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ANSWER KEY & SCHEME OF EVALUATION

B. Tech. (S1 2022 Admitted Regular)

ACADEMIC REGULATION 2020

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Semester End Regular/Supplementary Examination, February - 2023

Degree	B. Tech. (U. G.)	Program	Common to All			Academic Year	2022 - 2023
Course Code	20HSX01	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Communicative English						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	What progress has India made in the fifty years of Independence with reference to 'Presidential Address" by Dr. A.P.J. Abdul Kalam?	20HSX01.1	L1
2	Write the meanings of the following words and use them in sentences. 1. Unruffled 2. Serene	20HSX01.2	L3
3	Differentiate Transitive and Intransitive verb with relevant examples each.	20HSX01.3	L2
4	Write any two phrasal verbs with appropriate examples.	20HSX01.4	L1
5	Give two examples of simple present tense with necessary rules.	20HSX01.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 10)	Learning Outcome (s)	DoK
6 (a)	Analyze Kalam's "song of youth" as a mission statement.	20HSX01.1	L2
6 (b)	Fill in the blanks with appropriate form adding relevant prefix or suffix. a. He was acting in a very_____ way. (child) b. He wants to be a_____ when he grows up. (mathematics) c. The road was too narrow, so they had to_____ it. (wide) d. She looked _____. She started to cry. (happy) e. I think that you should_____ your decision. It may f. not be the best thing to do. (consider) g. You need a_____ of motivation, organization and hard h. work to realize your dreams. (combine)	20HSX01.1	L3
	OR		
7 (a)	What is ironic about the way story ends?	20HSX01.1	L2
7 (b)	Pick out the adjectives and adverbs in the following sentences if they exist. Mention "No" if you don't find them in the given sentences. a. He spoke in a loud voice b. Do not talk so loudly c. It was a dangerous lake to swim in d. It was a magnificently beautiful performance e. He was a very sensible person f. She worked carefully with the sick child	20HSX01.1	L3
8 (a)	According to Pt. Nehru, how does a great leader help?	20HSX01.2	L1
8 (b)	Discuss the rules of *usage* and *omission* of article "The" with relevant examples. Write at least six rules for each element.	20HSX01.2	L2
	OR		
9 (a)	Write short notes on following : a) Paraphrasing b) Summarizing c) Any three rules on article "an"	20HSX01.2	L2
9 (b)	What does the image of the sky suggest in the poem "Bosom	20HSX01.2	L1

	Friend"?		
10 (a)	What does Nadella predict for the future of technology?	20HSX01.3	L1
10 (b)	Explain the following terms with necessary examples. a) Homophones b) Homonyms c) Homographs	20HSX01.3	L2
	OR		
11 (a)	As a member of your residential society, write an email to the inspector of local Police station, Mr. Sharma, informing him about miscreants who ride their bikes rashly every evening outside your society. Sign the email as William. Use the given phrases while composing mail. **Phrases:** Residential area – ride – rashly – children – play – elderly – walk – grocery shop – across the road – dangerous – accidents – nuisance – action – immediately.	20HSX01.3	L3
11 (b)	Write an essay on pollution.	20HSX01.3	L2
12 (a)	Read the following passage, identify the incorrect words and edit them. The Egyptian civilization were the first for make paper from Papyrus. The Papyrus material were a thick paper witch was used to write on during ancient times. Previously, this plants grew abundantly over the Nile Delta. The papyrus was also used to make hats, reed mats, etc.	20HSX01.4	L3
12 (b)	Use the following phrasal verbs into sentences. a) Sign off b) let down c) screw up d) Look forward e) Drop in f) Pop out	20HSX01.4	L3
	OR		
13 (a)	Correct the following sentences if necessary. a. I am attending spoken English classes for two months b. One of my friend has placed in Infosys c. My father is going for a walk every day d. The English is the language of the English e. The police is looking for the culprit f. Ravi is more taller than Rakesh	20HSX01.4	L3
13 (b)	Design a poster on Skill India.	20HSX01.4	L3
14 (a)	Write an essay on "Still I Rise"	20HSX01.5	L2
14 (b)	Discuss the structures and usages of present and past tense with relevant sentence examples for each usage.	20HSX01.5	L2
	OR		
15 (a)	Make your resume suitable for Microsoft .	20HSX01.5	L2
15 (b)	Choose the right form of the verbs for the given sentences. a. My son, along with two friends, (is, are) coming for the weekend b. Not only students, but also the teacher (has, have) been unhappy c. Either the photographer or her companions (was/were) the first to see the gorilla d. The news, about Afghanistan (is, are) shocking, isn't it e. The Whale Shark, the largest of all sharks, (grows /grows) up to 38 feet long f. The players, as well as the captain, (want, wants) to win	20HSX01.5	L3

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SONTYAM , ANANDAPURAM, VISAKHAPATNAM – 531 173

ANSWER KEY AND SCHEME OF EVALUATION

Semester End Regular/Supplementary Examination, February -2023

Degree	B. Tech. (U. G.)	**Program**	Common to All			**Academic Year**	2022 - 2023	
Course Code	20HSX01	**Test Duration**	3 Hrs.	Max. Marks	70	**Semester**	I	
Course	**Communicative English**							

No.	Questions (1 through 5)	MARKS
1	What progress has India made in the fifty years of Independence with reference to 'Presidential Address" by Dr. A.P.J. Abdul Kalam? Dr. Avul Pakir Jainulabdeen Kalam after being sworn in as the 11th President of India. In his first presidential speech, Kalam explains about his vision for developed India, elaborating on the nation's strengths and areas which need improvement. According to Dr. Kalam, India has made a considerable development in several fields after its independence, they are: • Food Production • Health Sector • Higher Education • Media and Mass Communication • Industrial Infrastructure • Information technology • Science and Technology • Defense	Content 5m Grammar & Spellings 2 m; presentation 1m
2	Write the meanings of the following words and use them in sentences. 1. Unruffled = not agitated or disturbed (1) He took another sip of his coffee , unruffled (2) However, I met him on Thursday, and he seems totally unruffled and mischievous as ever. 2. Serene = Calm, peaceful and untroubled	Content 1.5M Grammar/Spelling check 0.5

	(1) My dear Indira, you will grow up a child of light , unafraid and serene. (2) She was serene in the Park Hotel	
3	Differentiate Transitive and Intransitive verb with relevant examples each. **TRANSITIVE VERB** 1. A transitive verb always takes an object. 2. Eg.: Duncan kicked the ball. 3. I like trees **INTRANSITIVE VERB** 1. Intransitive verb means which do not have object. 2. Eg: The old man laughed loudly. 3. I was sleeping	Content 1.5M Grammar/Spelling check 0.5
4	Write any two phrasal verbs with appropriate examples. 1. Top off = Fill something to the top; to complete something in a special or spectacular way. Eg: May I top off your baverage 2. Take after = resemble, especially with parents and their children. Eg: Indira Gandhi takes after his father when it comes to politics.	Content 1.5M Grammar/Spelling check 0.5
5	Give two examples of simple present tense with necessary rules. **Simple Present Tense**:It is used to represent the present action. **(S+V1+O)** Eg: 1. I drink coffee every morning 3. Cathy works as a teacher.	Content 1.5M Grammar/Spelling check 0.5
No.	Questions (6 through 10)	
6 (a)	Analyze Kalam's "song of youth" as a mission statement. Kalam envisions the song of India which the youth can sing after India is transformed into a developed nation. He shares the song of youth which he normally recited when ever he visited any school. The song mentions that it is a crime to have small dreams. It pledges that one is ready to work and sweat for the vision of the development of the nation, the vision which will ignite the billion Indian souls. The song pledges to "keep the lamp of knowledge burning, to achieve the vision of - Developed India".	Content 5m Grammar & Spellings 2 m; presentation 1m
6 (b)	Fill in the blanks with appropriate form adding relevant prefix or suffix. a. He was acting in a very childish way. (child) b. He wants to be a mathematician when he grows up. (mathematics) c. The road was too narrow, so they had to widen it. (wide) d. She looked unhappy. She started to cry. (happy) e. I think that you should reconsider your decision. It may not be the best thing to do. (consider) f. You need a combination of motivation, organization and hard work to realize your dreams. (combine)	Content 1.5M Grammar/Spelling check 0.5
7 (a)	What is ironic about the way story ends? The last instance of irony is portrayed in the ending section of the story. Dukhi was given the name by his parents to avert misfortune of life. But it results in the opposite as Dukhi lived in extreme hardship and died pathetically. Even he could not have funeral rituals.	Content 1.5M Grammar/Spelling check 0.5

	Thus the author Premchand had used lots of irony in the story through which he reveals the hypocrisy of the Brahmins.	
7 (b)	Pick out the adjectives and adverbs in the following sentences if they exist. Mention "No" if you don't find them in the given sentences. a. He spoke in a loud voice Loud - Adjective b. Do not talk so loudly Loudly - Adverb c. It was a dangerous lake to swim in Dangerous - Adjective d. It was a magnificently beautiful performance Beautiful – Adjective, Magnificently - Adverb e. He was a very sensible person Sensible – Adjective, very - adverb f. She worked carefully with the sick child Carefully – Adverb, Sick - Adjective	Content 1.5M Grammar/Spelling check 0.5
8 (a)	According to Pt. Nehru, how does a great leader help? Nehru said that in our great freedom movement, under Bapuji's leadership, there was no room for secrecy. People were not afraid of what they did or what they said. They worked in the sun and the light. Nehru inspired Indira to do same then she would grow up a child of the light, unafraid and serene and unruffled whatever might happen. He wished her with all his love to grow up into a brave soldier in India's service	Content 5m Grammar & Spellings 2 m; presentation 1m
8 (b)	Discuss the rules of ***usage*** and ***omission*** of article "The" with relevant examples. Write at least six rules for each element. **Omission of Articles:** 1. Articles are not used in front of proper nouns Eg: Delhi is the capital city of India. 2. Articles are not used before languages. Eg: I learned Japanese within a year. 3. Before material noun Eg: I have gold chain 4. We don't use article before the names of meals like lunch, dinner, etc. Eg: Have you taken dinner? 5. No article is used with professions Eg: Engineering is a useful carrier. 6. No article is with years. Eg: 1947 was a wonderful year.	Content 1.5M Grammar/Spelling check 0.5
9 (a)	Write short notes on following : a) Paraphrasing: Para phrasing means to rewrite of phrase or sentence with the same meaning with the same meaning but using different words. b) Summarizing: Summarizing is an important functional skill and is extremely useful in various fields. c) Any three rules on article "an" (i) use an before vowel sounds (ii) An is used before an *h* mute (iii) An is used before *M* sound	Content 1.5M Grammar/Spelling check 0.5
9 (b)	What does the image of the sky suggest in the poem "Bosom Friend"? The speaker of the poem is a poor Dalit girl who invites her high caste, rich friend for dinner. The girl accepts the offer and has come to dinner. It gives a pleasant surprise to the speaker and this is why she says that her friend is broad minded and full of love for her. But the irony is that the rich	Content 5m Grammar & Spellings 2 m; presentation 1m

	girl friend finds fault with every bit of the dinner. She blames her friend for not serving buttermilk or yoghurt for the last course of rice. She also blamed the Dalit community and said that they would never improve	
10 (a)	What does Nadella predict for the future of technology? This is a critical time for the industry and for Microsoft. Nadella wants Microsoft to gear up for the increasing competition and prove itself as a strong rival to its competitors like it was a decade back. Nadella emphasises on the need to priorotise innovation that helps to empower users and organisations to 'do more'. This starts with clarity of purpose and sense of mission that lead to imagine the impossible and deliver it. All the employees need to do their best work, lead and help drive cultural change. Each of the employees should find meaning in his work. The Microsoft team proved it in the past and must continue to do the same. He says that talent, resources and perseverance are the foundation on which a company attains great heights, and concludes by saying that Microsoft has all of this in plenty. Nadella emphasises that with every new device or new service launch in the future, Microsoft should bring about more and more innovation. He envisions a bright future for Microsoft.	Content 5m Grammar & Spellings 2 m; presentation 1m
10 (b)	Explain the following terms with necessary examples. a) Homophones: Same pronunciation, different spelling and different meaning. Eg: Red, Read b) Homonyms: Same pronunciation, same spelling and different meaning. Eg: Bark , bat c) Homographs: Different pronunciation, same spelling and different meaning. d) Eg: Dove, dove	Content 5m Grammar & Spellings 2 m; presentation 1m
11 (a)	As a member of your residential society, write an email to the inspector of local Police station, Mr. Sharma, informing him about miscreants who ride their bikes rashly every evening outside your society. Sign the email as William. Use the given phrases while composing mail. **Phrases:** Residential area – ride – rashly – children – play – elderly – walk – grocery shop – across the road – dangerous – accidents – nuisance – action – immediately.	Content 5m Grammar & Spellings 2 m; presentation 1m
11 (b)	Write an essay on pollution.	Content 5m Grammar & Spellings 2 m; presentation 1m
12 (a)	Read the following passage, identify the incorrect words and edit them. The Egyptian civilization were the first for make paper from Papyrus. The Papyrus materials were a thick paper which was used to write on during ancient times. Previously, these plants grew abundantly over the Nile Delta. The papyrus was also used to make hats, reed mats, etc.	Content 5m Grammar & Spellings 2 m; presentation 1m
12 (b)	Use the following phrasal verbs into sentences. a) Sign off : To give final message at the end of letter. Eg: They always signed off its good night for me. b) let down : Failed to support or lower something slowly Eg: I don't want to let myself down in the exam c) screw up: Cause something to fail or go wrong Eg: Why are you trying to screw up your life. d) Look forward = To be placed or excited that it is going to be happen. Eg: I'm looking forward for the holiday e) Drop in = To pay an unexpected or casual visit	Content 5m Grammar & Spellings 2 m; presentation 1m

	Eg: Drop in whenever you are in the neighbourhood f) Pop out = come out suddenly or forcefully Eg: He poped out for a quick coffee break	
13 (a)	Correct the following sentences if necessary. a. I am attending spoken English classes for two months Ans: I <u>have been</u> attending spoken English classes for two months. b. One of my friend has placed in Infosys Ans: One of my <u>friends</u> has been placed in Infosys c. My father is going for a walk every day Ans: My father <u>goes</u> for a walk every day d. The English is the language of the English Ans: __x__ English is the language of the English e. The police is looking for the culprit Ans: The police <u>are</u> looking for the culprit f. Ravi is more taller than Rakesh Ans: Ravi is taller than Rakesh.	Content 1.5M Grammar/Spelling check 0.5
13 (b)	Design a poster on Skill India.	Content 5m Grammar & Spellings 2 m; presentation 1m
14 (a)	Write an essay on **"Still I Rise"** The poem takes the reader through a series of statements the speaker makes about herself. She praises her strength, her body, and her ability to rise up and away from her personal and historical past. There is nothing, the speaker declares, that can hold her back. She is going to "rise" above and beyond anything that seeks to control her.	Content 5m Grammar & Spellings 2 m; presentation 1m
14 (b)	Discuss the structures and usages of present and past tense with relevant sentence examples for each usage.	Content 5m Grammar & Spellings 2 m; presentation 1m
	OR	
15 (a)	Make your resume suitable for Microsoft. As per the resume format, they can write for Microsoft	Content 5m Grammar & Spellings 2 m; presentation 1m
15 (b)	Choose the right form of the verbs for the given sentences. a. My son, along with two friends, <u>is</u> (is, are) coming for the weekend b. Not only students, but also the teacher <u>has</u> (has, have) been unhappy c. Either the photographer or her companions <u>were</u> (was/were) the first to see the gorilla d. The news, about Afghanistan <u>is</u> (is, are) shocking, isn't it e. The Whale Shark, the largest of all sharks, <u>grows</u> (grows /grows) up to 38 feet long f. The players, as well as the captain, <u>want</u> (want, wants) to win	Content 1.5M Grammar/Spelling check 0.5

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Semester End Regular/Supplementary Examination, February - 2023

Degree	B. Tech.	Program	Common to All			Academic Year	2022 - 2023
Course Code	20BSX11	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Linear Algebra and Differential Equations						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Find the rank of $\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix}$	20BSX11.1	L1
2	Write the nature of Q.F. $2x_1x_2 + 2x_1x_3 + 2\,x_2x_3$	20BSX11.2	L1
3	Find the integrating factor of the equation $\frac{dy}{dx} + 2x - 2y = 0$	20BSX11.3	L1
4	Solve $4\frac{d^3y}{dx^3} + 4\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$	20BSX11.4	L1
5	State Rolle's theorem	20BSX11.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Find the rank of the matrix A = $\begin{bmatrix} 2 & 1 & -3 & -6 \\ 3 & -3 & 1 & 2 \\ 1 & 1 & 1 & 2 \end{bmatrix}$ by reducing into normal form	6M	20BSX11.1	L2
6 (b)	Test for consistency and solve the equations 5x + 3y +7z = 4; 3x +26y +2z = 9; 7x + 2y +10z = 5	6M	20BSX11.1	L3
	OR			
7 (a)	Find the rank of the matrix A = $\begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 11 & -5 & 3 \\ 2 & -5 & 3 & 1 \\ 4 & 1 & 1 & 5 \end{bmatrix}$ by reducing into Echelon form	6M	20BSX11.1	L2
7 (b)	Find the Eigen values and Eigen Vectors of $A = \begin{bmatrix} 3 & 10 & 5 \\ -2 & -3 & -4 \\ 3 & 5 & 7 \end{bmatrix}$	6M	20BSX11.1	L2
8	Prove that the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ satisfies Cayley Hamilton theorem and hence find A^{-1}	12M	20BSX11.2	L3
	OR			
9	Reduce the quadratic form $8x^2 + 7y^2 + 3z^2 - 12xy - 8yz + 4zx$ to the canonical form specify the matrix of the transformation and hence find its Rank, Index, Signature, and nature of the quadratic form	12M	20BSX11.2	L3

10 (a)	Solve $x\frac{dy}{dx} + y = x^3 y^6$	6M	20BSX11.3	L2
10 (b)	Find the orthogonal trajectories of the family of the curves $r^n = a^n \cos n\theta$	6M	20BSX11.3	L3
	OR			
11 (a)	Solve $xy\,(1 + xy^2)\frac{dy}{dx} = 1$	6M	20BSX11.3	L2
11 (b)	A bacterial population B is known to have a rate of growth proportional to B itself. If between noon and 2 PM the population triples, at what time, no controls being exerted, should B become 100 times what it was at noon?	6M	20BSX11.3	L3
12 (a)	Solve $(D^3 - 2D + 4)y = e^x sinx$, where $D = \frac{d}{dx}$	6M	20BSX11.4	L2
12 (b)	Solve $(D^2 - 2D + 5)y = 0, y(0) = -3, y'(0) = 1$, where $D = \frac{d}{dx}$	6M	20BSX11.4	L3
	OR			
13 (a)	Solve $(D^2 - 4D + 3)y = e^x cos2x$, where $D = \frac{d}{dx}$	6M	20BSX11.4	L2
13 (b)	Solve $(D^2 - 4D + 4)y = e^{2x} + sin3x$, where $D = \frac{d}{dx}$	6M	20BSX11.4	L3
14 (a)	Calculate approximately the root of the equation $x^4 - 12x + 7 = 0$ near 2 by using Lagrange's Mean Value theorem	6M	20BSX11.5	L2
14 (b)	Find the maximum and minimum distances from the origin to the curve $3x^2 + 4xy + 6y^2 = 140$ using Lagrange's Method of undetermined multipliers	6M	20BSX11.5	L3
	OR			
15	If $x = r\,sin\theta\,cos\varphi$, $y = r\,sin\theta\,sin\varphi$, $z = r\,cos\theta$ Then show that $\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)} = r^2\,sin\theta$	12M	20BSX11.5	L3

Semester End Regular / Supplementary Examination, February-2023

B.Tech - I Sem | Common to All | Academic year 2022-2023

Course Code: 20BSX11 | Max: 70

Course name: Linear Algebra and Differential Equation

Scheme of Valuation

Page No 1

1. Find the rank of $\begin{bmatrix} 1 & 1 & 1 \\ 2 & 2 & 2 \\ 3 & 3 & 3 \end{bmatrix}$

$R_2 \to R_2 - 2R_1$, $R_3 \to R_3 - 3R_1$ $\sim \begin{bmatrix} 1 & \phi & \phi \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ — 1M

$\rho(A) = 1$. — 1M

2M

(or) $|\ |_{3\times3} = 0$, $|\ |_{2\times2} = 0$, $|1|_{1\times1} \neq 0$. $\rho(A) = 1$

2. The nature of Q.F $2x_1x_2 + 2x_1x_3 + 2x_2x_3$

$A = \begin{matrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{matrix}$ — 1M

$\lambda = 2, -1, -1$ —

Nature: indefinite — 1M

3. $\frac{dy}{dx} + 2x - 2y = 0$

$\frac{dy}{dx} - 2y = -2x$

$P = -2 \quad Q = -2x$ — 1M

$IF = e^{\int P(x)dx} = e^{\int -2dx} = e^{-2x}$ — 1M

4. $4D^3y + 4D^2y + Dy = 0$

$(4D^3 + 4D^2 + D)y = 0$

$D(4D^2 + 4D + 1)y = 0$

$D = 0, \ (2D+1)^2 = 0$ — 1M

$D = 0, -\frac{1}{2}, -\frac{1}{2}$

$y = c_1 + (c_2 + c_3x)e^{-\frac{1}{2}x}$ — 1M

5. State Rolle's theorem.

Let $f(x)$ be a function defined on $[a,b]$

(i) $f(x)$ is continuous on $[a,b]$

(ii) $f(x)$ is derivable on (a,b)

and (iii) if $f(a) = f(b)$ then $\exists\ c \in (a,b) \ni f'(c) = 0$ — 2M

6 a. Find the rank of the matrix $A = \begin{bmatrix} 2 & 1 & -3 & -6 \\ 3 & -3 & 1 & 2 \\ 1 & 1 & 1 & 2 \end{bmatrix}$ by reducing into Normal form

Sol Given $A = \begin{bmatrix} 1 & 1 & 1 & 2 \\ 3 & -3 & 1 & 2 \\ 2 & 1 & -3 & -6 \end{bmatrix}$

$R_2 \to R_2 - 3R_1$, $R_3 \to R_3 - 2R_1$ $\sim \begin{bmatrix} 1 & 1 & 1 & 2 \\ 0 & -6 & -2 & -4 \\ 0 & -1 & -5 & -10 \end{bmatrix}$ — 1M

$C_2 \to C_2 - C_1$, $C_3 \to C_3 - C_1$, $C_4 \to C_4 - 2C_1$

$\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -6 & -2 & -4 \\ 0 & -1 & -5 & -10 \end{bmatrix}$

$R_3 \to R_3 + R_2$ $\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -6 & -2 & -4 \\ 0 & -7 & -7 & -14 \end{bmatrix}$

$R_2 \to \frac{R_2}{-2}$, $R_3 \to \frac{R_3}{-7}$ $\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 3 & 1 & 2 \\ 0 & 1 & 1 & 2 \end{bmatrix}$

Any alternative operations can also give marks. Atleast each operations one marks.

$R_2 \to R_2 - R_3$ $\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 1 & 1 & 2 \end{bmatrix}$

$R_2 \to \frac{R_2}{2}$ $\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 2 \end{bmatrix}$

$R_3 \to R_3 - R_2$ $\sim \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 2 \end{bmatrix}$ — 3M

$C_4 \to C_4 - 2C_3$

$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$ — 1M

$[I_3 \; 0]$

$\rho(A) = 3$. — 1M

6M

6(5). Test for consistency and solve the eqns $5x+3y+7z=4$, $3x+26y+2z=9$, $7x+2y+10z=5$.

Sol The given system can be expressed as

$$\begin{bmatrix} 5 & 3 & 7 \\ 3 & 26 & 2 \\ 7 & 2 & 10 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 4 \\ 9 \\ 5 \end{bmatrix} \quad -1M$$

$AX=B$

where $A=\begin{bmatrix} 5 & 3 & 7 \\ 3 & 26 & 2 \\ 7 & 2 & 10 \end{bmatrix}$, $X=\begin{bmatrix} x \\ y \\ z \end{bmatrix}$, $B=\begin{bmatrix} 4 \\ 9 \\ 5 \end{bmatrix}$

The augmented matrix $[A|B]=\begin{bmatrix} 5 & 3 & 7 & 4 \\ 3 & 26 & 2 & 9 \\ 7 & 2 & 10 & 5 \end{bmatrix}$ — 1M

$R_1 \to 3R_1$, $R_2 \to 5R_2$ $\sim \begin{bmatrix} 15 & 9 & 21 & 12 \\ 15 & 130 & 10 & 45 \\ 7 & 2 & 10 & 5 \end{bmatrix}$

$R_2 \to R_2 - R_1 \sim \begin{bmatrix} 15 & 9 & 21 & 12 \\ 0 & 121 & -11 & 33 \\ 7 & 2 & 10 & 5 \end{bmatrix}$

$R_1 \to R_1 - 2R_3$, $R_2 \to \frac{R_2}{11} \sim \begin{bmatrix} 1 & 5 & 1 & 2 \\ 0 & 11 & -1 & 3 \\ 7 & 2 & 10 & 5 \end{bmatrix}$

$R_3 \to R_3 - 7R_1 \begin{bmatrix} 1 & 5 & 1 & 2 \\ 0 & 11 & -1 & 3 \\ 0 & -33 & -3 & -9 \end{bmatrix}$

$R_3 \to R_3 + 3R_2 \sim \begin{bmatrix} 1 & 5 & 1 & 2 \\ 0 & 11 & -1 & 3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ — 2M

Which is in Echelon form.

$\rho(A)=2$, $\rho(A|B)=2$

$\rho(A)=\rho(A|B)=r=2<3(n)$

The system has infinitely many solution. — 1M.

The system can be expressed

$x+5y+z=2$

$11y-z=3$

Choose $y=k$, $k \in \mathbb{R}$

$y=\frac{3+z}{11}$, $\frac{3+k}{11}$

$x=2-5y-z$

$2-5\left(\frac{3+k}{11}\right)+k$

$x=\frac{7}{11}-\frac{16}{11}k$.

$X=\begin{bmatrix} x \\ y \\ z \end{bmatrix}=\begin{bmatrix} \frac{7-16k}{11} \\ \frac{3+k}{11} \\ k \end{bmatrix}$

$k \in \mathbb{R}$

— 1M

7(a). Find the rank of the matrix $A = \begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 11 & -5 & 3 \\ 2 & -5 & 3 & 1 \\ 4 & 1 & 1 & 5 \end{bmatrix}$ by Reducing into Echelon form.

Given $A = \begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 11 & -5 & 3 \\ 2 & -5 & 3 & 1 \\ 4 & 1 & 1 & 5 \end{bmatrix}$ — 1M

$R_3 - 2R_1$, $R_4 \to 4R_1$ $\sim \begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 11 & -5 & 3 \\ 0 & -11 & 5 & -3 \\ 0 & -11 & 5 & -3 \end{bmatrix}$ — 2M

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$R_4 \to R_4 + R_2$, $R_3 \to R_3 + R_2$ $\sim \begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 11 & -5 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ — 2M

$R_2 \to \frac{R_2}{11}$ $\begin{bmatrix} 1 & 3 & -1 & 2 \\ 0 & 1 & -\frac{5}{11} & \frac{3}{11} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ — 1M

which is in Echelon form, $\rho(A) = 2$ — 1M

6M

7(b) Find the Eigen values and Eigen vectors of $\begin{bmatrix} 3 & 10 & 5 \\ -2 & -3 & -4 \\ 3 & 5 & 7 \end{bmatrix}$

Che eqn $|A - \lambda I| = 0$ $\begin{vmatrix} 3-\lambda & 10 & 5 \\ -2 & -3-\lambda & -4 \\ 3 & 5 & 7-\lambda \end{vmatrix} = 0$ — 1M

Characteristic eqn. $-(3-\lambda)(\lambda^2 - 4\lambda + 4) = 0 \Rightarrow (3-\lambda)(\lambda-2)^2 = 0$ — 2M

$\lambda_1 = 3, \lambda_2 = 2, \lambda_3 = 2$ — 1M

Eigen vector corresponding to $\lambda = 3$ is $\begin{bmatrix} -\frac{1}{2} \\ -\frac{1}{2} \\ 1 \end{bmatrix}$ or $\begin{bmatrix} 1 \\ 1 \\ -2 \end{bmatrix}$ — 1M

Eigenvalue 2, multiplicity 2, Eigen vector corresponding to $\lambda = 2$ is $\begin{bmatrix} -1 \\ -\frac{2}{5} \\ 1 \end{bmatrix}$ — 1M

6M

Q. 8. Prove that the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ satisfies Cayley Hamilton Theorem and find A^{-1}

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Given matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ — 1M

Char eqn $|A - \lambda I| = 0$ $\begin{vmatrix} 1-\lambda & 2 & 3 \\ 2 & 4-\lambda & 5 \\ 3 & 5 & 6-\lambda \end{vmatrix} = 0$ — 1M

Char. eqn $\lambda^3 - 11\lambda^2 - 4\lambda + 1 = 0$. — 3M

Cayley Hamilton theorem states that every square matrix satisfies its own char. eqn

$A^3 - 11A^2 - 4A + I = 0$ — 2M

$A^2 = \begin{bmatrix} 14 & 25 & 31 \\ 25 & 45 & 56 \\ 31 & 56 & 70 \end{bmatrix}$ — 1M

$A^3 = \begin{bmatrix} 157 & 283 & 353 \\ 283 & 510 & 636 \\ 353 & 636 & 793 \end{bmatrix}$ — 1M

$A^3 - 11A^2 - 4A + I = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ — 1M

To find A^{-1}

$A^3 - 11A^2 - 4A = -I$

$-A^{-1} = A^2 - 11A - 4I \Rightarrow A^{-1} = -A^2 + 11A + 4I$ — 1M

$= \begin{bmatrix} 1 & -3 & 2 \\ -3 & 3 & -1 \\ 2 & -1 & 0 \end{bmatrix}$ — 1M

12 Marks.

7. Given Q.F $8x^2+7y^2+3z^2-12xy-8yz+4zx$

Symmetric matrix $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$ — 1M

Char. eqn $|A-\lambda I|=0$, $\begin{vmatrix} 8-\lambda & -6 & 2 \\ -6 & 7-\lambda & -4 \\ 2 & -4 & 3-\lambda \end{vmatrix} = 0 \Rightarrow \lambda(\lambda-3)(\lambda-15)=0$ — 2M

The eigen values are $\lambda_1=0, \lambda_2=3, \lambda_3=15$ — 1M

The eigen vectors corresponding to Eigen value $\lambda_1=0$ is $X_1 = \begin{bmatrix} 1 \\ 2 \\ 2 \end{bmatrix}$ — 1M

$\lambda_2=3$, $X_2 = \begin{bmatrix} 2 \\ 1 \\ -2 \end{bmatrix}$ or $\begin{bmatrix} -2 \\ -1 \\ 2 \end{bmatrix}$ — 1M

$\lambda=15$, $X_3 = \begin{bmatrix} 2 \\ -2 \\ 1 \end{bmatrix}$ — 1M

Modal matrix $P = X_1\ X_2\ X_3 = \begin{bmatrix} 1 & -2 & 2 \\ 2 & -1 & -2 \\ 2 & 2 & 1 \end{bmatrix}$ — 1M

Normalized modal matrix. $P = \begin{pmatrix} \frac{1}{3} & -\frac{2}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{1}{3} & -\frac{2}{3} \\ \frac{2}{3} & \frac{2}{3} & \frac{1}{3} \end{pmatrix}$ — 1M

$D = P^T A P = \begin{bmatrix} \frac{1}{3} & \frac{2}{3} & \frac{2}{3} \\ -\frac{2}{3} & \frac{1}{3} & \frac{2}{3} \\ \frac{2}{3} & -\frac{2}{3} & \frac{1}{3} \end{bmatrix} \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix} \begin{bmatrix} \frac{1}{3} & -\frac{2}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{1}{3} & \frac{2}{3} \\ \frac{2}{3} & -\frac{2}{3} & \frac{1}{3} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 15 \end{bmatrix}$ — 1M — 10M

Canonical form $Q = Y^T D Y = \begin{bmatrix} y_1 & y_2 & y_3 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 15 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = 0y_1^2 + 3y_2^2 + 15y_3^2$ — 1M

Rank: 3.

Index 3

Signature: 3. — 1M

Nature: Positive Definite

12 marks

10 a. Solve $x\frac{dy}{dx} + y = x^3y^6$

Given DE is $x\frac{dy}{dx} + y = x^3y^6$

Dividing with x

$\frac{dy}{dx} + \frac{1}{x}y = x^2y^6$ — 1M

$\frac{dy}{dx} + P(x)y = Q(x)y^n$

$P = \frac{1}{x}$, $Q = x^2$, $y^n = y^6$, $n = 6$.

Bernoullin

Dividing with y^6,

$y^{-6}\frac{dy}{dx} + \frac{1}{x}y^{-5} = x^2$ — 1M

Put $y^{-5} = t$ — 1M

$-5y^{-6}\frac{dy}{dx} = \frac{dt}{dx}$

$y^{-6}\frac{dy}{dx} = -\frac{1}{5}\frac{dt}{dx}$

$-\frac{1}{5}\frac{dt}{dx} + \frac{1}{x}t = x^2$

$\frac{dt}{dx} - \frac{5}{x}t = -5x^2$

This is of the form $\frac{dt}{dx} + P(x)t = Q(x)$

$P(x) = -\frac{5}{x}$, $Q(x) = -5x^2$,

which is linear in t

$IF = e^{\int P(x)dx} = e^{\int -\frac{5}{x}dx} = e^{-5\log x} = x^{-5}$ — 1M

$IF = x^{-5} = \frac{1}{x^5}$

General solution is $t(IF) = \int Q(x)(IF)dx + c$ — 1M

$t\cdot\frac{1}{x^5} = \int -5x^2 \cdot x^{-5}dx$

$\frac{t}{x^5} = -5\int x^{-3}dx$

$\frac{t}{x^5} = \frac{-5}{-2}x^{-2} + C$

$t = \frac{5}{2}x^3 + Cx^5$

Solution $\frac{1}{y^5} = \frac{5}{2}x^3 + Cx^5$. — 1M

6M

10 (5). Find the OT of the family of the curve $r^n = a^n\cos n\theta$

$r^n = a^n\cos n\theta$ — (1) — 1M

Taking log on b.s.

$n\log r = n\log a + \log\cos n\theta$. — 1M

diff wrt θ

$n\cdot\frac{1}{r}\frac{dr}{d\theta} = 0 + \frac{1}{\cos n\theta}(-n\sin n\theta)$

$\frac{1}{r}\frac{dr}{d\theta} = -\tan n\theta$ — 1M

is the diff eq^n of given family

To get DE of O.T replace $\frac{dr}{d\theta}$ by $-r^2\frac{d\theta}{dr}$ — 1M

$\frac{1}{r}\left(-r^2\frac{d\theta}{dr}\right) = -\tan n\theta$.

$r\frac{d\theta}{dr} = \tan n\theta$

$\frac{d\theta}{\tan n\theta} = \frac{dr}{r}$ — 1M

on integrating

$\int\frac{dr}{r} = \int\cot n\theta d\theta$

$\log r = \frac{1}{n}\log|\sin n\theta| + \log c$

$n\log r = \log(c\sin n\theta)$ — 1M

$r^n = c\sin n\theta$.

is the O.T

6M

11. (a) Solve $xy(1+xy^2)\frac{dy}{dx}=1$

Sol:

$$\frac{dx}{dy} = xy + x^2y^3 \Rightarrow \frac{dx}{dy} + (-y)x = (y^3)x^2 \quad \text{— (1)}$$

which is of the form $\frac{dx}{dy} + Px = Qx^2$,

a Bernoulli's linear DE in x, where

$$P = -y,\ Q = y^3$$

By dividing (1) with x^2, we get

$$\frac{1}{x^2}\frac{dx}{dy} + (-y)\left(\frac{1}{x}\right) = y^3 \quad \text{— 1M}$$

Put $\frac{-1}{x} = t \Rightarrow \frac{1}{x^2}\frac{dx}{dy} = \frac{dt}{dy}$

$$\Rightarrow \frac{dt}{dy} + (y)t = y^3 \ \text{i.e.,}\ \frac{dt}{dy} + P_1 t = Q_1, \quad \text{— (2)}$$

a Leibnitz's linear DE in t. — 1M

$$I.F = e^{\int P_1 dy} = e^{\int y\,dy} = e^{y^2/2} \quad \text{— 2M}$$

The C.S of (2) is

$$t\,(I.F) = \int Q_1\,(I.F)\,dy + c$$

$$\Rightarrow t\,e^{y^2/2} = \int y^3 \cdot e^{y^2/2}\,dy + c$$

$$= \int y^2 \cdot e^{y^2/2}\,(y\,dy) + c$$

$$\left(\text{Put } \frac{y^2}{2} = s \Rightarrow y\,dy = ds\right)$$

$$= \int 2s \cdot e^s \cdot ds + c = 2(s-1)e^s + c$$

$$= 2\left(\frac{y^2}{2} - 1\right)e^{y^2/2} + c$$

$$\Rightarrow t \cdot e^{y^2/2} = (y^2 - 2)\,e^{y^2/2} + c$$

$$\Rightarrow -\frac{1}{x} \cdot e^{y^2/2} = (y^2-2)\,e^{y^2/2} + c. \quad \text{— 2M}$$

11.(b) The bacterial population B is changing with time t. Rate of change of B is proportional to B i.e., $\frac{dB}{dt} = kB$; $k>0$.

