}\frac{\partial t}{\partial \phi}\hat{\boldsymbol{\phi}}$$

Divergence: $$\nabla \cdot \mathbf{v} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta\, v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}$$

Curl: $$\nabla \times \mathbf{v} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}(\sin\theta\, v_\phi) - \frac{\partial v_\theta}{\partial \phi}\right]\hat{\mathbf{r}} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial v_r}{\partial \phi} - \frac{\partial}{\partial r}(r v_\phi)\right]\hat{\boldsymbol{\theta}} + \frac{1}{r}\left[\frac{\partial}{\partial r}(r v_\theta) - \frac{\partial v_r}{\partial \theta}\right]\hat{\boldsymbol{\phi}}$$

Gradient: $$\nabla t = \frac{\partial t}{\partial s}\hat{\mathbf{s}} + \frac{1}{s}\frac{\partial t}{\partial \phi}\hat{\boldsymbol{\phi}} + \frac{\partial t}{\partial z}\hat{\mathbf{z}}$$

Divergence: $$\nabla \cdot \mathbf{v} = \frac{1}{s}\frac{\partial}{\partial s}(s v_s) + \frac{1}{s}\frac{\partial v_\phi}{\partial \phi} + \frac{\partial v_z}{\partial z}$$

Curl: $$\nabla \times \mathbf{v} = \left[\frac{1}{s}\frac{\partial v_z}{\partial \phi} - \frac{\partial v_\phi}{\partial z}\right]\hat{\mathbf{s}} + \left[\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right]\hat{\boldsymbol{\phi}} + \frac{1}{s}\left[\frac{\partial}{\partial s}(s v_\phi) - \frac{\partial v_s}{\partial \phi}\right]\hat{\mathbf{z}}$$

Attempt all questions

1. (a) Show that $W := \{(x, y, z) \in \mathbb{R}^3 \mid x+y+z = 1\}$ is not a vector space over $\mathbb{R}$ under the induced operation of the vector space $\mathbb{R}^3$ over $\mathbb{R}$. [1.5]

   (b) Show that in a vector space V over $\mathbb{R}$, any element v has unique additive inverse. Further, show that the inverse of v is $-1 \cdot v$. [3.5]

2. (a) Let $f : \mathbb{R}^2 \longrightarrow \mathbb{R}$ be given by

$$f(x, y) = \begin{cases} \dfrac{x^3 y}{x^4 + y^2} & if\ (x, y) \neq (0, 0) \\ 0 & otherwise \end{cases}$$

   Show that $D_{\vec{v}}(f)|_{(0,0)} =< \nabla f|_{(0,0)},\ \vec{v} >$ for all unit vectors $\vec{v}$. Further, show that f is not differentiable at $(0, 0)$ [Hint: find "the limit" on moving along parabolas]. [3.5]

   (b) Let $h(x, y) = 2e^{-x^2} + e^{-3y^2}$ denotes the height on a mountain at position (x, y). Argue to find the direction in which one should begin walking in order to climb it fastest from the point $(1, 0)$. [1.5]

3. (a) Let $C := \gamma(t),\ t \in [a, b]$ be a C^1-type curve. Show that $-C$ is also of C^1-type. [2.5]

   (b) Let C be a curve given by the cartesian equation

$$x^2 = y^3,\ y = z^2,\ x, y, z \in \mathbb{R},\ x \geq 0,\ z \geq 0.$$

   Parametrize the curve with initial point $(0, 0, 0)$. Find the arc length function of the given curve with initial point $(0, 0, 0)$. [2.5]

END

Indian Institute of Space Science and Technology
Quiz I Question Paper, February, 2018
Basic Electronics (AV121), 2nd Semester (9/2/2018).

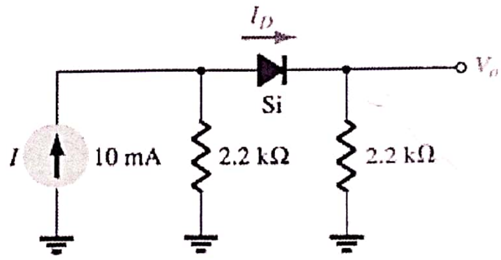
Marks: 15 Time: 1 Hr.

Write Part A and Part B in separate sheets

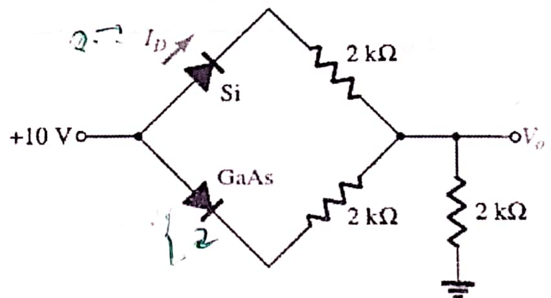
Make Suitable assumptions if necessary. Consider the simplified equivalent model (only voltage source) for all the diodes.

Part A

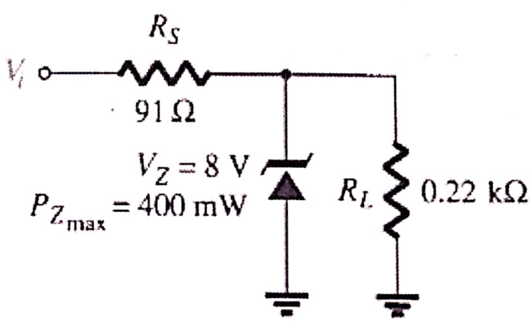
1. Determine v_O and I_D for the network shown in Figure below. **1.5**



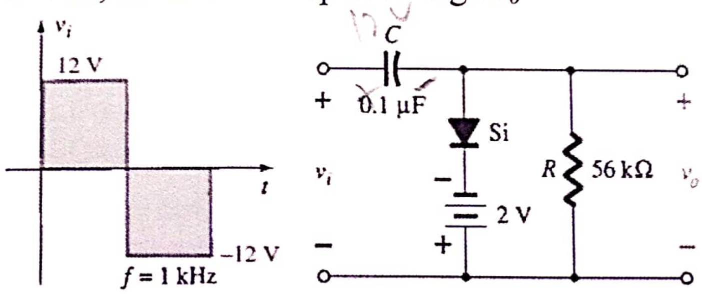
2. Determine the output voltage v_O for the following network. The cut in voltage for the GaAs diode is 1.2 V. **2.5**



3. For the network shown below, determine the range of V_i that will maintain V_L (voltage across R_L) at 8 V and not exceed the maximum power rating of the Zener diode. **2.5**



4. For the following network, sketch the output voltage v_O. **1.5**



Part B

1. For the circuit shown in Fig.1 , the Boolean expression for the output Y in terms of P, Q, R and S is

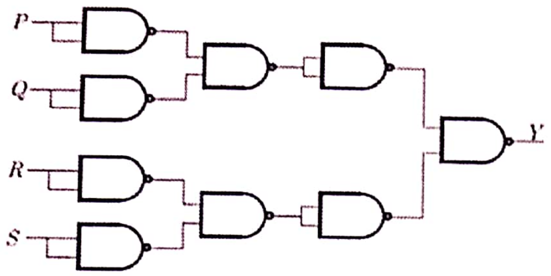


Fig.1 **1**

2. (i) Add the hexadecimal number $ABC_H + DEF_H$

   (ii) Subtract using 2's complement $1010011_2 - 1101010_2$. **1.5**

3. Simplify the Boolean function F_1 with K map and implement the logic circuit.

   $F_1 = \Sigma m(4,5,6,7,12,13,14) + \Sigma d(1,9,11,15)$ **1.5**

4. Plot the following function using K map and find the reduced expression.

   $F = A'B' + CD' + ABC + A'B'CD' + ABC'D$ **1.5**

5. Obtain the truth table and express the given function in product of maxterms,

   $F_2 = (xy+z)(y+xz)$. **1.5**

...END...

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM

Quiz I – February 7, 2018
CH 121- Materials Science and Metallurgy
Second Semester

Time: 1 h **Max. Marks: 25**

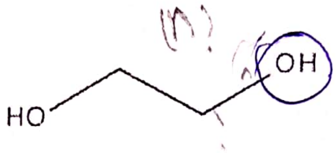
Answer all questions

1. A polymer sample 'X' is prepared by mixing three mono-disperse fractions (A, B and C) of the polymer. If 'X' contains 2 parts by weight of A, 1 part by weight of B and 1 part by weight of C, calculate Mn and Mw of 'X'. Molecular weights of A, B and C are 50,000, 70,000 and 40,000 gmol^{-1} respectively. (5 marks)

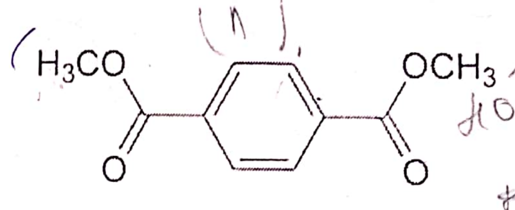
2. You need to prepare polystyrene to be used as calibration standard in Gel permeation chromatography (GPC). Suggest and explain the mechanism by which you would be able to prepare the polymer and the reason for your choice. (4 marks)

3. Polyethylene terephthalate (PET) was prepared from dimethyl terephthalate and ethylene glycol. If the molecular weight of the polymer was found to be 43,200 g mol^{-1} and the product contained 2.5×10^{-3} mols of hydroxyl groups, find out the quantity (in grams) of the monomers initially taken for the reaction and the extent of polymerization. (5 marks)

(Hint: (a) contribution of end groups to molecular weight may be neglected (b) reactants were taken in 1:1 molar ratio)



ethylene glycol



dimethyl terephthalate

4. Ashwin and Priyanshu were to prepare polystyrene by polymerization in presence of BPO. To get a higher molecular weight polymer, Priyanshu performed the reaction for 3 h, while Ashwin performed the reaction for 2 h keeping all other conditions same. Will

Priyanshu get higher molecular weight polymer than Ashwin ? Explain your answer. Derive all the necessary kinetic equations. (6 marks)

5. Polypropylene is available as soft waxy material or rigid and strong engineering plastic. How can you explain these contradicting properties based on the structure. (2 marks)

6. You have the catalyst system BF_3/H_2O and the following monomers in your laboratory. (i) $CH_2{=}CHCN$ (ii) $CH_2{=}C(CH_3)_2$. Which one of the monomers can be subjected to polymerization with the available catalyst? Why ? Write the mechanism of the reaction (3 marks)

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

First Year B. Tech. - Quiz II
MA122-Computer Programming and Applications

21.03.2018 **Time: 09:00-10.00** **Maximum Marks: 30**

Note: *There are four pages in this question paper. Answer* all *questions. Do not* split *your answers.*

SECTION A

There are five questions in this section. Each question carries 2 *marks.*

1. What is the output of the following program?

```
#include <iostream>
using namespace std;
int add(int first, int second)
{
    return first + second + 15;
}
int operation(int first, int second, int (*functocall)(int, int))
{
    return (*functocall)(first, second);
}
int main()
{
    int  a;
    int  (*plus)(int, int) = add;
    a = operation(15, 10, plus);
    cout << a;
    return 0;
}
```

~~38~~ 40

3

2. Which of the following two entities (reading from Left to Right) can be connected by the dot operator?

(a) A class member and a class object.

