Total No. of Questions – [4] Total No. of Printed Pages: 04

G.R. No.	22110123

PAPER CODE	U111-201A

DECEMBER 2021 (INSEM+ ENDSEM) EXAM
F.Y. B. TECH. (SEMESTER - I)
COURSE NAME: LINEAR ALGEBRA
COURSE CODE: ES10201A
(PATTERN 2020)

Time: [2Hr] [Max. Marks: 60]

(*) Instructions to candidates:

1) **Figures to the right indicate full marks.**
2) **Use of scientific calculator is allowed**
3) **Use suitable data where ever required**

Q.1 **Solve the following**

i) Rank of the matrix A= $\begin{bmatrix} 4 & 4 & -4 \\ 0 & 4 & 4 \\ 0 & 0 & 4 \end{bmatrix}$ is [2]

A] 1 B] 2 C] 3 D] 0

ii) Non zero *Solution of* [2]
$x + y + z = 0, 2x + 2y + 2z = 0, 3x + 3y + 3z = 0$ *is*

A) $x = t_1 + t_2, y = t_1, z = t_2$
B) $x = t_1 + 2t_2, y = t_1, z = t_2$
C) $x = t_1 - t_2, y = t_1, z = t_2$
D) $x = -t_1 - t_2, y = t_1, z = t_2$

iii In solving the system of equations AX = B if $\rho(A) \neq \rho([A:B])$. [2]
Then given system has

A] Unique solution B] No Solution
C] One free parameter solution D] Two free parameter solutions

iv) Rank of the matrix A= $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ is [2]

A] 0 B] 1 C] 2 D] 3

v) Solution of the homogenous system x+y=0 and x-2y=0 is [2]

A] No solution B] $x = 0, y = 0$ C] x=1 y=1 D] x=2 ,y=0

vi) Which of the following set is subspace of $\mathbb{R}^2$? [2]

A] $W=\{(x,y) / \ y=2x+3\}$

B] $W=\{(x, y) / \ x = 3\}$

C] $W=\{(x,y) / \ y=2x\}$

D] $W=\{(x,y) / \ y = 2\}$

vii) Linear Span of vectors v1= (1 ,1) and V2 = (1, 2) is [2]

A] One dimensional Subspace of $\mathbb{R}^3$

B] Two dimensional Subspace of $\mathbb{R}^3$

C] Three dimensional Subspace of $\mathbb{R}^3$

D] Zero dimensional Subspace of $\mathbb{R}^3$

viii)Let V be vector space of set of all polynomials of degree ≤ 2 [2]

V= $\{a_0 + a_1 t / a_0 , a_1, a_2, a_3 \in \mathbb{R}\}$ then Basis of V are

A] $\{1 \ t\}$ B] $\{t\}$

C] $\{1, t, t^2 \ t^3\}$ D] $\{0, t, t^2\}$

ix) Dimensions of the row space of the matrix $A = \begin{bmatrix} 1 & 3 \\ 1 & 1 \\ 1 & 1 \end{bmatrix}$ are [2]

A] 1 B] 2 C] 3 D] 4

x) Basis of the Column space of the matrix $A = \begin{bmatrix} 1 & 2 & -1 \\ 0 & 0 & 1 \end{bmatrix}$ are [2]

A] $\{ \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 0 \end{bmatrix}, \begin{bmatrix} -1 \\ 1 \end{bmatrix} \}$

B] $\{ \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 0 \end{bmatrix} \}$

C] $\{ \begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} -1 \\ 1 \end{bmatrix} \}$

D] A] $\{ \begin{bmatrix} -1 \\ 1 \end{bmatrix} \}$

xi) Which of the following is Linear Transformation from $\mathbb{R}^3 \longrightarrow \mathbb{R}^2$? [2]

A] $T\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} x+y \\ 3x-7y+3z \end{bmatrix}$ B] $T\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} xy \\ z \end{bmatrix}$