$\Rightarrow \frac{dB}{B} = k\,dt$

By integrating, $\int \frac{1}{B}\,dB = k\int dt + c$

$\Rightarrow \log_e B = kt + c$ ——— (1)

Let $B = B_0$ initially (at noon) i.e., at $t=0$

Then $\log_e B_0 = k(0) + c \Rightarrow \boxed{c = \log_e B_0}$

$\therefore$ (1) changes to $\log_e B = kt + \log_e B_0$ ——— (2)

Given $B = 3B_0$ at $t=2$

i.e., $\log_e (3B_0) = 2k + \log_e (B_0) \Rightarrow \log_e 3 = 2k \Rightarrow \boxed{k = \frac{1}{2}\log_e 3}$

$\therefore$ (2) changes to $\log_e B = \frac{t}{2}\log_e 3 + \log_e B_0$ ——— 3M

Now, when $B = 100\,B_0$, we get

$\log_e (100\,B_0) - \log_e B_0 = \frac{t}{2}\log_e 3 \Rightarrow \log_e 100 = \frac{t}{2}\log_e 3$

$\Rightarrow t = 2\,\frac{\log_e 100}{\log_e 3} = 4\,\frac{\log_e 10}{\log_e 3}$. ——— 1M

12. (a) Solve $(D^3 - 2D + 4)\,y = e^x \sin x$

Sol: The A.E is $m^3 - 2m + 4 = 0$

$$P.I = \frac{1}{D^3 - 2D + 4} e^x \sin x = e^x \frac{1}{(D+1)^3 - 2(D+1) + 4} \sin x$$

$$= e^x \frac{1}{D^3 + 3D^2 + 3D + 1 - 2D - 2 + 4} \sin x$$

$$= e^x \frac{1}{D^3 + 3D^2 + D + 3} \sin x$$

put $D^2 = -1^2 = -1$

$$= e^x \frac{1}{D(-1)+3(-1)+D+3} \sin x = e^x \frac{1}{0} \sin x, \text{ a failure case}$$

$$= e^x \cdot x \cdot \left(\frac{1}{3D^2+6D+1} \sin x\right) = x e^x \left(\frac{1}{3(-1)+6D+1} \sin x\right)$$

$$= x e^x \cdot \frac{1}{6D-2} \sin x = x e^x \left(\frac{6D+2}{36D^2-4}\right) \sin x$$

$$= x e^x \left(\frac{6D+2}{-36-4} \sin x\right) = \frac{x e^x}{-40} \{6\cos x + 2\sin x\}$$

$$= -\frac{x e^x}{20} (3\cos x + \sin x)$$

The G.S is $y = CF + PI$.

$$= CF - \frac{x e^x}{20} (3\cos x + \sin x)$$

12. (b) $(D^2 - 2D + 5)y = 0$, $y(0) = -3$, $y'(0) = 1$

Sol: The AE is $m^2 - 2m + 5 = 0 \Rightarrow m = \frac{2 \pm \sqrt{4-20}}{2}$

$$= \frac{2 \pm 4i}{2} = 1 \pm 2i$$

$\therefore CF = e^x [C_1 \cos 2x + C_2 \sin 2x]$ — (2M).

The G.S is $y = CF$.

$\Rightarrow y = e^x (C_1 \cos 2x + C_2 \sin 2x)$ — (1)

Given $y = -3$ at $x = 0$

ie, $-3 = C_1$

$\therefore y = e^x (-3\cos 2x + C_2 \sin 2x)$ — (2)

— 2M

$\Rightarrow y' = e^x(6\sin 2x + 2C_2\cos 2x)$

Given $y' = 1$ at $x = 0$

$\Rightarrow 1 = 2C_2 \Rightarrow C_2 = 0.5 = \frac{1}{2}$

$\therefore$ By (2), $y = e^x(-3\cos 2x + \frac{1}{2}\sin 2x)$. — 2M

13. (a) Solve $(D^2 - 4D + 3)y = e^x \cos 2x$.

Soln. The AE is $m^2 - 4m + 3 = 0 \Rightarrow (m-1)(m-3) = 0$

$\Rightarrow m = 1, 3$

$\therefore C.F = C_1e^x + C_2e^{3x}$ — 2M

$$P.I = \frac{1}{D^2-4D+3} e^x \cos 2x = e^x \left\{ \frac{1}{(D+1)^2 - 4(D+1) + 3} \cos 2x \right\}$$

$$= e^x \left\{ \frac{1}{D^2 + 2D + 1 - 4D - 4 + 3} \cos 2x \right\}$$

$$= e^x \left\{ \frac{1}{D^2 - 2D} \cos 2x \right\} = e^x \left\{ \frac{1}{-4 - 2D} \cos 2x \right\}$$

$$= \frac{e^x}{-2} \left\{ \frac{1}{D+2} \cos 2x \right\} = \frac{-e^x}{2} \left\{ \frac{D-2}{D^2-4} \cos 2x \right\}$$

$$= \frac{-e^x}{2} \left\{ \frac{D-2}{-4-4} \cos 2x \right\} = \frac{e^x}{16} \left\{ \frac{d}{dx}\cos 2x - 2\cos 2x \right\}$$

$$= \frac{e^x}{16} \left\{ -2\sin 2x - 2\cos 2x \right\} = \frac{-e^x}{8}(\sin 2x + \cos 2x)$$

— 3M

The C.S. is $y = C.F. + P.I.$

$\Rightarrow y = C_1e^x + C_2e^{3x} - \frac{e^x}{8}(\sin 2x + \cos 2x)$ — 1M.

13. (b) Solve $(D^2-4D+4)y = e^{2x} + \sin 3x$

Sol: The AE is $m^2-4m+4=0 \Rightarrow (m-2)^2=0$

$\Rightarrow m=2,2.$

$C.F = (c_1+c_2x)e^{2x}$ — (2M)

$P.I = \frac{1}{D^2-4D+4} e^{2x} + \frac{1}{D^2-4D+4} \sin 3x$ — (1)

$\frac{1}{D^2-4D+4} e^{2x} = \frac{1}{4-8+4} e^{2x} = \frac{1}{0} e^{2x}$, a failure case

$= x \cdot \left\{ \frac{1}{2D-4} e^{2x} \right\} = x\left\{ \frac{1}{4-4} e^{2x} \right\}$

$= x\left[\frac{1}{0} e^{2x}\right\}$, again a failure case

$= x^2 \left\{ \frac{1}{2} e^{2x} \right\}.$ — (2M)

$\frac{1}{D^2-4D+4} \sin 3x = \frac{1}{-9-4D+4} \sin 3x = \frac{1}{-4D-5} \sin 3x$

$= -\left(\frac{4D+5}{16D^2-25} \sin 3x\right) = -\left\{\frac{4D+5}{16(-9)-25} \sin 3x\right\}$

$= \frac{1}{169}\left\{ 4\frac{d}{dx}\sin 3x + 5\sin 3x \right\}$

$= \frac{1}{169}\left\{ 4(3\cos 3x) + 5\sin 3x \right\}$

$= \frac{1}{169}\left(12\cos 3x + 5\sin 3x \right)$

$\therefore$ By (1), $P.I = \frac{x^2}{2} e^{2x} + \frac{1}{169}(12\cos 3x + 5\sin 3x)$ — (2M)

The Complete Solution is $y = C.F + P.I$

$\Rightarrow y = (c_1+c_2x)e^{2x} + \frac{x^2}{2}e^{2x} + \frac{1}{169}(12\cos 3x + 5\sin 3x)$.

15. $x = r\sin\theta\cos\phi$, $y = r\sin\theta\sin\phi$, $z = r\cos\theta$.

$$\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)} = \begin{vmatrix} \frac{\partial x}{\partial r} & \frac{\partial x}{\partial \theta} & \frac{\partial x}{\partial \phi} \\ \frac{\partial y}{\partial r} & \frac{\partial y}{\partial \theta} & \frac{\partial y}{\partial \phi} \\ \frac{\partial z}{\partial r} & \frac{\partial z}{\partial \theta} & \frac{\partial z}{\partial \phi} \end{vmatrix} \quad \text{— (2M)}$$

$$= \begin{vmatrix} \frac{\partial}{\partial r}(r\sin\theta\cos\phi) & \frac{\partial}{\partial \theta}(r\sin\theta\cos\phi) & \frac{\partial}{\partial \phi}(r\sin\theta\cos\phi) \\ \frac{\partial}{\partial r}(r\sin\theta\sin\phi) & \frac{\partial}{\partial \theta}(r\sin\theta\sin\phi) & \frac{\partial}{\partial \phi}(r\sin\theta\sin\phi) \\ \frac{\partial}{\partial r}(r\cos\theta) & \frac{\partial}{\partial \theta}(r\cos\theta) & \frac{\partial}{\partial \phi}(r\cos\theta) \end{vmatrix}$$

$$= \begin{vmatrix} \sin\theta\cos\phi & r\cos\theta\cos\phi & -r\sin\theta\sin\phi \\ \sin\theta\sin\phi & r\cos\theta\sin\phi & r\sin\theta\cos\phi \\ \cos\theta & -r\sin\theta & 0 \end{vmatrix} \quad \text{(6M)}$$

By taking out r from C_2 and $r\sin\theta$ from C_3,

$$= (r)(r\sin\theta)\begin{vmatrix} \sin\theta\cos\phi & \cos\theta\cos\phi & -\sin\phi \\ \sin\theta\sin\phi & \cos\theta\sin\phi & \cos\phi \\ \cos\theta & -\sin\theta & 0 \end{vmatrix}$$

By expanding along R_1, we get-

$$= r^2\sin\theta\left[\sin\theta\cos\phi\{0+\sin\theta\cos\phi\} - \cos\theta\cos\phi\{0-\cos\theta\cos\phi\} - \sin\phi\{-\sin^2\theta\sin\phi - \cos^2\theta\sin\phi\}\right]$$

$$= r^2 \sin\theta \Big[\sin^2\theta \cos^2\phi + \cos^2\theta \cos^2\phi - \sin\phi \{ \sin^2\theta + \cos^2\theta \} (-\sin\phi) \Big]$$

$$= r^2 \sin\theta \Big[(\sin^2\theta + \cos^2\theta) \cos^2\phi + (\sin^2\theta + \cos^2\theta) \sin^2\phi \Big]$$

$$= r^2 \sin\theta \Big[(1) \cos^2\phi + (1) \sin^2\phi \Big]$$

$$= r^2 \sin\theta \Big[\cos^2\phi + \sin^2\phi \Big] = r^2 \sin\theta. \quad \text{— (4 M)}$$

16/2/23
HoD. S&H

(Dr. M.V.V.S Bhaskara Murthy)
Course Coordinator.

NSRIT

Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech. (U. G.)	Program	All Programs			Academic Year	2022 - 2023
Course Code	20ESX02	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Programming for Problem Solving Using 'C'						

Part A (Short Answer Questions 5 x 2 = 10 Marks)				
No.	Questions (1 through 5)		Learning Outcome (s)	DoK
1	List the different data types available in C		20ESX02.1	L1
2	Recall the syntax of if-else statement		20ESX02.2	L1
3	How to declare and initialize 1-D AND 2-D array with an example?		20ESX02.3	L1
4	Distinguish between structure and union		20ESX02.4	L2
5	List any four file handling functions in C		20ESX02.5	L1
Part B (Long Answer Questions 5 x 12 = 60 Marks)				
No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Develop a C program to find the sum of numbers from 1 to n	6M	20ESX02.1	L3
6 (b)	Outline the structure of C program with suitable example	6M	20ESX02.1	L2
	OR			
7	Elaborate the various types of operators available in C with suitable example	12M	20ESX02.1	L2
8 (a)	Develop a C program to check whether a given number is even or odd	6M	20ESX02.2	L3
8 (b)	Develop a C program to find the factorial of a given number	6M	20ESX02.2	L3
	OR			
9	Illustrate the various looping statements used in C with suitable examples	12M	20ESX02.2	L2
10 (a)	How to declare and initialize a two dimensional array? Discuss with an example	6M	20ESX02.3	L3
10 (b)	Illustrate the following string handling functions with suitable example i. strcpy() ii) strcmp() iii) strcat()	6M	20ESX02.3	L2
	OR			
11	Explain the various function prototypes with suitable examples	12M	20ESX02.3	L2
12 (a)	Explain pointer with a suitable example	6M	20ESX02.4	L2
12 (b)	Discuss about the structure with an example	6M	20ESX02.4	L2
	OR			
13	Develop a C program that defines a structure employee containing the details such as empno, empname, department name and salary. The structure has to store 10 employees in an organization. Use the appropriate method to define the above details and define a function that will display the contents	12M	20ESX02.4	L3
14	Explain the following file handling functions i. fseek() ii) ftell() iii) rewind() iv) feof()	12M	20ESX02.5	L2
	OR			
15 (a)	Recall the syntax for opening a file with various modes and closing a file	6M	20ESX02.5	L1
15 (b)	Develop a C program to copy the contents from one file to another file	6M	20ESX02.5	L3

N S RAJU INSTITUTE OF TECHNOLOGY
(AUTONOMOUS)
SONTYAM , ANANDAPURAM, VISAKHAPATNAM – 531 173

PPSUC – Feb. 2023

ANSWER KEY AND SCHEME OF EVALUATION

Part A (Short Answer Questions 5 x 2 = 10 Marks)	
No.	Questions (1 through 5)
1	List the different data types available in C a. char b. int c. float d. double

2	Recall the syntax of if-else statement
	If(condition)
	{
	// body
	}
	else
	{
	//body
	}

3	How to declare and initialize 1-D AND 2-D array with an example? int A[5] = {1,2,3,4,5}; int B[2][2{}={1,2},{3,4}};
4	Distinguish between structure and union Structure provides space for all individual members where as Union provides space for the largest member. All elements in structure can be accessed separately but in Union only one element can be initialized and accessed at once
5	List any four file handling functions in C fopen(),flcose(),frpintf(),fscanf(),fputc(),fgetc() etc

Part B (Long Answer Questions 5 x 12 = 60 Marks)				
No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Develop a C program to find the sum of numbers from 1 to n	6M	20ESX02.1	L3
6 (b)	Outline the structure of C program with suitable example	6M	20ESX02.1	L2

6a.

```
#include <stdio.h>
int main() {
  int n, sum = 0;
  printf("Enter a positive integer n: ");
  scanf("%d", &n);
  for (int i = 1; i <= n; i++) {
    sum += i;
  }
  printf("The sum of the first %d natural numbers is %d\n", n, sum);
    return 0;
}
```

1. Documentation Section
2. Header File section
3. Definition Section
4. Global declaration section
5. main( ) section
6. Declaration part
7. Execution part
8. Sub program section

Example:

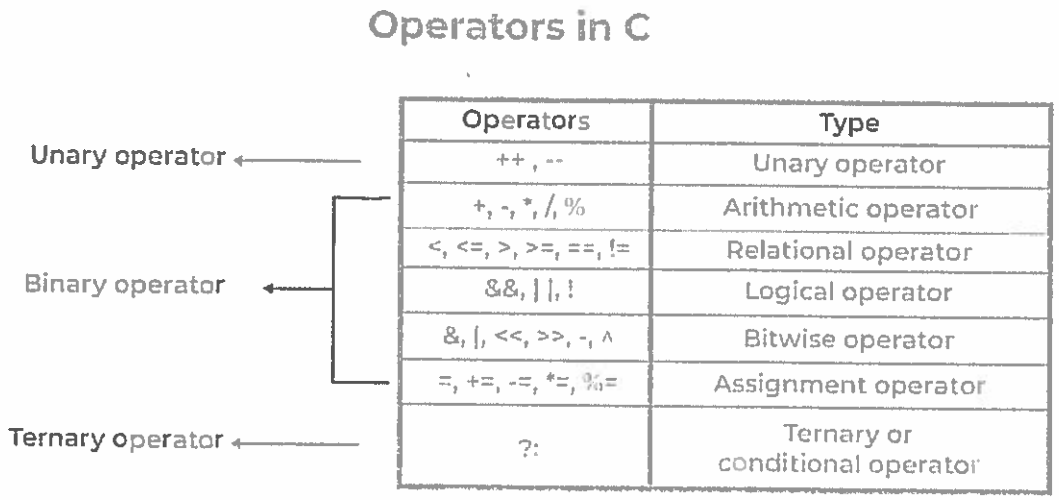
```
/* Documentation Section */
// File : Addition.c
// Description          : Addition of Three Numbers
// Author       : Student123

/* Header File Section */
#include<stdio.h> #inlcude<conio.h>

/* Definition Section */
# define c 3

/* Global declaration section */
int calcsum(int,int,int);
/* main( ) section */
int main()
{
/* Declaration part */
int a,b,sum;
/* Execution part */
printf("Enter Two numbers");
scanf("%d %d", &a, &b);
sum=calcsum(a,b,c); printf("The
sum is: %d", sum);
}
/* Sub program section*/
int calcsum(int x,int y, int z)
{
int d; d=x+y+z; return d;
}
```

7	Elaborate the various types of operators available in C with suitable example	12M

An operator is a symbol which helps the user to command the computer to do a certain mathematical or logical manipulations. Operators are used in C language program to operate on data and variables. C has a rich set of operators which can be classified as

1. Arithmetic Operators :
2. Relational Operators
3. Logical Operators
4. Assignment Operators

5. Increments and Decrement Operators
6. Conditional Operators
7. Bitwise Operators



8 (a)	Develop a C program to check whether a given number is even or odd	6M	20ESX02.2	L3
8 (b)	Develop a C program to find the factorial of a given number	6M	20ESX02.2	L3

8a.
```
#include <stdio.h>

int main() {
  int num;

  printf("Enter a number: ");
  scanf("%d", &num);

  if (num % 2 == 0) {
    printf("%d is even\n", num);
  } else {
    printf("%d is odd\n", num);
  }

  return 0;
}
```

- Enter a number: 12
  12 is even

8b.
```
#include <stdio.h>

int main() {
  int num, i;
  long long fact = 1;

  printf("Enter a number: ");
  scanf("%d", &num);

  if (num < 0) {
    printf("Error: Factorial of negative number does not exist.");
  } else {
    for (i = 1; i <= num; ++i) {
      fact *= i;
    }
    printf("Factorial of %d = %lld", num, fact);
  }

  return 0;
}
```

Error: Factorial of negative number does not exist.

- Enter a number: 5
  Factorial of 5 = 120

9	Illustrate the various looping statements used in C with suitable examples	12M	20ESX02.2	L2

while loop syntax
```
while (condition) {
  // code to be executed repeatedly as long as condition is true
}
```
The while loop evaluates the condition at the beginning of each iteration. If the condition is true, it executes the code block. If the condition is false, it skips the code block and exits the loop.

do-while loop syntax
```
do {
  // code to be executed at least once
} while (condition);
```
The do-while loop executes the code block at least once, and then evaluates the condition. If the condition is true, it repeats the loop. If the condition is false, it exits the loop.

for loop syntax
```
for (initialization; condition; increment) {
  // code to be executed repeatedly as long as condition is true
}
```

The for loop initializes a counter variable (initialization), evaluates the condition at the beginning of each iteration, and increments the counter variable (increment) at the end of each iteration. If the condition is true, it executes the code block. If the condition is false, it skips the code block and exits the loop.

1. while loop
A while loop executes a block of code repeatedly as long as a given condition is true. Here's an example of a while loop that prints the first 10 even numbers:

```
int i = 0;

while (i < 10) {
  printf("%d\n", 2 * i);
  i++;
}
```
In this example, the loop executes as long as i is less than 10. Each time through the loop, it prints the value of 2 * i and then increments i by 1.

2. do-while loop
A do-while loop is similar to a while loop, but it guarantees that the loop body will execute at least once, even if the condition is false. Here's an example of a do-while loop that prompts the user to enter a positive number:

```
int num;

do {
  printf("Enter a positive number: ");
  scanf("%d", &num);
} while (num <= 0);
```
In this example, the loop body executes at least once, because the condition is checked at the end of each iteration. The loop prompts the user to enter a positive number, and repeats until the user enters a number greater than 0.

3. for loop

that prints the first 10 odd numbers:

```
for (int i = 1; i <= 19; i += 2) {
  printf("%d\n", i);
}
```

In this example, the loop initializes i to 1, and repeats as long as i is less than or equal to 19. Each time through the loop, it prints the value of i, and then increments i by 2.

4. break statement

A break statement can be used to exit a loop prematurely, even if the loop condition is still true. Here's an example of a while loop that exits when it encounters a negative number:

```
int num;

while (1) {
  printf("Enter a number: ");
  scanf("%d", &num);
  if (num < 0) {
    break;
  }
  printf("You entered %d\n", num);
}
```

In this example, the loop condition is 1, which is always true, so the loop would run indefinitely if we didn't include a break statement. The loop prompts the user to enter a number, and if the number is negative, it exits the loop. Otherwise, it prints the number that the user entered.

5. continue statement

A continue statement can be used to skip the rest of the loop body for a particular iteration. Here's an example of a for loop that prints the first 10 numbers, but skips over multiples of 3:

```
for (int i = 1; i <= 10; i++) {
  if (i % 3 == 0) {
    continue;
  }
  printf("%d\n", i);
}
```

In this example, the loop prints the value of i for each iteration, but skips over multiples of 3 using a continue statement.

10 (a)	How to declare and initialize a two dimensional array? Discuss with an example	6M	20ESX02.3	L3
10 (b)	Illustrate the following string handling functions with suitable example i. strcpy() ii) strcmp() iii) strcat()	6M	20ESX02.3	L2

10a. In C programming, a two-dimensional array is an array of arrays. It is often used to represent matrices and tables with rows and columns. Here's how you can declare and initialize a two-dimensional array in C:

- // Declare a 2D array with 3 rows and 4 columns

```
int myArray[3][4];
```

- // Declare and initialize a 2D array

```
int myArray[3][4] = {
  {1, 2, 3, 4},
  {5, 6, 7, 8},
  {9, 10, 11, 12}
};
```

10b.

some examples of the strcpy(), strcmp(), and strcat() string handling functions in C:

strcpy()
The strcpy() function is used to copy one string to another. It takes two arguments: the destination string (where the copied string will be stored) and the source string (the string to be copied).

```
#include <stdio.h>
#include <string.h>

int main() {
  char dest[20];
  char src[] = "Hello, world!";

  strcpy(dest, src);

  printf("Copied string: %s\n", dest);

  return 0;
}
```

In this example, we declare a character array called dest with a length of 20 and a string called src containing the text "Hello, world!". We then use strcpy() to copy src to dest. Finally, we print the contents of dest using printf(). The output of this program will be:

```
Copied string: Hello, world!
```

strcmp()
The strcmp() function is used to compare two strings. It takes two arguments: the first string to compare and the second string to compare. The function returns 0 if the strings are equal, a negative value if the first string is less than the second, or a positive value if the first string is greater than the second.

```
#include <stdio.h>
#include <string.h>

int main() {
  char str1[] = "Hello";
  char str2[] = "Hello, world!";

  int result = strcmp(str1, str2);

  if (result == 0) {
    printf("The strings are equal.\n");
  } else if (result < 0) {
    printf("String 1 is less than string 2.\n");
  } else {
    printf("String 1 is greater than string 2.\n");
  }

  return 0;
}
```

In this example, we declare two character arrays called str1 and str2. We then use strcmp() to compare the two strings and store the result in the result variable. Finally, we use a series of if statements to determine whether the strings are equal or which string is greater.

strcat()
The strcat() function is used to concatenate (i.e., join together) two strings. It takes two arguments: the destination string (the string to which the other string will be added) and the source string (the string to be added to the destination string).

```
#include <stdio.h>
```

```
int main() {
  char dest[20] = "Hello";
  char src[] = ", world!";

  strcat(dest, src);

  printf("Concatenated string: %s\n", dest);

  return 0;
}
```

In this example, we declare a character array called dest containing the string "Hello" and a character array called src containing the string ", world!". We then use strcat() to concatenate src to dest. Finally, we print the contents of dest using printf(). The output of this program will be:

Concatenated string: Hello, world!

11	Explain the various function prototypes with suitable examples	12M	20ESX02.3	L2

Function with no return type and no arguments:

```
#include <stdio.h>

void print_hello() {
  printf("Hello, world!\n");
}

int main() {
  print_hello();
  return 0;
}
```

In this example, print_hello() is a function with no return type and no arguments. It simply prints "Hello, world!" to the console. In the main() function, we call print_hello() to execute its code.

Function with no return type and with arguments:

```
#include <stdio.h>

void print_num(int num) {
  printf("The number is %d\n", num);
}

int main() {
  int x = 42;
  print_num(x);
  return 0;
}
```

In this example, print_num() is a function with no return type and one argument of type int. It prints the value of the argument to the console. In the main() function, we declare a variable x and assign it the value 42. We then call print_num(x) to pass the value of x to the print_num() function.

Function with return type and no arguments:

```
#include <stdio.h>

int get_random_number() {
  return rand() % 100;
}

int main() {
  int x = get_random_number();
```

```
  return 0;
}
```

In this example, get_random_number() is a function with a return type of int and no arguments. It generates a random number between 0 and 99 using the rand() function and returns it. In the main() function, we call get_random_number() and assign its return value to the variable x. We then print the value of x to the console.

Function with return type and arguments:

```
#include <stdio.h>

int add(int a, int b) {
  return a + b;
}

int main() {
  int x = 5;
  int y = 7;
  int z = add(x, y);
  printf("The sum of %d and %d is %d\n", x, y, z);
  return 0;
}
```

In this example, add() is a function with a return type of int and two arguments of type int. It adds the two arguments together and returns the result. In the main() function, we declare two variables x and y and assign them the values 5 and 7, respectively. We then call add(x, y) to add x and y together and assign the result to the variable z. Finally, we print the values of x, y, and z to the console.

12 (a)	Explain pointer with a suitable example	6M	20ESX02.4	L2
12 (b)	Discuss about the structure with an example	6M	20ESX02.4	L2

12a.

a pointer is a variable that stores the memory address of another variable. Pointers are very useful for dealing with dynamic memory allocation, passing parameters to functions by reference, and working with complex data structures like arrays and linked lists.

Here is an example that illustrates how to use pointers in C:

```
#include <stdio.h>

int main() {
int x = 42;  // declare an integer variable
int *ptr = &x;  // declare a pointer variable and initialize it to the address of x

printf("The value of x is %d\n", x);  // print the value of x
printf("The address of x is %p\n", &x);  // print the address of x
printf("The value of ptr is %p\n", ptr);  // print the value of ptr (which is the address of x)
printf("The value stored at the address pointed to by ptr is %d\n", *ptr);  // print the value stored at the address pointed to by ptr (which is the value of x)

*ptr = 99;  // assign a new value to the variable x using the pointer variable

printf("The new value of x is %d\n", x);  // print the new value of x

return 0;
}
```

In this example, we first declare an integer variable x and initialize it to the value 42. We then declare a pointer variable ptr and initialize it to the address of x using the address-of operator &. This means that ptr now points to the same memory location as x.

print the value of ptr, which is the address of x.

To access the value stored at the address pointed to by ptr, we use the dereference operator *. This means that *ptr gives us the value of x. We print this value using the %d format specifier.

We then use the dereference operator to assign a new value of 99 to the variable x using the pointer variable ptr. Finally, we print the new value of x.

Note that when using pointers, it's important to be careful about the memory addresses you are accessing, as accessing invalid memory can result in undefined behavior and potentially crash your program.

12b.

In C, a structure is a user-defined data type that groups together related variables of different data types under a single name. Structures are useful for organizing and manipulating complex data.

Here is an example that illustrates how to define and use a structure in C:

```
#include <stdio.h>
#include <string.h>

// Define a structure called "Person"
struct Person {
  char name[50];
  int age;
  float height;
};

int main() {
  // Declare a variable of type "Person"
  struct Person p1;

  // Assign values to the variables inside the structure
  strcpy(p1.name, "John Doe");
  p1.age = 30;
  p1.height = 1.75;

  // Print the values of the variables inside the structure
  printf("Name: %s\n", p1.name);
  printf("Age: %d\n", p1.age);
  printf("Height: %.2f\n", p1.height);

  return 0;
}
```

In this example, we define a structure called "Person" using the struct keyword. The structure contains three variables of different data types: a character array called name to store the person's name, an integer called age to store the person's age, and a float called height to store the person's height.

We then declare a variable of type Person called p1 in the main function. We can access the variables inside the structure using the dot operator .. For example, we assign the value "John Doe" to the name variable of p1 using the strcpy function. We also assign the values 30 and 1.75 to the age and height variables of p1, respectively.

We then print the values of the variables inside the structure using the printf function. Note that we use the %s format specifier for the name variable, %d for the age variable, and %f for the height variable.

Structures can also be used to create arrays of related data.

For example, we can declare an array of type Person like this:

```
struct Person people[3];
```

This declares an array called people that can store 3 Person structures. We can then access individual structures in the array using array notation, and access the variables inside the structures using the dot operator.

13	Develop a C program that defines a structure employee containing the details such as empno, empname, department name and salary. The structure has to store 10 employees in an organization. Use the appropriate method to define the above details and define a function that will display the contents	12M	20ESX02.4	L3

Here's a C program that defines a structure employee and stores the details of 10 employees in an array of structures. The program also includes a function display() that displays the contents of the structure.

```
#include <stdio.h>

struct employee {
  int empno;
  char empname[50];
  char deptname[50];
  float salary;
};

void display(struct employee emp);

int main() {
  struct employee emp[10];
  int i;

  // Read employee details
  for (i = 0; i < 10; i++) {
    printf("Enter employee %d details:\n", i+1);
    printf("Employee number: ");
    scanf("%d", &emp[i].empno);
    printf("Employee name: ");
    scanf("%s", emp[i].empname);
    printf("Department name: ");
    scanf("%s", emp[i].deptname);
    printf("Salary: ");
    scanf("%f", &emp[i].salary);
  }

  // Display employee details
  printf("\nEmployee details:\n");
  for (i = 0; i < 10; i++) {
    display(emp[i]);
  }

  return 0;
}

void display(struct employee emp) {
  printf("\nEmployee number: %d\n", emp.empno);
  printf("Employee name: %s\n", emp.empname);
  printf("Department name: %s\n", emp.deptname);
  printf("Salary: %.2f\n", emp.salary);
}
```

name), deptname (department name), and salary (salary). We then define an array of 10 employee structures called emp.

We use a for loop to read the details of each employee using scanf() and store them in the corresponding structure in the array.

We then use another for loop to display the details of each employee using the display() function. The display() function takes an argument of type struct employee and prints out the details of the employee.

14	Explain the following file handling functions i. fseek() ii) ftell() iii) rewind() iv) feof()	12M	20ESX02.5	L2

i. fseek() function:
The fseek() function in C is used to move the file pointer to a specific position in the file. The syntax of the fseek() function is as follows:
int fseek(FILE *stream, long int offset, int origin);
where stream is a pointer to the file, offset is the number of bytes to offset from the origin, and origin specifies the starting point for the offset.

Example:

Suppose we have a file "data.txt" with the following contents:

This is line 1.
This is line 2.
This is line 3.
We can use fseek() function to move the file pointer to a specific position. For example, the following code moves the file pointer to the beginning of the second line in the file:

```
#include <stdio.h>

int main() {
  FILE *fp = fopen("data.txt", "r");
  if (fp == NULL) {
    printf("Error opening file.\n");
    return 1;
  }

  fseek(fp, 18, SEEK_SET);  // move the file pointer to the beginning of the second line
  char c = fgetc(fp);       // read the first character of the second line
  printf("The first character of the second line is: %c\n", c);

  fclose(fp);
  return 0;
}
```

Output:
The first character of the second line is: T
ii. ftell() function:
The ftell() function in C is used to get the current position of the file pointer. The syntax of the ftell() function is as follows:

long int ftell(FILE *stream);
where stream is a pointer to the file.

Example:

Suppose we have a file "data.txt" with the following contents:

This is line 1.
This is line 2.

We can use ftell() function to get the current position of the file pointer. For example, the following code gets the current position of the file pointer and prints it:

```
#include <stdio.h>

int main() {
  FILE *fp = fopen("data.txt", "r");
  if (fp == NULL) {
    printf("Error opening file.\n");
    return 1;
  }

  long int pos = ftell(fp);  // get the current position of the file pointer
  printf("The current position of the file pointer is: %ld\n", pos);

  fclose(fp);
  return 0;
}
```

Output:

The current position of the file pointer is: 0

rewind() function:
Syntax:

```
void rewind(FILE *stream);
```

Example:

Suppose you have a file named "data.txt" that contains some text. You want to read the file twice - once from the beginning and again from the middle. You can use the rewind() function to reset the file pointer to the beginning of the file as follows:

```
#include <stdio.h>

int main() {
  FILE *fp;
  char ch;

  fp = fopen("data.txt", "r");

  // read the file from the beginning
  while ((ch = fgetc(fp)) != EOF) {
    printf("%c", ch);
  }

  // reset the file pointer to the beginning of the file
  rewind(fp);

  // read the file from the middle
  fseek(fp, 10, SEEK_SET);
  while ((ch = fgetc(fp)) != EOF) {
    printf("%c", ch);
  }

  fclose(fp);
  return 0;
}
```

In the above example, rewind(fp) resets the file pointer to the beginning of the file after the first loop. Then, the file is read again from the middle using fseek().

4. feof() function:
Syntax:

```
int feof(FILE *stream);
```

Example:

Suppose you have a file named "data.txt" that contains some text. You want to read the file until the end and print the number of characters read. You can use the feof() function as follows:

```
#include <stdio.h>

int main() {
  FILE *fp;
  char ch;
  int count = 0;

  fp = fopen("data.txt", "r");

  // read the file until the end
  while (!feof(fp)) {
    ch = fgetc(fp);
    count++;
  }

  printf("Number of characters read: %d\n", count);

  fclose(fp);
  return 0;
}
```

In the above example, feof(fp) returns true when the end of the file is reached, and the loop terminates. The total number of characters read is stored in the count variable and printed at the end.

15 (a)	Recall the syntax for opening a file with various modes and closing a file	6M	20ESX02.5	L1
15 (b)	Develop a C program to copy the contents from one file to another file	6M	20ESX02.5	L3

To open a file, you can use the fopen() function which takes two arguments: the name of the file and the mode in which the file is to be opened. The mode argument is a string which can be one of the following:

"r": Opens a file for reading. The file must exist.

"w": Opens a file for writing. If the file does not exist, it will be created. If it does exist, its contents will be truncated.

"a": Opens a file for appending. If the file does not exist, it will be created. If it does exist, new data will be written to the end of the file.

"r+": Opens a file for both reading and writing. The file must exist.

"w+": Opens a file for both reading and writing. If the file does not exist, it will be created. If it does exist, its contents will be truncated.

"a+": Opens a file for both reading and appending. If the file does not exist, it will be created. If it does exist, new data will be written to the end of the file.

Syntax for opening a file:

```
FILE *fopen(const char *filename, const char *mode);
```

```
FILE *fp;

// open file for writing
fp = fopen("output.txt", "w");
if (fp == NULL) {
   printf("Error opening file.\n");
   exit(1);
}

// write data to file

// close file
fclose(fp);
```

To close a file, you can use the fclose() function which takes a single argument: a pointer to the file to be closed.