(b) A class object and a class.

(c) A class and a member of that class.

(d) A class object and a member of that class.

3. Identify the error/errors in the following program?

```
#include<iostream>
using namespace std;
class Room
  {
    int length;
    int width;

  public:
    Room(int l=0, int w)
      {
      length=l;
      width=w;
      }
  };
int main()
{
  Room objRoom1;
  Room objRoom2(12,8);
  return 0;
}
```

width is not initialized.

4. Identify the error/errors in the following program?

```
#include<iostream>
#include<cstring>
using namespace std;
class base
{
  public:
      base()
      {
        cout<<"This is 123"<<endl;
       }
  private:
      base(int i)
      {
        cout<<"This ABC"<<endl;
       }
   };

 int main()
 {
   base b();
   base c;
   base d=base(0);
   base base();
   return 0;
}
```

// class . name class with capital & the constructor also

5. In the following code segment, replace the comments with statements that perform the task:

```
#include<iostream>
using namespace std;
int n = 33;
namespace block1
{
     int n = 77;
}
int main()
{
     int n = 55;
     // print the n whose value is 33
     // print the n whose value is 55
     // print the n whose value is 77
     return 0;
}
```

std::cout << n ;
block1::cout << n ;
cout << n

SECTION B

There are two questions in this section. Each question carries 10 *marks.*

6. Write a code that asks the user to enter a positive integer and then creates a dynamic array of that many **ints**. Do this by using **new**.

7. Define a class *Marks* to store the marks scored by students in quiz 1, quiz 2 and end semester examinations for a specific subject. Construct the class *Marks* using

   a. Private members:

      i. a double array *science* of size 3 to store quiz 1, quiz 2 and end semester marks of a student,

      ii. a double variable *total* to store the total marks of a student,

   and

   b. Member functions:

      i. a default constructor to set all marks and total mark of a student to zero,

      ii. a constructor to set the quiz 1, quiz 2 and end semester marks,

      iii. a function *totalmarks* to calculate and set the total marks of a student,

      iv. a function *show* to display all marks including total marks of a student

      v. a destructor.

   Write a program to implement the class *Marks* in the following way

   c. create an object A to set the marks to default values (zero),

   d. create an object B to set the marks (quiz 1: 22.5, quiz 2: 24, end sem: 38) using constructor,

   e. set the marks of object A using the following values: (quiz 1: 18, quiz 2: 20, end sem: 42),

   f. create an object C to set the marks implicitly (quiz 1: 11, quiz 2: 13.5, end sem: 28),

   g. create an object D to set the marks to default values (zero),

   h. copy the marks of B to D,

   i. display the marks of all objects.

II QUIZ

PH 121 PHYSICS II

II Semester B.Tech (All Branches)

Date : 22.03.2018   Time : 9.00 hrs to 10.00 hrs   Marks : 20

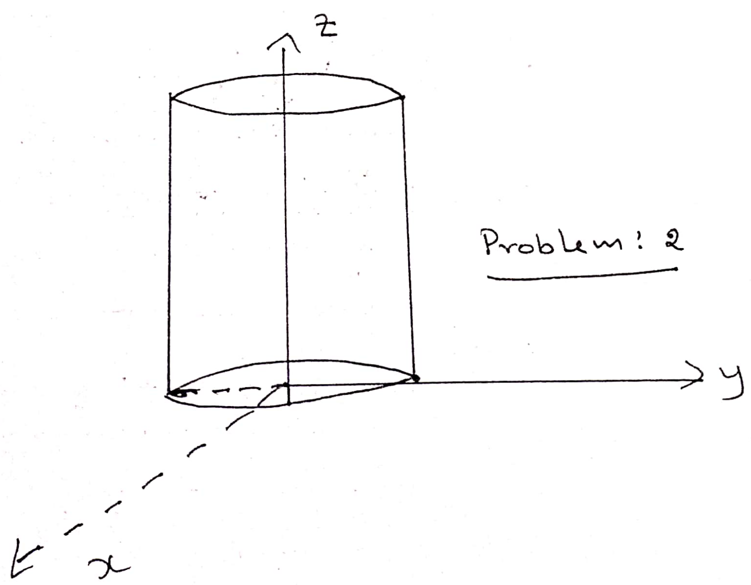
(attempt all questions)

1. Show that whether magnetic fields of i) infinite straight wire carrying current I (at distance r) equal to $\frac{\mu_0 I}{2\pi r}\hat{\phi}$, ii) Solenoid with n -turns and length l carrying current I equal to $\frac{\mu_0 n I}{l}\hat{z}$(inside) and iii) The torroidal coil with n-turns and radius r carrying current I equal to $\frac{\mu_0 n I}{2\pi r}\hat{\phi}$(inside) obeys $\nabla \cdot \mathbf{B} = \mathbf{0}$.(05)

2. A closed cylinder of height h radius R is placed in a magnetic field given by $\vec{B} = B_0(sin\phi\hat{\rho} + cos\phi\hat{\phi} - \hat{z})$. If the axis of cylinder is aligned along z- axis then find flux through top, bottom and curved surface of the cylinder. (05)

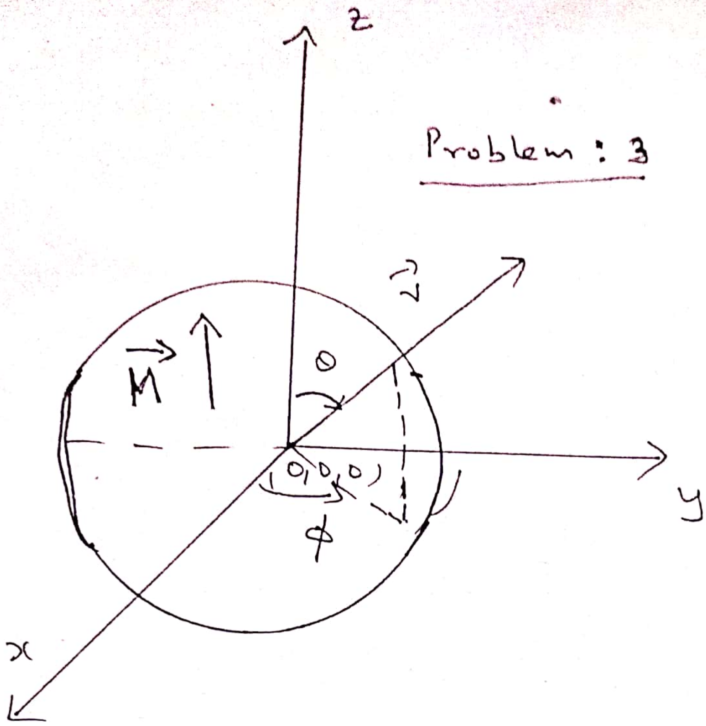
3. The magnetiztion $\mathbf{M}$ of a uniformly magnetized sphere of radius R is along $\hat{z}$ direction. Find J_b, K_b and magnetic field of the sphere inside and show that the field outside the sphere is same as that of a pure dipole. (05)

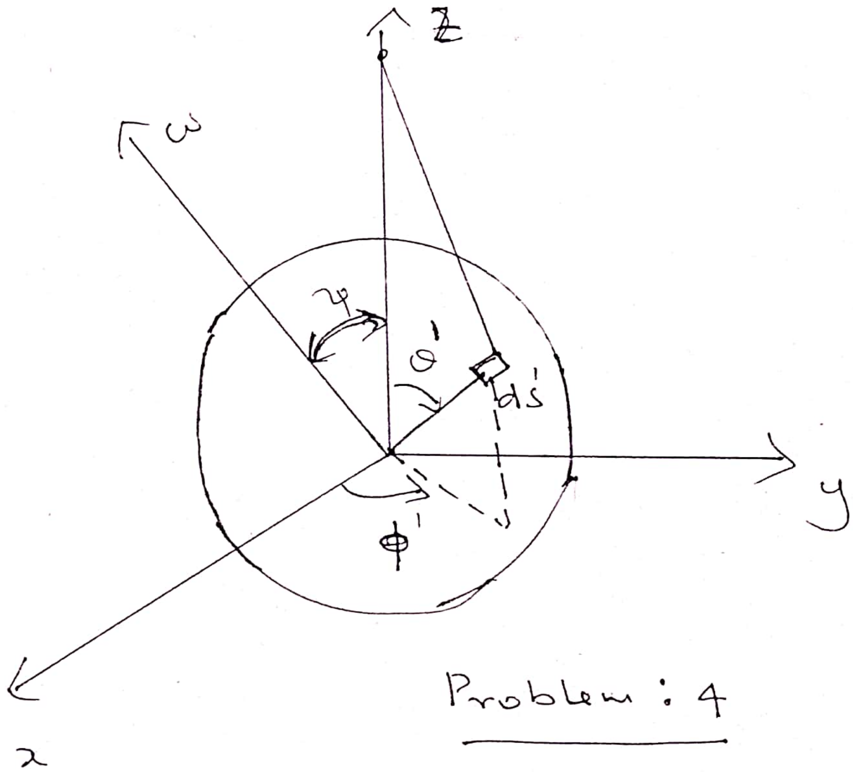
4. A spherical shell of radius R carrying a uniform surface charge σ is set spinning at angular velocity ω. Find the magnetic dipole moment inside and outside the spherical shell. (05)



P.T.O . .