C] $T\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} x+y \\ x+yz \end{bmatrix}$ D] $T\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} x-y+2 \\ 3 \end{bmatrix}$

xii) Consider the Linear Transformation A : $\mathbb{R}^3 \longrightarrow \mathbb{R}^3$ define as AX= Y [2]

Where A= $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$ then dimensions of Im A are

A] 1 B] 2 C] 3 D] 4

xiii) Consider the Linear Transformation $A : \mathbb{R}^3 \longrightarrow \mathbb{R}^3$ define as AX= Y [2]

Where A= $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ then dimensions of Kernel A are

A] 1 B] 2 C] 3 D] 4

xiv) Linear Transformation Y = AX where A= $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 3 & 1 \\ 0 & 0 & 2 \end{bmatrix}$ is [2]

A] Regular B] Orthogonal C] Singular D] Composite

xv) Linear Transformation Y = AX where A= $\begin{bmatrix} 1 & 0 & 0 \\ 2 & 2 & 0 \\ 1 & 1 & 3 \end{bmatrix}$ is [2]

A] Regular B] Orthogonal C] Singular D] Composite

Q2 **Solve any two out of three**

a) Apply the Gram-Schmidt orthogonalization process to find orthogonal basis, of the vectors S= $\left\{ \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix}, \begin{bmatrix} -2 \\ 1 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \\ -2 \end{bmatrix} \right\}$ [5]

b) . Let V be a vector space of polynomials with inner product [5]

$\langle f(t) , g(t) \rangle = \int_{-1}^{1} f(t)g(t)dt$ Apply the Gram-Schmidt orthogonalization process to $S = \{ 1, \ t, \ t^2 \}$ to find orthogonal basis.

c) Let P(t) be vector space of polynomials with inner product [5]

$\langle f(t) , g(t) \rangle = \int_{0}^{1} f(t)g(t)dt$ then for $f(t) = t^2$ & $g(t) = t - 3$

find i) ||f|| ii) ||g||

Q.3 **Solve any two out of three**

a) Find all Eigen values and Eigen vectors of the matrix A= $\begin{bmatrix} 5 & 6 \\ 3 & -2 \end{bmatrix}$ [5]

b) Check whether or not A is diagonalizable and if yes then diagonalize it , where A= $\begin{bmatrix} 5 & -1 \\ 1 & 3 \end{bmatrix}$ [5]

c) Verify Caley-Hamilton Theorem for the matrix [5]

A= $\begin{bmatrix} -1 & 8 & 7 \\ 0 & -8 & 0 \\ 0 & 0 & -3 \end{bmatrix}$ & use it to find A^{-1}

Q.4 **Solve any two out of three**

a) Find the symmetric matrix that corresponds to the following quadratic form and hence determine the nature of the quadratic form [5]

$q(x\ y\ z) = 2x^2 + 4xy + 2y^2 + z^2$

b) Find Signature of the quadratic form [5]

$Q(x,y,z) = 3x^2 + 4xy - 2xz + 3y^2 - 2yz + 4z^2$

c) Using orthogonal digitalization find Canonical form corresponding to quadratic form $Q(x,y,z) = 3x^2 + 3y^2 + 6xy$ [5]

@@@END @@@

Total No. of Questions – [3] Total No. of Printed Pages: 04

G.R. No.	2210123

PAPER CODE	U111 – 202A

DECEMBER 2021 (INSEM+ ENDSEM) EXAM

F.Y. B. TECH. (SEMESTER - I)

COURSE NAME: FUNDAMENTALS OF PROGRAMMING

COURSE CODE: CS10202A

(PATTERN 2020)

Time: [2Hr] [Max. Marks: 60]

(*) Instructions to candidates:

1) **Figures to the right indicate full marks.**
2) **Use of scientific calculator is allowed**
3) **Use suitable data where ever required**
4) **Write correct syntax while writing program**

Q.1 **Select the correct option for following questions.** **[30]**

i) **Which of the following is NOT a character constant** [2]

(A) 'Thank You'
(B) 'Enter values of P, N, R'
(C) '23.56E-03'
(D) All the above

ii) **Which of the following statement is wrong?** [2]