Syntax for closing a file:

```
int fclose(FILE *stream);
```

Example:

```
FILE *fp;

// open file for reading
fp = fopen("input.txt", "r");
if (fp == NULL) {
   printf("Error opening file.\n");
   exit(1);
}

// read data from file

// close file
fclose(fp);
```

15b.

```
#include <stdio.h>
#include <stdlib.h>

int main() {
   FILE *fp1, *fp2;
   char ch;

   // open the source file in read mode
   fp1 = fopen("source.txt", "r");
   if (fp1 == NULL) {
      printf("Error opening source file.\n");
      exit(1);
   }

   // open the destination file in write mode
   fp2 = fopen("destination.txt", "w");
   if (fp2 == NULL) {
      printf("Error opening destination file.\n");
      exit(1);
   }
```

```
    // copy from the source file to the destination file
    while ((ch = fgetc(fp1)) != EOF) {
        fputc(ch, fp2);
    }

    // close both files
    fclose(fp1);
    fclose(fp2);

    printf("File copied successfully.\n");

    return 0;
}
```

Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech.	Program	Civil Engg. & Mechanical Engg.			Academic Year	2022 - 2023
Course Code	20BSX21	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Engineering Chemistry						

Part A (Short Answer Questions 5 x 2 = 10 Marks)			
No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Differentiate hard water from soft water	20BSX21.1	L2
2	List three uses of electrochemical series	20BSX21.2	L1
3	Indicate the composition and calorific value of LPG and CNG	20BSX21.3	L1
4	Define Polymer	20BSX21.4	L1
5	What is adsorption?	20BSX21.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)				
No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Estimate the carbonate, non-carbonate, and total hardness of water by the EDTA method	6M	20BSX21.1	L1
6 (b)	Explain sludge and scale formation in boiler. Describe the disadvantages of scale and sludge formation	6M	20BSX21.1	L2
	OR			
7 (a)	Describe the demineralization of water by the ion-exchange process. How are exhausted cation and anion exchange resins regenerated?	6M	20BSX21.1	L1
7 (b)	Discuss the principle and salient features of desalination of water by reverse osmosis	6M	20BSX21.1	L2
8 (a)	Demonstrate the construction and working of a Calomel electrode. Write down its advantages and limitations	6M	20BSX21.2	L2
8 (b)	Illustrate the construction, cell reaction, and working of the MCFC electrode	6M	20BSX21.2	L2
	OR			
9 (a)	With suitable reactions, discuss the mechanism ofelectrochemical corrosion	6M	20BSX21.2	L2
9 (b)	Discuss the different constituents of paints	6M	20BSX21.2	L2
10 (a)	Calculate the HCV and LCV of a fuel having the following composition. 78% carbon, 4.2 % hydrogen, 1.4 % sulphur, 2.1% nitrogen and 2.2% ash	6M	20BSX21.3	L2
10 (b)	Explain the analysis of flue gas by Orsat apparatus	6M	20BSX21.3	L2
	OR			
11 (a)	Discuss briefly the following i. Octane rating ii. Cetane rating	6M	20BSX21.3	L2
11 (b)	Describe the Fischer Tropsch method for the synthesis of petrol	6M	20BSX21.3	L2
12 (a)	Explain the free radical mechanism of chain growth polymerization	6M	20BSX21.4	L2
12 (b)	Differentiate thermoplastics from thermosetting plastics	6M	20BSX21.4	L2
	OR			
13 (a)	Outline the preparation, properties and applications of Buna S rubber	6M	20BSX21.4	L2
13 (b)	Discuss the fiber and structural reinforced composites, enlist their engineering applications	6M	20BSX21.4	L2

14 (a)	What are nanomaterials? Explain any one electrochemical synthesis method for nanometals	7M	20BSX21.5	L2
14 (b)	How does the X-ray diffraction method describe the surface of a substance?	5M	20BSX21.5	L2
	OR			
15 (a)	Enumerate the applications of nanomaterials and colloids	7M	20BSX21.5	L2
15 (b)	Give examples for the BET equation of surface analysis	5M	20BSX21.5	L2

Engineering Chemistry KEY Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech.	**Program**	Civil Engg. & Mechanical Engg.			**Academic Year**	2022 - 2023
Course Code	20BSX21	**Test Duration**	3 Hrs.	Max. Marks	70	**Semester**	I
Course	**Engineering Chemistry KEY**						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Differentiate hard water from soft water Water, which produces lather, readily with soap solution is called soft water, Carbonate hardness Water which does not produce lather with soap solution,Non-Carbonate hardness	20BSX21.1	L2
2	List three uses of electrochemical series Comparison of relative reducing (or) oxidizing power of elements. Example, E0 (Zn/Zn2+) = -0.76 V, E0 (Ni/Ni2+) = -0.25 V. From the values Zinc occupies a position higher in the series as compare to Nickel. So Zinc is a strong reducing agent than Nickel.	20BSX21.2	L1
3	Indicate the composition and calorific value of LPG and CNG Methane , 27800 kcal/m3and Iso butane	20BSX21.3	L1
4	Define Polymer Polymer is a large molecule formed by the repeated combination of small molecules	20BSX21.4	L1
5	What is adsorption? the process by which a solid holds molecules of a gas or liquid or solute as a thin film.	20BSX21.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Estimate the carbonate, non-carbonate, and total hardness of water by the EDTA method **PRINCIPLE:** In this complex metric titration, the hard water is titrated with standard solution of di sodium salt of EDTA using Eriochrome black-T (EBT) indicator . EBT indicator when added to hard water at pH = 10, forms weak complexes with calcium and magnesium present in hard water. It results in the formation of Ca-EBT or Mg-EBT complexes which is wine-red, these are unstable. During titration with EDTA, calcium or magnesium reacts to form stable complex releasing the free indicator (blue) the colour changes from wine-red to blue at the endpoint.	6M	20BSX21.1	L1

Ca^{2+} + EBT (Blue) ⟶ [Ca – EBT] (unstable complex) (wine-red)

Mg^{2+} + EBT (unstable complex) ⟶ [Mg – EBT] (wine-red)

[Ca – EBT] EBT(blue) + EDTA ⟶ [Ca – EDTA] (stable complex) + (blue)

[Mg – EBT] EDTA ——[Mg► EDTA] + EBT
(stable complex) (blue)

Procedure :

Step-1: Preparation of standard hard water solution :
Required quantity of accurately weighed MgSO4.7H2O is transferred into a 100 mL volumetric flask and then makes upto the mark with distilled water.
Step-II: Standardisation of EDTAsolution

Pipette out 20 mL of MgSO4 solution into a conical flask .Then add 3 mL of pH -10 buffer and 1-2 drops of E.B.T indicator. It is titrated against EDTA solution until the colour changes from wine red to blue. Repeat the same procedure until concurrent values(V2) occur
.The molarity(M2) of EDTA solution is calculated as follouws

M1V1 = M2V2

Step-III Determination of Temporary hardness of water sample

Pipette out 20 mL of given water sample into a conical flask .Then add 3 mL of pH -10 buffer and 1-2 drops of E.B.T indicator. It is titrated against EDTA solution until the colour changes from wine red to blue. Repeat the same procedure until concurrent values(V2) occur.The molarity(M3) of given water sample is calculated as follouws

M2V2 = M3V3

Temporary hardness of given water sample = M3*100*1000 = ppm
Step-IV Determination of Permanent hardness of water sample

Pipette out 20 mL of boiled water sample(filtrate) into a conical flask .Then add 3 mL of pH -10 buffer and 1-2 drops of E.B.T indicator. It is titrated against EDTA solution until the colour changes from wine red to blue. Repeat the same procedure until concurrent values occur(V2).The molarity(M4) of given water sample is calculated as follouws

M2V2 = M4V4

Permanent hardness of given given water sample = M4*100*1000 = ppm
Temporary hardness of water = Total hardness – permanent hardness = ppm

Explain sludge and scale formation in boiler. Describe the disadvantages of scale and sludge formation

1. Scale and sludge formation

1) <u>Sludge and Scale formation</u>

6 (b) 6M 20BSX21.1 L2

In boilers, because of continuous evaporation of water, the concentration of salts increase progressively and after the saturation point is reached, precipitate form on the inner walls of boiler. The precipitation takes place in two ways:

In the form of soft, loose and slimy deposits formed comparatively in the colder portions of boiler which is called "Sludge" and

Scales : Scales are hard, adhering precipitates formed on the inner walls of the boilers. They stick very firmly on to the inner wall surface and are difficult to remove with chisel and hammer.

Salts like Ca (HCO3)2, CaCl2 and CaSO4. are responsible for scale formation in boilers

Disadvantages:

i. Wastage of fuel: The scale formation causes decreases of heat transfer, so wastage of fuel occurs.

ii. Danger of Explosion: The hot scale cracks because of expansion and water suddenly comes in contact with overheated iron plates. This causes in formation of large amount of steam suddenly. This results high pressure causing boiler to burst.

iii. Scale decreases efficiency of boilers.

OR

Describe the demineralization of water by the ion-exchange process. How are exhausted cation and anion exchange resins regenerated?

Ion exchange process:

Ion-exchange process includes the exchange of the cations and anions of the dissolved salts with H+ and OH- respectively. For this two types of ion-exchangers are used, which are insoluble, cross–linked long chain organic polymers with microporous structure. In de-ionization process all the ions present in water are eliminated by using ion-exchange resins.

7 (a) Basically resins with acidic functional group are capable of exchanging H+ ions with other cations. Resins with basic functional groups are capable of exchanging OH- ions with other anions. 6M 20BSX21.1 L1

Resins are classified as

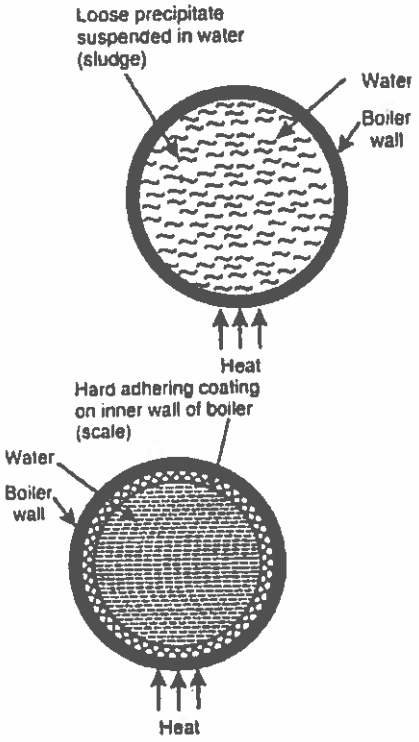
1. Cation Exchange Resins

2. Anion Exchange Resins

1. Cation Exchange Resins:

These are mainly styrene divinyl benzene co-polymers, which contains sulphonic or carboxylic functional groups. They are capable of exchanging their hydrogen ions with cations present in water.

In the form of hard, adherent coating on the inner walls of the boiler which is called "Scale".



SLUDGE 2. SCALE

1. Sludge formation: Sludges are soft, loose, slimy and non-sticky precipitates produced due to the higher concentration of dissolved salts.

Reasons for the formation of sludges: The dissolved salts whose solubility is more in hot water and less in cold water produce sludges. Eg: $MgCO_3$, $MgCl_2$, $CaCl_2$ and $MgSO_4$.

The sludges were formed at comparatively colder portions of the boiler and get collected where rate of flow of water is low.

Disadvantages of sludges:

Sludges are bad conductors of heat and results in the wastage of heat and fuel.

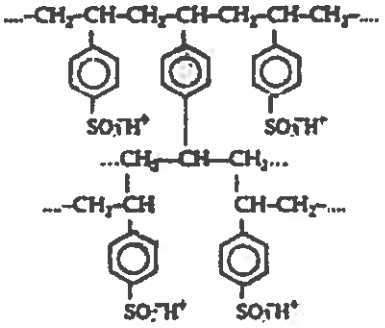
Excessive sludge formation leads to the settling of sludge in slow circulation areas such as pipe connections, plug openings, gauge-glass connections leading to the choking of pipes.

Prevention of sludge formation:

By using well softened water.

2. By frequently carrying out blow down operation. (Removal of concentrated water and

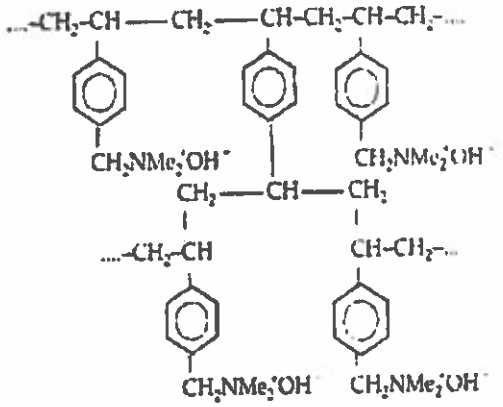
filling the boiler with fresh water).



Sulphonated styrene co-polymer –cationic resin

2. Anion Exchange Resins:

Anion exchange resins are styrene-divinyl benzene or amine-formaldehyde copolymers, which contains amino, quaternary ammonium or quaternary phosphonium or tertiary sulphonium groups as an internal parts of the resin matrix. These after treatment with dilute NaOH solution become capable of exchanging their OH- ions with anions present in water.



N-methyl ammonium hydroxyl styrene co-polymer –anionic resin

In ion-exchange process hard water is allowed to pass through cation exchange resins, which remove Ca+2and Mg+2 ions and exchange equivalent amount of H+ ions. Anions exchange resins remove bicarbonates, chlorides and sulphates from water and exchange equivalent amount of OH- ions. Thus by passing hard water through cation exchanger hardness is removed by the following reactions.

Cation Exchange Resins

$$2RH^+ + Ca^{+2} \longrightarrow R_2Ca^{+2} + 2H^+$$

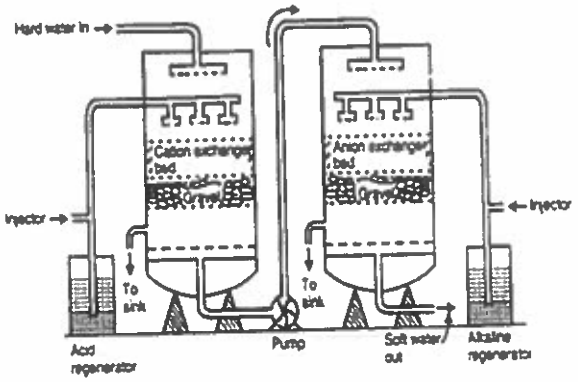
$$2RH^+ + Mg^{+2} \longrightarrow R_2Mg^{+2} + 2H^+$$ (RH+ = cation exchange resin)

Anion Exchange Resins

$$2R1OH + Cl\text{-}2 \longrightarrow 2R1Cl + 2OH\text{-}$$

$$2R1OH\text{-} + SO4\text{-}2 \longrightarrow R12SO4\text{-}2 + 2OH\text{-}$$

$$2R1OH + CO3\text{-}2 \longrightarrow R12CO3\text{-}2 + 2OH\text{-}$$



De-ionization of water

Regeneration:

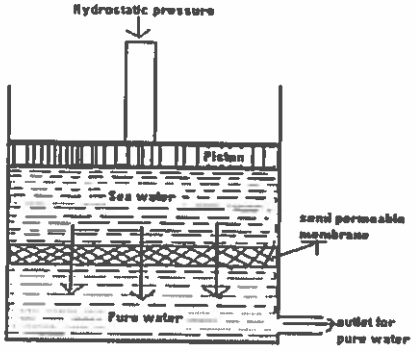
When cation exchanger losses capacity of producing H+ ions and anion exchanger losses capacity of producing OH- ions, they are said to be exhausted. The exhausted cation exchanger is regenerated by passing it through dilute sulphuric acid.

$$R2Ca+2 + 2H+ \rightarrow 2RH+ + Ca+2$$

The exhausted anion exchanger is regenerated by passing a dilute solution of NaOH.

$$R21SO4\text{-}2 + 2OH\text{-} \rightarrow 2R1OH\text{-} + SO4\text{-}2$$

7 (b)	Discuss the principle and salient features of desalination of water by reverse osmosis Reverse Osmosis: When two solutions of unequal concentrations are separated by a semi permeable membrane, flow of solvent takes place from dilute to concentrated sides, due to osmosis. If, however, a hydrostatic pressure in excess of osmotic pressure is applied on the concentrated side, the solvent flow is reversed, i.e. solvent is forced to move from concentrated side to dilute side across the membrane. This is the principle of reverse osmosis. This membrane filtration is also called 'super-filtration' or 'hyper – filtration. The membrane consists of very thin films of cellulose acetate, affixed to either side of a perforated tube. However, more recently superior membranes made of polymethacrylate and polyamide polymers have come into use.	6M	20BSX21.1	L2



Reverse Osmosis

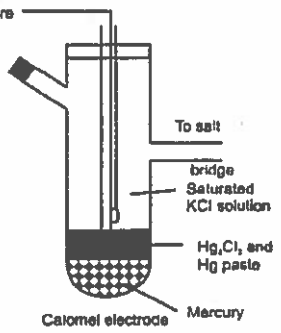
Method of purification: The reverse osmosis cell consists of a chamber fitted with a semi permeable membrane, above which sea water / impure water is taken and a pressure of 15 to 40 kg/cm2 is applied on the sea water / impure water. The pure water is forced through the semi-permeable membrane which is made of very thin films of cellulose acetate.

Demonstrate the construction and working of a Calomel electrode. Write down its advantages and limitations

Construction:

- It consists of mercury, solid mercurous chloride and potassium chloride solution.
- Mercury is placed at the bottom of a glass tube with a side tube on both the sides.
- It is connected to the outer circuit by means of a platinum wire sealed in a glass tube.
- The surface of mercury is covered with a paste of mercurous chloride (calomel).
- A saturated, normal and deci normal potassium chloride solution is introduced through the side tube present in the right side.

8 (a)



6M 20BSX21.2 L2

- Working:
- When this electrode acts as anode the following reaction takes place:

At Anode: $2Hg(l) \leftrightarrows Hg_2^{2+} + 2e^-$ (Oxidation)

At Cathode: $Hg_2Cl_2 + 2e^- \leftrightarrows 2Hg + 2Cl^-$ (Reduction)

Thus calomel electrode is reversible with respect to ions.
This electrode is represented as

Hg, Hg2Cl2(S); KCl (Solution)

The potential of the calomel electrode depends upon the concentration of the potassium chloride solution. It can be determined accurately by connecting the electrode to a standard hydrogen electrode.

Electrode potentials of calomel electrode at different concentrations of potassium chloride at 25°C are:

For saturated KCl solution, E = 0.24 volts

For 1 N KCl Solution, E = -0.28 volts

For 0.1 N KCl Solution, E = -0.34 volts

8 (b)	Illustrate the construction, cell reaction, and working of the MCFC electrode	6M	20BSX21.2	L2
	OR			
9 (a)	With suitable reactions, discuss the mechanism ofelectrochemical corrosion	6M	20BSX21.2	L2
9 (b)	Discuss the different constituents of paints	6M	20BSX21.2	L2
10 (a)	Calculate the HCV and LCV of a fuel having the following composition. 78% carbon, 4.2 % hydrogen, 1.4 % sulphur, 2.1% nitrogen and 2.2% ash HCV = 1/100[8080 C + 34500 (H-O/8) + 2240 S] kcal/kg LCV = HCV – 0.09 x H x 587	6M	20BSX21.3	L2
10 (b)	Explain the analysis of flue gas by Orsat apparatus Gases after combustion contain CO, CO2, N2 etc. In order to know the exact details about any fuel it is essential to analyze the flue gases. The mixture of gases mostly CO2 issuing out of the combustion chamber is called flue gas. The efficiency of combustion can be well understood by the analysis of flue gas. For instance, if the presence of CO is indicated then carbon is suffering incomplete combustion due to insufficient supply of oxygen. But if the analysis shows the excess of CO2, more of O2, it implies that oxidation is complete and the supply of oxygen may be excessive. The analysis of flue gases is carried out with the help of Orsat's apparatus. 1. Flue gas is a mixture of gases produced from the products of combustion of a fuel 2. Its major constituents are CO, CO2,O2, and N2 3. The efficiency of combustion can be understood by the qualitative analysis of flue gases 4. Orsat's apparatus is used for flue gas analysis	6M	20BSX21.3	L2

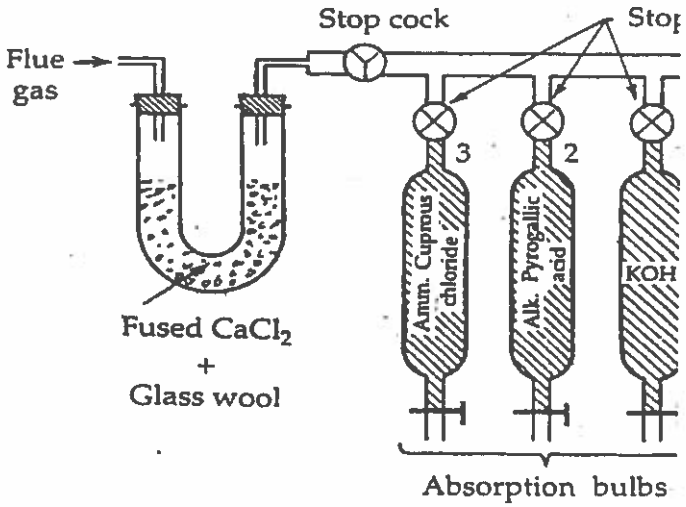


Fig: Orsat's Apparatus

Flue gas ⇨ KOH sol ⇨ Alk. Pyrogallic sol ⇨

ammm.Cu2Cl2 sol

-CO2 -O2

-CO

OR

Discuss briefly the following

i. Octane rating

ii. The performance of gasoline in internal combustion has been rated on the basis of octane number

iii. The higher the octane number, lower is knocking and better is its performance

iv. The knocking is maximum for n-heptane and has lowest antiknock value and its octane number is assigned as zero

v. Knocking is minimum for iso-octane (2,2,4-trimethyl pentane), has highest anti-knocking value and its octane number is given as 100.

vi. Octane number of gasoline is the percentage of iso-octane in the mixture of isooctane and n-heptane which has same knocking as the gasoline itself

11 (a) 6M 20BSX21.3 L2

vii. The higher the octane number, lower is knocking

viii. The octane number of poor fuels can be raised by the addition of extremely poisonous materials such as tetraethyl lead (C2H5)4Pb and diethyl-telluride (C2H4)2Te

The tendency of knocking is based on the chemical structure of hydrocarbons

ix.

x. Cetane rating

Diesel knocking is defined as the rattling sound produced in diesel engine due to ignition lag of fuel air mixture

Knocking is due to improper ignition of fuel –air mixture.

Knocking decreases the efficiency of engine.

Petrol Knock is maximum in open chain straight paraffins and

least in aromatics

xi.

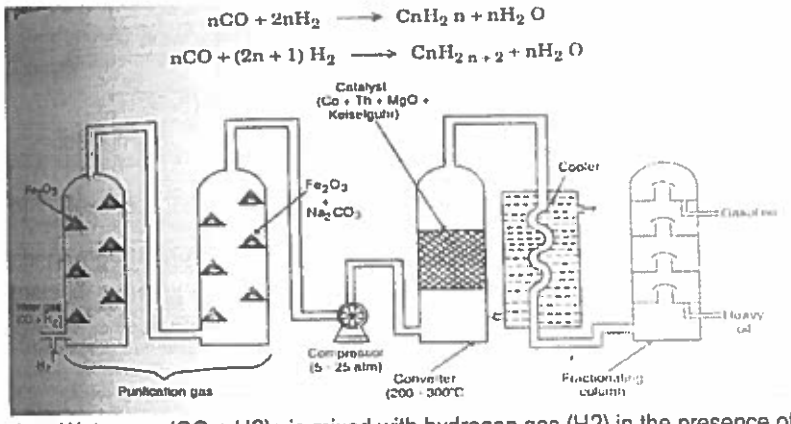
11 (b) Describe the Fischer Tropsch method for the synthesis of petrol 6M 20BSX21.3 L2

. Fischer-Tropsch's method: This method was developed by Franz Fischer & Hans Tropsch (German scientists). The raw material is the hard coke which is converted into water gas (CO + H2) by passing steam over red hot coke.

In general, the mechanism of the reactions can be represented as

$$nCO + 2nH2 \xrightarrow{Ni \text{ or } Co} CnH2n + nH2O$$

$$nCO + (2n + 1)\,H2 \longrightarrow CnH2n+2 + nH2O$$

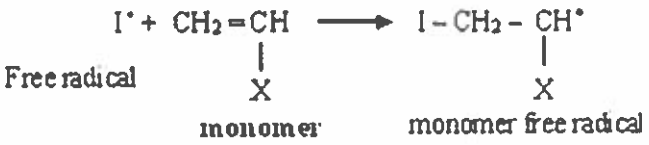


- Water gas (CO + H2)s is mixed with hydrogen gas (H2) in the presence of catalyst
- Catalyst consists of mixture of 100 parts of Co, 5 parts of Th, 8 parts of MgO and 200 parts of Kieselguhr earth
- Water gas and hydrogen gas mixture is purified by passing through Fe2O3 and Fe2O3 + Na2CO3
- Pressure is maintained to 5-25 atmosphere
- Passed through a convertor where the catalyst and temperature are maintained at 200-300oC.
- In the convertor polymerization takes place
- Hot gases are passed through a cooler where crude oil produced
- Crude oil is fractionated in a fractionating column and the gasoline fraction is produced in the top fraction
- The high boiling heavy oil is obtained at the bottom can be used for cracking to get more gasoline

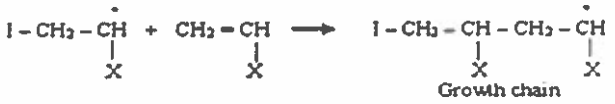
12 (a) Explain the free radical mechanism of chain growth polymerization 6M 20BSX21.4 L2

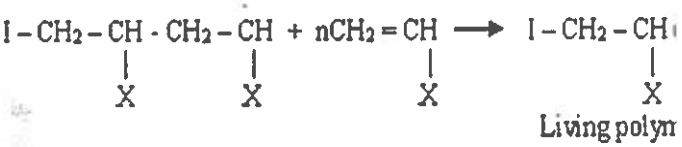
Free radical additional polymerization: During polymerization of alkenes the presence of a small amount of an initiator is necessary. Commonly known initiators are peroxides.

Chain initiation step:- Initiators are unstable compounds and undergoes homolytic fission to produce free radicals which react with πe's of the monomer to produce monomer free radical.

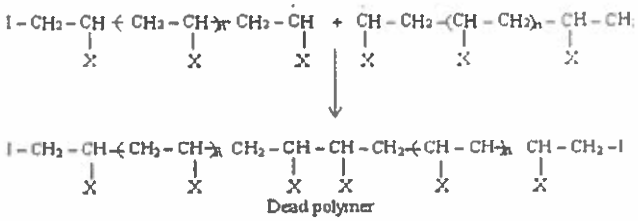


H2O2 is good initiator for free radical chain polymerization.
b) Propagation:- The monomer free radical chain reacts with a number of monomers rapidly resulting the chain growth with free radical site at the end of the chain producing a living polymer.





By adding fresh monomer to the living polymer with free radical site, again chain growth starts. Hence it is known as living polymer.
Termination: (To stop chain growth) The reaction is terminated by the recombination of final free radicals producing dead polymer



Cationic

12 (b) Differentiate thermoplastics from thermosetting plastics
1. Thermo plastics:
i) These are linear long chained polymer, which can be softened on heating and hardened on cooling.
ii) These are formed by addition/chain polymerization.
iii) They posse's weak vanderwall forces in between two polymeric chains.

6M 20BSX21.4 L2

iv) These resins are usually soluble in organic solvents.
v) These plastic can be reclaimed from waste.
vi) They can be reshaped, remoulded and reshaped.
vii) These plastic are softer and flexible
viii) Eg: P.E, P.V.C, P.S & P.T.F.E
2. Thermo setting plastic
i) These plastics are 3D, cross linked polymers. Which cannot be softened on heating and
hardened on cooling.
ii) Once they are solidified they cannot be softened.
iii) They are formed by condensation/step polymerization.
iv) They cannot be reused and reshaped.
v) They cannot be reclaimed from waste.
vi) They are hard, strong and more brittle.
vii) These are insoluble in almost all organic solvents.
viii) Eg: Bakelite, Urea-formaldehyde

OR

Outline the preparation, properties and applications of Buna S rubber

Synthetic Rubbers:

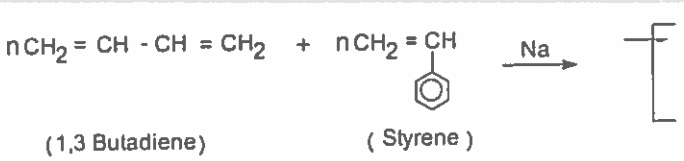
1. Styrene Butadiene Rubber (BUNA – S):
   'BU' stands for Butadiene – monomer
   'NA' stands for Sodium – catalyst
   'S' stands for Styrene - monomer

Preparation:

- 1,3 butadiene reacts with styrene in presence of 'Na' catalyst to form

Butadiene styrene rubber, it is co-polymer rubber.

Chemical equation:

13 (a)  6M 20BSX21.4 L2

(1,3 Butadiene) (Styrene)

Properties:

- It is hard and high tensile strength.
- It is insoluble in all organic solvents.
- It is highly resistant to all mineral acids.

Applications:

- It is used for manufacturing of tyres.
- It is used in the footwear industry for making shoe soles and footwear components.
- It is also used for making wires and cable insulations.

13 (b) Discuss the fiber and structural reinforced composites, enlist their engineering applications 6M 20BSX21.4 L2

What are nanomaterials? Explain any one electrochemical synthesis method for nanometals

Sol-gel method one of the important methods for processing fine nano particles with nano size distribution with controlled chemical composition at low temperatures

The solution in which the molecules of nanometer are dispersed appear clear. The colloids in which molecules of size ranging from 20 nm to 100 nm appear milky. A colloid suspended in a liquid is called as Sol. A suspension that keeps its shape is called gel. This sol gels are suspensions of colloids in liquids that keep their shape.

The materials used in the preparation of sol are metal alkoxides and alkoxy silanes. The most widely used are tetramethoxysilanes (TMOS) and tetraethoxysilanes. Sol-gel formation occurs in different stages.

Step1: Hydrolysis:

TEOS is a molecule which displays 4 functional arms (O-C2H5). During hydrolysis, addition of water results in the replacement of (O-C2H5) group with OH group. Formation of different stable solutions of alkoxide or solvated metal precursor (the sol)

$$(C_2H_5O)_3\text{-Si-}OC_2H_5 + H_2O \longrightarrow (C_2H_5O)_3\text{-OH} + C_2H_5OH$$

14 (a) Step 2: Condensation: 7M 20BSX21.5 L2

Gelation resulting from the formation of an oxide or alcohol bridged network (the gel) by polycondensation reaction.

$$(C_2H_5O)_3\text{-Si-OH} + HO\text{-Si-}(OC_2H_5)_3 \longrightarrow (C_2H_5O)_3\text{–Si-O-Si-}(OC_2H_5)_3$$

The continuous formation of bridges (Si-O-Si bridges), induces the formation of a polymetric tri-dimensional network. This results in dramatic increase in the viscosity of the solution.

Step 3: Growth and Agglomeration:

As the number of siloxane bonds increase, the molecules aggregate in the solution. Ageing of the gel, during which the polycondensation reactions continue until the gel transforms into solid mass. This is accompanied by contraction of the gel network and expulsion of solvent from gel pores

Step 4: Drying of the gel when water and other volatile liquids are removed from the gel network

Step 5: Dehydration, during which surface bound M-OH groups are removed. This is normally achieved by calcination.

The typical steps that are involved in sol gel processing are shown by different process, one can get either nanofilm coating or nanopores or dense ceramic with nanograins

Advantages of sol gel method:

1. It requires low temperatures processing temperature

2. It provides high homogeneity and pure products
3. The nano particles produced by this method range from 5-30nm

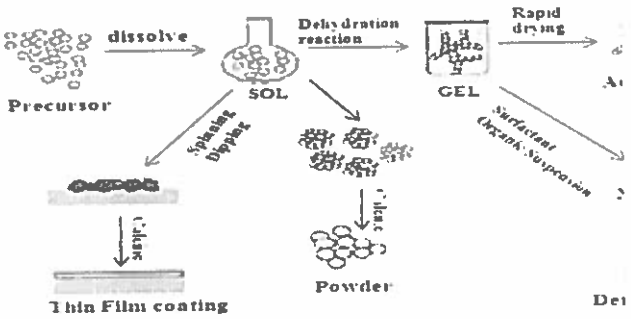


Fig: Schematic representation of Sol-Gel process for synthesis

How does the X-ray diffraction method describe the surface of a substance?

X-ray powder diffraction (XRD) is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, homogenized, and average bulk composition is determined.

Fundamental Principles of X-ray Powder Diffraction (XRD)

Max von Laue, in 1912, discovered that crystalline substances act as three-dimensional diffraction gratings for X-ray wavelengths similar to the spacing of planes in a crystal lattice. X-ray diffraction is now a common technique for the study of crystal structures and atomic spacing.

14 (b) X-ray diffraction is based on constructive interference of monochromatic X-rays and a crystalline sample. These X-rays are generated by a cathode ray tube, filtered to produce monochromatic radiation, collimated to concentrate, and directed toward the sample. The interaction of the incident rays with the sample produces constructive interference (and a diffracted ray) when conditions satisfy Bragg's Law ($n\lambda=2d\sin\theta$). This law relates the wavelength of electromagnetic radiation to the diffraction angle and the lattice spacing in a crystalline sample. These diffracted X-rays are then detected, processed and counted. By scanning the sample through a range of 2θangles, all possible diffraction directions of the lattice should be attained due to the random orientation of the powdered material. Conversion of the diffraction peaks to d-spacings allows identification of the mineral because each mineral has a set of unique d-spacings. Typically, this is achieved by comparison of d-spacings with standard reference patterns. 5M 20BSX21.5 L2

All diffraction methods are based on generation of X-rays in an X-ray tube. These X-rays are directed at the sample, and the diffracted rays are collected. A key component of all diffraction is the angle between the incident and diffracted rays. Powder and

single crystal diffraction vary in instrumentation beyond this.

OR

Enumerate the applications of nanomaterials and colloids

materials for specific applications in the field of medicine, advanced catalysis, control pollution, storage devices, optical and electronic devices.

In Electronic Devices:

The potential application of nano particles is in the design of new super computers, includes zero dimensional quantum dots, one dimensional quantum dot, nano scale circuits etc.

In communication technology, nano wires 20 times thinner and longer than conventional wires are used

In Solar Cells:

Nanotechnology improves energy efficiency, storage and production of solar cells.

Solar cells are expensive and nano-meter sized solar cells provide more energy at a cheaper price.

This would reduce the usage of fossil and nuclear fuels.

In Food:

Silver nanoparticles embedded in plastic for storage bins to kill bacteria, minimizing health risks from harmful bacterial

Clay nanoparticles used in bottles, cartons and films to act as barrier to the passage of gasses and odours

A combination of nanomaterials with enzymes improves the durability of enzymes, creates localized high concentration of proteins and reduces cost by minimizing losses.

In Automobiles:

15 (a)	Nylon nanocomposites containing small amount of clay are capable of withstanding high temperature environments and used in automobile air intake covers. High power switches in ignition devices On-line sensors for the measurement of wear and abrasion Create more efficient ultra-thin hydrocarbon membranes which allow to build light-weight fuel cells To Control Pollution: Nanotechnology helps in reducing chemical pollution. Nanoparticles as catalysts to transform vapours escaping from cars or industrial plants into harmless gases Nanostructures menbranes to separate CO2 from industrial plant exhaust streams Eg. TiO2 nanocrystals for air purification, manganeseoxide nanoparticles containing catalysts for removal of volatile organic compounds in indudtrial air emissions. Water Pollution Nanotechnology helps in reducing water pollution Iron nanoparticles convert the contaminating chemicals to harmless compound Usage of electrodes composed of nano-sized filters to remove salts or metals Usage of filters of few nanometer in diameter to remove virus cells from water. Eg. nanofibres As Catalyst: Catalyst are stable at high temperatures and can be used in smaller possible amount have been discovered.	7M	20BSX21.5	L2

Eg: Rhodium hydrosols are the effective catalysts for the hydrogenation of olefins in organic phase.
The complex oxide barium hexaaluminate BaO3 Al2O3 retains its catalytic activity at high temperature.
Nano chemical routes catalyze the chemical reactions at much lower temperature, pressure and in a very short period of time.
In Medical field:
In the field of medicine and surgery nano technology possesses several potential applications
Mutations in DNA could be repaired and cancer cells, toxic chemicals, viruses could be destroyed with the help of nano devices.
Sensor systems which detect the emerging diseases in the body would shift the focus from the treatment of disease to early detection and prevention.