Problem : 3





Problem : 4

USE CONVERSION FORMULAS

$r.r' \cos \theta$

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INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

Quiz II - March 2018

B.Tech - II Semester

MA121 - Vector Calculus and Differential Equations

Date: 26/03/2018 | **Time: 09.00 am - 10.00 am** | **Max. Marks: 15**

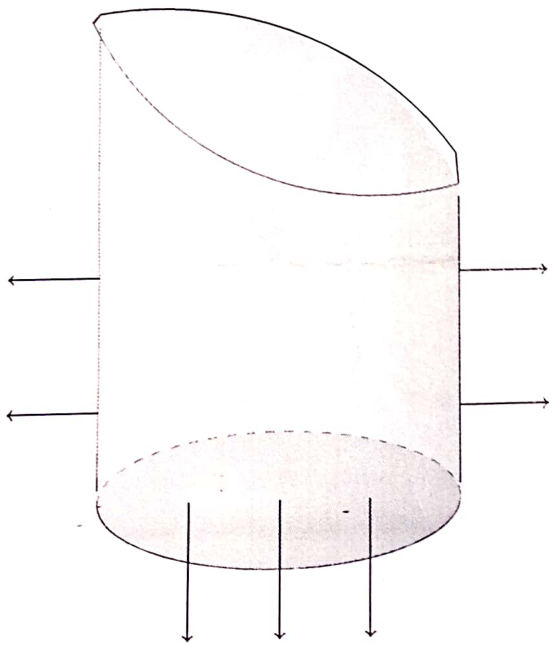
Answer all questions

1. (a) Explain the concepts of pointwise convergence and uniform convergence of a sequence of functions. [2]

   (b) Show that if $a > 0$, the sequence $\{n^2x^2e^{-nx}\}$ converges uniformly on the interval $[a, \infty)$, but that it does not converge uniformly on the interval $[0, \infty)$. [3]

2. (a) State Green's theorem on simply connected domains. [1]

   (b) With proper explanation, using Green's theorem, find the area of the region bounded by the curves $\frac{x^2}{4} + \frac{y^2}{9} = 1$ and $y = x$ in the region "$y \geq x$". [4]

3. 

   Verify Stoke's theorem for the vector field $F(x, y, z) = (x^2, y^2, e^z)$ over the "outward" oriented surface $S = S_1 \cup S_2$ where
   $S_1 : x^2 + y^2 \leq 1$ and
   S_2 is the portion of a cylinder given by
   $x^2 + y^2 = 1; x + y + z \leq 2$ & $z \geq 0$ [5]

END

$x = a\cos\theta$

$y = b\sin\theta$

$z = 2\cos a$

$\int ds \quad \int ds$

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

II Semester B.Tech

Materials Science and Metallurgy (CH 121)

Quiz II, March 23, 2018

Time: 1 hour **Maximum marks: 25**

(Answer all Questions)

1. (a) Calculate the theoretical density of gallium arsenide (GaAS). The gallium arsenide supposes to exist in zinc blend structure with lattice constant of 5.42 A°. The atomic weight of Ga and Arsenic are 69.7 and 74.9g/mole, respectively. [3]
(b) What are metallic glasses? How are they prepared? [2]

2. (a) What Is glass transition temperature? Why poly (vinyl chloride) shows relatively high glass transition temperature? [3]

(b) Explain the crystal structure of $BaTiO_3$ and ThO_2 [2]

3. (a) How the force-distance and energy-distance curves of bonds is useful to predict the material properties? [3]

(b) What are smart materials? Give examples [2]

4. Plot (graphical representation) the variation of shear stress and normal stress for the planes oriented at 30°, 45°, 60°,90°, 120°,135°, 150°, 180° to the basal plane for the specimen having a diameter of 2cm and 10cm length, being pulled in tension with a magnitude of 1000N. Derive the corresponding equations for normal and shear stress. [4]

5. In spite of possessing 48 slip systems, BCC metals are relatively stronger than FCC metals. Explain with reasons. [4]

6. Explain the polymorphic transformations in ZrO_2 [2]

Cl

=CH2

Indian Institute of Space Science and Technology (IIST)

Quiz II Question Paper, March, 2018

Avionics, Basic Electronics (AV121), 2nd Semester.

Marks: 15 | Time: 1 Hr.

Make Suitable assumptions if necessary. Write the answers for PART A and PART B in separate answer scripts.

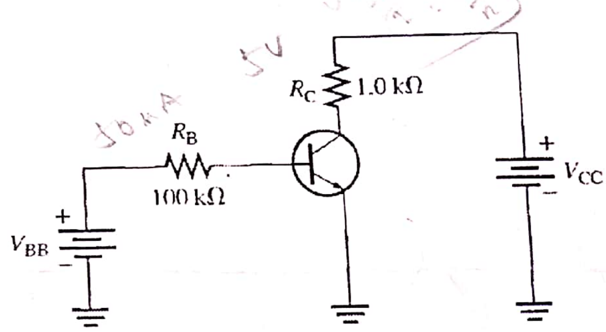
PART A

1. What do you mean by early effect in a bipolar junction transistor and write down the effects of early effect in transistor characteristics. [1.5]

2. Explain the purpose of a thin, and lightly doped base region in a BJT. [1.5]

3. If the emitter current of a transistor is 8 mA, and I_B is 1/100 of I_C, determine the level of I_C and I_B. [1]

4. For the circuit shown in figure below, a base current of 50 μA is applied to the transistor and a voltage of 5 V is measured across R_C. Determine the common emitter current amplification factor of the transistor. [2]



5. What do we mean by a linear amplifier? Can we make a linear amplifier with a non-linear device? If yes, explain how? If no, explain why. *(Answer qualitatively. No derivations are expected.)* [2]

6. Sketch the desirable input and output characteristics of a two port network, for it to be usable as an amplifier. [1]

PART B

1. Implement the function Y=AB'+A'B using ONLY four 2 input NAND gates. [1]
2. Design a counter using T FF to count the following sequence: 001, 100, 101, 111, 110, 010, 011, 001,... [2]
3. Design a circuit to compare two 4-bit numbers, A and B, to check if they are equal. The circuit has one output x, so that x=1 if A=B and x equal 0 if A is not equai to B. [1.5]
4. Realize the given function (w,x,y,z) = $\sum$ (4,5,6,7, 8, 12, 14) using 8X1 Multiplexers. 1.5]

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

PH 121 PHYSICS II
II Semester B.Tech (All Branches)
END SEMESTER EXAMINATION 2018

Date : 25.04.2018 **Time : 9.30 to 12.30 hrs** **Marks : 100**

Section A
(attempt all questions)

1. 1. An infinite plane has a uniform surface charge distribution σ on its surface (Fig.1) . Adjacent to it is an infinite parallel layer of charge of thickness d and uniform volume charge density ρ. Find the electric field E in all the regions marked. (05)

2. Consider a spherical shell of charge (Fig.2), of radius a and surface density σ, from which a small circular piece of radius $b \ll a$ has been removed. What is the direction and magnitude of the field at the midpoint of the hole? (05)

Q.3

3. A spherical condenser consists of two concentric conducting spheres of radii a and b (ab). The outer sphere is grounded and a charge Q is placed on the inner sphere. The outer conductor then contracts from radius a to radius a'. What is the work done by the field? (05)

a > B

4. An electric quadrupole consists of three point charges arranged on the z axis; a charge +q at $z = b$, a charge -2q at z=0 and a charge +q at $z = -b$. Calculate the potential approximately at $r \gg b$.(05)

5. If the magnetic field $\vec{B} = \frac{a}{\rho} cos^2\phi\hat{\rho}$ then find $\vec{\nabla}.\vec{B}$ and $\vec{\nabla} \times \vec{B}$. (05)

6. Find the vector potential of an infinite solenoid with n-turns per unit length, radius R and current I. Then show that $\vec{\nabla} \times \vec{A} = \vec{B}$. (05)

7. An infinitely long cylinder of radius R carries a frozen in magnetization parallel to the axis as $\mathbf{M} = ksin\phi\hat{z}$ where k is constant and there is no free current any where. Find the magnetic field inside and outside the cylinder. (05)

8. The magnetic feild in certain region is given by the value $\vec{B(t)} = B_0 sin(kz - \omega t)\hat{x}$. Find curl of induced electric field and the direction of electric field component. (05)

9. Using the charging of a capacitor show that Ampere's law becomes $\int \mathbf{B}.dl = \mu_0 I_{enc} + \mu_0\epsilon_0 \int (\frac{\partial \mathbf{E}}{\partial t}).ds$. (05)

16

10. Show that the tangential component of intensity of magnetic field is continuous at the interface between two different medium except if one of the surfaces is a conductor using Maxwell's equation. (05)

Section B

(attempt any five questions)

11. Consider the electric field $\vec{E} = s\hat{\phi} - z\hat{z}$. (a) Verify Stokes theorem for the hemispherical surface of radius R bounded by the circular contour C shown in the figure below (Fig.3). (b) Calculate the total charge within the hemisphere of radius R (c) Can this electric field be produced by a system of static charges. (10)

12. A hollow cylinder, of radius a and length b, with open ends, has a total charge Q uniformly distributed over its surface. The centre of the cylinder is at the origin and the axis of the cylinder is z. What is the difference in potential between a point on the axis at one end and the midpoint of the cylinder? (10)

13. Consider an uncharged small sphere of dielectric constant ϵ and radius a, placed near a long wire of radius R and linear charge density λ. The distance between the centre of the sphere and the axis of the wire is D. Consider

$a \ll R$ aR(a)What is the external field, E_0 , acting on the sphere? (b) What is the total electric field inside the dielectric sphere? (c)What is the Polarization **P** within the dielectric? Express all the results in terms of λ, D, ϵ, a. (10)