(A) mes = 123.56 ;
(B) con = 'T' * 'A' ;
(C) this = 'T' * 20 ;
(D) 3 + a = b ;

iii) **If a is an integer variable, a = 5 / 2 ; will return a value** [2]

(A) 2.5
(B) 3
(C) 2
(D) 0

iv) **What will be the value of d if d is of float data type for the operation d = 2 / 7.0** [2]

(A) 0
(B) 0.2857
(C) Cannot be determined
(D) 2

v) **Which one of the following statement is best suitable?** [2]

(A) Machine Level Language is Hardware independent Language
(B) Machine Level and Assembly Languages are Hardware Independent Language
(C) Assembly Languages are platform independent
(D) Machine Level and Assembly Languages are Hardware Dependent Language

vi) **What will be the output of following C code?** [2]

```
main( )
{
int p = 8, q = 20 ;
if ( p == 5 && q > 5 )
printf ( "\nWhy not C" ) ;
```

```
else
printf ( "\nDefinitely C !" ) ;
}
```

(A) Why not C
(B) Definitely C
(C) Compile time error
(D) Runs fine

[2]

vii) **What will be the output of following code**

```
#include <iostream>
using namespace std;
int main()
{
int n1 = 10;
float n2 = 10;
cout << sizeof(n1 + n2);
return 0;
}
```

(A) 20
(B) 4
(C) 40
(D) 8

[2]

viii) **What will be the output of following C++ code?**

```
#include <iostream>
using namespace std;
int main()
{
 main( )
 {
 int i = -4, j, num ;
 j = ( num < 0 ? 0 : num * num ) ;
 cout<<j ;
 }
```

(A) 0
(B) Error
(C) -4
(D) None

[2]

ix) **What is the output of the following code snippet in C++?**

```
#include <iostream>
using namespace std;
int main()
{
int i = 0 ;
 while(++i <= 10)
cout<<i ;
}
```

(A) 1...10
(B) 1...9
(C) 2...10
(D) 0...10

[2]

x) **What will be the output of following C++ code?**

```
#include <iostream>
 using namespace std;
 int main()
 {
 int x = 1 ;
 while ( x == 1 )
```

```
{
x = x - 1 ;
cout<<x ;
}
```

(A) 0
(B) 1
(C) Error
(D) No output

xi) **What will be the output of following C++ code?** [2]

```
#include <iostream>
using namespace std;
int main()
{
int x = 4, y = 0, z ;
while ( x >= 0 )
{
if ( x == y )
break ;
else
cout<<x<<y<<"\n" ;
x-- ;
y++ ;
}
```

(A) 4 0
3 1
(B) 3 1
4 0
(C) All 0
(D) compilation error

xii) **Which of the following is a predefined function** [2]

(A) date()
(B) timestamp()
(C) log()
(D) roundoff()

xiii) **Which operators we use get value out of address in pointers?** [2]

(A) De-referencing operator
(B) Value at the address operator
(C) Modulus operator
(D) address of another variable

xiv) **What is the output of following code** [2]

```
#include <iostream>
using namespace std,
int main()
{
  int l = 0;
  cout<<l++<<"\t"<<++l;
  return 0;
}
```

(A) 0 0
(B) 0 1
(C) 1 1
(D) 0 2

xv) **which data type is used to store value having 12 digits** [2]

(A) Long
(B) Int
(C) Long int
(D) Double

Q.2 **Solve any three out of four** **[15]**

a) Compare C language and C++ language? [5]

b) Define classes and object. With real world examples. [5]

c) Write a C++ program to calculate area of circle, triangle and rectangle using classes and object. [5]

d) Compare Constructor and functions. [5]

Q.3 **Solve any three out of four** **[15]**

a) Compare run time polymorphism and compile time polymorphism. Explain function overloading with suitable example. [5]

b) List out advantages of friend function with an example. [5]

c) Define inheritance. Enlist the types of inheritance. Describe function overriding with suitable example. [5]

d) Write a C++ program to overload increment operator (++) with correct syntax and expected output. [5]