15 (b)	Give examples for the BET equation of surface analysis Brunauer-Emmett-Teller (BET): Surface areas of materials have been observed by Brunauer-Emmett-Teller (BET). For micro porous material, surface area is a very ambiguous concept for two reasons: 1. The microscopic definition of the molecular surface is arbitrarily defined, and there are several sensible definitions available, which can yield significantly different results under certain circumstances. 2. All surfaces are highly corrugated at the atomic scale, which can give higher than expected surface areas if microscopic definitions are used; this is a continuing source of difficulty in comparisons of simulated and experimental results on porous materials. Experimental surface areas are most commonly obtained through the analysis of adsorption isotherms of nitrogen or some other gas. For this analysis the Brunauer-Emmett-Teller (BET) method is used. It is based on a well-defined adsorption model and it gives a monolayer capacity of the material. This capacity is a well-defined quantity and can be used to compare experimental and simulated systems. In order to convert to a surface area, a value for the monolayer density is needed, which is obtained experimentally using a reference system of known surface area. The requirement of this method for accuracy that the monolayer density be transferable, i.e. it is not dependent on the surface curvature or pore structure and not strongly dependent on the chemistry of the underlying surface.	5M	20BSX21.5	L2

20/12/22
HOD S&H

Head of the Department
Dept. of Science & Humanities
N.S.Raju Institute of Technology
Sontyam, Visakhapatnam - 531173

(8) (b) Illustrate the construction of the MCFC electrode — 2m
cell reaction of the MCFC electrode — 2m
working of the MCFC electrode — 2m

(9) (a) With suitable reactions — 2m
Discuss the mechanism of electrochemical corrosion — 4m

(b) Discuss the different constituents of paints — 6m

(10) (a) Calculate the HCV & LCV of a fuel having the following composition 78% carbon, 4.2% hydrogen, 1.4% sulphur, 2.1% nitrogen & 2.2% ash — 6m

(b) Explain the analysis of fuel gas by Orsat apparatus — 6m

(11) (a) Discuss briefly the following
octane rating — 3m
cetane rating — 3m

(b) Describe the Fischer Tropsch method for the synthesis of petrol — 6m

(12) (a) Explain the free radical mechanism of chain growth polymerisation. — 6m

(b) Differentiate thermoplastics from thermosetting plastics — 6m

(13) (a) Preparation of Buna-S rubber — 2m
properties of Buna-S rubber — 2m
Applications of Buna-S rubber — 2m

(b) Discuss the fiber & structural reinforced composites — 4m
enlist their engineering applications — 2m

(14) (a) What are nanomaterials — 2m
Explain any one electrochemical synthesis method for nanomaterials — 5m

(b) How does the X-ray diffraction method describe the surface of a substance — 5m

(15) (a) Enumerate the applications of nano materials — 3.5m
applications of colloids — 3.5m

(b) Give examples for the BET equation of surface analysis — 5m

Hull 21/2/23
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Semester End Regular / supplementary Examination

February – 2023

Scheme

Degree : B.Tech Program : Civil Engg & Mechanical Academic Year : 2022–2023

Course code : 20BSX21 Test Duration : 3 Hrs. Semester : I

Course : Engineering chemistry max marks : 70

PART – A [Short Answer Questions 5X2 = 10 m]

(1) Differentiate hard water from soft water — 2m

(2) List three uses of electrochemical series — 2m

(3) Indicate the composition and calorific value of LPG and CNG — 2m

(4) Define polymer — 2m

(5) What is adsorption

PART – B [Long Answer Questions 5X12 = 60 m]

(6) (a) Estimate the carbonate hardness of water by the EDTA — 2m
Non-carbonate hardness of water by the EDTA method — 2m
total hardness of water by the EDTA method — 2m

(b) Explain sludge and scale formation in boiler — 4m
Describe the disadvantages of scale and sludge formation — 2m

(7) (a) Describe the demineralization of water by the ion-exchange process. — 3m
How are exhausted cation & anion exchange resins regenerated

(b) Discuss the principle of reverse osmosis — 2m
Salient features of desalination of water by reverse osmosis — 2m
Block diagram of Reverse osmosis — 2m

(8) (a) Demonstrate the construction and working of a calomel electrode — 3m
Write down its advantages & — 1m
Limitations — 1m

Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech.	Program	CSE, CSE (AI & ML), CSE (DS) & EEE			Academic Year	2022 - 2023
Course Code	20BSX33	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Applied Physics						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define polarization	20BSX33.1	L1
2	List any two applications of LASER	20BSX33.2	L1
3	List any two applications of dielectric materials	20BSX33.3	L1
4	List any two properties of matter waves	20BSX33.4	L1
5	Define n - type semiconductor	20BSX33.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6	Quantitatively explain Newton's Ring experiment with interference concept and derive diameters for dark and bright rings	12M	20BSX33.1	L2
	OR			
7 (a)	Describe the construction and working of Nicol prism	10M	20BSX33.1	L2
7 (b)	Define the phenomenon of double refraction	2M	20BSX33.1	L2
8 (a)	With a neat energy level diagram, exemplify the construction and working of ruby laser	10M	20BSX33.2	L2
8 (b)	List any two characteristics of laser	2M	20BSX33.2	L2
	OR			
9 (a)	Derive acceptance angle and numerical aperture of optical fiber	10M	20BSX33.2	L2
9 (b)	Indicate the conditions required to achieve total internal reflection	2M	20BSX33.2	L2
10	Summarize the characteristics of magnetic materials	12M	20BSX33.3	L2
	OR			
11 (a)	Discuss various types of polarization mechanisms in di-electrics	10M	20BSX33.3	L2
11 (b)	Define Di-electric constant	2M	20BSX33.3	L2
12	Formulate Schroedinger's time dependent and independent wave equations	12M	20BSX33.4	L2
	OR			
13	Discuss merits and de-merits of classical free electron theory	12M	20BSX33.4	L2
14	Illustrate the motion of an electron in a periodic potential based on Kroning-Penney model	12M	20BSX33.5	L2
	OR			
15	Define Hall Effect and derive an expression for Hall coefficient. List any two applications of Hall Effect	12M	20BSX33.5	L2

N S RAJU INSTITUTE OF TECHNOLOGY

(AUTONOMOUS)

SONTYAM , ANANDAPURAM, VISAKHAPATNAM – 531 173

ANSWER KEY AND SCHEME OF EVALUATION

APPLIED PHYSICS (20BSX33)

Part A (short answer questions 5*2=10M)

1 . Define polarization.

It is a property of waves that describes the orientation of their oscillations. (Or)

The wave which has acquired the property of One - Sidedness is called polarized wave and the phenomena is known as polarization.

2. List any two applications of Lasers.

- Industries: Drilling high quality holes, high quality welding. high quality cutting.
- Communications: Optical fiber systems, CD/DVD/USB/HDD writing and reading.
- Medicine: Blood less surgery, endoscopic studies.

3. List any two applications of dielectric materials.

- Insulating materials: Dielectric materials can be used as insulating materials.The material should have low dielectric constant, low dielectric loss, high dielectricstrength and high resistance.
- Capacitors: Dielectric materials are used to prepare dielectric capacitors which havehigher capacity value and also can be operated at higher voltages.

4. List any two properties of matter waves.

- Ψ must be finite, continuous and single valued everywhere. Ψ must be normalisable.
- $\frac{\partial\Psi}{\partial x}, \frac{\partial\Psi}{\partial y}$ and $\frac{\partial\Psi}{\partial z}$ must be finite, continuous and single valued everywhere.

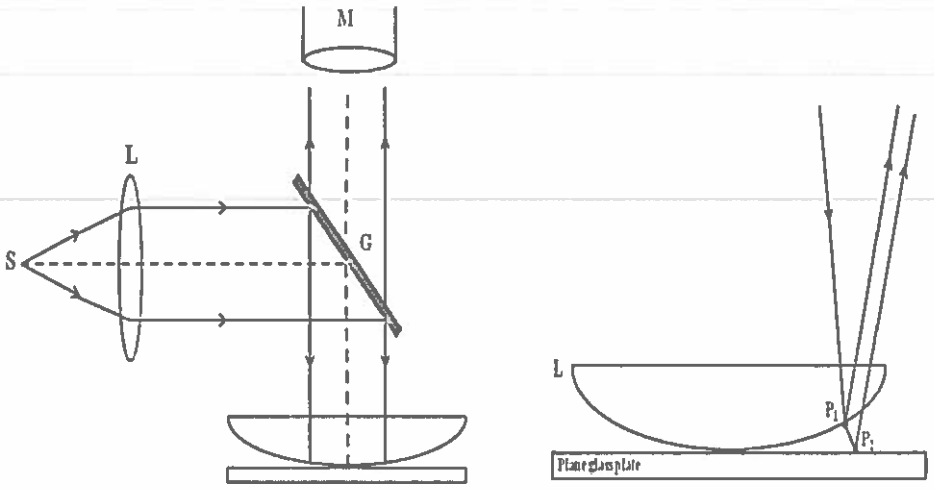
5. Define n - type semiconductor.

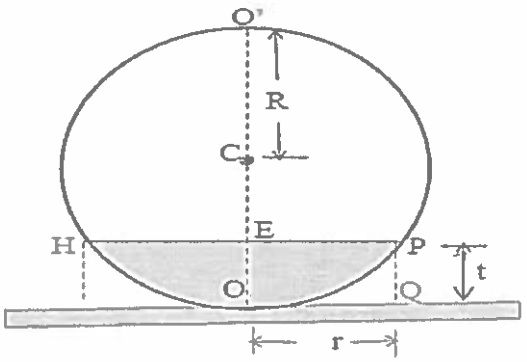
In a pure (intrinsic) semiconductor, when pentavalent an impurity like Phosphorous atom consisting of five valance electrons is doped, and then concentration of electrons increases than holes. Hence the given semiconductor formed is called N – type semiconductor.

Part B (Long Answer Questions 5 x 12 = 60 Marks)

6. Quantitatively explain Newton's Ring experiment with interference concept and derive diameters for dark and bright rings.

A plano-convex lens L of large radius of curvature and is placed on a plane glass plate. The light from monochromatic source is incident on a glass plate, which is placed at an angle of 45° with vertical. The glass plate reflects normally a part of incident light towards the air film enclosed by the lens L and the glass plate P. A part of the incident light is reflected by the curved surface of the lens L and remaining is transmitted which is reflected back from the plane surface of the glass plate P. These two reflected rays (P_1 and P_2) are interfering and produce an interference pattern in the form of bright and dark circular rings. These rings can be viewed in a microscope M focused on the film.





Let 'R' be the radius of curvature of the lens 'L' let us choose a point 'P' at a distance 'r' from 'O' and

So the total path difference= $2t + \frac{\lambda}{2} - - - - - (1)$

When this path difference is $n\lambda$, constructive interference occurs.
Hence the condition for bright rings is

$2t + \frac{\lambda}{2} = n\lambda$

$2t = (2n-1)\frac{\lambda}{2} - - - - - (2)$, where $n = 1,2,3, \ldots$

Similarly the condition for dark rings is

$2t + \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$

$2t = n\lambda - - - - - (3)$, where $n = 0,1,2, \ldots$

Let us consider the curved surface of the lens as an arc of the circle, whose centre is at 'C'.

From figure,

$HE \times EP = OE \times EO' \; [\because HE = EP = r, \; OE = t]$

$r^2 = t(OO' - OE)$

$= t(2R - t)$

$= 2Rt - t^2$

Since 't' is very small, then 't^2' can be neglected.

Hence, $r^2 = 2Rt$

$t = \frac{r^2}{2R} - - - - - (4)$

Substituting equation (4) in (2), we get

$\frac{2r^2}{2R} = (2n-1)\frac{\lambda}{2}$

$r^2 = (2n-1)\frac{\lambda}{2}R$

$r = \sqrt{(2n-1)\frac{\lambda}{2}R} - - - - - (5)$, where $n = 1,2,3, \ldots$

If D is the diameter of the ring, r=D/2

$D^2/4 = (2n-1)\frac{\lambda}{2}R$

$D^2 = 2(2n-1)\,\lambda R$

$D = \sqrt{2(2n-1)\,\lambda R}$

$$D \propto \sqrt{(2n-1)}$$

Therefore the diameter of the bright ring is proportional to the square root of the oddnatural numbers.

Substituting equation (4) in (3), we get

$$2t = n\lambda$$

$$\frac{2r^2}{2R} = n\lambda$$

$$r^2 = n\lambda R$$

$$r = \sqrt{n\lambda R} - - - - - (6), \text{ where } n = 0,1,2, \ldots$$

If D is the diameter of the ring, r=D/2

$$D^2/4 = n\lambda R$$
$$D^2 = 4n\lambda R$$
$$D = \sqrt{4n\lambda R}$$
$$D \propto \sqrt{n}$$

Therefore, the diameter of the dark ring is proportional to the square root of naturalnumbers.

7 (a). Describe the construction and working of Nicol prism.

It was invented by William Nicol in 1828 and is known as "Nicol Prism".

Nicol prism is an optical device used for producing and analyzing plane polarized light.

It is based on the phenomenon of double refraction. It is made from "Calcite Crystal".

Construction:

A calcite crystal whose length is three times its breath is taken. The two ends AB and CD of the crystal are cut, so that the angle ABC reduces from 71^o *to* 68^o.

Then the crystal is cut into two halves along the plane A_1C_1, which passes through the blunt corners and perpendicular to both the principle section and end faces.

A_1C_1 makes an angle of 90^o with C_1D and A_1B.

The two cut faces are well polished and cemented together using a thin layer of **Canada balsam**.

It is a transparent material. It has refractive index 1.55 for $\lambda = 5893\ A^o$.

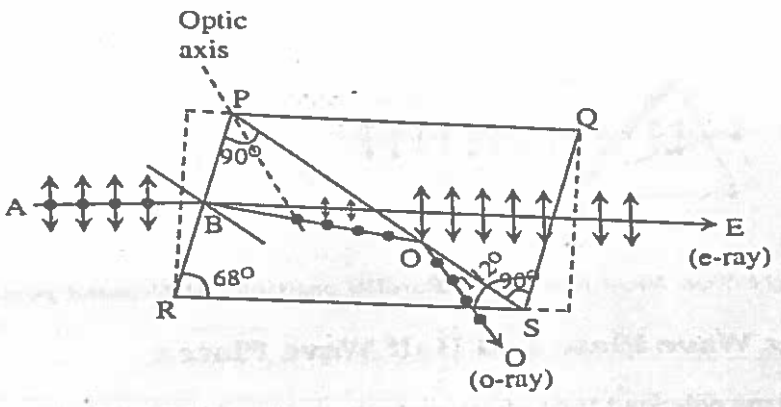


Fig. 3.10 Nicol prism

working:

When Unpolarized light enters the Nicol prism, it splits into ordinary and extra ordinary rays. Inside the crystal when ordinary ray meets the thin layer of Canada balsam cement, it has to travel from denser medium to rarer medium. Because of shaping of the crystal face, the ordinary ray is refracted more.

The angle of incidence at the Canada balsam interface is greater than the critical angle. Hence it undergoes total internal reflection and leaves the crystal through its side.

Hence extra ordinary ray emerges out of the prism parallel to its original direction. So extra ordinary ray is plane polarized having vibrations parallel to the principle plane, the light emerging from the Nicol's prism is plane polarized.

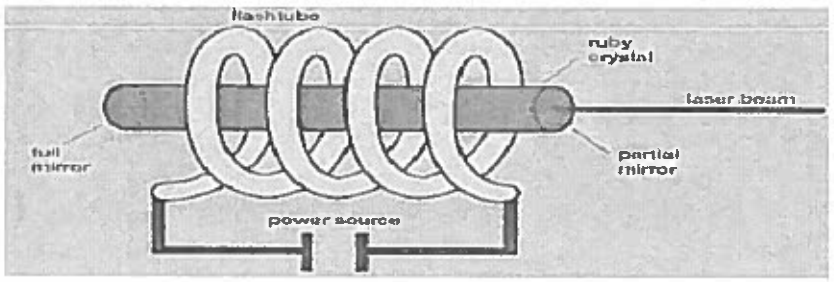
7(b). Define the Phenomenon of double refraction.

When a beam of ordinary light is passed through a transparent crystal like calcite($CaCo_3$) or Quartz(SiO_2), it is split up into two refracted rays i.e., ordinary ray and extra ordinary ray. Both the rays are plane polarized. This phenomenon is called double refraction (or) birefringence.

8 (a). With a neat energy level diagram, exemplify the construction and working of ruby laser.

Ruby laser was first laser device, fabricated by T.H. Maiman in 1960. Ruby laser produces high output power of the order of Mega Watts in form of pulses, so that it is called **pulsed laser.**

Ruby is basically Aluminum oxide (Al_2O_3) crystal doped with Chromium oxide (Cr_2O_3) atoms. The percentage of **Al_2O_3 is 99.95%** and the percentage of **Cr_2O_3 is 0.05%.** Due to the presence of chromium atoms the ruby rod is appear as **pink** in color.



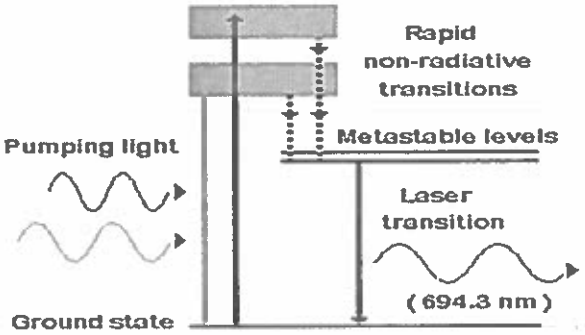
Construction:

Ruby laser consist a long narrow cylinder rod (**Al_2O_3 + Cr_2O_3**) the length of the rod is 4 centimeters and the diameter is 1 centimeter. The end faces of ruby rod made strictly parallel and are coated with silver such that one end face becomes fully reflected and the other end face is partially

reflecting. The ruby rod is surrounded by helical xenon flash tube which provides the suitable light energy to raise the chromium ions to the high energy level. The flash of the xenon tube lasts several milliseconds and the tube consumes several thousand joules of energy. Only a part of this energy is used in pumping the chromium ions while the rest heats up the apparatus. For this purpose a cooling system is used.

Working:

The chromium atoms are active atoms and have three active energy levels named as ground state, Meta stable state and higher energy state. Initially the Cr^{3+} ions are in the ground state. When the ruby rod is irradiated with light of xenon flash, the Cr^{3+} atoms are excited to higher energy state where the light absorption band 5600Å.



Energy levels of chromium ions in ruby

The excited Cr atoms in the high energy state stay only 10^{-8} sec and decays into the metastable state by non-radiation transition. That is the chromium atoms give a part their energy to the crystal lattice in the form of heat. The metastable state becomes more populated than that of ground state within a short interval of time and hence desired population inversion is achieved. The spontaneous transition may cause an induced transition which produces a photon.

The end of the ruby rods acts as reflecting mirrors. Therefore photons that are not moving parallel to the uniform rod escape from the side but those moving parallel to the rod are reflected back. These stimulated the emission of similar other photons. The chain reaction quickly develops a beam of photons moving parallel to the rod, which is monochromatic and coherent. When the beam develops sufficient intensity, it emerges through the partially silvered end. Once all the chromium ions in the metastable state have to return to ground state laser action stops. The wavelength of the laser beam is 6943Å corresponding to the red color.

8(b). List any two characteristics of laser.

The laser radiation has the following characteristics over ordinary light source. They are

1. Monochromaticity
2. Directionality (or) small divergence
3. Coherence and
4. Brightness (or) high intensity.

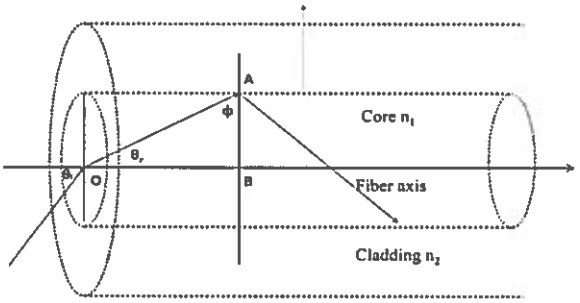
9(a). Derive acceptance angle and numerical aperture of optical fiber.

The maximum angle of incidence at the end face of an Optical fiber for which the light ray can be propagated along core-cladding interface is known as maximum Acceptance angle. It is also called

Acceptance angle:

Consider a ray of light travelling along a medium of refractive index n_0, incident at air-core interface of the optical fiber and making an angle θ_i with the axis of the fiber. It is refracted into the core of refractive index n_1 with angle of refraction θ_r. This ray makes an angle ϕ with the normal at the core-cladding interface and is totally reflected into the core as shown in figure.

If ϕ is the greater than the critical angle θ_c, the ray undergoes total internal reflection at the interface, since $n_1 > n_2$. As long as the angle ϕ is greater than θ_c the light will stay within the fiber.



According to Snell's law

$$n_0 \sin\theta_i = n_1 \sin\theta_r$$

$$\sin\theta_i = \frac{n_1}{n_0}\sin\theta_r \quad \text{..... (1)}$$

If θ_i is increased beyond a limit, ϕ will decrease below the critical angle θ_c and ray escapes from the side walls of the fiber.

from Δ^{le} OAB, $\phi + \theta_r = 90°$

$\theta_r = 90° - \phi$

$\sin\theta_r = \sin(90° - \phi)$

$= \cos\phi$ ..... (2)

Substituting equation (2) in equation (1), we get

$$\sin\theta_i = \frac{n_1}{n_0}\cos\phi \quad \text{..... (3)}$$

When $\varphi = \theta_c$

$\sin\theta_{i(max)} = \frac{n_1}{n_0}\cos\theta_c$ ..... (4) but the condition for total internal reflection, $\sin\theta_c = \frac{n_2}{n_1}$

$$\cos\theta_c = \sqrt{1-\sin^2\theta_c}$$

$$\cos\theta_c = \sqrt{1-(\frac{n_2}{n_1})^2}$$

$$\cos\theta_c = \frac{\sqrt{n_1^2 - n_2^2}}{n_1}$$

Substituting $\cos\theta_c$ in equation (4)

$$\sin\theta_{i(\max)} = \frac{n_1}{n_0}\frac{\sqrt{n_1^2 - n_2^2}}{n_1}$$

$$\sin\theta_{i(\max)} = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

Representing $\sin\theta_{i(\max)}$ as θ_a

$$\sin\theta_a = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

For air medium n_0=1, then

$$\sin\theta_a = \sqrt{n_1^2 - n_2^2}$$

$$\theta_a = \sin^{-1}\sqrt{n_1^2 - n_2^2}$$

This is required expression for Maximum Acceptance Angle in optical fibers.

The angle θ_a is called the acceptance angle of the fiber.

Numerical Aperture:

The light gathering capacity of an optical fiber is known as Numerical Aperture and it is proportional to Acceptance Angle. It is numerically equal to sine of minimum Acceptance Angle. Numerically it is equal to sine of the acceptance angle.

$$NA = \sin\theta_a$$

$$\sin\theta_a = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

For air medium n_0=1, then

$$NA = \sqrt{n_1^2 - n_2^2}$$

Generally n_1 is slightly greater than n_2.

$$NA = \sqrt{(n_1 + n_2)(n_1 - n_2)}$$

Since $(n_1 \approx n_2)$ therefore $n_1 + n_2 \approx 2n_1$

$$NA = \sqrt{(2n_1)(n_1 - n_2)}$$

$$NA = \sqrt{(2n_1^2)(\frac{n_1 - n_2}{n_1})}$$

$$NA = \sqrt{n_1^2 2\Delta} \quad \text{Where } \Delta = \frac{n_1 - n_2}{n_1}$$

$$NA = n_1\sqrt{2\Delta}$$

Where Δ is a fractional difference between the refractive indices of core and cladding. It is

known as fractional refractive index change. It is expressed as $\Delta = \frac{n_1 - n_2}{n_1}$.

9(b). Indicate the conditions required to achieve total internal reflection.

1. The light must be travelling from denser medium into a rarer medium (ie glass to air);
2. The angle of incidence must be greater than the critical angle ($i > \theta_c$).

10. Summarize the characteristics of magnetic materials.

Magnetic materials are those which are effected by a magnet.
They can be classified as diamagnetic materials, paramagnetic materials, ferromagnetic materials, anti-ferromagnetic materials and ferri magnetic materials.
The behavior of magnetic substances can be explained on the basis of electron theory.

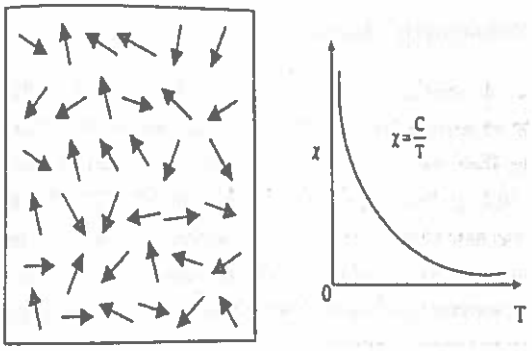
Diamagnetic materials:

1. The materials which are weakly magnetized in a direction opposite to that of theapplied magnetic field are called diamagnetic materials.
2. When a diamagnetic material placed in a non-uniform field, then it tends to movetowards the weaker part from the stronger part of the field.
3. A diamagnetic liquid in a U shaped tube is depressed, when subjected to a magneticfield.
4. The lines of force do not prefer to pass through the specimen, since the ability of amaterial to permit the passage of magnetic lines of force through it is less.
5. There is no permanent dipole moment, so the magnetic effects are very small.
6. The magnetic susceptibility is negative. It is independent of temperature and magneticfield strength.
7. The relative permeability μ_r for diamagnetic substances is less than one.
8. Eg: metals (Cu, Au, Bi, Sb, Hg), semiconductors (Si, Ge), rare gas elements (He, Ne,Ar), benzene, Naphthalene, Nacl, air, water, H_2 etc.

Paramagnetic materials:

1. The paramagnetic materials are feebly magnetized in the direction of the magnetizingfield. When a paramagnetic rod is suspended freely in a uniform magnetic field, it alignsitself in the direction of magnetic field.
2. The magnetic susceptibility is small and positive, is of the order of 10^{-3}
3. In a non-uniform magnetic field, the paramagnetic substances are attracted towardsthe stronger parts of the magnetic field from the weaker part of the field.
4. As soon as the magnetizing field is removed, the paramagnetic materials lose their magnetization.
5. The paramagnetic susceptibility varies inversely with temperature. Where C is the Curie constant, this relation is called curies law.

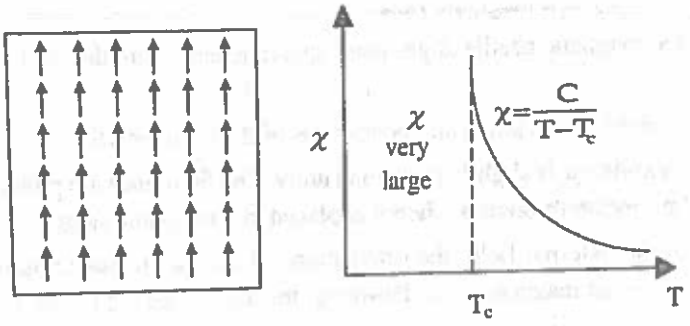
6. Eg: metals, salts of the transition elements, rare earths and actinide series containing elements,compounds etc



Ferromagnetic materials:

1. These materials get strongly magnetized in the direction of the field.
2. These materials possess permanent magnetic moments even when applied field is zeroi.e., they possess spontaneous magnetization.
3. The magnetic susceptibility and relative permeability are positive and exhibit veryhigh values.
4. These materials having permanent magnetic dipoles are orderly oriented.
5. Because of nonlinear relationship between B and H, the permeability of ferromagneticmaterial does not have a constant value.
6. These materials possess all the properties of paramagnetic materials with muchgreater intensity.
7. Above a certain temperature, ferromagnetic materials behaves paramagnetic and the susceptibility varies with temperature. Where C is Curie constant and Tc is curie constant.

   This relation is called Curie- Weiss law. The Curie temperature is depends on the material.

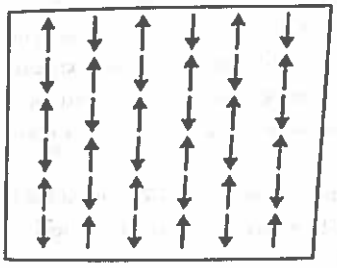


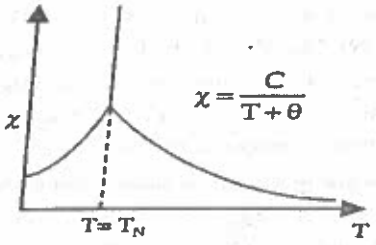
8. Eg: Fe, Ni, Co, Gd, Fe2O3, ZnFe2O3, MnFe2O3 etc.

Anti-ferromagnetic materials:

1. These materials, the atomic dipoles are arranged antiparallel to one another netmagnetic moment is zero.
2. These are crystalline materials which exhibit small positive susceptibilities of theorder of 10^{-3} to 10^{-5}.
3. The variation of susceptibility with temperature is given by the relation,
   $X_{af} = C/T+T_N$

   $T > T_N$, where C is Curie constant and T_N is Neel temperature.



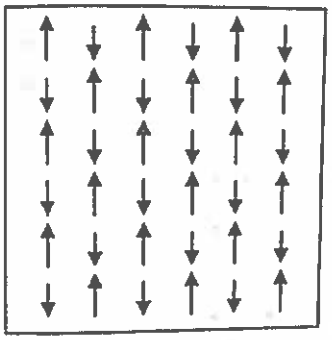


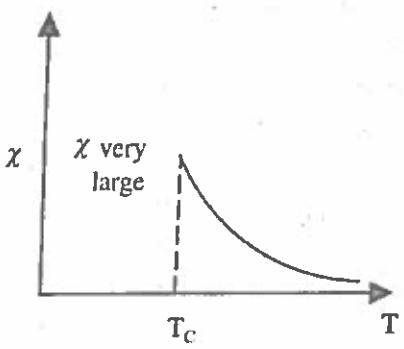
4. They attain maximum susceptibility at Neel temperature, TN. above TN thesematerials become paramagnetic.
5. Anti-ferromagnetic materials show very little external magnetism.Eg: MnO, NiO, MnS, MnTe, CoO, MnCl2, FeCl2 etc.

Ferrimagnetic materials (Ferrites):

1. In these materials the atomic dipoles are arranged antiparallel to one another but the moments in one direction have a larger magnitude so that the net magnetization exists.
2. The magnetic susceptibility is large and positive.
3. They also show Curie-Weiss behavior. The susceptibility varies with temperature is given by the relation,
   $X_{ferri} = C/T+T_N$

   where C is the Curie constant and TN is Neel temperature.
4. The ferrimagnetic materials behave like ferromagnetic materials below the Neeltemperature and are paramagnetic above Neel temperature.
5. The ferrimagnetic materials are also exhibit hysteresis property similar to ferromagnetic materials. The hysteresis curve of ferrites is normally has a square shape.
6. Eg: Fe2O4, NiFe2O4, PbFe12O19, BaFe12O19 etc.





11 (a). Discuss various types of polarization mechanisms in di-electrics.

When the specimen is placed inside a D.C. electric field, the specimen is polarizeddue to four types of processes.

1. Electronic polarization
2. Ionic polarization
3. Orientational polarization
4. Space charge polarization

Electronic Polarization:

A dielectric material consists of a large number of atoms. Let us consider a dielectric material consists only one atom. The nucleus is at its centre while electrons are revolving around the nucleus.

When an electric field is applied to an atom, positively charged nucleus displaces in the direction of field and electron could in opposite direction. This kind of displacement will produce an electric dipole within the atom.

The polarization produced due to the displacement of electrons is called as electronic polarization.

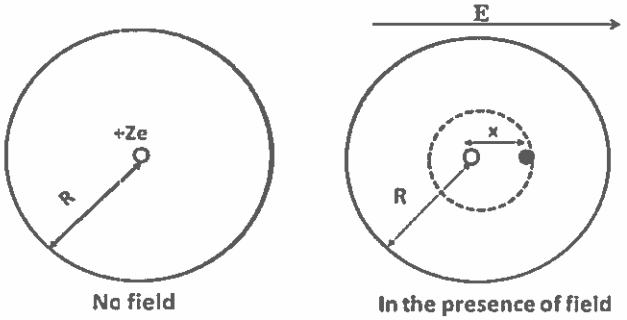
The dipole moment is proportional to the magnitude of field strength and is given by

$$\mu_e \propto E \Rightarrow \mu_e = \alpha_e E$$

Where 'α_e' is called electronic Polarizability constant

- It increases with increase of volume of the atom.
- This kind of polarization is mostly exhibited in monatomic gases
- It occurs only at optical frequencies (10^{15}Hz)
- It is independent of temperature.

Let Z be the atomic number, R be the radius of atom and e is the charge of an electron.



$$\therefore \alpha = 4\pi\varepsilon_0 R^3$$

Hence electronic polarizability is directly proportional to cube of the radius of the atom.

For N is the number of atoms, then the electronic polarizability can be written as

$P = N\alpha_e E$, where N is the number of atoms.

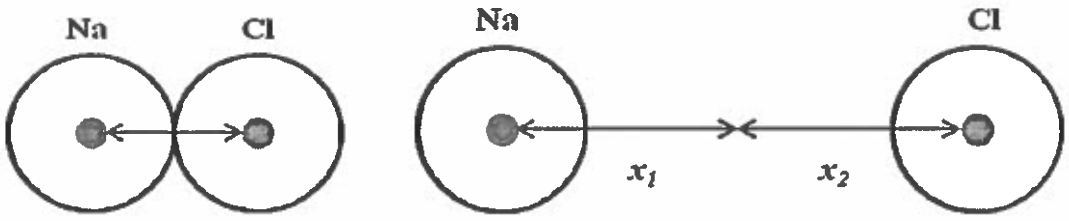
Ionic Polarization:

When an electric field is applied to the molecule, the polarization that arises due to the displacement of positive ions away from the field and displacement of negative ions towards the field is known as ionic or atomic polarization.

This type of polarization occurs in ionic molecules like NaCl, KBr, KCl etc.

Let us consider the ionic molecule. In absence of electric field, there is no displacement of ions.

When an electric field E is applied to an ionic crystal the positive ions are displaced through a distance x_1 in the direction of applied electric field and negative ions are displaced through a distance x_2 in the opposite direction of electric field.



The distance between the positive and negative ions is

$$x = (x_1 + x_2) \ldots\ldots (1)$$

The Lorentz force acting on the positive ions is eE and on the negative ions is $-eE$,where e is the charge of the ion.

The restoring force acting on the positive ions is $k_1 x_1$

The restoring force acting on the negative ions is $k_2 x_2$

$$\alpha_{ionic} = \frac{e_0^2}{\omega^2 \left[\frac{1}{M} + \frac{1}{m}\right]}$$

- This polarization occurs at frequency 10^{13} Hz (IR).
- It is a slower process compared to electronic polarization.
- It is independent of temperature.

Orientational Polarization:

The orientational polarization is a characteristic of polar dielectrics.

The contribution of the polarization due to the orientation of the molecular dipoles is called orientational polarization. It is also called dipolar or molecular polarization.

The molecules such as H_2, N_2, O_2, Cl_2 ,CH_4, CCl_4 etc., does not carry any dipole because

centre of positive charge and centre of negative charge coincides. On the other hand molecules like CH_3Cl, H_2O, HCl, ethyl acetate (polar molecules) carries dipoles even in the absence of electric field.

In case of electronic and ionic polarizations, the force due to external field is balancedby a restoring force due to coulomb attraction but for orientational polarization, restoring force does not exist. However, the dipole alignment is counteracted by thermal agitation. At high temperatures, thermal agitation is high.

The orientational polarization strongly depends on the temperature.

$$\alpha_o = \frac{\mu_{orie}^2}{3k_BT}$$

Where K_B is the Boltzmann constant and T is the absolute temperature. The orientational polarizability is inversely proportional to the absolute temperature of the dielectric material.

- It occurs at a frequency 10^6 Hz to 10^{10} Hz.
- It is slow process compare to ionic polarization.
- It greatly depends on temperature.

11 (b). Define Di-electric constant.

The dielectric constant is defined as the ratio of the permittivity of the medium to the permittivity of the free space.

$$\text{i.e } \varepsilon_r = \frac{\varepsilon}{\varepsilon_0} = \frac{c}{c_0}$$

Where ε is the absolute permittivity of the medium.

Where ε_0 is the permittivity of free space, $\varepsilon_0 = 8.854 \times 10^{-12}$ farad/ metre.

ε_r is the relative permittivity of the medium and is also called the dielectric constant.

12. Formulate Schroedinger's time dependent and independent wave equations.

Time dependent wave equation:

It is the differential equation of the de-Broglie waves associated with particles and it describes the motion of the free particles.

Let us consider a system of stationary waves associated with a particle of wave function Ψ is moving freely in positive X direction, therefore

$$\Psi = Ae^{-i\omega\left(t-\frac{x}{V}\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But we know

$$\omega = 2\pi\vartheta$$

$$V = \vartheta\lambda$$

By substituting these values in the above equation, we get

$$\Psi = Ae^{-i2\pi\vartheta\left(t-\frac{x}{\vartheta\lambda}\right)}$$

$$= Ae^{-i2\pi\vartheta t+\frac{i2\pi\vartheta x}{\vartheta\lambda}}$$

$$= Ae^{-i2\pi\vartheta t+\frac{i2\pi x}{\lambda}}$$

$$= Ae^{-i2\pi\left(\vartheta t-\frac{x}{\lambda}\right)} \ldots\ldots (2)$$

We know that, the energy of the particle is $E = h\vartheta$

Since $\hbar = \frac{h}{2\pi}$

$$E = 2\pi\hbar\vartheta$$

$$\vartheta = \frac{E}{2\pi\hbar} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

De-Broglie wavelength $\lambda = \frac{h}{p} = \frac{2\pi\hbar}{p}$ ..... (4)

Substituting equation (3) and (4) in eqn. (2), we get

$$\Psi = Ae^{-i2\pi\left(\frac{Et}{2\pi\hbar}-\frac{xp}{2\pi\hbar}\right)}$$

$$= Ae^{\left(\frac{-i2\pi Et}{2\pi\hbar}+\frac{i2\pi xp}{2\pi\hbar}\right)}$$

$$= Ae^{-\frac{i}{\hbar}[Et-xp]} \ldots\ldots\ldots\ldots (5)$$

Differentiating the above eqn. with respect to 't', we get

$$\frac{\partial\Psi}{\partial t} = -\left(\frac{iE}{\hbar}\right)Ae^{-\left(\frac{i}{\hbar}\right)(Et-xp)}$$

$$= -\left(\frac{iE}{\hbar}\right)\Psi$$

Multiply and divide by 'i' and substitute $i^2 = -1$, we get

$$\frac{\partial\Psi}{\partial t} = \frac{-i \times i \times E}{i \times \hbar}\Psi$$

$$= \frac{-i^2 \times E}{i \times \hbar}\Psi = \frac{E\Psi}{i\hbar}$$

$$E\Psi = i\hbar\ \frac{\partial\Psi}{\partial t} \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Similarly differentiating the equation (5) with respect to 'x', we get

$$\frac{\partial \Psi}{\partial x} = \left(\frac{ip}{\hbar}\right) Ae^{-\left(\frac{i}{\hbar}\right)(Et-xp)}$$

$$= \left(\frac{ip}{\hbar}\right) \Psi$$

$$P\Psi = \frac{\hbar}{i} \frac{\partial \Psi}{\partial x} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Since the total energy of the particle is $E = KE + PE = \frac{p^2}{2m} + V$

By applying the wave function on both sides, we get

$$E\,\Psi = \frac{P^2}{2m}\Psi + V\Psi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Putting the values of $E\,\Psi$ and $P\,\Psi$ in equation (8), we get

$$i\hbar \frac{\partial \Psi}{\partial t} = \frac{1}{2m} \frac{\partial^2 \Psi}{\partial x^2} \frac{\hbar^2}{i^2} + V\Psi$$

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \Psi}{\partial x^2} + V\Psi \ldots\ldots\ldots\ldots (9)$$

This equation is called one dimensional Schrödinger's time dependent wave equation.