14. i) A phonograph record of radius R carries a uniform surface charge σ is rotating at an angular velocity ω. Then find its magnetic dipole moment and the magnetic field. ii) Two concentric metal spherical shells of radius a and b (Fig.4)are separated by a material conductivity σ. If they are maintained at different potential difference V then find the current I flowing between them and the resistance between the shells. (10)

15. i) The magnetic field inside of a long straight wire is $\vec{B} = \frac{\mu_0 I r}{2\pi r_0^2}\hat{\phi}$. Find the current density $\vec{J}$. ii) The magnetic field of of a circular parallel plate capacitor is $\vec{B} = \frac{\mu_0 V}{2\pi R} e^{\frac{-t}{RC}} (\frac{r}{r_0^2})\hat{\phi}$. Find the displacement current density. (10)

16. i) Two homogeneous isotropic dielectric medium(Fig.5) meets on a plane $z = 0$ for $z \geq 0, \epsilon_{r1} = 6$ and for $z \leq 0, \epsilon_{r2} = 4$. If a uniform electric field $\vec{E_1} = 5\hat{x} - 2\hat{y} + 3\hat{z} kV/m$ exists for $z \geq 0$ then find $\vec{E_2}$ for $z \leq 0$. ii) If the electric field $\vec{E} = E_m sin(-kz)\hat{y}$ in free space then show that it obeys Maxwell's equation. (10)

2

17. i) Show that the work done on the charges by electromagnetic force $\frac{dw}{dt}$ is equal to $-\frac{d}{dt}\int_v \frac{1}{2}(\epsilon_0 E^2 + \frac{1}{\mu_0}B^2)dv - \frac{1}{\mu_0}\int_s(\vec{E}\times\vec{B}).ds$ ii) A long co-axial cable of length i consists of an inner conductor(radius r_1) and an outer conductor (radius r_2). It is connected to a battery(Fig.6). The inner conductor carries a uniform charge *lambda* per unit length and a steady current I to th right and the outer current has opposite charge and current. Also find the hidden mechanical momentum stored in the cable by adding the resistance. (10)

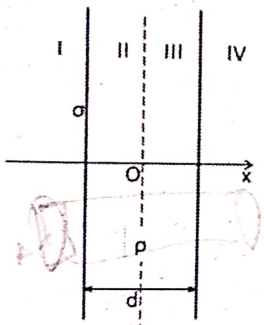


Fig. 1

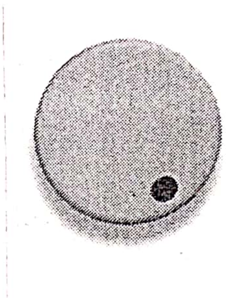


Fig. 2

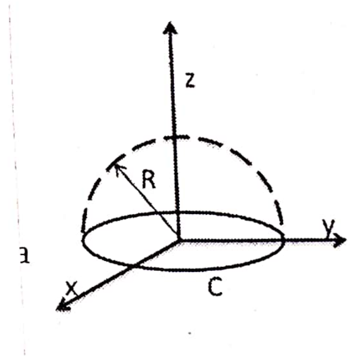
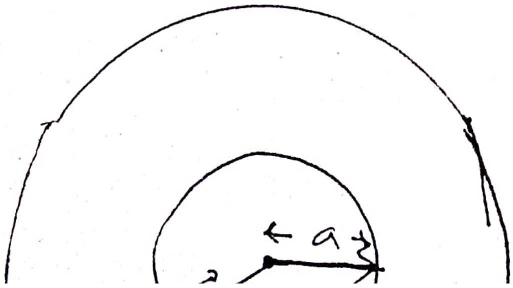
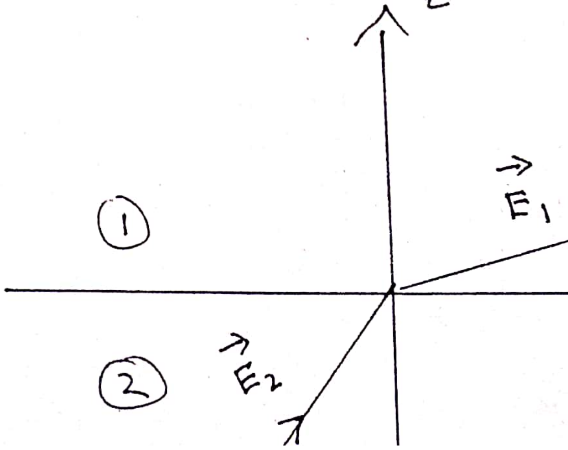


Fig. 3





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17. i) Show that the work done on the charges by electromagnetic force $\frac{dw}{dt}$ is equal to $-\frac{d}{dt}\int_v \frac{1}{2}(\epsilon_0 E^2 + \frac{1}{\mu_0}B^2)dv - \frac{1}{\mu_0}\int_s(\vec{E}\times\vec{B}).ds$ ii) A long co-axial cable of length i consists of an inner conductor(radius r_1) and an outer conductor (radius r_2). It is connected to a battery(Fig.6). The inner conductor carries a uniform charge *lambda* per unit length and a steady current I to th right and the outer current has opposite charge and current. Also find the hidden mechanical momentum stored in the cable by adding the resistance. (10)

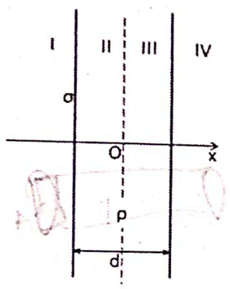

Fig.1

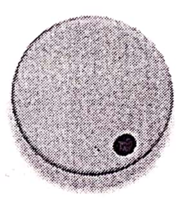

Fig.2

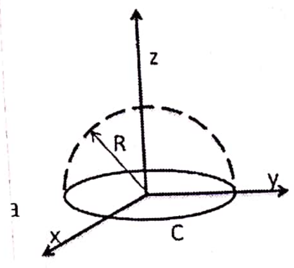

Fig.3

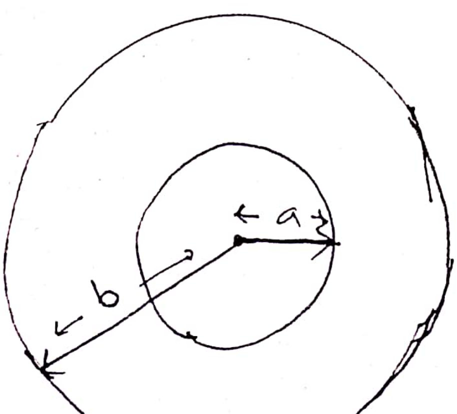

Fig. 4.

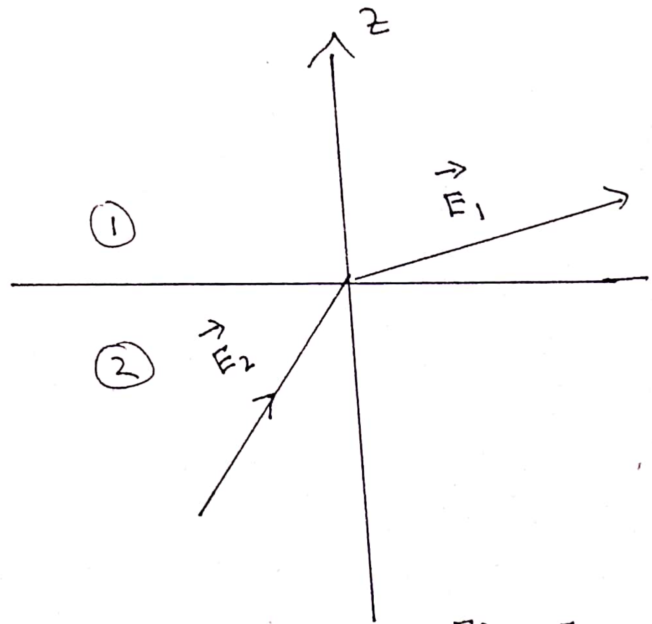

Fig. 5

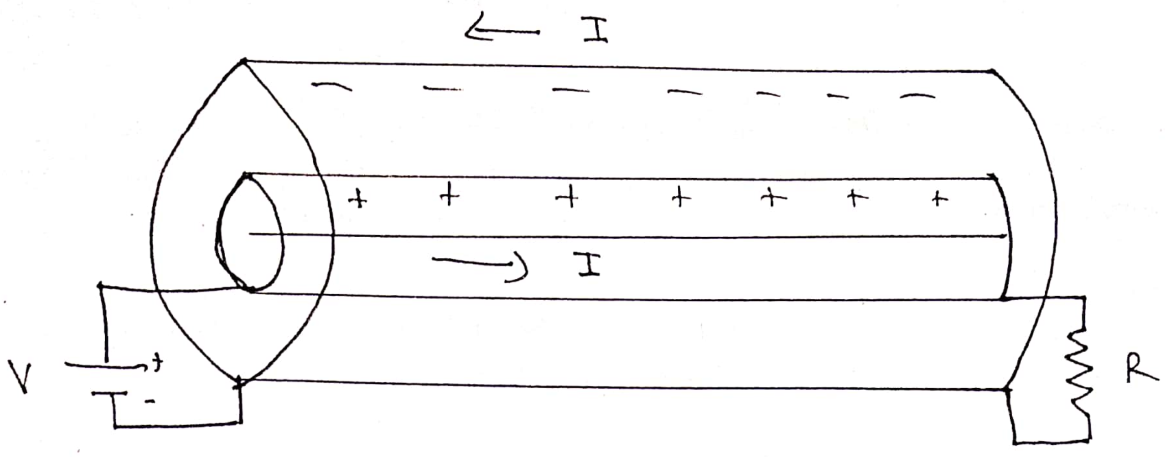

Fig. 6

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547

Thursday May. 03, 2018	**AV 121: Basic Electronics** B.Tech End semester exam	Time: 0930-1230 Marks: 100

Make Suitable assumptions if necessary. Write the answers for **Section A** and **Section B** on separate answer scripts.

Section A: Analog Circuits

1. (a) [1 mark] Given $P_{max} = 14$ mW for each of the diodes shown in Figure 1, determine the maximum current rating of each diode using approximate equivalent model.
   (b) [1 mark] Determine I_{max} for the parallel diode.
   (c) [2 marks] Determine the current through each diode at V_{imax}.
   (d) [1 mark] If only one diode were present, what would be the expected result?