Total No. of Questions – [4]

Total No. of Printed Pages: 4

G.R. No.	22110123

PAPER CODE	U111-203A

DECEMBER 2021 (INSEM+ ENDSEM) EXAM

F.Y. B. TECH. (SEMESTER - I)

COURSE NAME: BASIC ELECTRICAL ENGINEERING

COURSE CODE: ET10203A

(PATTERN 2020)

Time: [2Hr]

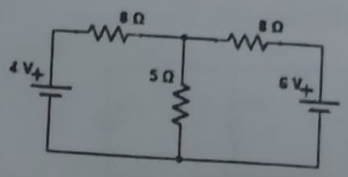
[Max. Marks: 60]

(*) Instructions to candidates:

1) **Figures to the right indicate full marks.**
2) **Use of scientific calculator is allowed**
3) **Use suitable data where ever required**

Q.1 **Solve the following**

i) For a given network as shown below, considering 5 Ω as a load resistance, the value of R_{eq} using Thevenin's theorem is [2]



a) 2 Ω
b) 4.5 Ω
c) 1.5 Ω
d) 4 Ω

ii) If two resistances R1 and R2 are connected in parallel across a voltage source VT and total current of circuit is IT, then current I2 in resistance R2 using current division rule is given by following formula [2]

a) $I_2=V_T \times [R_2/(R_1+R_2)]$
b) $I_2= I_T \times [R_2/(R_1+R_2)]$
c) $I_2= I_T \times [R_1/(R_1+R_2)]$
d) $I_2= V_T \times [R_1/(R_1+R_2)]$

iii) The load current IL in a load resistance RL using Norton's theorem is given by following formula [2]

a) $I_L= V_N \times R_N / (R_N+ R_L)$
b) $I_L= V_N / (R_N+ R_L)$
c) $I_L= I_N \times R_N / (R_N+ R_L)$
d) $I_L= I_N \times R_L / (R_N+ R_L)$

iv) In regard to Kirchhoff's Voltage Law (KVL) and concept of loop and circuit, following statement is true: [2]

a) A loop may contain different circuits and KVL can be applied only to a loop

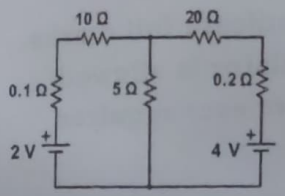
b) A circuit may contain different loops and KVL can be applied

only to a circuit
c) A circuit may contain different loops and KVL can be applied only to a loop
d) A loop may contain different circuits and KVL can be applied only to a circuit

v) If Thevenin resistance Req is 1 Ω and Thevenin voltage VTh is 24 V then load current IL flowing through load resistance RL of 5 Ω is [2]

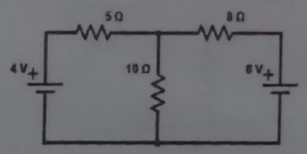
a) 2 A
b) 6 A
c) 1 A
d) 4 A

vi) For given electric circuit below, consider 5 Ω as load resistance. Applying Norton's Theorem to given electric circuit, Norton's Current i.e., Norton's short circuit current (IN or ISC) and Norton's equivalent resistance RN are respectively [2]



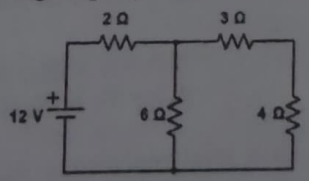
a) 0.396 A, 4.233 Ω
b) 0.396 A, 6.733 Ω
c) 0.126 A, 8.788 Ω
d) 0.246 A, 8.788 Ω

vii) For given electric circuit below, current flowing through resistance of 5 Ω using Kirchhoff's laws is [2]



a) 0.0706 A
b) 0.0231 A
c) 0.0511 A
d) 0.0921 A

viii) For the given circuit below, current flowing through resistance of 4 Ω using Superposition theorem is [2]