In three dimensions the above equation may be written as

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m}\left[\frac{\partial^2 \Psi}{\partial x^2} + \frac{\partial^2 \Psi}{\partial y^2} + \frac{\partial^2 \Psi}{\partial z^2}\right] + V\Psi$$

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \Psi + V\Psi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Where $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ is called Laplacian operator.

Time independent wave equation:

The potential energy of the particle does not depend on time. The forces that act upon it and hence V vary only with the position of the particle.

$$\Psi = Ae^{-\frac{i}{\hbar}[Et-xp]} \ldots\ldots\ldots\ldots (1)$$

$$= A\,e^{-\frac{iEt}{\hbar} + \frac{iPx}{\hbar}}$$

$$= A\,e^{-\frac{iEt}{\hbar}}\; e^{\frac{iPx}{\hbar}}$$

Where $\Psi_0 = A\;\; e^{\frac{iPx}{\hbar}}$

$$\Psi = \Psi_0\; e^{-\frac{iEt}{\hbar}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Differentiating the above eqn. with respect to 't', we get

$$\frac{\partial \Psi}{\partial t} = -\left(\frac{i}{\hbar}\right) E\Psi_0 \; e^{-\frac{iEt}{\hbar}} \ldots\ldots\ldots\ldots (3)$$

$$\frac{\partial^2 \Psi}{\partial x^2} = \frac{\partial^2}{\partial x^2} \Psi_0 \; e^{-\frac{iEt}{\hbar}} \ldots\ldots\ldots\ldots\ldots (4)$$

Substituting the equations (2), (3) and (4) in One dimensional Schrodinger's time dependent wave equation (5).

$$\text{i.e.} \quad i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \Psi}{\partial x^2} + V\Psi \ldots\ldots\ldots\ldots\ldots (5)$$

$$i\hbar - \left(\frac{i}{\hbar}\right) E\Psi_0 \; e^{-\frac{iEt}{\hbar}} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \Psi_0 \; e^{-\frac{iEt}{\hbar}} + V \Psi_0 \; e^{-\frac{iEt}{\hbar}}$$

$$E\Psi_0 \; e^{-\frac{iEt}{\hbar}} = e^{-\frac{iEt}{\hbar}} \left[-\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \Psi_0 + V \Psi_0 \right]$$

$$E\Psi_0 = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} \Psi_0 + V \Psi_0$$

$$\frac{\partial^2 \Psi_0}{\partial x^2} + \frac{2m}{\hbar^2}(E - V)\Psi_0 = 0 \ldots\ldots\ldots\ldots\ldots (6)$$

This equation is called one dimensional Schrödinger's time independent wave equation.

In three dimensional cases the above equation may be written as

$$\nabla^2 \Psi_0 + \frac{2m}{\hbar^2}(E - V)\Psi_0 = 0 \ldots\ldots\ldots\ldots\ldots (7)$$

Where $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ is called Laplacian operator.

For any free particle, the potential energy is zero. Hence Schrödinger's wave equation for such particle may written as

$$\nabla^2 \Psi_0 + \frac{2m}{\hbar^2} E\Psi_0 = 0 \ldots\ldots\ldots\ldots\ldots (8).$$

13. Discuss merits and de-merits of classical free electron theory.

Success:

- It verifies ohm's law.
- It explains the electrical and thermal conductivities of metals.
- It derives Weidman-Franz law. I.e. the relation between electrical conductivity (σ) and thermal conductivity (k).
- It explains optical properties of metals.

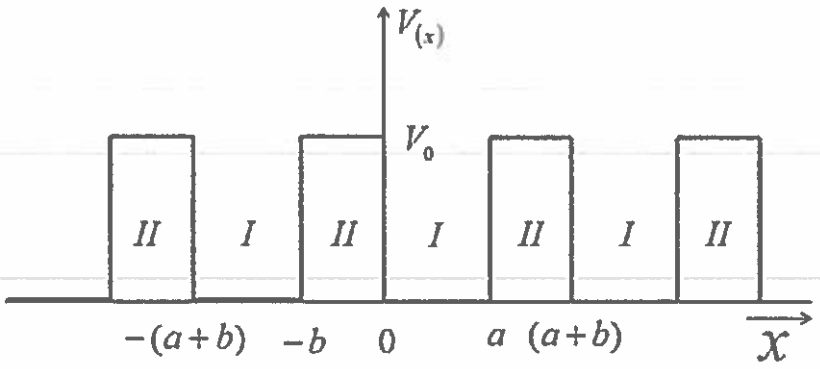
Drawbacks:

- It is a macroscopic theory.
- Atomic fine spectra could not be accounted.

- Dual nature of matter is not explained.
- The phenomena such as photoelectric effect, Compton Effect and the black body radiation couldn't be explained by classical free electron theory.
- According to the classical free electron theory the value of specific heat of metals is not verified.
- Electrical conductivity of semiconductor or insulators couldn't be explained using this model.
- At low temperatures, electrical conductivity (σ) and thermal conductivity (k) are varied in different ways.
- Ferromagnetism couldn't be explained by this theory. The theoretical value of paramagnetic susceptibility is greater than the experimental value.

14. Illustrate the motion of an electron in a periodic potential based on Kroning-Penney Model.

According to the zone theory, the potential of the solid varies periodically with the periodicity of space lattice 'a' which is nothing but inter atomic spacing. It is assumed that the potential energy of electron is zero near the nucleus of the positive ion in the lattice and maximum when it is halfway between adjacent nuclei.
Kronig and Penny model proposed simpler potential in the form of array of square wells as shown in fig.



The Schrödinger wave equation for an electron moving in one dimensional periodic potential is

$$\frac{d^2\varphi}{dx^2} + \frac{2m}{\hbar^2}(E - V)\Psi = 0 \ldots\ldots\ldots (1)$$

The solutions of this equation have the form

$$\Psi(x) = e^{\pm ikx}.\mu_k(x) \quad \text{(According to Bloch theorem)}$$

Where $\mu_k(x)$ is the periodic with the periodicity of the lattice.

$$\text{i.e., } \mu_k(x) = \mu_k(x + a)$$

Assuming V_0w (barrier strength) remains constant, it turns out that solutions are possible only for energies given by the relation.

$$\cos ka = \frac{P \sin \alpha a}{\alpha a} + \cos \alpha a$$

Where $P = \frac{4\pi^2 ma}{h^2} V_0 w$ and $\alpha = \frac{2\pi}{h}\sqrt{2mE}$

The left hand side of this equation imposes a limitation on the values that the right hand side of the function can have, namely, a maximum value of +1 and a minimum value of -1. Hence only certain range of values of α are allowed. This means that energy E is restricted to lie within certain ranges which form the allowed energy bands or zones.

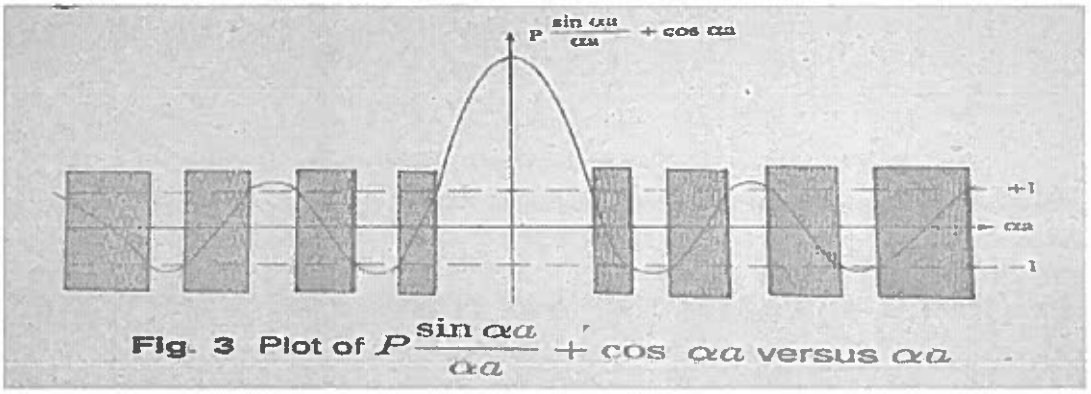


Fig. 3 Plot of $P\frac{\sin \alpha a}{\alpha a} + \cos \alpha a$ versus αa

The permitted values of energy are shown as shaded portions. This gives rise to the concept of ranges of permitted values of α for a given ion lattice spacing a.
Detailed analysis result in the following interesting conclusions.

(a) The allowed ranges of αa which permit wave mechanical solution to exit is shown as shaded portions. The motion of electrons in a periodic lattice is characterize by the bands of allowed energy separated by forbidden regions.
(b) As values of α increases the width of allowed energy bands also increases and width of forbidden band decreases.
(c) If P is large, the function described by the right hand side of equation crosses +1 and -1 region at a steeper angle. Thus allowed bands become narrower and forbidden band become widest.
(d) If $P \to \infty$ the allowed energy band reduces to one single energy level corresponding to the discrete energy level of isolated atom.
(e) If $P \to 0$, $coska = cosaa$ (or) $k^2 = \alpha^2 = \frac{4\pi^2}{h^2}(2mE)$

$$E = \frac{h^2k^2}{8m\pi^2} = \frac{h^2}{8\pi m}\left(\frac{2\pi}{8m\pi^2}\right)\left(\frac{2\pi}{\lambda}\right)^2 = \frac{h^2P^2}{2mh^2} = \frac{P^2}{2m} = \frac{1}{2}mv^2$$

This indicates that the particle is completely free and no energy levels exist.

15. Define Hall Effect and derive an expression for Hall coefficient. List any two applications of Hall Effect.

When a slab of metal or semiconductor carrying current is placed in a transverse magnetic field, A potential difference is produced in the direction normal to both current and magnetic field. This Phenomenon is called Hall Effect. And the generated voltage is known as Hall voltage.
It is discovered by E.H. HALL in 1879.

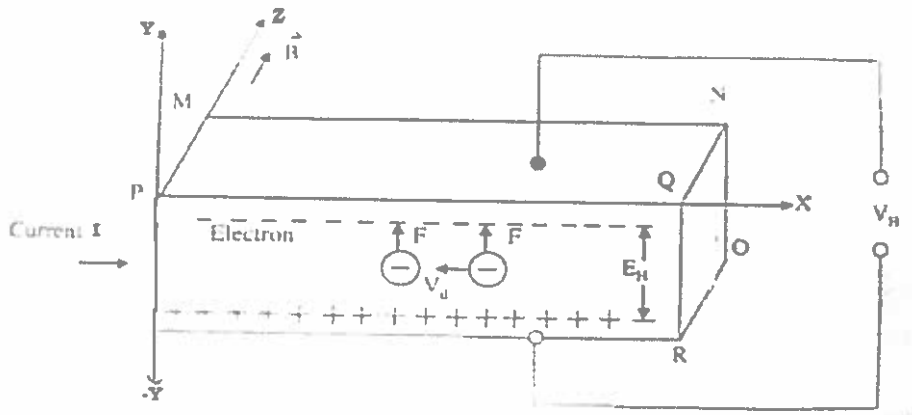
Consider a slab of conductor in which a current "I" is flowing in the +ve x-direction as shown in fig. Let a magnetic field "B" be applied along the Z-direction the the electrons experience a Lorentz Force is given by

$$F_L = -Bev_d$$

Where e is charge of the electron and V_d is the drift velocity of the electron.

Applying the Flemings Left hand rule the force exerted on the electron is in the –ve Y-direction. Therefore the electrons are deflected in the downward direction as a result, the density

of the electrons increases in the lower end of the material due to which it bottom surface becomes negatively charged.



On the other hand, the loss of electrons from the upper of the material becomes positively charged. Hence potential V_h called Hall Voltage appears between the upper and lower surfaces of the semiconductor which establishes an electric field Eh called the Hall electric field.
The electric field E_H exerts an upward force F_h in the electron is given by

$$F_H = -eE_H$$

Now, as the deflection of electrons continues in the downward direction due to the Lorentz force it also contributes to the growth of the Hall electric field as a result F_H which acts on the electron in the upward direction also increases.
At equilibrium position two forces are equal

$$F_L = F_H$$

$$eE_H = eBV_d \text{ or } E_H = BV_d$$

For n -type material the charge carriers are electrons, and the density "J" is

$$J = -nev_d$$

Where n is the concentration of charge carriers

Therefore, $V_d = -J/ne$ (or) $E_H = -JB/ne$

The Hall Effect is described in terms of the Hall coefficient R_H and is given by

$$R_H = -1/ne$$

Hence, $E_H = R_H JB$

i.e $\mathbf{R_H = E_H/JB = -1/ne}$

The Hall coefficient can be evaluated by substituting E_HJ and B. By knowing the Hall coefficient the carrier density "n" can be estimated . Since, the charge carriers are holes for p-type material.

The Hall coefficient is

$$\mathbf{R_H = E_H/JB = 1/pe}$$

Where p is the density of holes. The hall coefficient R_H is inversely proportional to density of Charge carriers.

Applications of Hall Effect:

1. The sign of charge carriers can be determined.
2. The carrier density can be calculated.
3. The mobility of charge carriers can be measured directly.
4. It can be used to determine whether the given material is metal, insulator or semiconductor.

THE END

NSRIT (A)

I year I Semester Examinations February-2023

20BSx33 : Applied Physics.

Scheme of Valuation

Part-A

(1) Basic definition of polarization in optics. 2M

(2) Any two applications of LASERS (each-1M) 2x1 = 2M

(3) Any two applications of dielectric materials (each-1M) 2x1 = 2M

(4) Any two properties of matter waves (each-1M) 2x1 = 2M

(5) Definition of n-type semiconductor. 2M

Part-B

(6) Experimental description of Newton's Rings 3M

Diagram 3M

Derivation of Diameter of the bright ring 3M

Derivation of Diameter of the dark ring 3M

(OR)

(7) (a) Introduction to Nicol's Prism 2M

construction with diagram 4M

working of Prism 4M

(b) Basic definition of double refraction 2M

(8) (a) Introduction to ruby LASER 2M

construction with diagram 4M

working with energy level diagram 4M

(b) Any two characteristics of LASER 2M

(OR)

(9) (a) Definition & diagram 2M

Acceptance angle derivation 3M

Numerical Aperture Definition 2M

Derivation 3M

(b) condition with critical angle 2M

(10) List of magnetic materials 2M

Discussion on each class of magnetic materials 5×2=10M

(OR)

(11) (a) List of polarizations in dielectrics 2M

Discussion on each type of polarization 4×2=8M

(b) Basic definition of dielectric constant. 2M

(12) formulation of Schroedinger time independent wave equation from classical wave equation 6M

schroedinger time dependent wave equation from independent wave equation 6M

(OR)

(13) Merits of classical free electron theory 4M

Demerits of classical free electron theory 8M

(14) Kronig-Penny model potential definition and diagrams 4M

Derivation 4M

Discussion on special cases 4M

($P \to \infty$ & $P \to 0$)

(OR)

(15) Definition & Description of Hall effect 4M

Derivation of Hall coefficient 4M

conclusion & Applications 4M.

21/4/23

21/4/23
HOD. S&H

Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech. (U. G.)	Program	ECE			Academic Year	2022 - 2023
Course Code	20BSX23	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Applied Chemistry						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	List any two examples of a bifunctional monomer.	20BSX23.1	L1
2	Indicate any two importance of salt bridge in an electrochemical cell.	20BSX23.2	L1
3	Write a formula for bond order calculation.	20BSX23.3	L1
4	List the two limitations of Beer–Lambert's law.	20BSX23.4	L1
5	What is meant by molecular modeling?	20BSX23.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Compare addition and condensation polymerization with two examples for each type.	6M	20BSX23.1	L2
6 (b)	What are phenolic - formaldehyde resins? Elaborate its preparation method.	6M	20BSX23.1	L2
	OR			
7 (a)	Write the mechanism of free radical addition polymerization of ethylene.	6M	20BSX23.1	L2
7 (b)	What are conducting polymers? Write a note on the characteristics of conducting polymers.	6M	20BSX23.1	L2
8 (a)	Explain the construction and working of calomel electrode, with appropriate equations.	6M	20BSX23.2	L2
8 (b)	Derive the Nernst equation for a single electrode potential.	6M	20BSX23.2	L2
	OR			
9 (a)	Explain the construction and workingof Zinc –Air battery.	6M	20BSX23.2	L2
9 (b)	Describe the construction and working of Photovoltaic cell.List its two applications.	6M	20BSX23.2	L2
10 (a)	Explain the energy level diagram of CO molecule with their magnetic characteristic and bond order.	7M	20BSX23.3	L2
10 (b)	Illustrate the band diagrams of conductors, semiconductors and insulators	5M	20BSX23.3	L2
	OR			
11 (a)	What is crystal field theory? Explain the crystal field splitting in octahedral complexes.	6M	20BSX23.3	L2
11 (b)	Explain the energy level diagram of O_2 molecule with their magnetic characteristic and bond order.	6M	20BSX23.3	L2
12 (a)	Explain the principle and instrumentation of UV-visible spectroscopy with block diagram.	6M	20BSX23.4	L2
12 (b)	Summarize any six applications of Nuclear magnetic resonance spectroscopy.	6M	20BSX23.4	L2
	OR			
13 (a)	Explain the principle and instrumentation of HPLC.	6M	20BSX23.4	L2
13 (b)	Demonstrate the process of acid-base titration through conductometric method.	6M	20BSX23.4	L2
14 (a)	Write a note on supra molecular reactivity and catalysis, Self-assembly in biological systems	7M	20BSX23.5	L2
14 (b)	How macrocyclic ligands are synthesized? Give an example.	5M	20BSX23.5	L2
	OR			
15 (a)	Explain basic Lock and Key principles.	7M	20BSX23.5	L1
15 (b)	Write a note on cation, anion and simultaneous cation and anion bindings.	5M	20BSX23.5	L2

Semester End Regular/Supplementary Examination
February - 2023

Scheme

Degree: B.Tech (U.G) Program: ECE Academic Year: 2022-2023

Course code: 20BSX23 Test Duration: 3 Hrs Semester: I

Course: Applied Chemistry Max marks: 70

PART-A (Short Answer Questions 5X2=10M)

(1) List any two examples of a bifunctional monomer — 2M

(2) Indicate any two importance of salt bridge in an electrochemical cell. — 2M

(3) Write a formula for bond order calculation — 2M

(4) List the two limitations of Beer-Lambert's Law — 2M

(5) What is meant by molecular modelling — 2M

PART-B (Long Answer Questions 5X12=60M)

6(a) compare addition and condensation polymerization — 3M

2 examples of addition & condensation polymerization — 3M

(b) What are phenolic-formaldehyde resin — 2M

Elaborate its preparation method — 4M

7)(a) Write the mechanism of free radical addition polymerization of ethylene — 6M

(b) What are conducting polymers — 2M

write a note on the characteristics of conducting polymers — 3M

8)(a) Explain the construction and working of calomel electrode with appropriate equations. — 6M

(b) Derive the Nernst equation for a single electrode potential — 6M

(9) (a) Explain the construction of zinc-Air battery — 3m
working of zinc-Air battery — 3m

(b) Describe the construction of photovoltaic cell — 2m
working of photovoltaic cell — 2m
List ties two applications of photovoltaic cell — 2m

(10) (a) Explain the energy level diagram of co molecules — 5m
magnetic characteristic and bond order — 2m

(b) Illustrate the band diagrams of conductors — 5m
semiconductors & insulators

(11) (a) what is crystal field theory — 2m
Explain the crystal field splitting in octahedral complexes — 4m

(b) Explain the energy level diagram of O_2 molecules — 4m
magnetic characteristics & bond orders — 2m

12) (a) Explain the prineiple of UV-visible spectroscopy — 2m
Explain the instrumentation of UV-visible spectroscopy — 2m
Block diagram — 2m

(b) summarize any six applications of Nuclear magnetic — 6m
resonance spectroscopy

13) (a) Explain the prineiple of HPLC — 3m
Instrumentation of HPLC — 3m

(b) Demonstrate the process of acid-base titration through — 6m
conductometric method

14) (a) write a note on supramolecular reactivity and catalysis — 4m
self-assembly in biological systems. — 3m

(b) How macrocyclic ligands are synthesized — 3m
Give an example — 2

15 (a) Explain beste lock & key prineiples — 7m

(b) write a note on cation, anion and simultaneous — 5m
cation and anion binding

21/2/23
HOD. Sc. H

Semester End Regular / Supplementary Examination, Feb - 2023.

KEY

Degree: B.Tech (U.G) Program: ECE Academic Year: 2022-23

Course Code: 20BSX23 Semester: I

Course: Applied Chemistry Test Duration: 3 Hrs.

Max. Marks: 70M

PART - A (Short Answer Questions) 5 X 2 = 10 M

1. List any two examples of a bi-functional monomer.

Ans:- 1. Ethylene ($CH_2=CH_2$)

2. Vinyl chloride ($CH_2=\underset{Cl}{CH}$)

2. Indicate any two importance of salt bridge in electro chemical cell.

Ans:- 1. It serves to maintain electrical neutrality and allow the flow of ions between the cells.

2. It helps to complete the circuit by allowing the ions to flow from one solution to other without mixing the two solutions.

3. Write a formula for bond order calculation.

Ans:- Bond order $= \frac{\text{No. of } e^- \text{ in bonding MO's} - \text{No. of } e^- \text{ in anti bonding mo's}}{2}$

$$B.O = \frac{N_B - N_{Ab}}{2}$$

4. List the two limitations of Beer–Lambert's law.

Ans: 1. It assumes that the light source is monochromatic i.e., it emits light of single wave length. However most light sources emits polychromatic light, i.e., light of multiple wave lengths, which can lead to errors in the measured absorbance.

2. It assumes that the sample is uniform & homogeneous throughout the path of the light. However, in non-uniform samples such as suspensions, emulsions & heterogeneous solutions, the light path can be scattered & deviated by the particles & droplets present in the sample. this can lead to errors in the measured absorbance, as the light path length can vary and the scattering of light can interfere with the accuracy of the measurements

5. What is meant by molecular modeling?

Ans. Molecular modelling encompasses all methods, theoretical and computational used to model or mimic the behaviour of molecules. The methods are used in the fields of computational chemistry, drug design, computational biology and materials science to study molecular systems ranging from small chemical systems to large biological molecules.

PART-B (Long Answer Questions) - 5 X 12 = 60 M

6(a) Compare addition and condensation polymerization with two examples for each type.

Ans:- Addition polymerization :- In this type of polymerization, the monomers are unsaturated compounds that contain double & triple bonds. these monomers add to each other to form a long chain polymer without the elimination of any small molecule byproducts.

→ It is also known as chain growth polymerization
→ Repeating units & monomers are same
→ Reaction is fast and polymer is formed at once.
→ products obtained are thermoplastic.
→ Byproducts not formed

Eg:- 1. polythene is prepared by additional polymerization of ethene

$$n\ (CH_2=CH_2) \xrightarrow[\text{Polymn}]{\text{Addition}} \left(CH_2-CH_2\right)_n$$

ethene → polythene

Eg:- 2. polystyrene is prepared by additional polymerization of Styrene.

$$n\ (CH_2=CH) \xrightarrow[\text{polymn}]{\text{Addition}} \left[CH_2-CH\right]_n$$

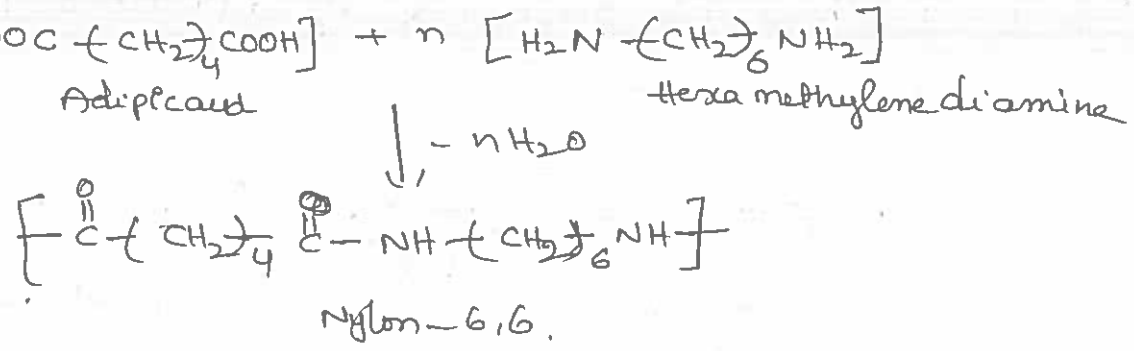
(CH = benzene ring)

Styrene → polystyrene.

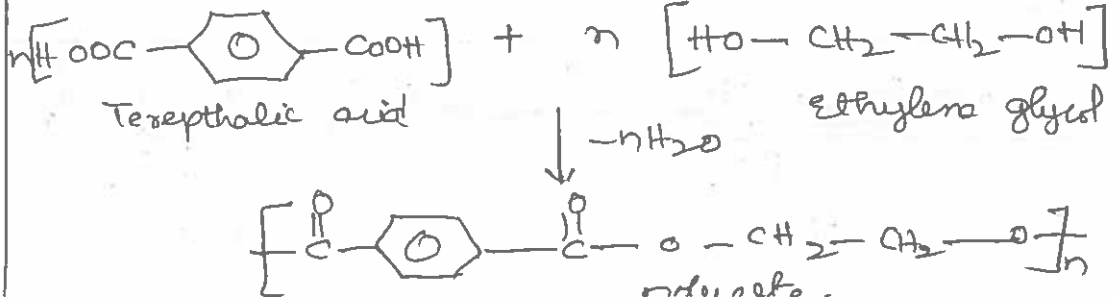
Condensation polymerization:- In this type of polymerization the monomers are bifunctional or polyfunctional that contain two or more reactive groups. During the polymerization process, small molecules such as water, CH_3OH, HCl etc eliminated as by products.

→ It is also known as step growth polymerization
→ In this monomers having reactive functional groups
→ By products like H_2O, CH_3OH, HCl are formed.
→ Repeating units are different.
→ polymer is formed in gradual steps.
→ Products obtained may be thermo setting plastic.

Eg:- 1. preparation of Nylon-6,6:- It is produced by the Condensation polymerization of diamine with di acid.



Eg:-2. preparation of polyester:- It is produced by the polymerization of di acid & di ol.

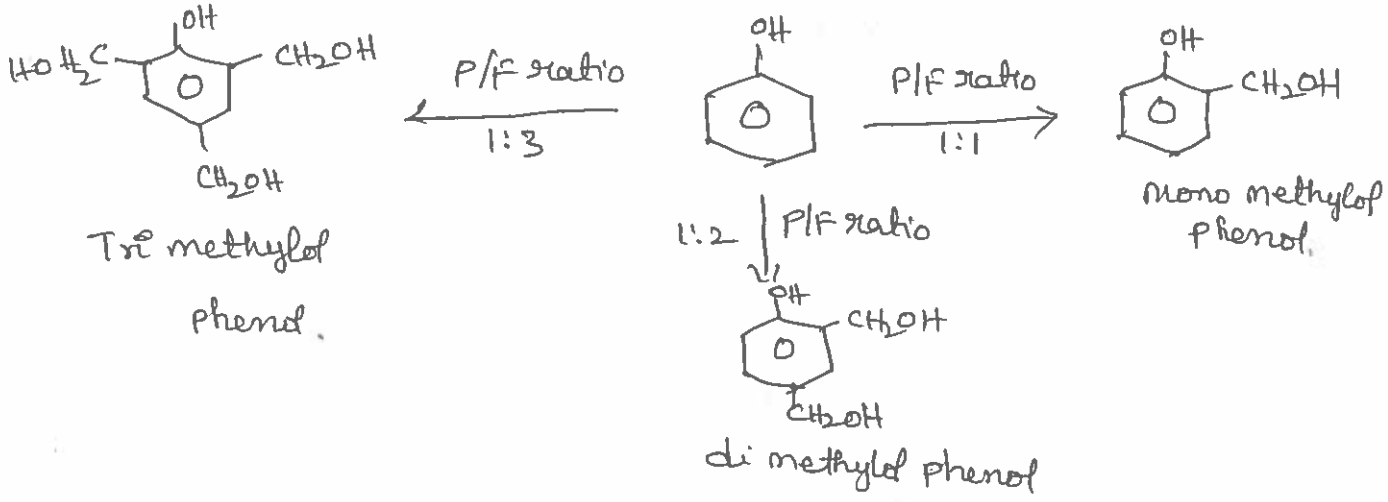


6(b) What are phenolic - formaldehyde resins? Elaborate its preparation method.

Ans:- phenolic - formaldehyde resin or Bakelite is produced by the reaction which is condensation polymerization of phenol and formaldehyde in presence of acid or alkali catalyst & at proper temperature.

Preparation :- It involves in 3 steps.

Step I :- phenol & formaldehyde in presence of acid/alkali forms mono, di, trimethylol phenols depends on phenol formaldehyde ration (P/F ratio).

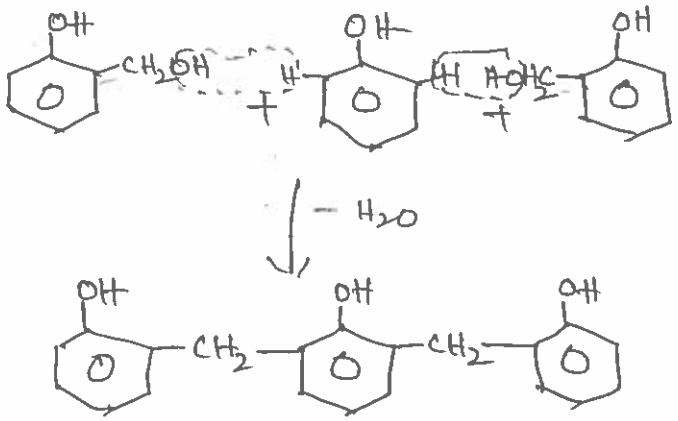


Tri methylol phenol.

Mono methylol Phenol.

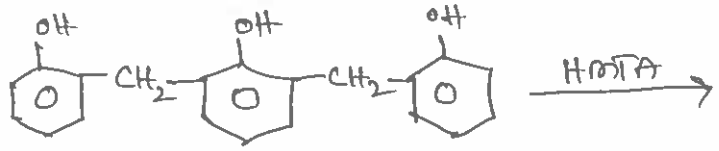
di methylol phenol

Step II :- mono, di, tri methylol phenols reacts with excess of phenol to form linear polymer is called as novolac.

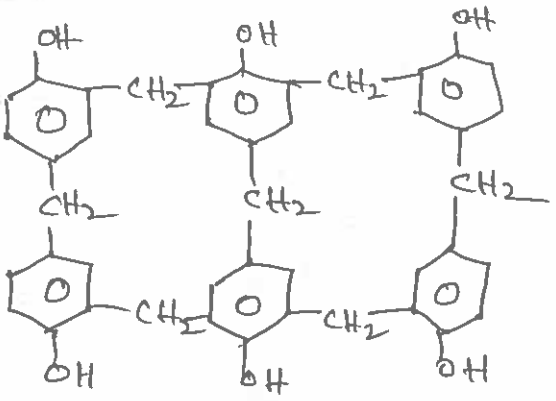


NOVOLAC.

Step-II :- on further heating, in the presence of hexamethylene-tetra amine, Novolac produces 3D-crosslinked thermosetting polymer which is known as Bakelite.



Novolac.



Bakelite.

[OR]

7(a) Write the mechanism of free radical addition polymerization of ethylene.

Ans:- Free radical addition polymerization mechanism :-

It involves in 3 steps. 1. Chain initiation
2. Chain propagation
3. Chain Termination.

1. Chain initiation:- In this process to generate free radical from unstable moleable by using heat / light / catalyst, the free radical combine selective monomer to produce monomer free radical.

$$\text{Initiator} = R = H_2O_2 / C_6H_5COOC_6H_5COO$$

$$2R \longrightarrow R^{\bullet} + R^{\bullet}$$

$$R^{\bullet} + CH_2=CH_2 \longrightarrow R-CH_2-CH_2^{\bullet}$$

free radical — ethylene monomer — monomer free radical

2. Chain propagation :- In this stage the chain will propagate by addition of number of monomers to the monomer free radical & forms living polymer.

$$R-CH_2-CH_2^{\bullet} + n(CH_2=CH_2) \longrightarrow R\text{-}(CH_2-CH_2)_n CH_2-CH_2^{\bullet}$$

living polymer

3. Chain termination :- In this stage the chain will terminate at a particular point by using another free radical. Resulting in the formation of dead polymer.

$$R\text{-}(CH_2-CH_2)_n CH_2-CH_2^{\bullet} + R^{\bullet} \longrightarrow R-CH_2-CH_2-CH_2-CH_2-R$$

Dead polymer.

7(b) What are Conducting polymers ? Write a note on the characteristics of conducting polymers.

Ans:- Conducting polymers :- Those polymers which conduct electricity are called as conducting polymers. the Conduction of polymers is due to unsaturation & due to the presence of externally added ingredients to them.

Characteristics :-

→ These have ability to conduct electricity, which makes them attractive for use in electronic devices and other applications that require Conductivity.

→ These can be modified by changing their chemical composition, doping level, & processing conditions, which allows for the fine tuning of their properties such as conductivity, solubility & mechanical strength.

→ These can be easily synthesized & processed into various shapes and forms, such as films, fibres, and coatings, which makes them versatile for different applications.

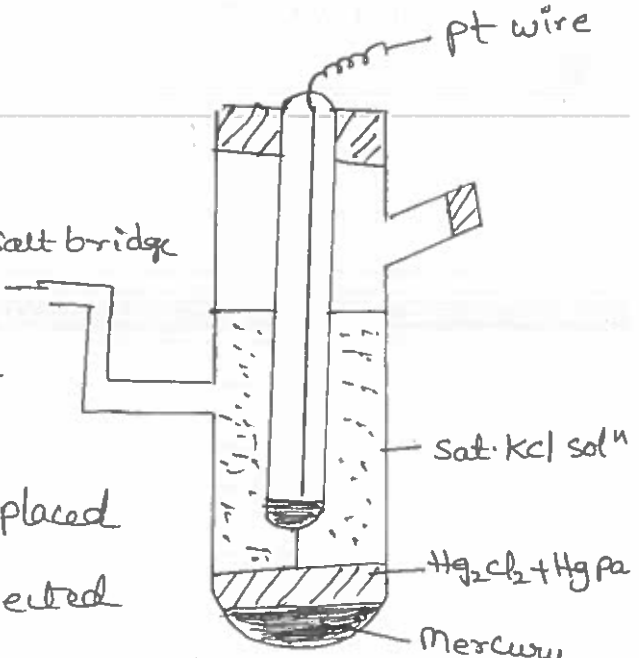
→ These are generally stable in air and water, which makes them suitable for use in harsh environments and under a variety of conditions.

→ These have a wide range of applications, such as in electronic devices, sensors, batteries, and solar cells.

8(a) Explain the Construction and working of calomel electro

Ans:- Calomel Electrode:- It is reference electrode for measuring the single electrode potential.

Working & Construction:- It Consists of a glass tube having a side tube on each side as show in figure. The mercury of high purity is placed at the bottom of this tube & connected to the circuit by means of pt wire, sealed in glass tube. The surface of mercury is coured with a paste of mercurous chloride (calomel) & mercury in KCl solution. The electrolyte is a solution of potassium chloride. The Electrode is connected with the the help of a side tube



on the left through salt bridge with the other electrode, whose potential has to be measured. The potential of calomel electrode depends upon the conc^n of KCl solution. The electrode is represented as $Hg, Hg_2Cl_{2(s)} / KCl$ (Sat. Sol). The standard reduction potential of this electrode at 25°C.

$$Hg_2Cl_{2(s)} + 2e^- \rightleftharpoons 2Hg(l) + 2Cl^-$$

8(b) Derive the Nernest equation for a single electrode potential

Ans:- Derivation of Nernest Equation:- Nernest found that the single electrode potential varies with the change in concentration of ions and temperature and hence the EMF of the cell varies. He derived a mathematical relationship b/w the standard Electrode potential, temp & Conc^n of ions. This relationship is known as the Nernest equation.

Consider the redox reaction: $M^{n+} + ne^- \rightleftharpoons M$

From the above reversible reaction the free energy change (G) & it's equilibrium constant (K) are related by the following reaction. $\Delta G = RT \ln K + RT \ln \frac{\text{Product}}{\text{reactant}}$

$$\Delta G = \Delta G^\circ + RT \ln \frac{\text{product}}{\text{reactant}}$$

when ΔG° is standard free Energy change.

the free energy change is equivalent to the electrical energy $-nFE$

F = Faraday (96500 C)

E = Electrode potential

$R = 8.314$ J/K mole

T = Temperature

$$-nFE = -nFE^\circ + RT \ln \frac{[M]}{[M^{n+}]}$$ (∵ [M] is unity)

$$-nFE = -nFE^\circ - RT \ln [M^{n+}]$$

$$= -nFE^\circ - RT\, 2.303 \log_{10}[M^{n+}]$$

Dividing the equation by $-nF$

$$E = E^\circ + \frac{2.303RT}{nF} \log_{10}[M^{n+}]$$

$$\frac{2.303RT}{nF} = \frac{0.0591}{n}$$

$$\boxed{E = E^\circ + \frac{0.0591}{n} \log_{10}[M^{n+}]}$$

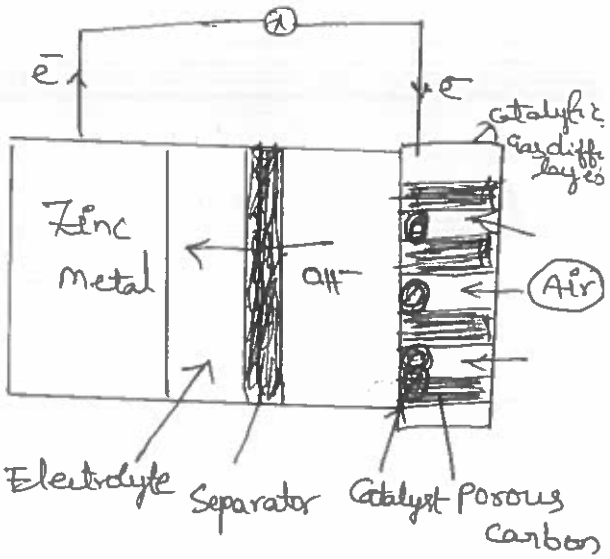
[OR]

9(a) Explain the construction and working of Zinc-Air battery.