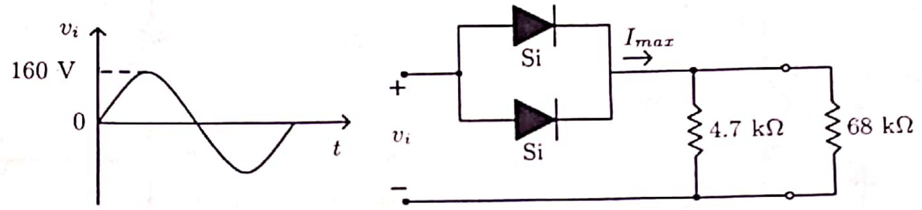

Figure 1: Circuit for question 1

2. [3 marks] Sketch the output voltage V_0 and determine the dc voltage available for the network shown in Figure 2.

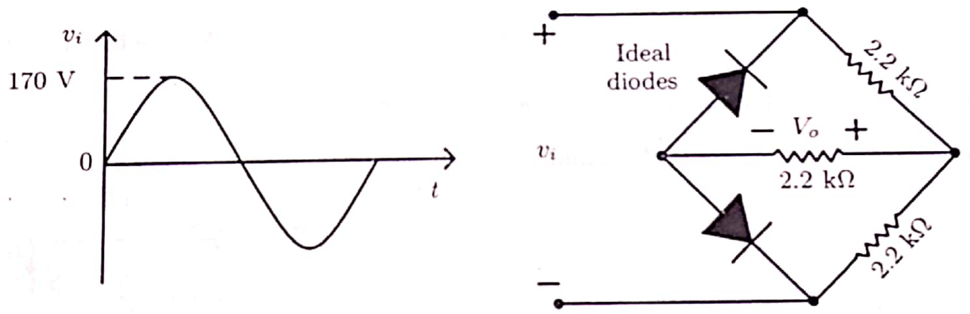

Figure 2: Circuit for question 2

3. [6 marks] Sketch i_R and v_0 for the network in Figure 3 for the given input shown.

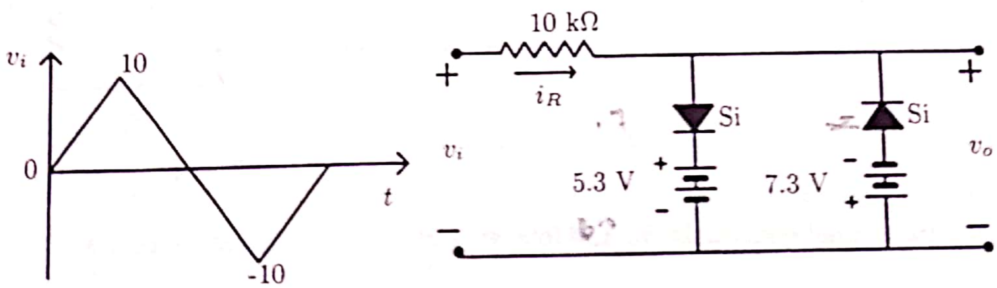

Figure 3: Circuit for question 3

4. Given the information appearing in Figure 4, determine

(a) $\boxed{\text{1 mark}}$ I_C

(b) $\boxed{\text{1 mark}}$ V_E

(c) $\boxed{\text{1 mark}}$ V_{CC}

(d) $\boxed{\text{1 mark}}$ V_{CE}

(e) $\boxed{\text{1 mark}}$ V_B

(f) $\boxed{\text{1 mark}}$ R_1

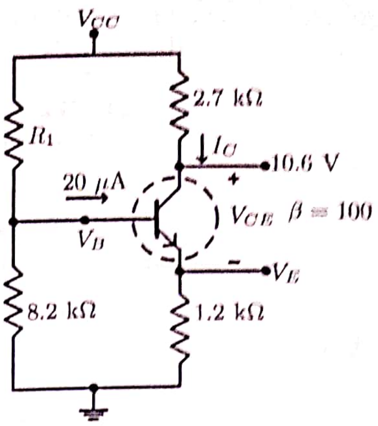

Figure 4: Circuit for question 4

5. $\boxed{\text{3 marks}}$ Calculate the current I in the circuit shown in Figure 5.

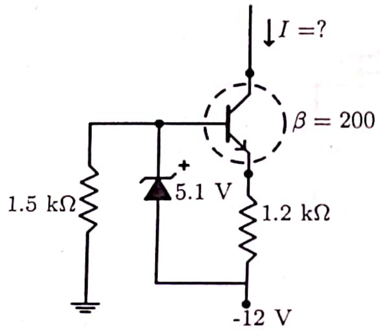

Figure 5: Circuit for question 5

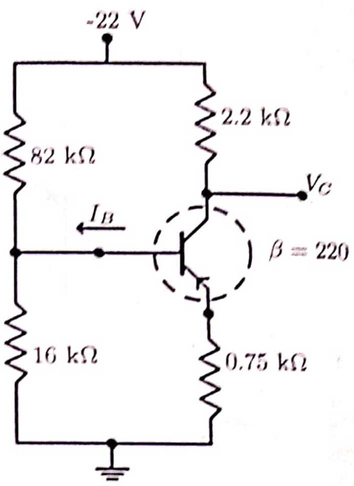

Figure 6: Circuit for question 6

6. $\boxed{\text{5 marks}}$ Determine V_C and I_B for the network shown in Figure 6.

7. For the network shown in Figure 7 below, determine

(a) $\boxed{\text{2 marks}}$ r_e

(b) $\boxed{\text{2.5 marks}}$ the input impedance

(c) $\boxed{\text{2.5 marks}}$ the voltage gain.

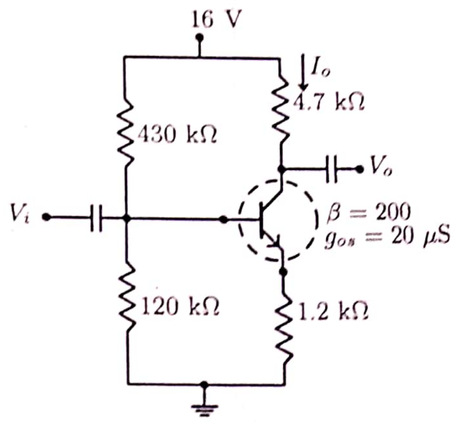

Figure 7: Circuit for question 7

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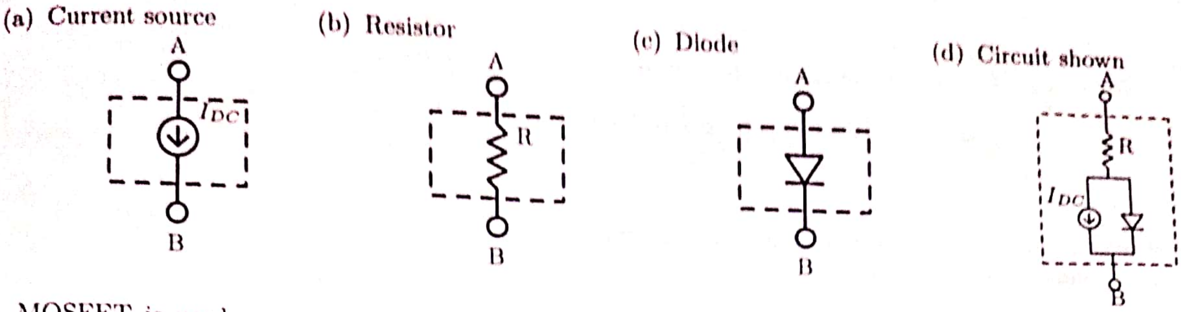
8. $\boxed{\text{5 marks}}$ Draw the small signal equivalent for the following circuit components/circuits.



9. A MOSFET is used as a common source amplifier, the circuit diagram of which is shown in Figure 8. For the MOSFET used, the product of channel mobility and oxide capacitance per unit area is $\mu_n C_{ox} = 145\ \mu A/V^2$ and the threshold voltage $V_{th} = 350$ mV. The width and length of the transistor are 20 μm and 0.5 μm respectively. Assume the supply voltage is 3.3 V. The gate is biased with a voltage of 680 mV and the load resistance is 8.2 kΩ.

   (a) $\boxed{\text{1 mark}}$ Calculate the drain current through the transistor.

   (b) $\boxed{\text{1 mark}}$ Calculate the small signal transconductance of the transistor (i.e. y_{21} or g_m)

   (c) $\boxed{\text{1 mark}}$ Ignoring the effect of channel length modulation, calculate the gain of the amplifier.

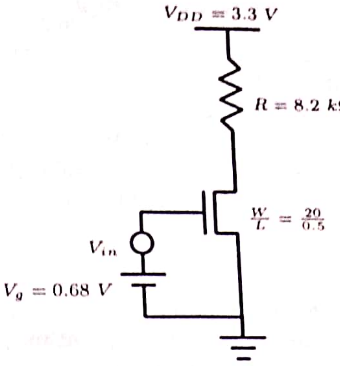
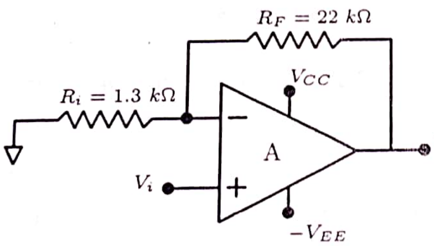


Figure 8: Circuit for question 9.

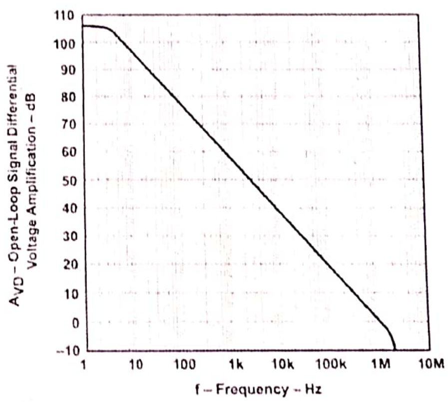
   (d) $\boxed{\text{1 mark}}$ If the channel length modulation parameter is $\lambda = 0.02$ calculate the new gain.