a) 2 A
b) 2.25 A
c) 1 A
d) Superposition theorem not applicable to this circuit

ix) If R = 10 Ω and XL= 25 Ω then the impedance in rectangular form can be expressed as [2]

a) (10 - j25) Ω
b) (10 + j25) Ω
c) (10 - j5) Ω
d) (10 + j15) Ω

a) (10 - j25) Ω
b) (10 + j25) Ω
c) (10 - j5) Ω
d) (10 + j15) Ω [2]

x) A coil has a resistance of 10 Ω and inductance of 0.06 H. The supply voltage is 150 Volts, 50 Hz. The active power consumed by the coil will be
a) 694.24 W
b) 694.24 VAR
c) 494.24 W
d) 494.24 VA [2]

xi) A series circuit consisting of a resistance of 100 Ω and a capacitance of 50 μF is connected across a 230 V, 50 Hz ac supply. The circuit impedance will be
a) 128.54 Ω
b) 118.54 Ω
c) 125.66 Ω
d) 130 Ω [2]

xii) A coil has a resistance of 10 Ω and reactance as 25 Ω connected across 230 V ac supply. The power factor of circuit is
a) 0.928 lag
b) 0.561 lead
c) 0.371 lag
d) 0.371 lead [2]

xiii) A circuit draws a current of 10 Amps at a 0.8 lagging pf. when connected across a voltage source of 200 V. The reactive power will be
a) 1600 VAR
b) 1400 VAR
c) 1200 VAR
d) 1000 VAR [2]

xiv) *If* V1= 4+j3 and V2= 5+j6, the product V1 × V2 in volts as expressed in polar form will be
a) 0.64 < -13.32
b) 39.05 < 87.06
c) 7.81 < 50.19
d) 7.81 <- 50.19 [2]

xv) Comment on following statements:
1. For a given combination of 'L' and 'C', there is only one resonance frequency 'fr'.
2. There is only one combination of 'L' and 'C' possible for any specified resonance frequency 'fr'.
a) Statement 1 and 2 both are true.
b) Statement 1 and 2 both are false.
c) Statement 1 is true but statement 2 is false.
d) Statement 2 is true but statement 1 is false.

Q2 **Solve any three out of four**

a) A 40 kVA, 2200V/220V, 50 Hz, 1-phase transformer has an iron loss of 250 W. The resistances of low and high voltage windings are 0.005 Ω and 0.5 Ω respectively. Calculate efficiency at full load and load power factor of 0.8 lagging. [5]

b) A single phase 5 kVA transformer has 400 turns on its primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm^2. When the primary winding is [5]

connected to 500 V, calculate (i) maximum value of flux density in the core with 50 Hz supply (ii) voltage induced in the secondary winding and (iii) secondary full load current.

c) A single phase 100 kVA, 1000 V/250 V, 50 Hz transformer has an iron loss of 1 kW. The copper loss when primary carries current of 50 A is 500 W. Determine: - i) area of cross section of the limb if the flux density in the core is 0.9 Tesla and 1000 turns on primary side ii) primary and secondary side full load current iii) the efficiency at full load and 0.8 power factor lagging. [5]

d) A transformer is rated at 90 KVA, at full load its copper losses are 1100W and its iron losses are 950 W. Calculate: [5]
i. Efficiency at full load, unity power factor
ii. Efficiency at 60% of full load, 0.8 power factor

Q.3 **Solve any three out of four**

a) An electric pump lifts 64m^3 of water per hour to a height of 20 m. If its overall efficiency is 80 %, find the input power of motor. If the pump is used for 2 hours a day, find the daily cost of energy at the rate of Rs. 3/- per unit. [5]

b) A 1500V dc locomotive draws a load of 1200-tonne of mass at 40 km per hour. The tractive resistance of the load is 50 N/ tonne and system efficiency is 80 %, calculate the current drawn by the locomotive when the train travels along a level track. [5]

c) In a residential flat, following is the usage of various electrical appliances during a day. [5]
i. 4 fluorescent tubes each of 20 W for 5 hours
ii. 1.5 kW electric geyser for 1 hour
iii. 5 ceiling fans each of 53 W for 6 hours
iv. 800 W electric iron for 45 minutes
v. Other miscellaneous load of 600 W for 3 hours
Estimate the monthly electricity bill for this residential flat for a month of 28 days at the rate of Rs. 3/- per unit.