Ans:- Construction & working:-

↳ In Zinc-air battery the anode is made of Zinc plates

↳ A perforated carbon plate treated with water repellants acts as cathode.



↳ NaOH / KOH solution used as an electrolyte

↳ The anode, cathode & the electrolyte are contained in an ebonite (or) polymer case & it also has a vent for the entry of air & O_2 into the cell.

At anode, Zinc reacts with electrolyte to form Zincate ions which decay into Zinc oxide and water.

→ The electrons released at the anode, travel to the cathode, where oxygen of air accepts the electrons to form hydroxide ions.

The cell reactions are

At anode :- (−1.25V) $2Zn(s) + 4(OH^-)(aq) \longrightarrow 2ZnO(s) + 2H_2O(l) + 4e^-$

At Cathode :- (0.4V) $O_2(g) + 2H_2O(l) + 4e \longrightarrow 4(OH^-)$

$2Zn(s) + O_2(g) \longrightarrow 2ZnO.$

It produces 1.65 volts.

9(6) Describe the construction and working of photo voltaic cell. List its two applications.

Ans:- Photo voltaic cell :-

It is a device which converts the solar energy directly to electrical energy using photo voltaic cell.

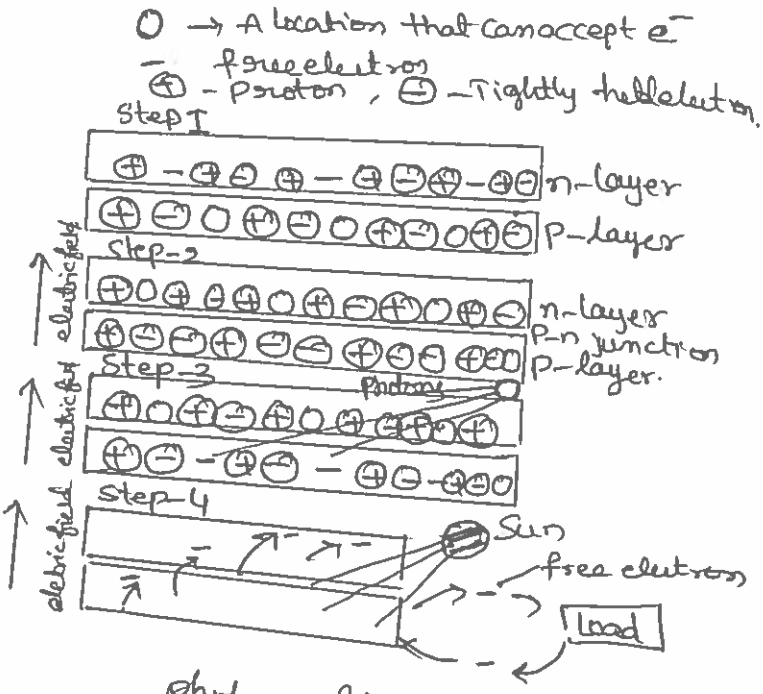


Photo voltaic cell

Construction & working :-

It is made up of n-type & p-type semic conducting materials. the two semi conducting (materials) layers

separated by a distance at 2.5×10^{-3} cm. Due to close contact electrons may mobile from one end to another.

→ when solar radiation is absorbed by the material electrons are removed from the material atoms.

→ The electrons are naturally migrating to the surface. when the electrons leave their position positive holes are formed.

→ Electrons carry negative charge, travel towards the border (n-type layer) of the cell.

→ The resulting imbalance of charge b/w the border (n-type layer) and back surfaces (p-type layer) creates a voltage potential like the negative & positive terminals of battery,

→ In presence of solar radiation e^- flow from n-type layer to p-type layer & generate electricity.

Applications:-

1. These are used as electronic equipment to generate little amount of electric current
2. these are used in commercial application, using electric grid it is converted into alternative current (A.C).

written by
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Asst. Prof

(10)

(a) 1) The number of molecular orbitals are formed is equal to the number of atomic number

2) The molecular orbitals are classified into 2 types

3) Bonding molecular orbitals (BMO)
Anti bonding molecular orbitals (ABMO)

4) Bonding molecular orbitals are represented with letters are σ, π,

5) Anti bonding molecular represented with letters are σ^* π^*

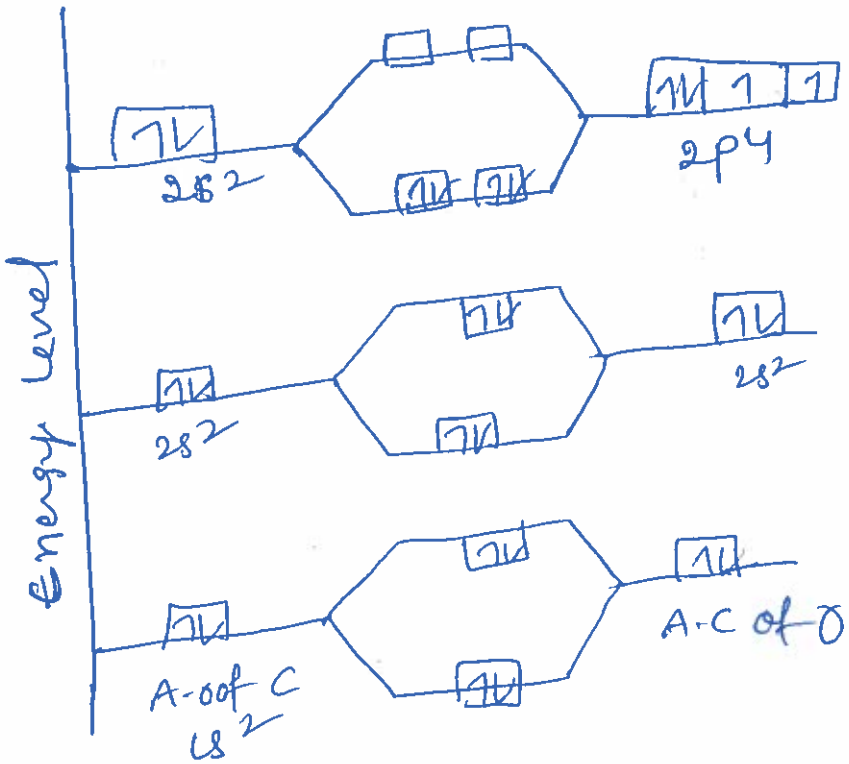
6) In general bonding molecular orbitals are having less energy than the atomic orbitals.

7) Anti bonding molecular orbitals are having higher energy than the atomic orbitals.

CO

Electronic configuration of carbon is $6 - 1s^2, 2s^2, 2p^2$

Electronic configuration of oxygen is $8 - 1s^2, 2s^2, 2p^4$

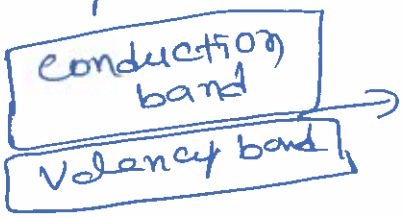


$$B.O = \frac{NB - NA}{2} = \frac{10-4}{2} = \frac{6}{2} = 3$$

(b) Conductors :- Those substances through which electricity can pass easily.

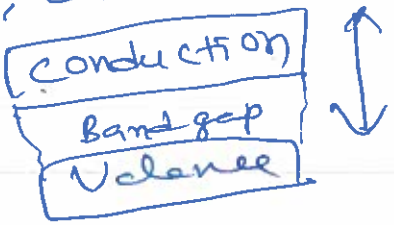
Ex:- All metals

2) Have zero gap
3) have large number of electrons without importing any extra energy.



Semiconductors: Conductivity lies b/w conductors & Insulators

Ex:- Silicon (Si), Carbon (C)



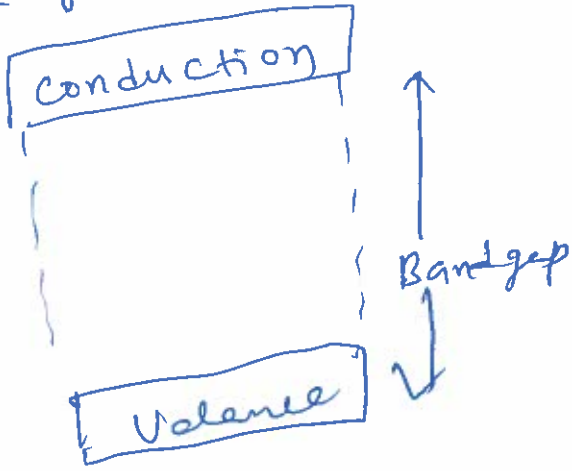
Ex:- Silicon, Carbon

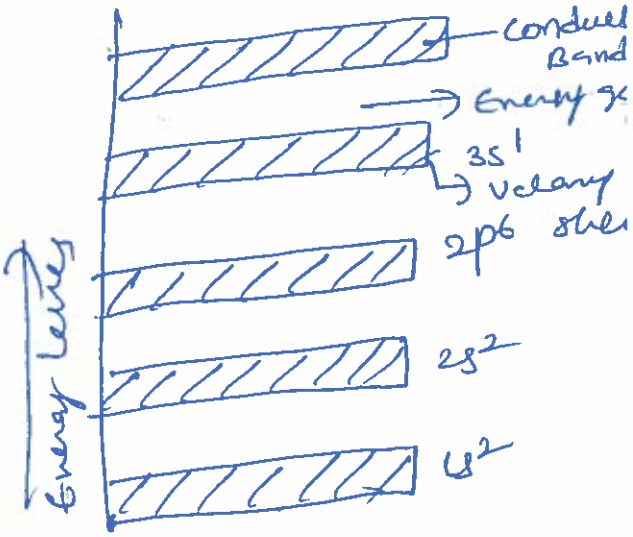
Have nearly equal to one electron volts, by importing temperature, electricity, they act as conductors.

at 0 K → Insulators, narrow forbidden gap.

Insulators :- Electricity can not pass through the substances Eg:- wood, rubber.

Have greater than 2 eV, no free electrons.





Electronic configuration. $1s^2\ 2s^2\ 2p^4$

$$B.O = \frac{nB - nA}{2} = \frac{10-6}{2} = \frac{4}{2} = 2.$$

(11) (a) What is crystal field theory? Explain the crystal field splitting in octahedral complexes.

Ans It is proposed by BRETHE & JOHN VENUR

chemical bonding b/w central metal atom & ligands.

Ex:- $[Ni(CO)_4]$

Central — Ligand

Ligand

F^-, Cl^-, Br^- — Na^+, Na^{2+} — CO, H_2O, NH_3

Crystal field theory explains the stability, strength, colour, magnetic nature of the complex compound.

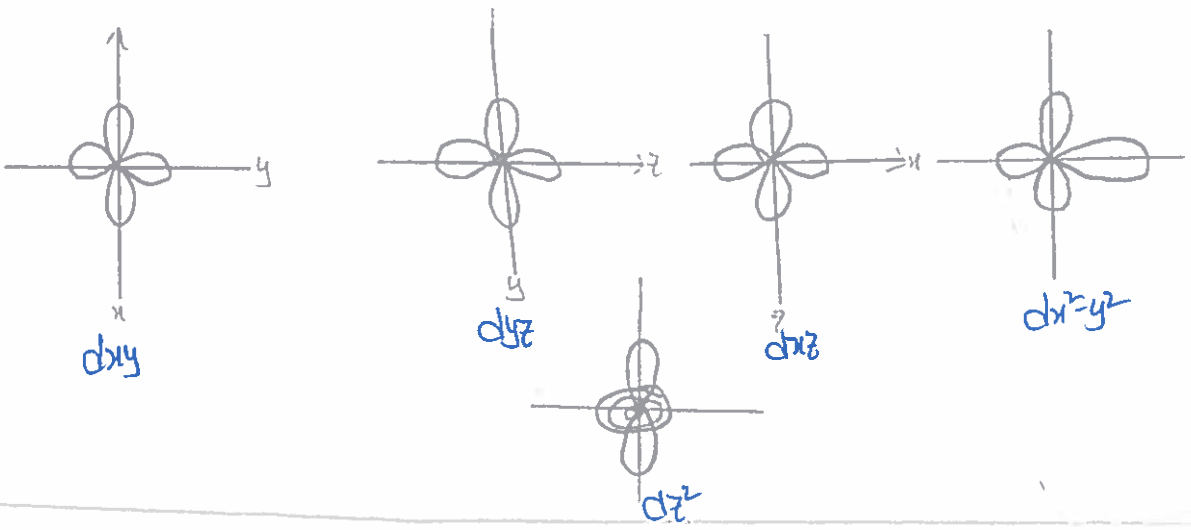
It is limit to the explain the nature of co-valent bond nature b/w the atoms and ligands

In this theory central metal atom and ligands are binded with strong ionic bond.

D-orbitals :- these are classified into two types

(i) axial (eg) dx^2-y^2, dz^2

(ii) non-axial (t_{2g}) dxy, dyz, dzx.



(11) (b) Explain the Energy level diagram of O_2 molecule with their magnetic characteristic and bond order.

Ans **Postulates :-**

It is Proposed by Hunds in 1932

Atomic orbitals are combined Each other forms molecular orbitals these molecular orbitals are having different levels of Energy.

The no of molecular orbitals are formed is equal to the no of atomic number are combine.

The molecular orbitals are classified into 2 types :-

i) Bonding molecular orbitals (B.m.o)

ii) Anti Bonding molecular orbitals (A.B.m.o)

B.m.o are represented with letters are :- σ, π

A.B.m.o are represented with letters are :- σ^*, π^*.

The filling of Electrons follows three Principles

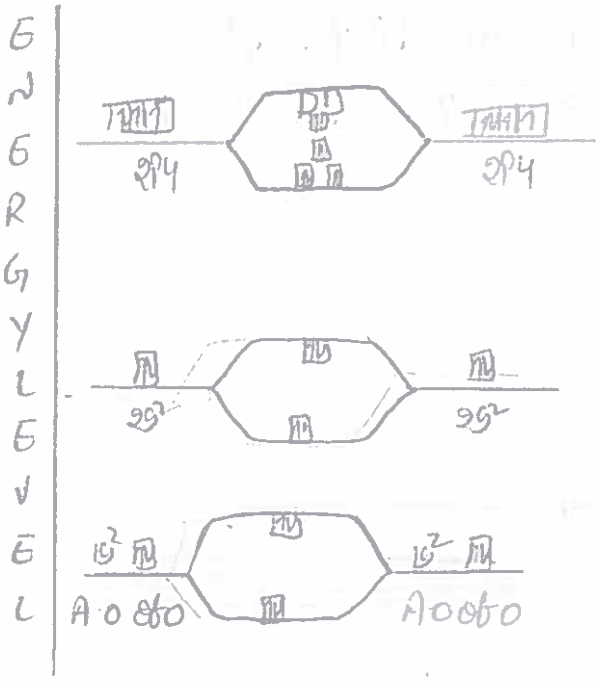
i) Pauli Exclusion law

ii) Hunds law

iii) Aufbaus law

Advantages :-

$B.O = \frac{N_b - N_A}{2}$ ... B.O $\propto$ Stability of molecule, B.O $\propto$ Energy of molecule



12(a) Explain the principle and instrumentation of uv-visible spectroscopy with block diagram.

principle:- when a uv-visible light is passes through the molecules containing multiple bonds occurs electronic transition from lower level to higher level due to adsorption of uv-visible radiation and gives the spectroscopic graph.

Instrumentation:-

*The uv-visible absorptions are measured by the instrument uv-spectro photo meter.

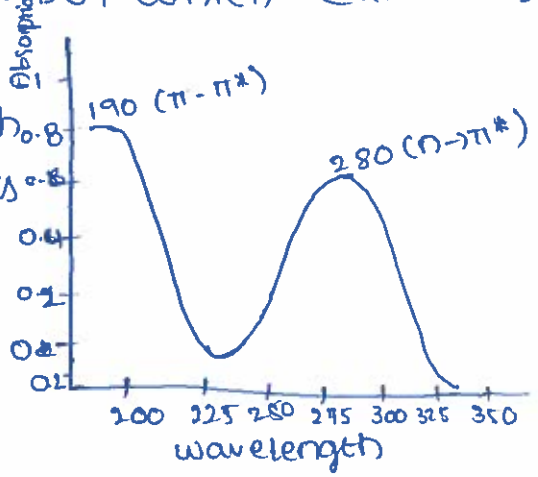
* The components when exposed to uv-light absorbs light in the uv-region due to presence of chromophore can isolated covalently bonded group shows adsorption in uv or visible region.

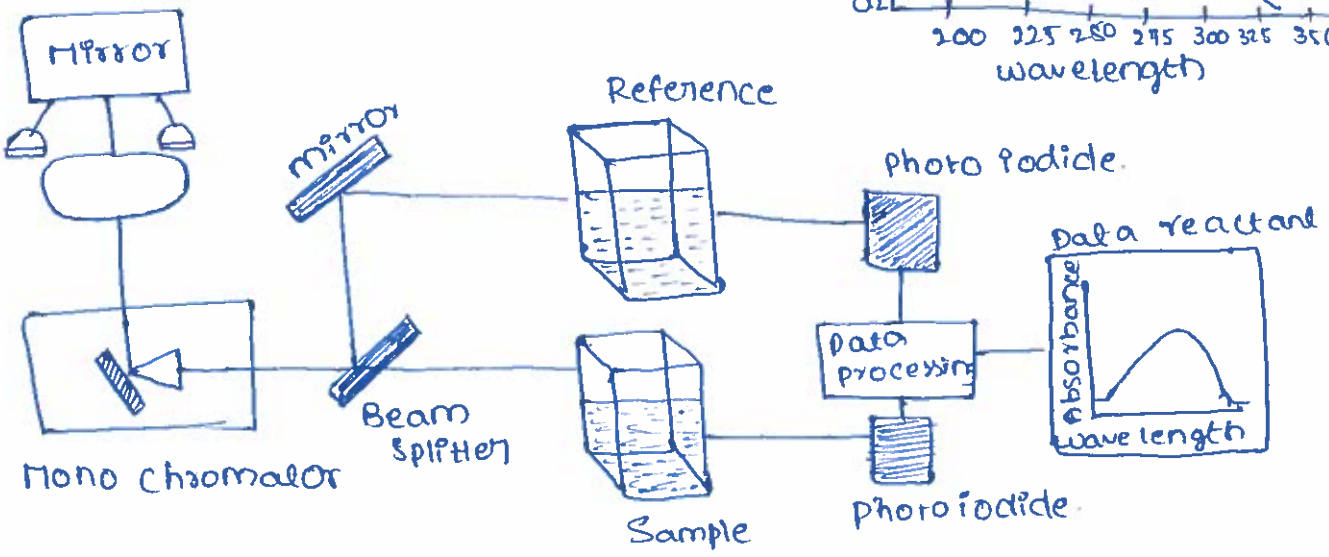
* To calculate the adsorbance at a given wavelength; The computer in spectrometer.

Then takes $\log_{10}$ of that number which called as absorbance $A = \log_{10} \frac{I_0}{I}$

* uv-spectrum is a simple graph of a plot of absorbance on y-axis and wavelength on x-axis

Absorption spectrum of acetone





(26) Summarize any six applications of Nuclear magnetic resonance spectroscopy

Ans:- Applications of NMR spectroscopy

-> By studying the peak of NMR spectra, chemists can determine the structure of many compounds.

-> It can be a very selective technique, distinguishing among many atoms within a molecule or collection of molecules of the same type but which differ only interms of their local chemical environment.

-> The detailed investigation includes

-> Identification of structural isomers

-> Detection of hydrogen bonding

-> Detection of aromaticity

-> Detection of electro Negativity atom or group.

13 (a) Explain the principle and instrumentation of HPLC

HPLC :-

=> It is technique for separation, Identification, quantification Components in a mixture

=> It is especially suitable for Compounds which are not easily volatilised thermally unstable and have high molecular weights

Principle:-

In this it releif on pumps to pass a pressurized liquid solvent Containing the sample mixture through a column filled with a Solid adsorbent material.

Each Component in the sample space Contracts slightly differently with the adsorbent material causing different flow rates for different Components

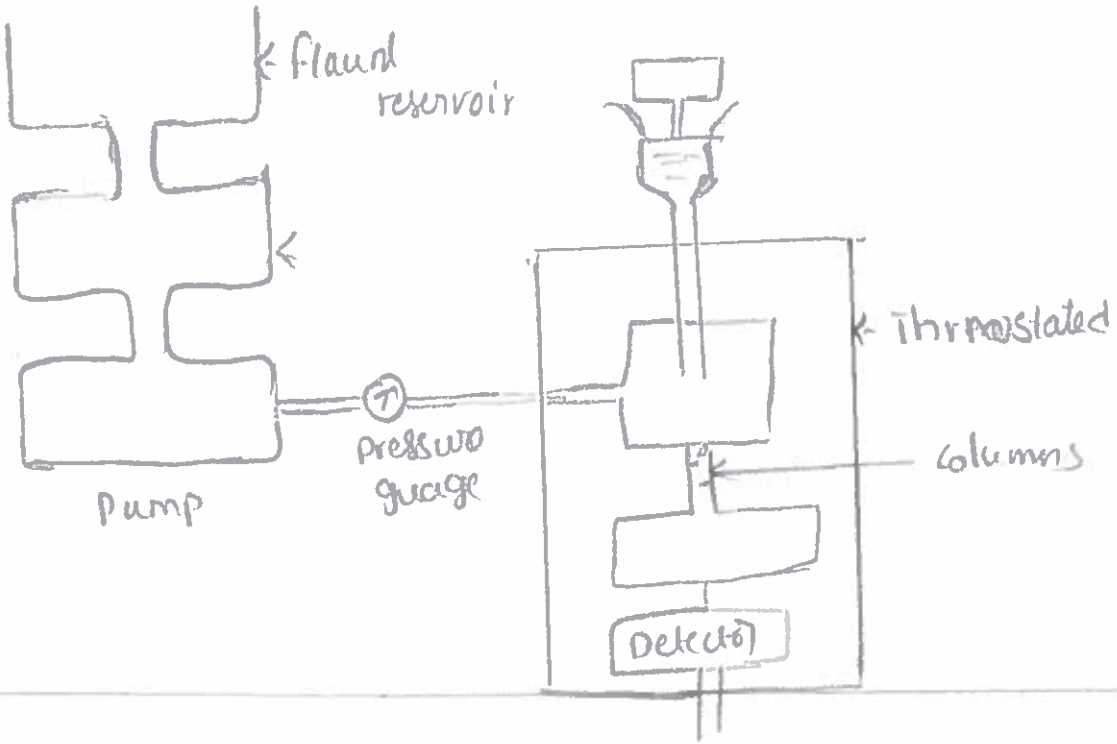
Theory and instrumentation:-

=> However because liquids are more viscous than gases. So, the pressure used to make them pass through a column is greater than in GLC

=> Such high pressure require a strong column, which is often about 25 cm in length

=> This principle in much same as in GLC

=> Because of its accuracy HPLC has become very widely used in analysis and research.



13b) Demonstrate the process of acid-base titration through Conductometric method.

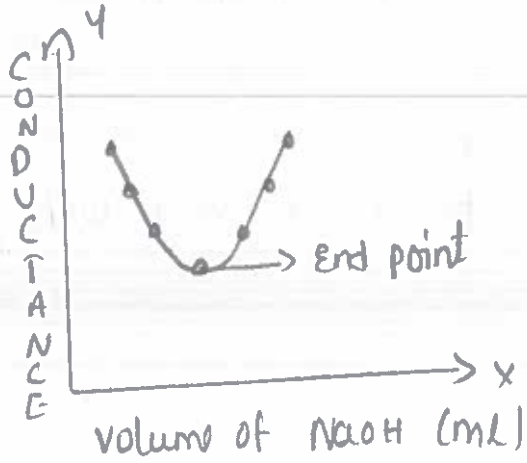
In acid-base conductometric titration the changes in the Conductivity of solution, its Conductance, is measured as the base is gradually added to the acid.

Titration of Strong acid with a strong base:

A strong base like NaOH which is taken in burette, then the fast moving H^+ ions are replaced by Na^+ slow moving ions and Conductance decreases gradually upto the end point.

After the end point on adding NaOH solution liberates fast moving OH^- ions to the solution and hence Conductance increasing gradually.

The conductometeric titration curve or graph plotted b/w Conductance of Solution on y-axis and volume of NaOH Soln on x-axis and end point is obtained.



$H^+ + Cl^- + Na^+ + OH^- \rightarrow Na^+ Cl^- + H_2O$

14(a) write a note on supra molecular reactivity and catalysis, self assembly in biological system

super molecular catalysis is not a well defined field but it generally refer to an applica-tion of super molecular chemistry, especially molecular recognition and guest binding. Because enzymes are structually complex and difficult to modify super molecular catalyst offer a simple model for studying factor involved in catalytic efficiency of the enzyme.

Another goal that motivates this field is the development of efficient and pratical catalyst that may or may not have an enzyme equivalent in nature. the structually complex and difficult to modify super molecular catalyst offer a sample model for studing.

A cosely related field study in asymmetric As there is another wikipedia article already written about small molecular asymmetric reach. non discrete and structually poorly defined system such as micelle and dendrimers are not included

14(b) How macrocylic ligands are synthesized? given an example?

In cordination chemistry, a macrocylic ligand is a macrocylic ring having atxnine atoms (including all hetro last atoms) and three or more donor

spte that serve as ligands that can bind to a central metal ion. crown ethers and porphyrins as prominent examples macrocylic ligands exhibit high affinity for metal ion.

the crown enthers calixarenes, porphyrins and cyclodextrins macrocyles.

describe a large, a mixture area of chemistry.

5)
a)

Explain basic lock and key principles?

In the supermolecular system, the attractive forces operate effeciently when host (recepter) provides suitable gap that property matches electronically and sterically with the guest (substance)

⇒ Thus in the guest-host molecular assembly, the molecular components must maintain the proper complementarity both electronically and sterically

⇒ Through the interplay of supermolecular non-covalent forces leads to molecular recognition and this lead to supermolecular assemblies (SM).

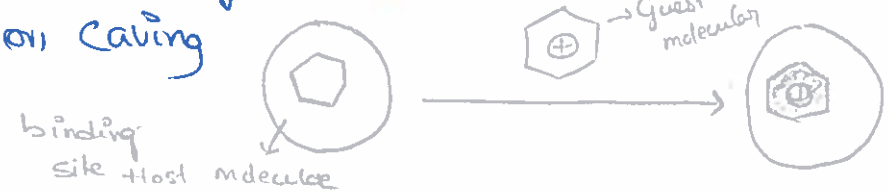
Guest + Host ⟶ Guest - host (G-H)

(Complex supermolecular assembly

+

write a note on cation, anion and simultaneous cation and anion bindings.

Cation binding :- Here Host molecular will have a binding site or caving



This binding is filled positively charged molecule (guest) i.e, cation. Hence it is called cation binding

(5)
(b) Factors effecting cation binding:

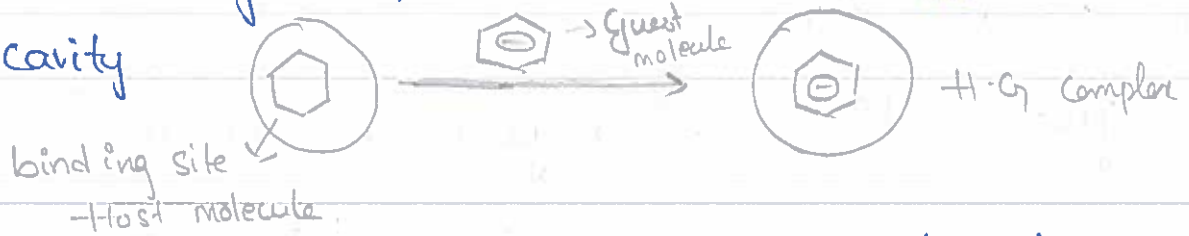
* Natuge of solvent
* Magnitude of charge of cation.
* Complementary between Host and guest molecule.

Applications of cation binding:

(1) Heamoglabin is a supramolecule it carries oxygen in blood to the entire living cell.

(2) Vitamin B_{12} is a particularly important for normal function-ing of nervous system.

Anion Binding: Here Host molecule will have a binding site con cavity



→ The binding site is filled by negatively charged guest molecular i.e Anion. Hence it is called Anion.

Applications of Anion binding:

→ ADP is binding element of DNA

→ Anion plays very crucial role in biological and chemical process.

→ About 70% of guest molecules are anni negatively charged anions.

21/12/23
HOD/SAH

written by
B. Sujatha
ASA-professor

NSRIT

Semester End Regular/Supplementary Examination, February – 2023

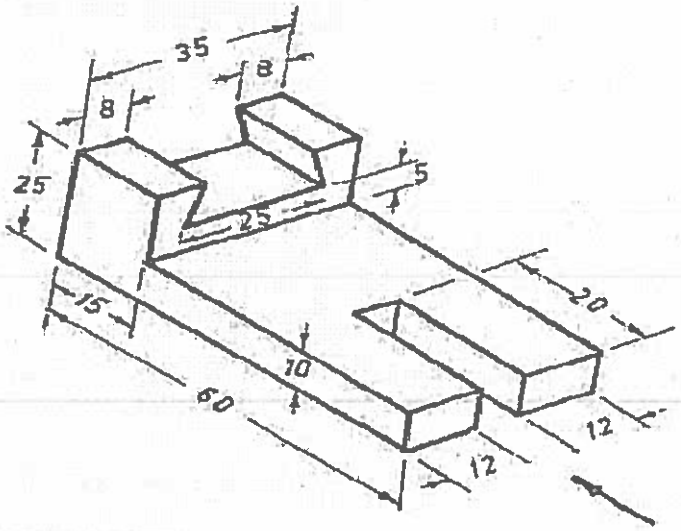
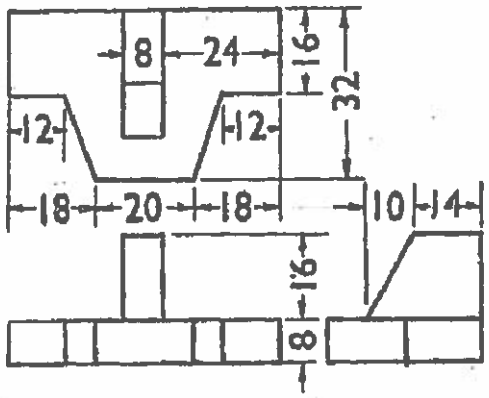
Degree	B. Tech.	Program	Civil Engg. & Mechanical Engg.			Academic Year	2022 - 2023
Course Code	20ESX01	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Engineering Drawing						

Part A (Short Answer Questions 2 x 5 = 10 Marks)

No.	Questions (1 through 2)	Learning Outcome (s)	DoK
1	Draw the projections of points on the common reference line i. Point P is 35 mm behind the VP and 20 mm below the HP ii. Point Q is 30 mm above the HP and 40 mm in front of VP iii. Point R 50 mm behind the VP and 15 mm above the HP	20ESX01.2	L1
2	A hexagonal plane of side 25 mm having one of its sides in the HP & perpendicular to VP. Draw the projection of the lamina.	20ESX01.3	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 10)	Learning Outcome (s)	DoK
3 (a)	Construct a regular pentagon of 30 mm side by general method.	20ESX01.1	L2
3 (b)	Construct a hyperbola when the distance between the focus and directrix is 30 mm and eccentricity is 4/3. Also draw the tangent and normal to any point on the curve	20ESX01.1	L3
	OR		
4 (a)	An area of 144 sq.cm on a map represents an area of 36 sq.km on the field. Find the R.F of the scale for this map and draw a diagonal scale to show kilometers, hectameters and decameters and to measure up to 10 kilometers. Indicate on the scale a distance of 7 kilometers, 5 hectometers and 6 decameters.	20ESX01.1	L3
4 (b)	Draw an ellipse by Oblong method. The major and minor axes given as 150 mm and 90 mm respectively. Draw normal and tangent at any point on the ellipse at a distance of 55 mm from the geometrical center of the ellipse.	20ESX01.1	L2
5 (a)	A line AB 65 mm long has its end A, 10 mm above HP and 25 mm in front of VP. It is inclined at 65° to HP and parallel to VP. Draw its projections. Also mark the traces.	20ESX01.2	L2
5 (b)	The midpoint of a straight line AB 90 mm long is 60 mm above HP and 50 mm in front of VP. It is inclined 45° to VP and 30° to HP. Draw the projections.	20ESX01.2	L3
	OR		
6 (a)	A line AB, 90 mm long, is inclined at 30 degrees to the HP and 20 mm in front of the VP. Its front view measures 65 mm. Draw the top view of AB and determine its inclination with the VP.	20ESX01.2	L3
6 (b)	A straight line is parallel to both VP and HP. Its one end is 25 mm behind VP and 15 mm above HP. Length of the line is 100 mm. Draw its projection.	20ESX01.2	L2
7 (a)	Draw a rhombus of diagonals 100 mm and 60 mm long, with the longer diagonal horizontal. The figure is the top view of a square of 100 mm long diagonals, with a corner on the ground. Draw its front view and determine the angle which its surface makes with the ground.	20ESX01.3	L3
7 (b)	A circular plate of diameter 70 mm has the end P of the diameter PQ in the HP and plate is inclined at 40^0 to the HP. Draw its projection a) The diameter PQ appears to the inclined at 45^0 to the VP in the top view b) The diameter PQ makes 45^0 with the VP.	20ESX01.3	L2

	OR		
8 (a)	A regular hexagonal lamina with its edge 50 mm has its plane inclined at 45⁰ to HP and lying with one of its edges in HP and perpendicular to VP. The corner nearest to VP is 15 mm in front of it. Draw its projections.	20ESX01.3	L2
8 (b)	A square lamina PQRS of side 40 mm rests on the ground on its corner P in such a way that the diagonal PR is inclined at 45° to the HP and parallel to VP. Draw its projections.	20ESX01.3	L3
9	A square prism of base side 30 mm and axis 70 mm rests on HP on one of its longer edges with the rectangular faces 45° inclined to HP and parallel to VP. Draw the top and front views of the prism.	20ESX01.4	L3
	OR		
10	A pentagonal pyramid of base side 30 mm and axis length 60 mm is suspended by means of a string from one of its base corners with its axis parallel to VP. Draw its projections.	20ESX01.4	L3
11	Draw the front view, top view and side view from the isometric view. All dimensions are in mm. 	20ESX01.5	L4
	OR		
12	Draw the isometric view of figure  (Third-angle projection)	20ESX01.5	L4

NSRIT

N S RAJU INSTITUTE OF TECHNOLOGY

(AUTONOMOUS)

SONTYAM , ANANDAPURAM, VISAKHAPATNAM – 531 173

ANSWER KEY AND SCHEME OF EVALUATION

Engineering Drawing

(1) (a) Projection of points, F.V & T.V – 5M

(2) (b) Hexagon General method – 3M

F.V & T.V Image – 2M

(2) (b) Hyperbola General method – 4M

Projections – 2M

Dimensions – 2M

(3) (b) pentagon General method – 4M

Dimensions – 2M

(9) (a) Finding Loc – 2M

Diagonal method in Scale – 3M

Divide a line method – 1M

4 (b) Ellipse Oblong method - 4 M

Dimensions - 1 M

Tangent & Normal - 1 M

5 (a) Inclined to One plane F.V - 3M

T.V = 3M

5 (b) finding True Inclination - 2M

Final F.V & T.V = 4M

6 (a) Inclination with VP finding - 3M

Inclined to Both - 3M

(b) F.V & T.V line - 6M

7 (a) Rhombus F.V & T.V finding - 6M

(b) Circular F.V & T.V finding - 6M

9 Square prism F.V & T.V - 12M

10 Pentagonal pyramid F.V & T.V - 12M

11 F.V finding - 6M

T.V finding - 4M

Side View - 2M

12 3- Dimensional Object - 10M

Dimensions - 2M

24/2

Semester End Regular / Supply Examination, Feb-2023

Degree :- B.Tech

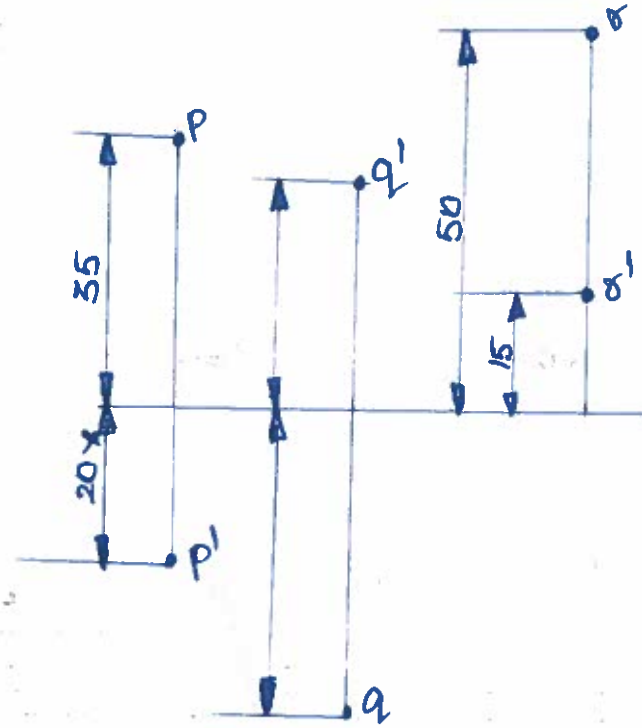
Course - Engineering Drawing

Program :- Civ & Mechanical

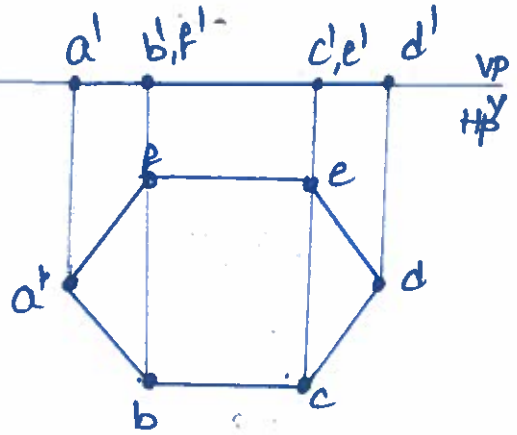
Course code - 20ESX01

PART A

(1) (a)