   (e) $\boxed{\text{4 marks}}$ Due to variations in manufacturing of the transistor, the product of channel mobility and oxide capacitance per unit area ($\mu_n C_{ox}$) got reduced by 10%. Calculate the new values of drain current, transconductance g_m and the new gain of the amplifier. What is the percentage change in gain? Again calculate this with and without channel length modulation.

10. Figure 10 shows an non-inverting amplifier constructed with an operational amplifier.



(a) Amplifier circuit for question 10



(b) Open loop characteristics of μA741 op-amp. For question 10(d).

Figure 10: Circuit and graph for question 10

   (a) $\boxed{\text{2 marks}}$ Assuming an ideal operational amplifier, what is the gain of the circuit?

   (b) $\boxed{\text{3 marks}}$ This ampifier circuit is constructed with μA741 op-amp (the same one you used in your practical sessions). If the DC open loop gain of the op-amp is 2×10^5, what is the exact gain of the amplifier? Also calculate the steady state error at the input of the op-amp.
   (Hint: Use the proportional control model for the op-amp circuit).

   (c) $\boxed{\text{1 mark}}$ If the open loop gain of the opamp reduces by 10%, what is the change in the gain of the amplifier?

   (d) $\boxed{\text{3 marks}}$ The frequency characteristics of the opamp are shown in Figure 10(b). If an input at 100 kHz is applied to the circuit, what will be the exact gain of the amplifier? Explain briefly why it is different from the value

calculated in question 10(b).
Note: Use the following formula for converting the gain from decibels to absolute value.

$$Gain = 10^{\left(\frac{\text{gain in dB}}{20}\right)}$$

11. $\boxed{\text{2 marks}}$ What would you infer from your calculations in question 9(e) and question 10(c)? Which is a better way to design an amplifier? Explain briefly.

12. $\boxed{\text{6 marks}}$ Answer **ANY ONE** of the following two questions.

(a) Consider two linear networks N_1 and N_2 connected by only one impedance Z as shown in Figure 11. The voltage at nodes X and Y are V_X and V_Y respectively. Since the network is linear we know that V_Y can be written as $V_Y = kV_X$, where k is a constant. Show how we can use Miller's theorem to split these two networks. Derive the expressions for the impedances in the new split networks.

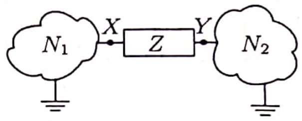


Figure 11: Schematic for question 12(a)

OR

(b) Draw the cross section of a MOSFET depicting the channel when the an inversion layer exists and the transistor is in the linear region of operation. From first principles derive the expression for the drain current in terms of the gate and drain voltages.

Section B:

13. $\boxed{\text{4 marks}}$ Represent the decimal number 4373 in (a) BCD (b) Excess 3 code (c) 2421 code. Demonstrate with an example how the 2421 code is self complementing.

14. $\boxed{\text{5 marks}}$ Show the truth table of a full subtractor and implement using **minimum number of** two input NAND gates only.

15. $\boxed{\text{3 marks}}$ Show how a J K FF can be converted to SR FF.

16. $\boxed{\text{4 marks}}$ A fictitious FF has two inputs A and B and functions as follows, draw the characteristic table and excitation table. For AB=00 and 11 the output becomes 0 and 1 respectively. For AB=01, FF retains the previous output while complements for AB=10.

17. $\boxed{\text{5 marks}}$ Design a circuit which converts a 3 bit gray code to a 3 bit binary code and implement using **minimum** number of gates.

18. $\boxed{\text{5 marks}}$ Simplify the following expression using K-map in (a) SOP and POS (b) Implement the simplified function in SOP using NOR gates only.

$AB\overline{C} + \overline{B}D + \overline{A}CD + \overline{A}B + BD + A\overline{D} + \overline{C}$

19. (a) $\boxed{\text{3 marks}}$ Design a Mod 7 asynchronous up counter using T flip-flop and draw the timing diagram.

(b) $\boxed{\text{2 marks}}$ Design a sequential circuit using D FF to divide the clock frequency by a factor of 4 and draw its timing diagram with respect to input clock frequency.

20. $\boxed{\text{4 marks}}$ If a sequential circuit has two T FF, one input x and one output y which are described algebraically by two input equation and an output equation $T_A = Bx$; $T_B = x$ and $y = AB$, Draw the sequential circuit, state diagram and state table.

calculated in question 10(b).
Note: Use the following formula for converting the gain from decibels to absolute value.

$$Gain = 10^{\left(\frac{\text{gain in dB}}{20}\right)}$$

11. $\boxed{\text{2 marks}}$ What would you infer from your calculations in question 9(e) and question 10(c)? Which is a better way to design an amplifier? Explain briefly.

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(a) Consider two linear networks N_1 and N_2 connected by only one impedance Z as shown in Figure 11. The voltage at nodes X and Y are V_X and V_Y respectively. Since the network is linear we know that V_Y can be written as $V_Y = kV_X$, where k is a constant. Show how we can use Miller's theorem to split these two networks. Derive the expressions for the impedances in the new split networks.

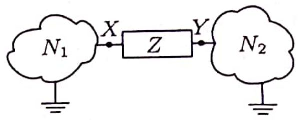

Figure 11: Schematic for question 12(a)

OR

(b) Draw the cross section of a MOSFET depicting the channel when the an inversion layer exists and the transistor is in the linear region of operation. From first principles derive the expression for the drain current in terms of the gate and drain voltages.

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20. $\boxed{\text{4 marks}}$ If a sequential circuit has two T FF, one input x and one output y which are described algebraically by two input equation and an output equation T_A=Bx; T_B=x and y=AB. Draw the sequential circuit, state diagram and state table.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM

End Semester Examination
April 27, 2018
CH 121- Materials Science and Metallurgy
Second Semester

Time: 3 h

Max. Marks: 100

Answer any 10 questions

1. a) What is a binary isomorphous system? Explain the construction of a binary isomorphous system from cooling curves of varying compositions of the two constituents. (6)

   b) Briefly describe the terms: (i) fatigue, (ii) ductility (4)

2. a) Explain with suitable reasons as why alloys possess higher strength when compared to their pure metal counterparts? (4)

   b) Draw the stress strain curve for a material containing few dislocations and for the same material containing no dislocations. Explain with proper reasoning for the discrepancy if any? (6)

3. Prove that the $\Delta G^*_{het} = \Delta G^*_{hm} \frac{(2-3\cos\theta+\cos^3\theta)}{4}$

   Given:

   $$V_s = \frac{\pi r^3}{3}(2-3.\cos\theta+\cos^3\theta) \quad A_{sl} = 2\pi r^2(1-\cos\theta) \quad A_{sm} = \pi r^2\sin^2\theta$$

   Vs = volume of spherical cap (solid nucleus), A_{sl} = Area of the solid-liquid interface, A_{sm} = Area of the solid-mould interface. (10)

4. Explain the principle of working of metallurgical microscope and the procedure for obtaining microstructure of an aluminium alloy. (10)

5. a) An aluminium alloy with grain sizes of 0.015 and 0.035 mm has yield strength of 170 and 151 MPa, respectively. What will be the grain size of the same alloy if its strength is 200 MPa ? (4)

   b) Why yield strength of an alloy increases with decrease in grain size? (3)

   c) What are the criteria for two metals to form complete solid solution? (3)

6. a) Calculate the planar density of (110) plane of a BCC metal whose unit cell parameter is 0.24 nm. (4)

b) Explain the crystal structure of
(i) MgO (Mg^{2+} to O^{2-} radius ratio = 0.5)
(ii) SiC (3)

c) Explain the nature of bonding in ceramics. (3)

7. a) In a BET experiment for the measurement of surface area, 0.5 g of a ceramic powder adsorb 0.2 liters of nitrogen gas at STP for uni-molecular surface coverage. Calculate the specific surface area of the powder. The cross sectional area of a nitrogen molecule is 0.16 nm^2. (4)

b) Explain solid state method for synthesis of $MgAl_2O_4$ powder. Mention the drawback of this method. (3)

c) What is the importance of granulation in powder pressing process? (3)

8. a) Explain the mechanisms of powder dispersion in aqueous medium. (4)

b) What is the principle of direct coagulation casting? (3)

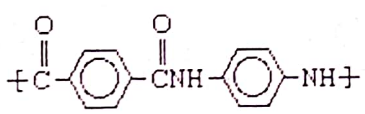
c) What are ultra high temperature ceramics? Give example. Mention their application in aerospace (3)

9. a) Two copolymers of ethylene and propylene contain the same ratio of the monomers and were prepared using the catalyst α-$TiCl_3/Al(C_2H_5)_3$. At room temperature, one is transparent, soft and rubbery, while the other one is rather opaque, stiff and tough. Explain the structural difference of the copolymers. (3)

b) What will be the property (transparent, soft and rubbery ***or*** opaque stiff and tough) of polyethylene and polypropylene prepared separately using the same catalyst ? Explain your answer. (2)

c) How can you synthesize high density polyethylene ? Write down the mechanism. (3)

d) Both Kevlar and linear polyethylene fibers contain high degree of crystallinity. However, the former is somewhat stronger than the latter. Is the statement true ? Explain, based on the structure of the polymers. (2)



Kevlar

10. a) Describe the polymerization technique through which you will obtain the final product in the form of fine particles (diameter in the range of nanometer). (5)

b) Explain a technique with principle and theory to find out the molecular weight of polymers. (5)

11. a) You prepared polystyrene to be used as standard for molecular weight determination. Find out M_n and M_w of the polystyrene if you have used 10 g of styrene and $2x10^{-4}$ g of n-butyl lithium for the polymerization reaction in THF as solvent (total volume : 2 L). Find out the initial rate of polymerization if the rate constant for propagation is 550 $Lmol^{-1}s^{-1}$. Atomic mass of Li is 7 g/mol. (5)

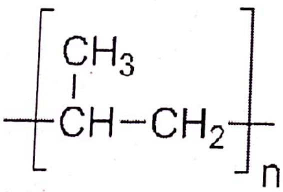
b) In large scale preparation of polymers by free radical polymerizations (bulk) the reaction is often stopped before achieving very high conversion. Why ? (2)

c) Arrange the polymers (each group separately) in the order of increasing Tg. Explain your answer based on the structure

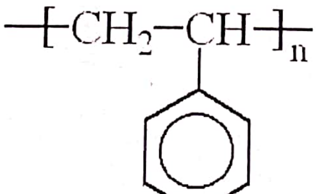
(i) PS, PE, PP

(ii) PC, PET, PEA (3)

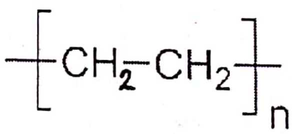
(Structure of the polymers)



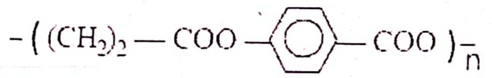
PP



PS



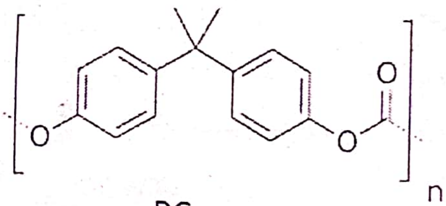
PE



PET

$-(CH_2CH_2-OOC-(CH_2)_4-COO)-_n$

PEA,



PC

Indian Institute of Space Science and Technology

Thiruvananthapuram-695547

End Semester Examination-May 2018

B.Tech 2nd Semester

MA121 - Vector Calculus and Differential Equations

Date : 1stMay, 2018 **Time: 9:30 am to 12:30 pm** **Max. Marks: 100**

SECTION A (Answer all 10 questions - 10x5= 50 marks.)