d) A delta- connected load draws a line current of 15 amperes at a lagging power factor of 0.85 from a 400 V, 50 Hz, 3-phase supply. Find the resistance and inductance of each phase. [5]

Total No. of Questions – [3] Total No. of Printed Pages: [4]

G.R. No.	22110123

PAPER CODE	U111-204A

DECEMBER 2021 (INSEM+ ENDSEM) EXAM

F.Y. B. TECH. (SEMESTER - I)

COURSE NAME: ENGINEERING PHYSICS

COURSE CODE: ES10204A

(PATTERN 2020)

Time: [2Hr] [Max. Marks: 60]

(*) Instructions to candidates:

1) **Figures to the right indicate full marks.**
2) **Use of scientific calculator is allowed**
3) **Use suitable data where ever required**

Q.1 **Solve the following**

i)For a damped spring mass system with m=12kg, k=100N/m, $u(0) = -1.8$cm, $\dot{u}(0) = -2cm/s$, $\zeta = 0.07$, the exponential envelop at 5 s in terms of the amplitude is [2]

$(a)0.36\,u_0$. (b) $\frac{1}{0.36u_0}$ (c) $\frac{1}{0.36}u_0$ (d) $\frac{0.36}{u_0}$

ii) A spring mass system with m=1kg, k=64N/m and ζ=0.19 is driven by an external harmonic force $F = (3.2N)sin\omega t$. Calculate the static amplitude and the angular frequency ω at which there will be resonance. [2]

a)0.05m, 8rad/s (b) 0.5m, 8rad/s (c) 0.005m, 8rad/s (d) 0.05m, 0.8rad/s

iii) A mass m = 1000g is suspended from a spring having a spring constant k= 410 N/m and damping ratio ζ=0.39. Find the value of deformation response factor R_d for frequency of forced oscillation of 3.22 Hz. [2]

(a) 1.82 (b) 1.28 (c) 1.52 (d) 1.25

iv) For a spring mass system, with mass of 7.5kg, oscillating with a damping ratio of 0.012 and a damped frequency of 5Hz, what is the critical damping coefficient? [2]

(a) 741 (b) 417 (c) 147 (d) 471

v) For a damped spring mass system with m=1kg, k=16N/m, ζ=0.8, calculate the natural frequency and the ratio of damped to undamped frequency. [2]

(a) 6 rad/s, 0.4 (b) 4 rad/s 0.6 (c) 6 rad/s, 4 (d) 4 rad/s, 6

vi) At what frequency ω of the external force does R_d exhibit a maximum for a spring and mass system with m = 5kg, spring constant k = 125N/m and damping ratio ζ= 0.5? [2]

(a)3.54rad/s (b) 3.44 rad/s (c) 3.43 rad/s (d) 3.34 rad/s

vii) In free damped vibrations, what is the effect of small ζ on $\frac{\omega_D}{\omega_n}$? [2]
(a) tends to 1 (b) tends to 0 (c) becomes infinitely large (d) takes a complex value

viii) In Forced Harmonic Oscillations with Viscous Damping, when the frequency of the harmonic driving force is much less than the natural frequency of the system ($\omega \ll \omega_n$), the deformation response factor is governed by [2]
(a)The mass of the system (b) The applied force (c) The stiffness of the system (d) None of these factors

ix) In a semiconductor at room temperature [2]
(a) the valence band is completely filled & the conduction band is completely empty
(b) the valence band is partially empty & conduction band is partially filled
(c) the valence band is completely filled & conduction band is partially filled
(d) the valence band is completely empty and the conduction band is completely filled