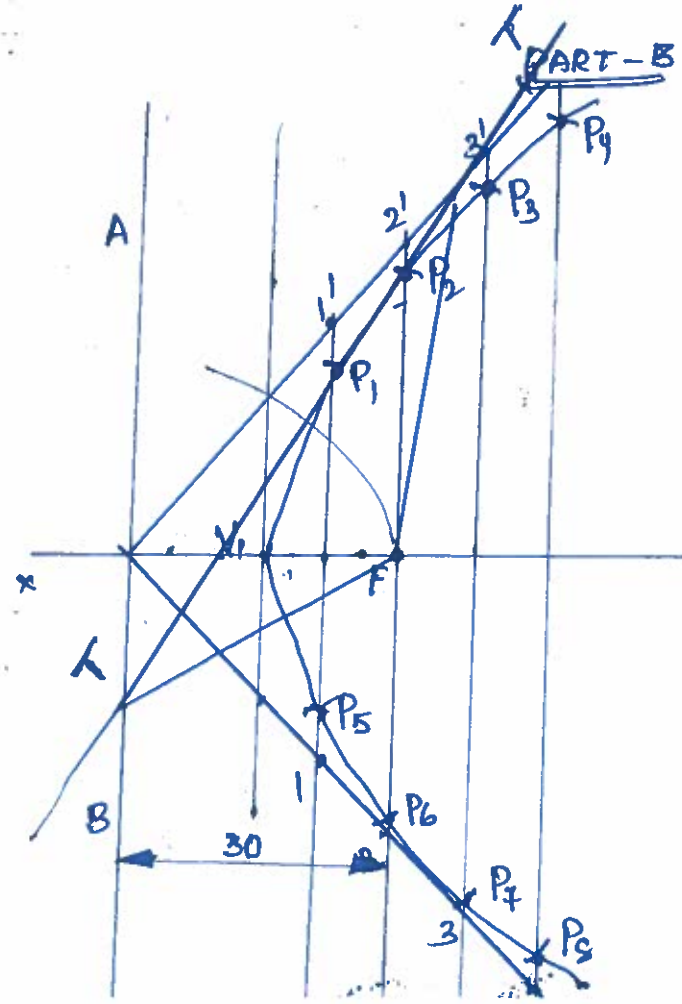


(2) (a)

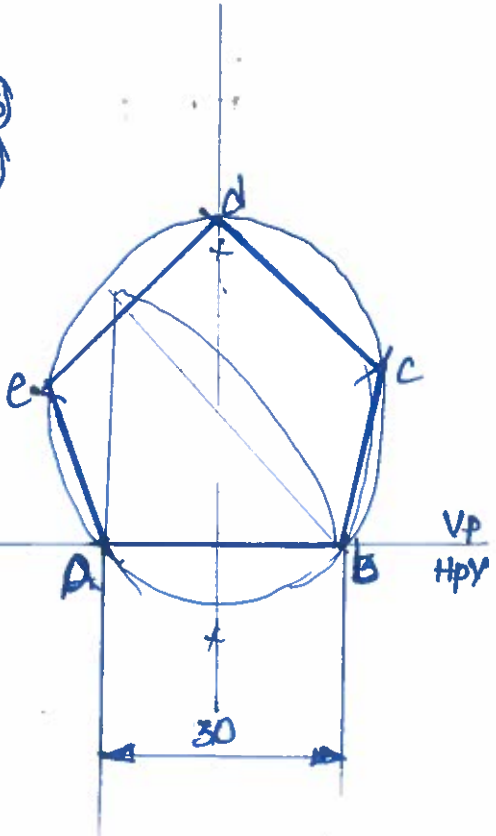


PART-B

(3) (b)



(3) (a)



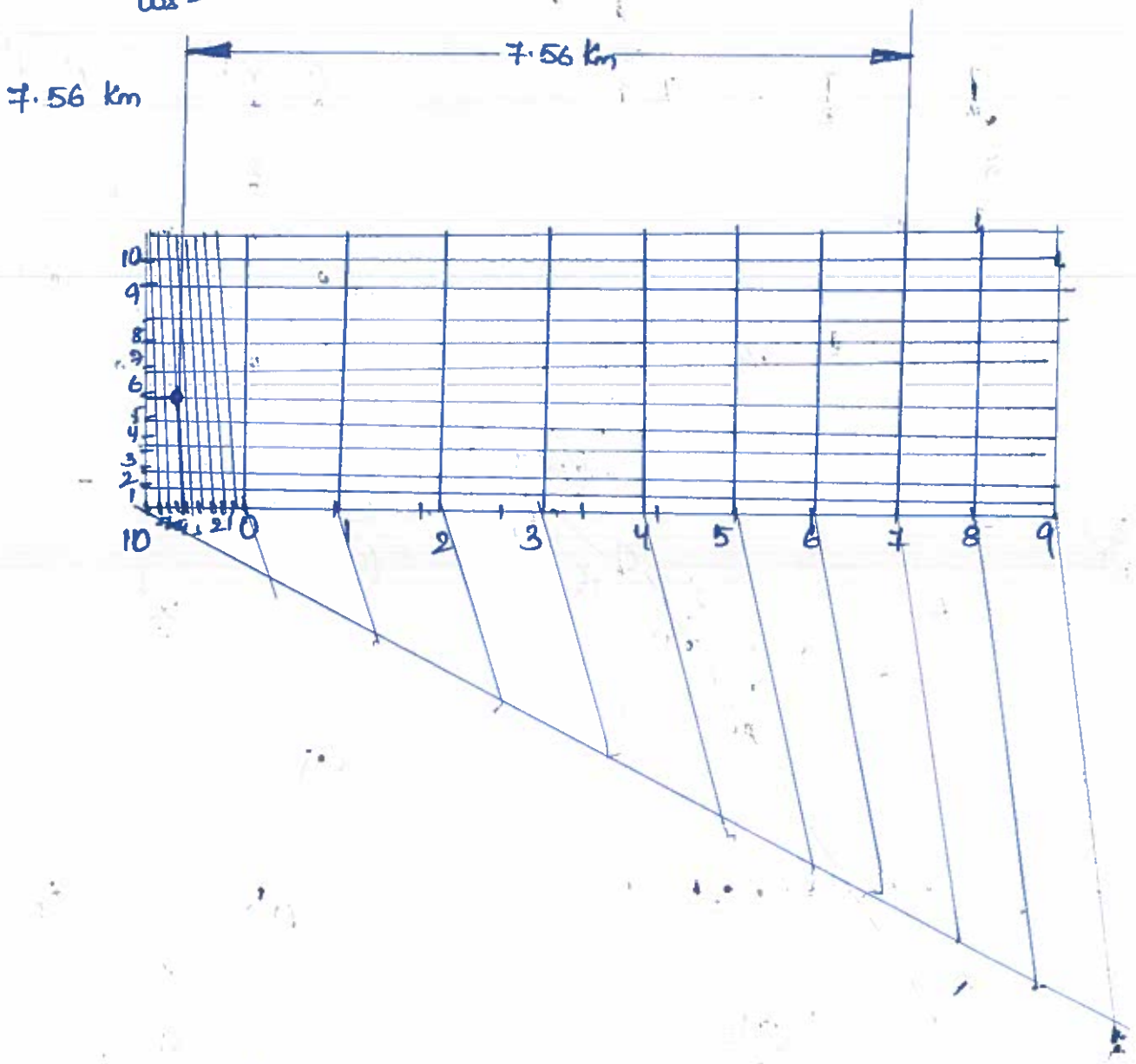
(4)
(a)

$$\text{Loss} = \frac{\text{Change in length}}{\text{Original length}} \times \text{max. length}$$

$$= \frac{144\ \text{Km}^2}{36\ \text{Km}^2} \times 10\ \text{Km}$$

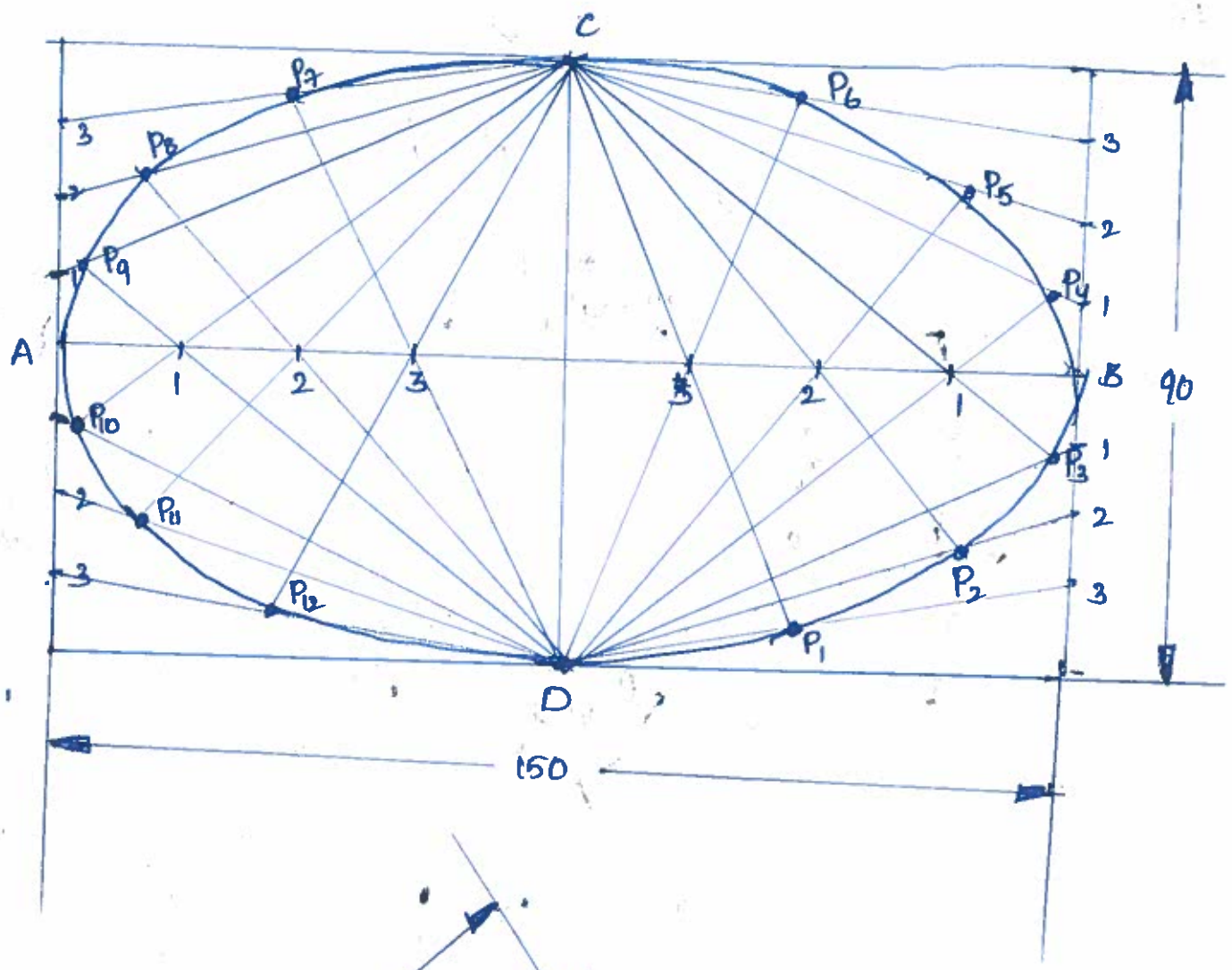
$$= \frac{144 \times 10^{\cancel{2}}}{36 \times 10^{\cancel{12}}} \times \cancel{10} \times \cancel{10^{6}}$$

$$\text{Loss} = 400\ \text{mm}$$



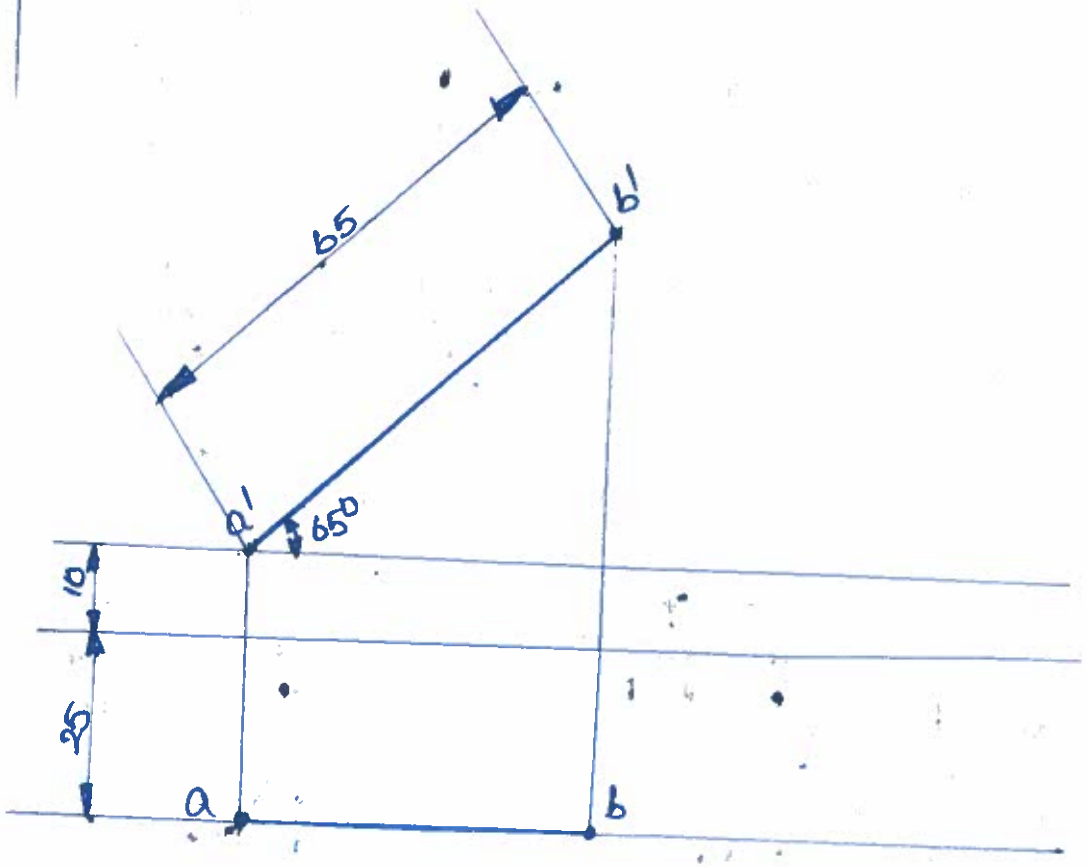
(4)

(6)

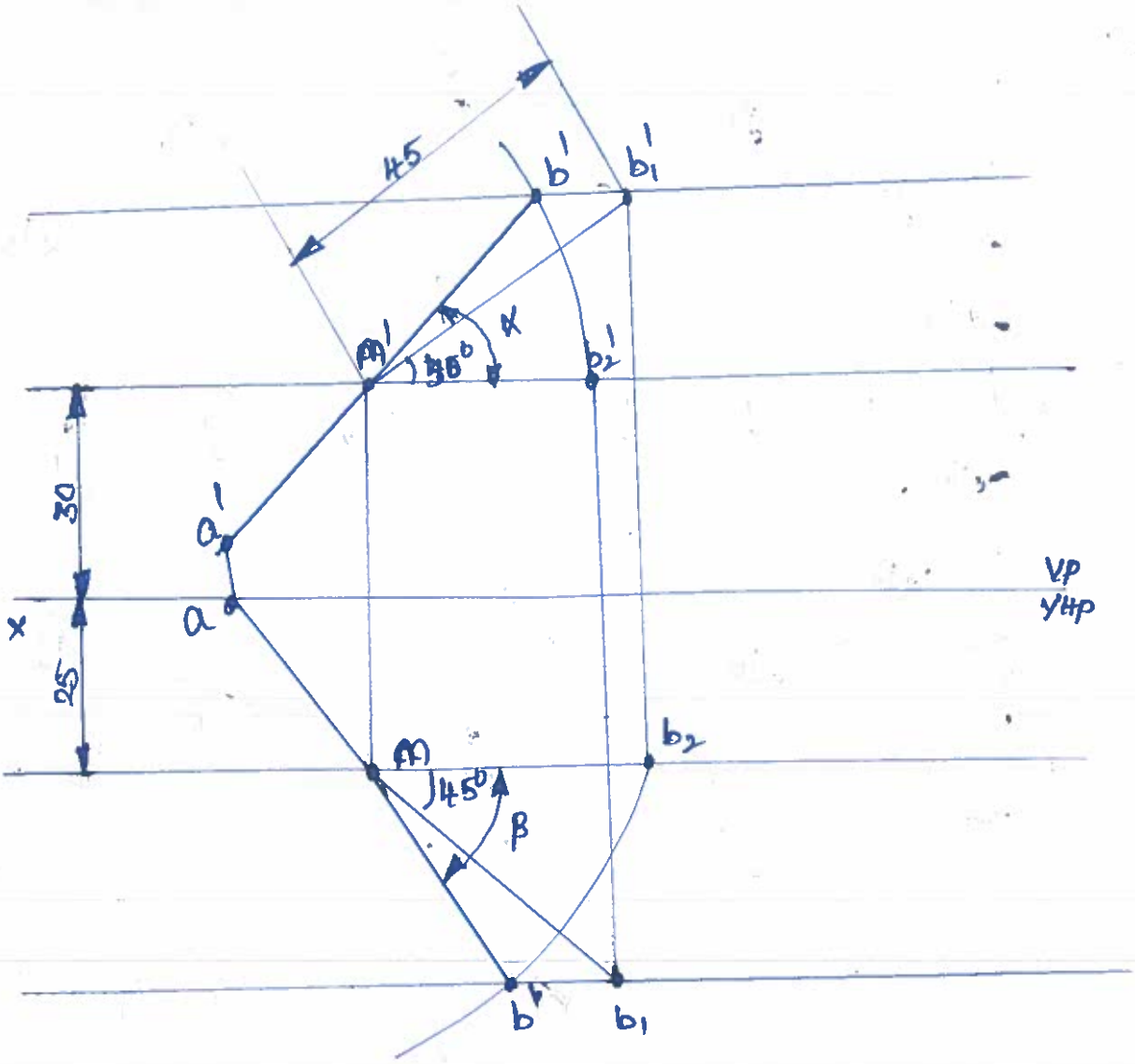

C
A
B
D
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
90
150

(5)

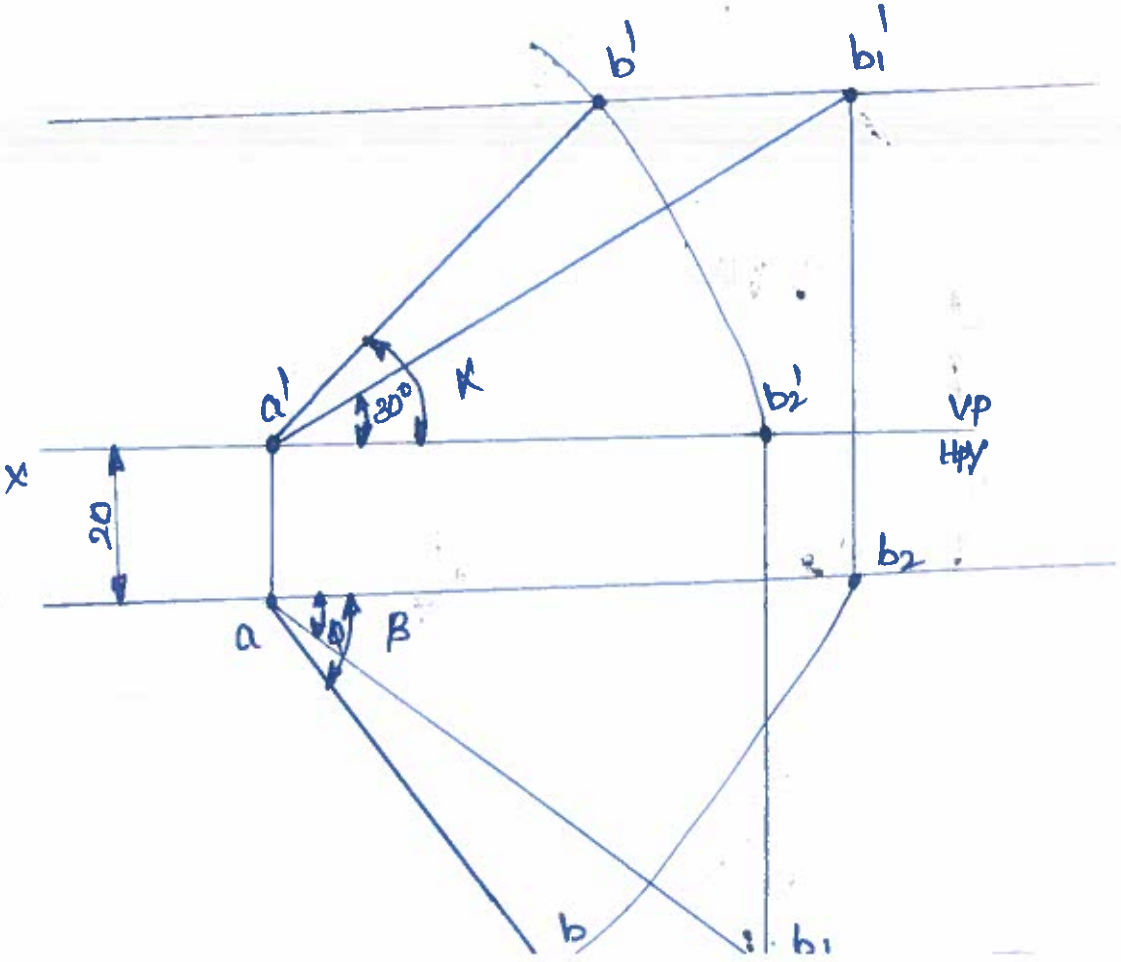
(a)


b1
65
a1
65°
10
40
a
b

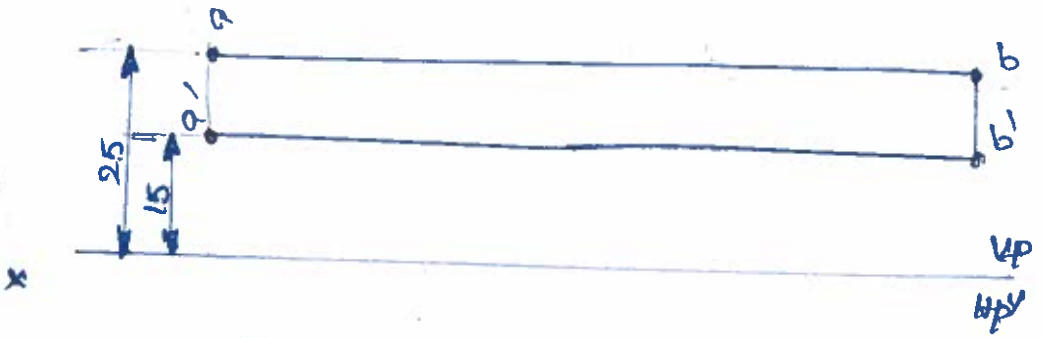
(5)
(b)


45
b'
b1'
a1'
35°
K
b2'
30
a'
VP
y'HP
x
a
25
b2
a1'
45°
β
b'
b1

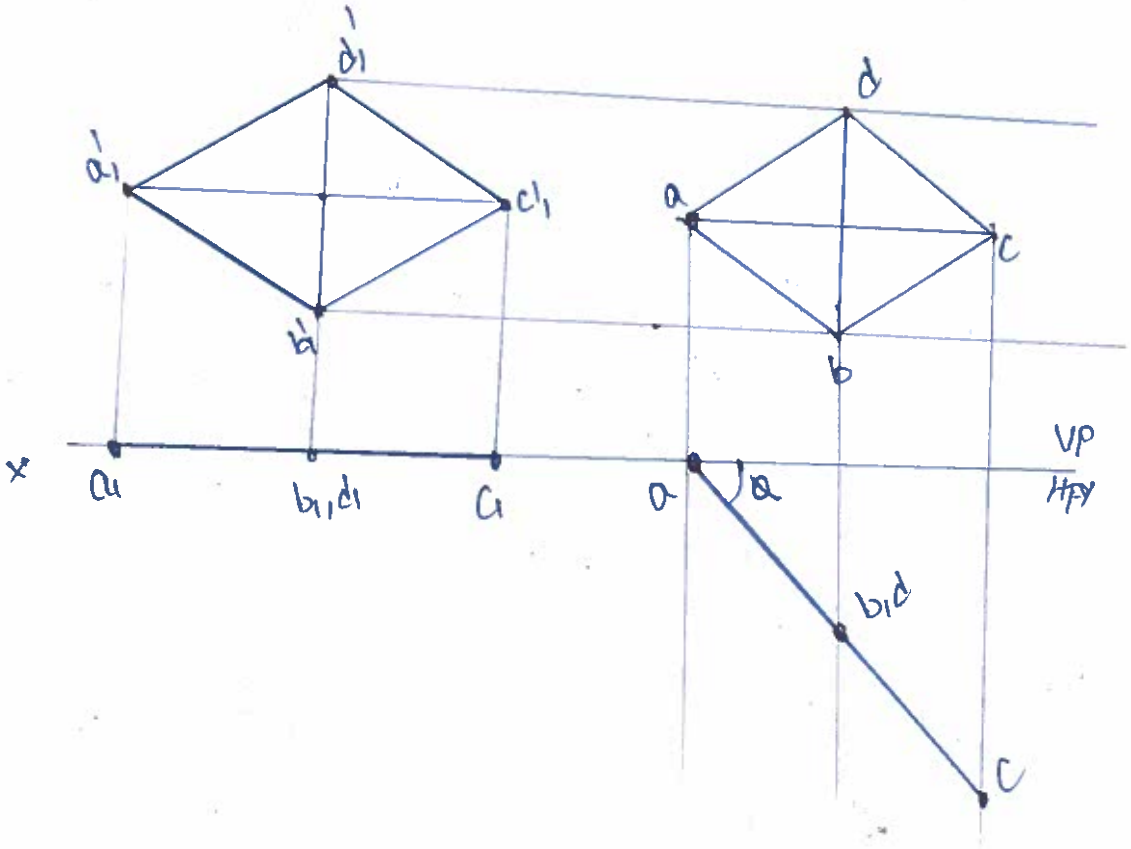
(6)
(a)


b'
b1'
a'
30°
K
b2'
VP
HP
x
20
b2
a
β
b
b1

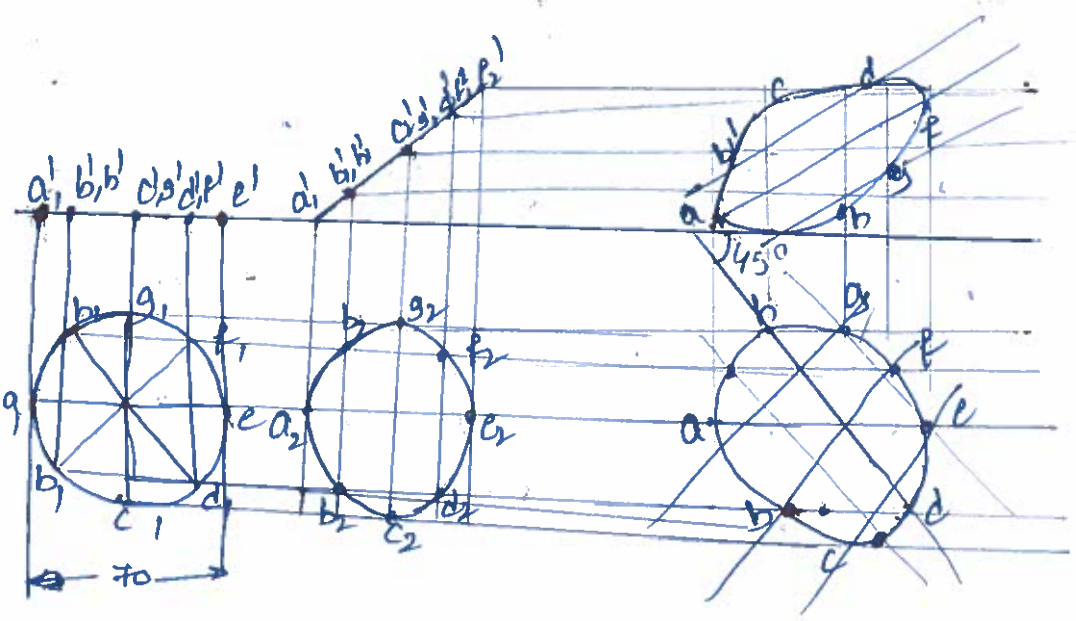
(6)
(b)


a
b
a'
b'
25
15
x
VP
HPP

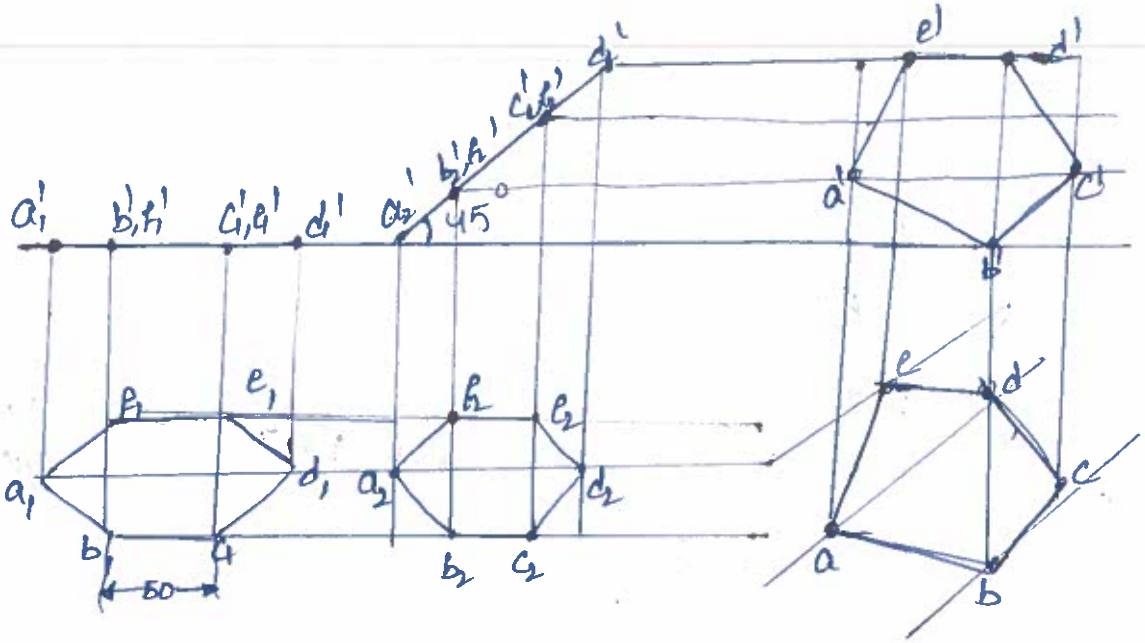
(7)
(a)


d'1
a'1
c'1
b'1
d
a
c
b
x
a1
b1,d1
c1
VP
HPP
a
θ
b1d
c

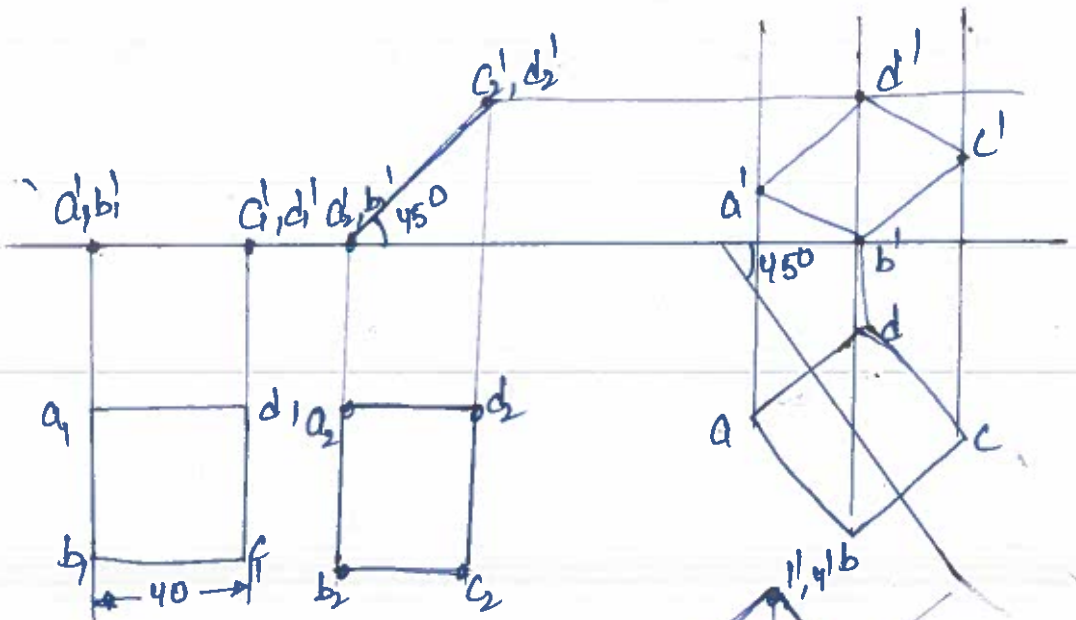
(7)
(b)


a', b',b' d',e' d',f' e'
a1 b1,h1
45°
70

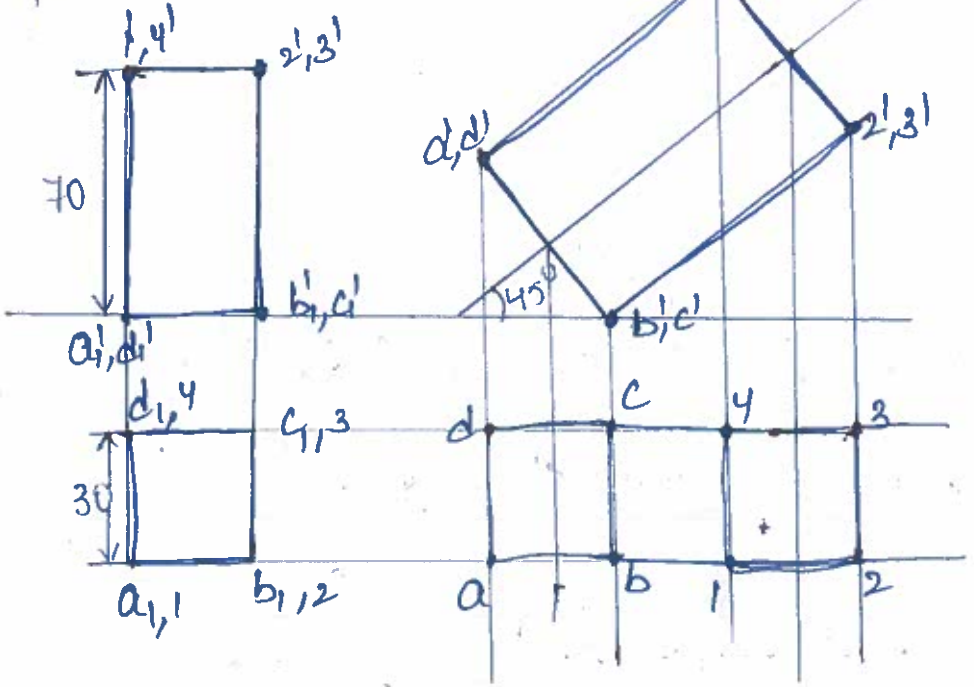
8 (a)


a'1 b'1,f'1 c'1,e'1 d'1 a'2 b'2,f'2 c'2,e'2 d'2
45°
e'1 d'1 a' c' b'
f1 e1 a1 d1 b c
f2 e2 a2 d2 b2 c2
50
e d a c b