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1. Let $g_n(x) = \dfrac{e^{-nx}}{n}$ for $x \geq 0, n \in \mathbb{N}$. Do $\{g_n\}$ and $\{g_n'\}$ converge? If so, find their limits and check whether the convergence is pointwise or uniform.

2. State Weierstrass M-Test in connection with a series of functions. Discuss the convergence and the uniform convergence of the series $\sum f_n$, where $f_n(x) = \dfrac{1}{x^2+n^2}$, $x \in \mathbb{R}$, $n \in \mathbb{N}$.

3. Let $W := \{(x,y) \in \mathbb{R}^2 \mid y = mx + c\}$, where $c \neq 0$. Show that W does not form a vector space over $\mathbb{R}$ with respect to operations induced from $\mathbb{R}^2$.

4. Let $f : \mathbb{R}^3 \longrightarrow \mathbb{R}$ be a map with properties

   (a) $f(v_1 + v_2) = f(v_1) + f(v_2)$ for all $v_1, v_2 \in \mathbb{R}^3$.

   (b) $f(t \cdot v) = tf(v)$ for all $t \in \mathbb{R}$ and $v \in \mathbb{R}^3$.

   Show that for any fixed unit vector $v_0 \in \mathbb{R}^3$, $D_{v_0}(f)|_P$ exists, and is constant for all $P \in \mathbb{R}^3$. Further, show that $D_v(f)|_{P_0}$ exists for all unit vector v at a fixed point P_0. What is the direction v for which $D_v(f)|_{(0,0,0)}$ is maximum?

5. Suppose $\gamma : [a,b] \longrightarrow \mathbb{R}^3$ a C^1-type curve such that $||\gamma(x)|| \neq 0$ for all $x \in [a,b]$. Show that the arc length function $s(x) \neq 0$ for all $x \in (a,b]$ and is of C^1-type.

6. Let $\vec{f} : \mathbb{R}^2 \longrightarrow \mathbb{R}^2$ a continuous vector field and C a smooth parametric curve. Show that $-C$ is also a smooth parapetric curve; and $\displaystyle\int_{-C} \vec{f} \cdot \vec{ds} = -\int_C \vec{f} \cdot \vec{ds}$.

7. Find the general solution of the equation $\dfrac{d^2y}{dx^2} + 6\dfrac{dy}{dx} + 9y = e^{-3x}/x$, $\quad x > 0$, using the method of variation of parameters.

8. Find the general solution of the equation $\dfrac{d^2y}{dx^2} + x\dfrac{dy}{dx} + y = 0$ in the form $y = c_0\phi_1(x) + c_1\phi_2(x)$, where $\phi_1(x)$ and $\phi_2(x)$ are the linearly independent power series solutions about $x = 0$ (compute up to first two terms of ϕ_1 and ϕ_2), where c_0 and c_1 are arbitrary real numbers.

9. State the *non-local existence theorem* and using this theorem, with proper justification, determine the largest interval in which the initial-value problem (IVP)

$$\frac{dy}{dx} + (\tan x)^2 y = \sin x, \quad y(\pi) = 2018,$$

has a unique solution.

$f(x_0 + hv_1, y_0+hv_2, z_0+hv_3)$

$P + hv$

10. Let $m(\neq 0) \in \mathbb{R}$. Transform the equation $x^2\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} + (m^2x^2+1)y = 0, \quad x > 0$, using the substitution $y = \frac{u(x)}{x}$ and hence find the general solution in terms of Bessel functions using the substitution $w = mx$.

SECTION B (Answer any 5 questions - 5x10= 50 marks.)

11. (a) Let $\{f_n\}, \{g_n\}$ be sequences of bounded functions on A that converge uniformly on A to f, g respectively. Show that $\{f_n g_n\}$ converges uniformly on A to fg.

(b) Let $\{h_n\}$ be a sequence of functions defined on $[0,1]$ by $h_n(x) = 2nxe^{-nx^2}$ for $x \in [0,1]$, $n \in \mathbb{N}$. Does $\lim h_n$ exist? If so, is the convergence uniform? Also, find $\int_0^1 \lim h_n(x)dx$ and $\lim \int_0^1 h_n(x)dx$ and check whether they are equal if $\lim h_n$ exists.

12. (a) Let $(1,1)$ and $(1,2)$ be two vectors in $\mathbb{R}^2$. Show that these two vectors generate whole $\mathbb{R}^2$ over $\mathbb{R}$. Further, argue that any one of these vectors alone can not generate $\mathbb{R}^2$ over $\mathbb{R}$.

(b) Let $f : \mathbb{R}^2 \longrightarrow \mathbb{R}$ defined by $f(x,y) = \sqrt{(x^2+y^2)}$ for all $(x,y) \in \mathbb{R}^2$. Check if $D_v f|_{(0,0)}$ exists for all unit vector v. Is f differentiable at $(0,0)$?

13. (a) Using Green's theorem find the area of the region G enclosed by the curves C_1, C_2 and x-axis where $C_1 : \frac{x^2}{4} + \frac{y^2}{9} = 1;\ x \geq 0;\ y \geq 0$ and $C_2 : x^2+y^2 = 9;\ x \geq 0;\ y \geq 0$.

(b) Let G be a non-simplyconnected region with outer boundary a positively oriented smooth loop γ whose equation is unknown such that P_0 is a point outside G with the property that $G \cup \{P_0\}$ is simplyconnected (ie, P_0 is the point exactly whose absence in G makes G non-simplyconnected: G is a region with point-hole). What can you say about the value of the integral $\int_\gamma \vec{F}\cdot\vec{ds}$ where $\vec{F}(x,y) = (x^2+3y, y^2+5x)$; and $Area(G) = \beta$.

14. (a) Let $S : \frac{x^2}{16} + \frac{y^2}{25} = z;\ z \leq 1$. Using Stoke's theorem find the value of surface integral $\iint_S Curl(\vec{F}).\vec{dS}$ where $\vec{F}(x,y,z) = (e^x, y+z, y+z)$.

(b) Fix $t \in \mathbb{R}$. Let $\vec{F}(x,y,z) = \left(\frac{-y}{x^2+y^2}, \frac{x}{x^2+y^2}, z\right)$ for all $(x,y,z) \in \mathbb{R}^3 \backslash z-axis$. Let $\Gamma_t : x^2+y^2 = t^2;\ z = t$. Set $\Phi(t) = \int_{\Gamma_t} \vec{F}.\vec{ds}$. Find $\frac{d}{dt}(\Phi(t)),\ t \neq 0$.

15. (a) State the *Picard's existence and uniqueness theorem* and using this theorem, with proper justification, determine the maximum value of h $(h > 0)$ such that the IVP

$$\frac{dy}{dx} = 1 + y^2, \quad y(0) = 0,$$

has a unique solution on the interval $|x| \leq h$. **[4 Marks]**

(b) Let $\phi_1(x)$ and $\phi_2(x)$ be two linearly independent series solutions of the equation

$$(x-x^2)\frac{d^2y}{dx^2} + (1-5x)\frac{dy}{dx} - 4y = 0,$$

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about the point $x = 0$ for $x > 0$. Determine $\phi_1(x)$ (compute up to <u>first two terms</u>) and also show that $\phi_2(x) = \phi_1(x)\ln x + c_0[2^2(1-2)x + \cdots]$, where $c_0(\neq 0)$ is an arbitrary real number. **[6 Marks]**

16. (a) Using the definition of Bessel function of first kind of order p $(p > 0)$, given by

$$J_p(x) = \sum_{n=0}^{\infty} \frac{(-1)^n}{n!\Gamma(n+p+1)} \left(\frac{x}{2}\right)^{2n+p}$$

establish the identity $\frac{d}{dx}[x^p J_p(x)] = x^p J_{p-1}(x)$ and using the *Rolle's theorem* show that between any two positive roots of $J_{p+1}(x) = 0$, there is a root of $J_p(x) = 0$. **[4 Marks]**

(b) Find the eigenvalues and eigenfunctions of the boundary value problem

$$\frac{d}{dx}\left(x\frac{dy}{dx}\right) + \frac{\lambda}{x}y = 0, \quad y'(1) = 0,\ y'(e^{2\pi}) = 0,$$

where λ is a non-negative real number. **[6 Marks]**

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First Year B. Tech. - End Semester Examination
MA122-Computer Programming and Applications

23.04.2018 | **Time: 09:30am-12.30pm** | **Maximum Marks: 100**

Note: *There are thirteen pages and twenty three questions in this question paper. Answer* **all** *questions. Do not* **split** *your answers.*

SECTION A: Output

Note: *There are* **six** *questions in this section. Each question carries* **three** *marks. What is the output of the following programs?*