x) In an unbiased p-n junction diode at equilibrium [2]
(a) Intrinsic Fermi energy E_{Fi} is higher on the p-side than that on the n-side
(b) Intrinsic Fermi energy E_{Fi} is lower on the p-side than that on the n-side
(c) Intrinsic Fermi energy E_{Fi} is equal on the p-side and the n-side
(d) none of the options

xi) The barrier potential V_{bi} in an unbiased p-n junction diode is due to [2]
(a) difference in the E_{Fn} and E_{Fp} of the n- and p- regions, respectively.
(b) difference in the E_{Fi} of the n- and p- regions
(c) difference in E_c of the n-region and E_v of the p- regions
(d) difference in E_v of the n-region and E_c of the p- regions

xii) The position of Fermi energy in a p-type semiconductor, with a low doping concentration, depends upon [2]
(a) acceptor impurity concentration
(b) intrinsic carrier density
(c) temperature
(d) all of the options

xiii) In a reverse biased p-n junction diode, [2]
(a) electrons travel from n-side to p-side and holes from p-side to n-side
(b) holes travel from n-side to p-side and electrons from p-side to n-side
(c) only electrons travel from n-side to p-side

(d) only holes from p-side to n-side

xiv) If the temperature of an intrinsic semiconductor is doubled, then the ratio of charge carrier densities at the two temperatures $\frac{n_i(2T)}{n_i(T)}$ is [2]

(a) 2 (b) $\frac{1}{2}$ (c) $e^{\frac{1}{2}}$ (d) $e^{\frac{E_g}{4kT}}$

xv) In a p-type silicon sample, the hole concentration is 2.25×10^{15} cm^{-3}. If the intrinsic carrier concentration is 1.5×10^{10} cm^{-3}, the electron concentration is [2]

(a) Zero (b) 10^{10} cm^{-3} (c) 10^{5} cm^{-3} (d) 1.5×10^{10} cm^{-3}

Q2 **Solve any three out of four**

a) Define acceptance angle of an optical fiber. Derive the expression for the same. Comment on what happens when light is incident at an angle greater than the acceptance angle. What does an optical fiber having larger NA imply qualitatively? [5]

b) A glass clad fiber is made with core glass of refractive index 1.55. The cladding is doped to give a fractional refractive index of 0.001. Find (a) the cladding index (b) the numerical aperture (NA) (c) the external acceptance angle and (d) the internal critical angle. What happens if light strikes the core cladding interface at an angle less than the critical angle? [5]

c) A multi-mode step index optical fibre with core refractive index of 1.4028 has a relative refractive index difference of 0.15% and is thirty kilometers long. Calculate RMS intermodal pulse broadening $(\Delta t)_s$. What is the total maximum bit rate if the RMS material pulse broadening is given as $(\Delta t)_m$=82 nanoseconds. [5]

d) Discuss in brief the various reasons for light to be attenuated in an optical fiber. Which of the processes is most dominant? How would this help in selecting a suitable wavelength for the source of light? [5]

Q.3 **Solve any three out of four**

a) In a state of thermal equilibrium, how are the population densities of two states E_1 and E_2 (E_2>E_1) related to each other? Find the ratio of population of the two states in a He-Ne laser that produces light of wavelength 6328Å at room temperature. Comment, with justification, whether lasing action can occur in such a system. [5]

b) Give the construction of an optical cavity with a neatly labelled diagram. Explain how it can be used to make the emergent laser beam monochromatic. [5]

c) A He-Ne laser has a full width of the gain curve of $\Delta\nu$ =2.6 GHz at 6328Å. If the length of the optical cavity of the laser is 0.25 m, what is the [5]

1) mode number m

2) peak frequency
3) width of the gain curve in terms of wavelength ($\Delta\lambda$)
4) mode separation frequency ν_{ms}
5) how many modes are allowed in the width of the gain curve

d) Explain with neatly labelled diagrams of the diode with band gap and refractive index variations, the construction and working of a single heterojunction laser (SHL). How is light confined to the active medium? [5]