1.

```
#include<iostream>
using namespace std;
int main()
{
 int i=5,j=8;
 j=j||(i++ && 11);
 cout<<i<<" "<<j<<endl;
 return 0;
 }
```

2.

```
#include<iostream>
using namespace std;

int main()
{
  switch(NULL)
  {
    break;
    case 0: cout<<"Hi"<<'\t';
    default: cout<<"Hello"<<endl;
    return 0;
  }
 }
```

3.

```
#include<iostream>
#include<cstring>
using namespace std;

void fun(char *s)
{
  s=new char[10];
  strcpy(s,"UVCE");
  cout<<s<<'\t';
  }

int main()
{
  char *str="BANGALORE";
  fun(str);
  cout<<str<<endl;
  return 0;
   }
```

4.

```
#include<iostream>
#include<cstring>
using namespace std;

int main()
{
  char p[9]={"ABCDEF"};
  if(!(p[strlen(p)/2]+='\0'))
  cout<<"strlen="<<strlen(p)<<'\t'<<"str="<<p;
  else
   cout<<"Hello"<<endl;
  return 0;
   }
```

5.

```
#include <iostream>
using namespace std;
int operate (int a, int b)
{
    return (a * b);
}
float operate (float a, float b)
{
    return (a / b);
}
int main()
{
    int x = 5, y = 2;
    float n = 5.0, m = 2.0;
    cout << operate(x, y) <<"\t";
    cout << operate(n, m);
    return 0;
}
```

6.

```
#include <iostream>
#include <vector>
using namespace std;
int main()
{
    vector <int> v1;
    vector <int> :: iterator i;

    for (int i = 1; i <= 5; i++)
        v1.push_back(i);

    for (i = v1.begin(); i != v1.end(); ++i)
        cout << *i <<" ";

    vector <int> g1;
    g1.reserve(10);
    for (int i = 1; i <= 5; i++)
        g1.push_back(i);

    cout << "\nSize : " << g1.size();
    cout << "\nCapacity : " << g1.capacity();
    return 0;}
```

SECTION B: Multiple choice questions

Note: *There are* **eight** *questions in this section. Each question carries* **three** *marks. Select correct answers for the questions. In the following questions output means either compiler output or runtime error*

7. What is the output of the following program?:

```
#include<iostream>
using namespace std;

class Base {
private:
        int i, j;
public:
        Base(int _i = 0, int _j = 0): i(_i), j(_j) { }
};
class Derived: public Base {
public:
        void show(){
                cout<<" i = "<<i<<" j = "<<j;
        }
};
int main(void) {
    Derived d;
    d.show();
    return 0;
}
```

(a) i=0 j=0

(b) Compiler Error: i and j are private in Base

(c) Compiler Error: Could not call constructor of Base

(d) None of the above

8. What is the output of the following program?:

```
1  #include<iostream>
2  using namespace std;
3
4  class Base
5  {
6  public:
7      void show()
8      {
9          cout<<" In Base ";
10     }
11 };
12
13 class Derived: public Base
14 {
15 public:
16     int x;
17     void show()
18     {
19         cout<<"In Derived ";
20     }
21     Derived()
22     {
23         x = 10;
24     }
25 };
26
27 int main(void)
28 {
29     Base *bp, b;
30     Derived d;
31     bp = &d;
32     bp->show();
33     cout << bp->x;
34     return 0;
35 }
```

(a) Compiler Error in line 32: "bp->show()"

(b) Compiler Error in line 33: "cout<<bp->x"

(c) In Base 10

(d) In Derived 10

9. What is the output of the following program?

```
#include <iostream>
#include<string>
using namespace std;
class Base
{
public:
    virtual void show() const
    {
        cout<<"This is Base class"<<endl;
    }
};

class Derived : public Base
{
public:
    virtual void show() const
    {
        cout<<"This is Derived class"<<endl;
    }
};

void describe(Base p)
{
    p.show();
}

int main()
{
    Base b;
    Derived d;
    describe(b);
    describe(d);
    return 0;
}
```

(a) This is Derived class
This is Base class

(b) This is Base class
This is Derived class

(c) This is Base class
This is Base class

(d) Compiler Error

```
1  #include<iostream>
2  using namespace std;
3
4  class Base
5  {
6  protected:
7      int a;
8  public:
9      Base() {a = 0;}
10 };
11
12 class Derived1: public Base
13 {
14 public:
15     int c;
16 };
17
18
19 class Derived2: public Base
20 {
21 public:
22     int c;
23 };
24
25 class DerivedDerived: public Derived1, public Derived2
26 {
27 public:
28     void show() {  cout << a; }
29 };
30
31 int main(void)
32 {
33     DerivedDerived d;
34     d.show();
35     return 0;
36 }
```

(a) Compiler Error in line 28: "cout<<a"

(b) 0

(c) Compiler Error in Line "class DerivedDerived: public Derived1, public Derived2

(d) None of the above

11. What is the output of the following program?

```
#include <iostream>

using namespace std;

namespace extra
{
    int i=10;

}

void i()
{
    using namespace extra;

    int i;
    i = 9;

    cout << i;

}
int main()
{
    enum letter { i=8, j};
    class i { letter j; };
    ::i();
    return 0;

}
```

(a) 8

(b) 9

(c) 10

(d) Compiler error

12. Why would you want to use inline functions?

(a) To decrease the size of the resulting program

(b) To increase the speed of the resulting program

(c) To simplify the source code file

(d) To remove unnecessary functions

13. What will happen when defining the enumerated type?

(a) it will not allocate memory

(b) it will allocate memory

(c) it will not allocate memory to its variables

(d) none of the mentioned above

14. What is the output of the following program?

```
#include <iostream>
using namespace std;
int main()
{
    int a[2][4] = {3, 6, 9, 12, 15, 18, 21, 24};
    cout << *(a[1] + 2) << " ";
    cout<<*(*(a + 1) + 1)<<" ";
    cout << 2[1[a]];
    return 0;}
```

(a) 12 18 12

(b) 21 9 12

(c) 21 18 21

(d) Compiler error

SECTION C: Error or Output

Note: There are **six** questions in this section. Each question carries **three** marks.

15. Find the error in the following program?

```
#include<iostream>
using namespace std;

int main()
{
  int i;
  cout<<"Enter the value of i \n";
  cin>>i;
  if(i<7)
  {
    i++;
    continue;
    }
```

```
cout<<"The final value of i is: "<<i;
return 0;
}
```

16. Find the error in the following program?

```
#include<iostream>
#include<cstring>
using namespace std;
int main()
{
  char *p;
  p=new char[20];
  strcpy(p,"Bangalore is the IT city");
  strcpy(p,(p[5]=='t')?cout<<"HI \n":cout<<"HELLO");
  cout<<p<<endl;
  return 0;
  }
```

17. Find the output or error in the following program?

```
#include<iostream>
using namespace std;
int main()
{
    const int i = 20;
    const int* const ptr = &i;
    (*ptr)++;
    int j = 15;
    ptr = &j;
    cout << i;
    return 0;}
```

18. Find the output or error in the following program?

```
#include <iostream>
using namespace std;
int main()
{
    int a = 10, *pa, &ra;
    pa = &a;
    ra = a;
    cout << "a=" << ra;
    return 0;
}
```

19. Find the output or error in the following program?

```
#include <iostream>
using namespace std;
int main()
{
    int i;
    i = 0x18 + 0110 + 11;
    cout<<"p= "<<i<<endl;
    return 0;
}
```

20. Find the output or error in the following program?

```
#include <iostream>
using namespace std;
int main()
{
    int x = 0, k;
    while (+(+x--) != 0)
    {
        x++;
    }
    cout<<x<<endl;
    return 0;
}
```

SECTION D

Note: *There are* **three** *questions in this section. Answer all questions in this section.*

21. Write a program to check whether a number can be expressed as a sum of two Prime numbers., [10]

22. Write a program to reverse a sentence using recursion. Write a function reverse which takes string as an input. [10]

23. Read all parts of this question before start writing the program. Consider a three dimensional vector in any one of the coordinate systems: rectangular cartesian (x, y, z), spherical polar (r, θ, ϕ) and circular cylindrical (ρ, φ, z) coordinates. The range of values are $0 \leq r, \rho \leq \infty$, $0 \leq \theta \leq \pi$, and $0 \leq \phi, \varphi \leq 2\pi$. The cartesian coordinates and spherical coordinates are related by the formula: [20]

$$
\begin{aligned}
x &= r \sin\theta \cos\phi, \\
y &= r \sin\theta \sin\phi, \\
z &= r \cos\theta.
\end{aligned}
$$

The cartesian coordinates and cylindrical coordinates are related by the formula:

$$
\begin{aligned}
x &= \rho \cos\varphi, \\
y &= \rho \sin\varphi, \\
z &= z.
\end{aligned}
$$

(a) Construct a class `myVector` which contains an fixed array (not a STL vector) `V` of size 3 as private/protected.

(b) Overload the operator [ ] to assign values to `V` and get values from `V`.

(c) Write appropriate constructors to assign values to array `V`.

(d) Create two `myVector` objects `V1` and `V2` in main program.

(e) Write operator functions to perform the following vector operations on the two vectors `V1` and `V2` : addition, subtraction, cross product and dot product.

(f) Create a `myVector` object `V3` and copy the vector `V1` to `V3`. Use copy constructor with single argument to perform this action at the time of creation of `V3`;

(g) Write appropriate derived classes to convert (use the function name `convert`) a given vector in one coordinate system to other two coordinate systems.

(h) Implement the classes: The classes should be generic, i.e., user should be able to choose the coordinate system of vectors `V1` and `V2`, and data type (integer or double). Take the components of the vectors `V1` and `V2` as inputs from the user. The program should give the following outputs (in the format given below) in a file named "vector.txt":

i. `V1` =

ii. `V2` =

iii. `V1+V2` =

iv. `V1-V2` =

v. `V1·V2` =

vi. `V1×V2` =

vii. `V3` = in X coordinate systems.

viii. `V3` in other two coordinate systems:

Note: In item no. vii, X is the initial coordinate system of the vector `V3`. Item no. viii: it should clearly specify the other two coordinate systems. The vectors `V1` and `V2` are in same coordinate system.