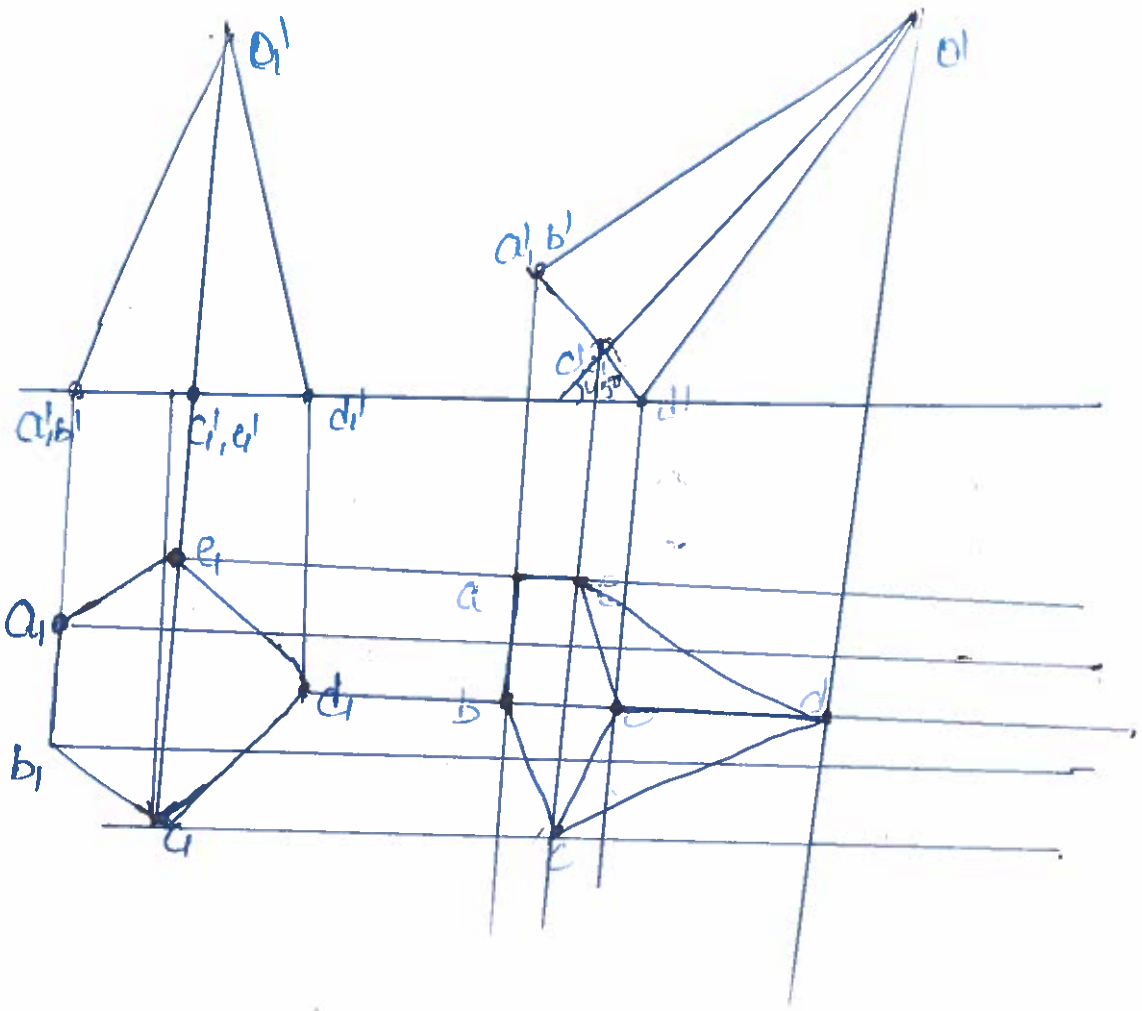
8 (b)


c'2,d'2 a'1,b'1 c'1,d'1 a'2,b' 45°
d' c' a' 45° b'
a1 d1 a2 d2 b1 f b2 c2
40
d a c

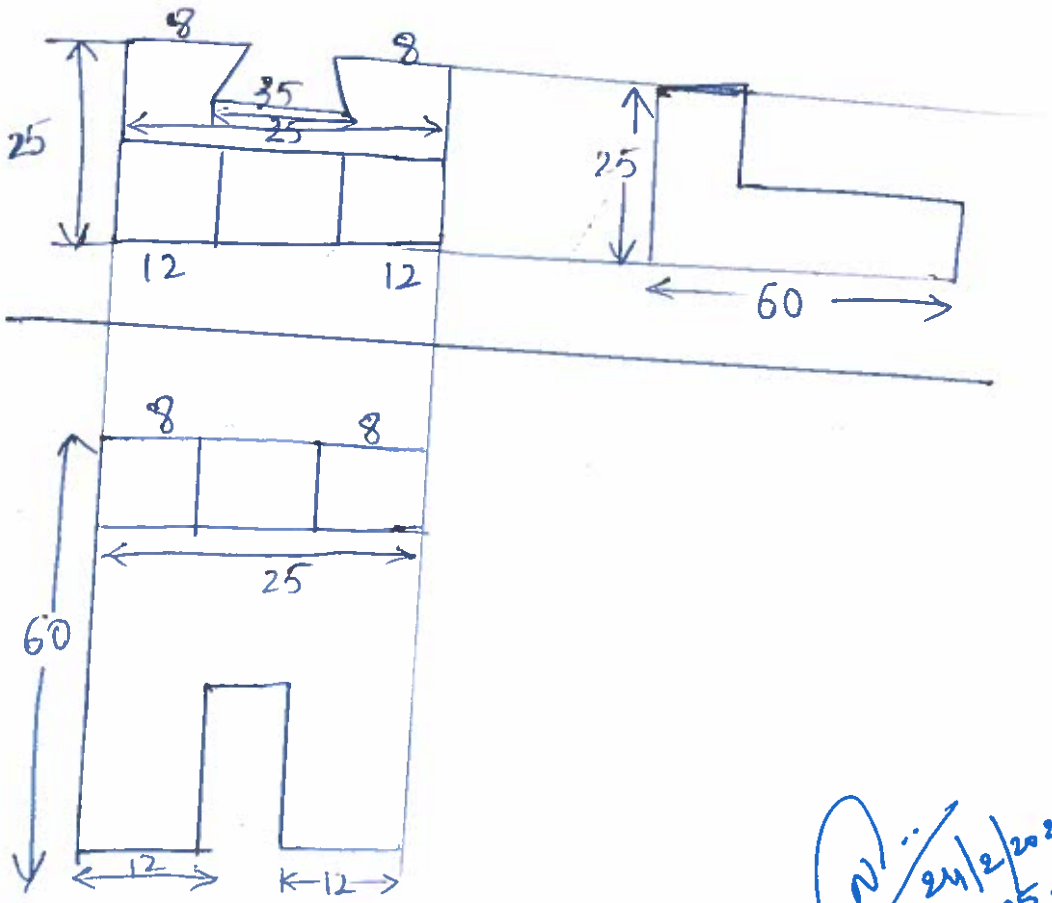
9 (a)


1',4' 2',3'
70
b'1,c'
a'1,d'1
d1,4 c1,3
30
a1,1 b1,2
1',4'b
d,d' 2',3'
45°
b',c'
d c 4 3
a f b 1 2

(10)



(11)



24/2/2023.
HOD-ME.

24/2

Semester End Regular/Supplementary Examination, Feb./March – 2023

Degree	B. Tech.	Program	CSE, CSE (AI & ML) & CSE (DS)			Academic Year	2022- 2023
Course Code	20CS101	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Fundamentals of Computer Science						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Differentiate between the characteristic of primary and secondary memory of computer.	20CS101.1	L2
2	Outline the flowchart for biggest among two numbers.	20CS101.2	L2
3	What is computer network?	20CS101.3	L1
4	Define database.	20CS101.4	L1
5	List any four applications of machine learning.	20CS101.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

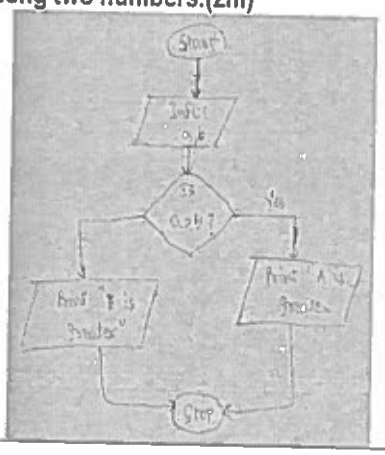
No.	Questions (6 through 10)	Marks	Learning Outcome (s)	DoK
6	Illustrate the various types of memory with suitable example.	12M	20CS101.1	L2
	OR			
7 (a)	Explain in detail about the input and output devices.	6M	20CS101.1	L2
7 (b)	Discuss in detail the central processing unit with neat sketch.	6M	20CS101.1	L2
8	Illustrate the various looping statements used in C with suitable examples.	12M	20CS101.2	L2
	OR			
9 (a)	Outline the flowchart for finding the biggest among 'n' numbers.	6M	20CS101.2	L2
9 (b)	Compare high level language and low level language.	6M	20CS101.2	L2
10	Name the four basic network topologies and explain them giving all the relevant features.	12M	20CS101.3	L2
	OR			
11 (a)	Explain process life cycle with a neat diagram.	6M	20CS101.3	L2
11 (b)	Explain different operating systems.	6M	20CS101.3	L2
12	Explain the various applications of data base systems.	12M	20CS101.4	L2
	OR			
13	Elaborate the following data base models i. Network model ii. Relational model	12M	20CS101.4	L2
14	Discuss the various foundational elements of artificial intelligence and applications of AI.	12M	20CS101.5	L2
	OR			
15	Explain different types of machine learning with necessary illustrations.	12M	20CS101.5	L2

N S RAJU INSTITUTE OF TECHNOLOGY

(AUTONOMOUS)

SONTYAM, ANANDAPURAM, VISAKHAPATNAM – 531 173

ANSWER KEY AND SCHEME OF EVALUATION

1	**Differentiate between the characteristic of primary and secondary memory of computer.** Characteristics of Main Memory:(1M) • These are semiconductor memories. • It is known as the main memory. • Usually volatile memory. • Data is lost in case power is switched off. • It is the working memory of the computer. • Faster than secondary memories. Characteristics of Secondary Memory:91M) • These are magnetic and optical memories. • It is known as the backup memory. • It is a non-volatile memory. • Data is permanently stored even if power is switched off. • It is used for storage of data in a computer. • Computer may run without the secondary memory. • Slower than primary memories.
2	**Outline the flowchart for biggest among two numbers.(2m)** 
3	**What is computer network? (2M)** A network is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. The purpose of having computer network is to send and receive data stored in other devices over the network. These devices are often referred as nodes.
4	**Define database. (2M)** Database is a collection of related data and data is a collection of unorganized facts and figures that can be processed to produce information.
5	**List any four applications of machine learning(2M).** The four applications of machine learning are: web search engine, photo tagging applications, spam detector, database mining for growth of automation, applications that cannot be programmed, understanding human learning.
6	**Illustrate the various types of memory with suitable example.** Memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells.

Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64k words, then this memory unit has 64 * 1024 = 65536 memory locations. The address of these locations varies from 0 to 65535. Memory is primarily of three types –

- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

Cache Memory(4m)
Cache memory is a very high-speed semiconductor memory which can speed up the CPU. It acts as a buffer between the CPU and the main memory. It is used to hold those parts of data and program which are most frequently used by the CPU. The parts of data and programs are transferred from the disk to cache memory by the operating system, from where the CPU can access them.

Advantages:
The advantages of cache memory are as follows –

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

Disadvantage:
The disadvantages of cache memory are as follows –

- Cache memory has limited capacity.
- It is very expensive.

Primary Memory (Main Memory) (4m)
Primary memory holds only those data and instructions on which the computer is currently working. It has a limited capacity and data is lost when power is switched off. It is generally made up of semiconductor device. These memories are not as fast as registers. The data and instruction required to be processed resides in the main memory. It is divided into two subcategories RAM and ROM. A computer cannot run without the primary memory.

Random Access Memory (RAM):
The most common type of memory is called RAM. RAM is like an electronic scratch pad inside the computer. RAM holds data and program instructions. When a program is launched, it is loaded and run from memory. As new data entered into computer, it is stored in RAM but only temporarily.

Random Access Memory is the internal memory of the CPU for storing data, program, and program result. It is a read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.

Access time in RAM is independent of the address, that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time. Data in the RAM can be accessed randomly but it is very expensive.

RAM is volatile, i.e., data stored in it is lost when we switch off the computer or if there is a power failure. Hence, a backup Uninterruptible Power System (UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold. RAM is of two types –

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

Read only Memory (ROM):
Unlike RAM, Read-Only Memory (ROM) permanently stores data. ROM never loses its contents.
The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture.

A ROM stores such instructions that are required to start a computer. This operation is referred to as bootstrap. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven. There are various types of ROMs - MROM, PROM, EPROM, EEPROM.

Secondary Memory (4m)
This type of memory is also known as external memory or non-volatile. It is slower than the main memory. These are used for storing data/information permanently. CPU directly does not access these memories, instead they are accessed via input- output routines. The

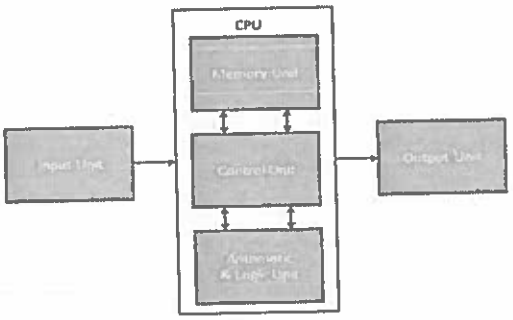
	contents of secondary memories are first transferred to the main memory, and then the CPU can access it. For example, disk, CD-ROM, DVD, etc.
7(a)	**Explain in detail about the input and output devices.** Input / Output Devices: These devices are used to enter information and instructions into a computer for storage or processing and to deliver the processed data to a user. Input / Output devices are required for users to communicate with the computer. These devices are also known as peripherals of a computer system. Input Devices(3m) An input device is any device that provides input to a computer. There are many input devices, but the two most common ones are a keyboard and mouse. Every key you press on the keyboard and every movement or click you make with the mouse sends a specific input signal to the computer. Keyboard: The keyboard is very much like a standard typewriter keyboard with a few additional keys. The basic QWERTY layout of characters is maintained to make it easy to use the system. There are also Functional Keys, used to perform certain special functions. Mouse: A device that controls the movement of the cursor or pointer on a display screen. A mouse is a small object you can roll along a hard and flat surface. Its name is derived from its shape, which looks a bit like a mouse. As you move the mouse, the pointer on the display screen moves in the same direction. Trackball: A trackball is an input device used to enter motion data into computers or other electronic devices. It serves the same purpose as a mouse, but is designed with a moveable ball on the top, which can be rolled in any direction. Touchpad: A touch pad is a device for pointing (controlling input positioning) on a computer display screen. It is an alternative to the mouse. Originally incorporated in laptop computers, touch pads are also being made for use with desktop computers. A touch pad works by sensing the user's finger movement and downward pressure. Touch Screen: It allows the user to operate/make selections by simply touching the display screen. A display screen that is sensitive to the touch of a finger or stylus. Widely used on ATM machines, retail point-of-sale terminals, car navigation systems, medical monitors and industrial control panels. Light Pen: Light pen is an input device that utilizes a light-sensitive detector to select objects on a display screen. Optical mark recognition (OMR): Optical mark recognition, also called mark sense reader is a technology where an OMR device senses the presence or absence of a mark, such as pencil mark. OMR is widely used in tests such as aptitude test. Bar Code Reader: Bar-code readers are photoelectric scanners that read the bar codes or vertical zebra strips marks, printed on product containers. These devices are generally used in super markets, bookshops etc. Scanner: Scanner is an input device that can read text or illustration printed on paper and translates the information into a form that the computer can use. A scanner works by digitizing an image. Output Devices(3m) Output device receives information from the CPU and presents it to the user in the desired from. The processed data, stored in the memory of the computer is sent to the output unit, which then converts it into a form that can be understood by the user. The output is usually produced in one of the two ways – on the display device, or on paper (hard copy). Monitor: It is often used synonymously with "computer screen" or "display." Monitor is an output device that resembles the television screen. The monitor is associated with a keyboard for manual input of characters and displays the information as it is keyed in. It also displays the program or application output.

Monitors, commonly called as Visual Display Unit (VDU), are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

Printer:
Printers are used to produce paper (commonly known as hard copy) output. They use chemical, heat or electrical signals to etch the symbols on paper.

Sound Cards and Speaker(s):
An expansion board that enables a computer to manipulate and output sounds. Sound cards are necessary for nearly all CD-ROMs and have become commonplace on modern personal computers. Sound cards enable the computer to output sound through speakers connected to the board, to record sound input from a microphone connected to the computer, and manipulate sound stored on a disk.

7(b) **Discuss in detail the central processing unit with neat sketch.**



(2M)

Input:
It is a device which is used to send data (or) instructions to a computer. Most commonly used input devices are Keyboard, mouse, etc.

CPU:(4m)
The major components of the CPU are:

- Memory Unit
- Control Unit
- Arithmetic Logical Unit

Memory Unit:
The data and instructions that are entered into the system have to stored inside the computer before actual processing takes place. Similarly, the final results produced by the computer also have to be stored before they are passed through output unit.

Control Unit:
Control unit directs and coordinates the activities of the entire computer. The operations of All transform the data to and from memory unit. The important function of control unit is program execution, fetching instructions from memory, decoding it and sending to computer to get it executed.

Arithmetic Logical Unit:
The ALU performs arithmetic operations (+, -, *, /). In ALU the required operation is done and result is sent back to memory for storage. ALU happens under control unit. ALU also performs logical operations (<, <=, >=, >)

Output:
It is a device which is used to displaying the final result. The commonly used output devices are monitor and printer.

8 **Illustrate the various looping statements used in C with suitable examples.**

In looping, a program executes the sequence of statements many times until the stated condition becomes false. A loop consists of two parts, a body of a loop and a control statement. The control statement is a combination of some conditions that direct the body of the loop to execute until the specified condition becomes false.

Types of Loops:
Depending upon the position of a control statement in a program, a loop is classified into two types:

- Entry Controlled Loop:

In an Entry Controlled Loop, a condition is checked before executing the body of a loop. It is also called as a Pre-Checking Loop.

- Exit Controlled Loop:

In an Exit Controlled Loop, a condition is checked after executing the body of a loop. It is also called as a Post-Checking Loop.

The specified condition determines whether to execute the loop body or not. 'C' programming language provides us with three types of loop constructs:

- The while loop (4m)
- The do-while loop(4m)
- The for loop(4m)

While Loop:
A while loop is the most straightforward looping structure. The basic format of while loop is as follows:

```
while (condition)
{
statements;
}
```

It is an entry-controlled loop. In while loop, a condition is evaluated before processing a body of the loop. If a condition is true then and only then the body of a loop is executed. After the body of a loop is executed then control again goes back at the beginning, and the condition is checked. Again if it is true, the same process is executed until the condition becomes false. Once the condition becomes false, the control goes out of the loop.

After exiting the loop, the control goes to the statements which are immediately after the loop. The body of a loop can contain more than one statement. If it contains only one statement, then the curly braces are not compulsory. It is a good practice though to use the curly braces even we have a single statement in the body. In while loop, if the condition is not true, then the body of a loop will not be executed, not even once. It is different in do-while loop.

Example: Write a Program to print series of numbers from 1 to 10 using a While loop.

```
#include<stdio.h>
main()
{
        int n=1;                    //Initializing the Variable.
        while(n<=10)                        //While loop with condition.
        {
                printf("\t%d",n);
                n++;                        //Incrementing Operation.
        }
}
```

Output: 1 2 3 4 5 6 7 8 9 10

Do-While Loop:
A do-while loop is similar to the while loop except that the condition is always executed after the body of a loop. It is also called an exit-controlled loop. The basic format of while loop is as follows:

```
do
{
statements;
} while (expression);
```

As we saw in a while loop, the body is executed if and only if the condition is true. In some cases, we have to execute a body of the loop at least once even if the condition is false. This type of operation can be achieved by using a do-while loop.

In the do-while loop, the body of a loop is always executed at least once. After the body is executed, then it checks the condition. If the condition is true, then it will again execute the body of a loop otherwise control is transferred out of the loop.

Similar to the while loop, once the control goes out of the loop the statements which are immediately after the loop is executed.

The critical difference between the while and do-while loop is that in while loop the while is written at the beginning. In do-while loop, the while condition is written at the end and terminates with a semi-colon (;).

Example: Write a Program to print Table of Number-2 using a Do-While loop.

```
#include<stdio.h>
```

```
main()
{
        int n=1;                        //Initializing the Variable.
        do                                      //Do-While loop
        {                                               '
                printf("\t%d",n*2);             '
                n++;                            //Incrementing Operation.
        } while(n<=10);
}
```

Output: 2 4 6 8 10 12 14 16 18 20

For Loop:
A for loop is a more efficient loop structure in 'C' programming. The general structure of for loop is as follows:

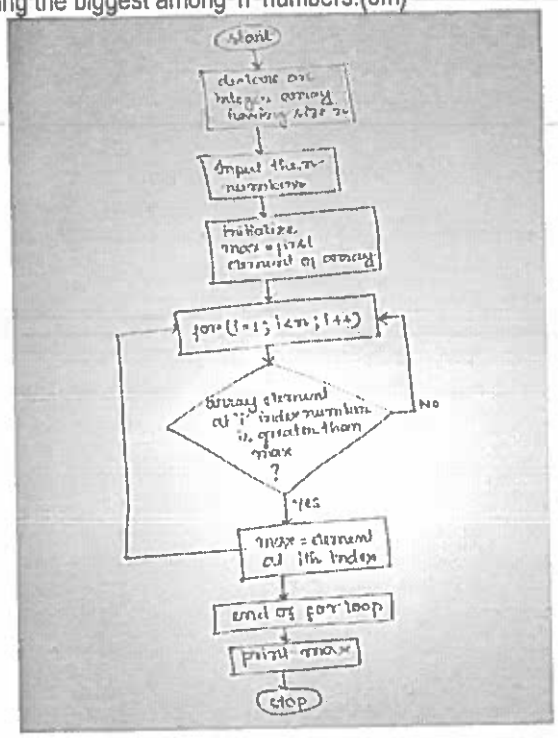
```
for (initial value; condition; incrementation or decrementation)
{
statements;
}
```

Example: Write a Program to print series of numbers from 1 to 10 using a For loop.

```
#include<stdio.h>
main()
{
        int n;
        for(n=1;n<=10;n++)              //For loop to print 1-10 numbers.
        {
                printf("\t%d",n);
        }
}
```

Output: 1 2 3 4 5 6 7 8 9 10

9(a) Outline the flowchart for finding the biggest among 'n' numbers.(6m)



9 (b) **Compare high level language and low-level language.**

Low Level Language (3m)

The low-level language is a programming language that is represented in 0 or 1 forms, which are the machine instructions.

The languages that come under this category are the Machine level language and Assembly language.

High Level Language(3m)

The computer system is simply a machine and hence it cannot perform any work; therefore, in order to make it functional different languages are developed, which are known as programming languages or simply computer languages. The high-level language is simple and easy to understand and it is similar to English language. Example of high-level language are: COBOL, FORTRAN, BASIC, C, C++, Python, etc.

When writing a program in a high-level language, then the whole attention needs to be paid to the logic of the problem. A compiler is required to translate a high-level language into a low-level language. Although a high-level language has many benefits, yet it also has a drawback. It has poor control on machine/hardware.

High-level languages are very important, as they help in developing complex software and they have the following advantages –

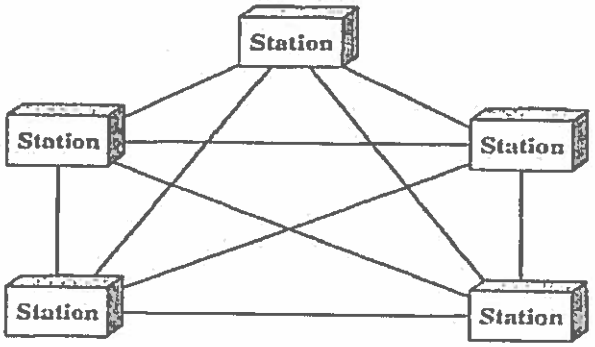
- Unlike assembly language or machine language, users do not need to learn the high-level language in order to work with it.
- High-level languages are similar to natural languages, therefore, easy to learn and understand.
- High-level language is designed in such a way that it detects the errors immediately.
- High-level language is easy to maintain and it can be easily modified.
- High-level language makes development faster.
- High-level language is comparatively cheaper to develop.
- High-level language is easier to document.

10 **Name the four basic network topologies and explain them giving all the relevant features.**

Topology The term topology refers to the way in which a network is laid out physically. One or more devices connect to a link; two or more links form a topology. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another. There are five basic topologies possible: Mesh, Star, Bus, Ring, and Hybrid

Mesh Topology: (3m)

In a Mesh Topology, every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects.



Advantages:

- The use of dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices.
- A mesh topology is robust. If one link becomes unusable, it does not incapacitate the entire system. Third, there is the advantage of privacy or security. When every message travels along a dedicated line, only the intended recipient sees it. Physical boundaries prevent other users from gaining access to messages. Finally, point-to- point links make fault identification and fault isolation easy. Traffic can be routed to avoid links with suspected problems. This facility enables the network manager to discover the precise location of the fault and aids in finding its cause and solution.

Disadvantages:

- Disadvantage of a mesh are related to the amount of cabling because every device must be connected to every other device, installation and reconnection are difficult.
- Second, the sheer bulk of the wiring can be greater than the available space (in walls, ceilings, or floors) can accommodate. Finally, the hardware required to connect each link (I/O ports and cable) can be prohibitively expensive. For these reasons a mesh topology is usually implemented in a limited fashion. For example, as a backbone connecting the main computers of a hybrid network that can include several other topologies.

Star Topology(3m)

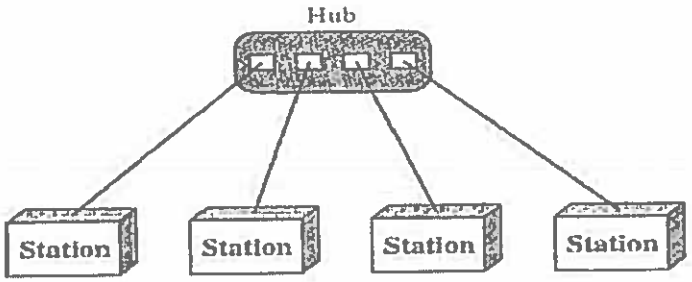
In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. The devices are not directly linked to one another. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts

as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.

Advantage:
A star topology is less expensive than a mesh topology. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure. Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub.

Other advantages include robustness. If one link fails, only that link is affected. All other links remain active. This factor also lends itself to easy fault identification and fault isolation. As long as the hub is working, it can be used to monitor link problems and bypass defective links.

Disadvantage:
One big disadvantage of a star topology is the dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead. Although a star requires far less cable than a mesh, each node must be linked to a central hub. For this reason, often more cabling is required in a star than in some other topologies (such as ring or bus).



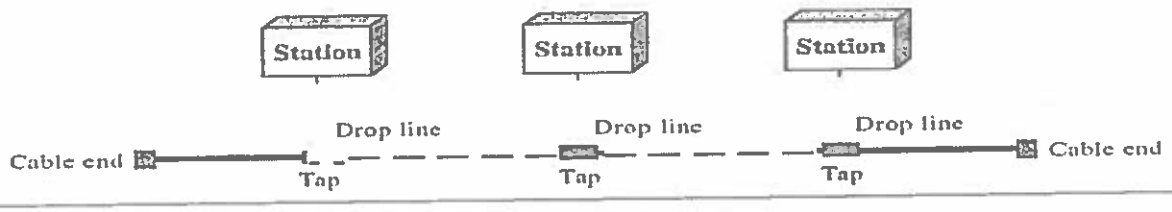
Bus Topology(3m)
The preceding examples all describe point-to-point connections. A bus topology, on the other hand, is multipoint. One long cable act as a backbone to link all the devices in a network.

Nodes are connected to the bus cable by drop lines and taps. A drop line is a connection running between the device and the main cable. A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core. As a signal travels along the backbone, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker as it travels farther and farther. For this reason, there is a limit on the number of taps a bus can support and on the distance between those taps.

Advantages:
A bus topology includes ease of installation. Backbone cable can be laid along the most efficient path, then connected to the nodes by drop lines of various lengths. In this way, a bus uses less cabling than mesh or star topologies. In a star, for example, four network devices in the same room require four lengths of cable reaching all the way to the hub. In a bus, this redundancy is eliminated. Only the backbone cable stretches through the entire facility. Each drop line has to reach only as far as the nearest point on the backbone.

Disadvantages:
It includes difficult reconnection and fault isolation. A bus is usually designed to be optimally efficient at installation. It can therefore be difficult to add new devices. Signal reflection at the taps can cause degradation in quality. This degradation can be controlled by limiting the number and spacing of devices connected to a given length of cable. Adding new devices may therefore require modification or replacement of the backbone.

In addition, a fault or break in the bus cable stops all transmission, even between devices on the same side of the problem. The damaged area reflects signals back in the direction of origin, creating noise in both directions. Bus topology was the one of the first topologies used in the design of early local area networks. Ethernet LANs can use a bus topology, but they are less popular.

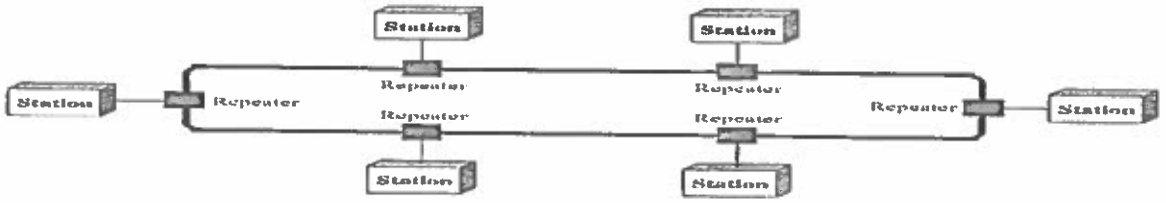


Ring Topology: 3M

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.

A ring is relatively easy to install and reconfigure. Each device is linked to only its immediate neighbours (either physically or logically). To add or delete a device requires changing only two connections. The only constraints are media and traffic considerations (maximum ring length and number of devices). In addition, fault isolation is simplified. Generally, in a ring, a signal is circulating at all times.

If one device does not receive a signal within a specified period, it can issue an alarm. The alarm alerts the network operator to the problem and its location. However, unidirectional traffic can be a disadvantage. In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.



Hybrid Topology:

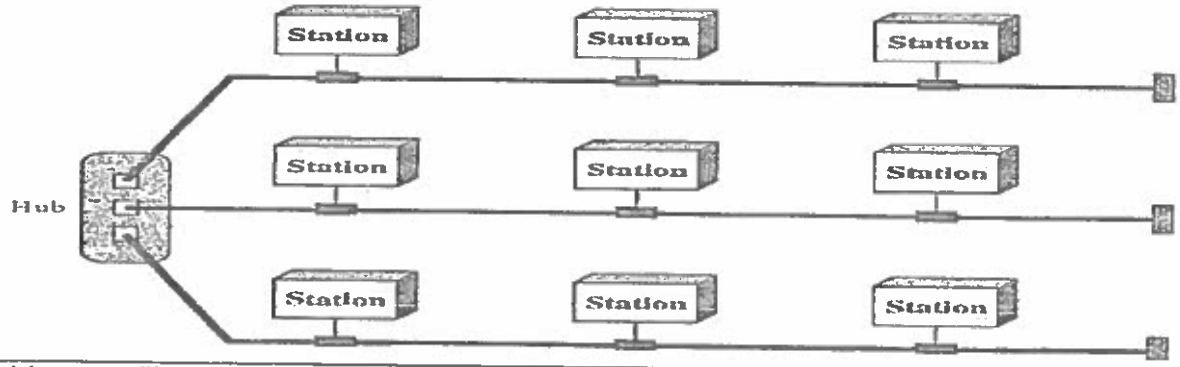
A hybrid topology is a type of network topology that uses two or more differing network topologies. These topologies can include a mix of bus topology, mesh topology, ring topology, star topology. For example, a combination of star and mesh topology is known as hybrid topology. we can have a main star topology with each branch connecting several stations in a bus topology as shown in Figure

Advantages:

- This type of topology combines the benefits of different types of topologies in one topology. Can be modified as per requirement
- It is extremely flexible. It is very reliable.

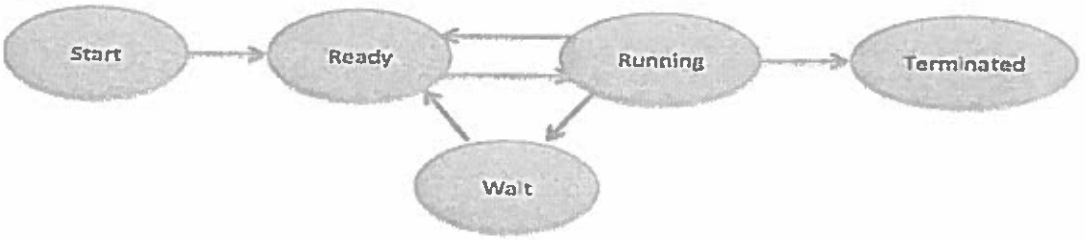
Disadvantages:

- Fault detection is difficult.
- Installation is difficult.
- Design is complex so maintenance is high expensive.



11(a) **Explain process life cycle with a neat diagram.**

When a process executes, it passes through different states. These stages may differ in different operating systems, and the names of these states are also not standardized. In general, a process can have one of the following five states at a time.(2M)



S.No	Component and Description(4M)
1	**Start:** This is the initial state when a process is first started / created.
2	**Ready:** The process is waiting to be assigned to a processor. Ready processes are waiting to have the processor allocated to them by the operating system so that they can run. Process may come into this state after Start state or while running it by but interrupted by the scheduler to assign CPU to some other process.
3	**Running:** Once the process has been assigned to a processor by the OS scheduler, the process state is set to running and the processor executes its instructions.
4	**Waiting:** Process moves into the waiting state if it needs to wait for a resource, such as waiting for user input, or waiting for a file to become available.
5	**Terminated or Exit:** Once the process finishes its execution, or it is terminated by the operating system, it is moved to the terminated state where it waits to be removed from main memory.

11(b) **Explain different operating systems.**

MS-DOS(3m)

Short for Microsoft Disk Operating System, MS-DOS is a non-graphical command line operating system derived from 86-DOS that was created for IBM compatible computers. MS- DOS originally written by Tim Paterson and introduced by Microsoft in August 1981 and was last updated in 1994 when MS-DOS 6.22 was released. MS-DOS allows the user to navigate, open, and otherwise manipulate files on their computer from a command line instead of a GUI like Windows.

Today, MS-DOS is no longer used; however, the command shell, more commonly known as the Windows command line is still used by many users. The bottom image is an example of a Windows command line window running in Microsoft Windows 10.

Windows OS(3m)

Windows OS, computer operating system (OS) developed by Microsoft Corporation to run personal computers (PCs). Featuring the first graphical user interface (GUI) for IBM - compatible PCs, the Windows OS soon dominated the PC market. Approximately 90 percent of PCs run some version of Windows.

The first version of Windows, released in 1985, was simply a GUI offered as an extension of Microsoft's existing disk operating system, or MS-DOS. Based in part on licensed concepts that Apple Inc. had used for its Macintosh System Software, Windows for the first time allowed DOS users to visually navigate a virtual desktop, opening graphical "windows" displaying the contents of electronic folders and files with the click of a mouse button, rather than typing commands and directory paths at a text prompt.

Subsequent versions introduced greater functionality, including native Windows File Manager, Program Manager, and Print Manager programs, and a more dynamic interface. Microsoft also developed specialized Windows packages, including the networkable Windows for Workgroups and the high-powered Windows NT, aimed at businesses. The 1995 consumer release Windows 95 fully integrated Windows and DOS and offered built- in Internet support, including the World Wide Web browser Internet Explorer.

In the 2001 release of Windows XP, Microsoft united its various Windows packages under a single banner, offering multiple editions for consumers, businesses, multimedia developers, and others. Windows XP abandoned the long-used Windows 95 kernel (core software code) for a more powerful code base and offered a more practical interface and improved application and memory management.

The highly successful XP standard was succeeded in late 2006 by Windows Vista, which experienced a troubled rollout and met with considerable marketplace resistance, quickly acquiring a reputation for being a large, slow, and resource- consuming system. Responding to Vista's disappointing adoption rate, Microsoft in 2009 released Windows 7, an OS whose interface was similar to that of Vista but was met with enthusiasm for its noticeable speed improvement and its modest system requirements.

UNIX:

UNIX is an operating system which was first developed in the 1960s, and has been under constant development ever since. By operating system, we mean the suite of programs which make the computer work. It is a stable, multi-user, multi-tasking system for servers, desktops and laptops.

UNIX systems also have a graphical user interface (GUI) similar to Microsoft Windows which provides an easy-to-use environment. However, knowledge of UNIX is required for operations which aren't covered by a graphical program, or for when there is no windows interface available.

Linux:

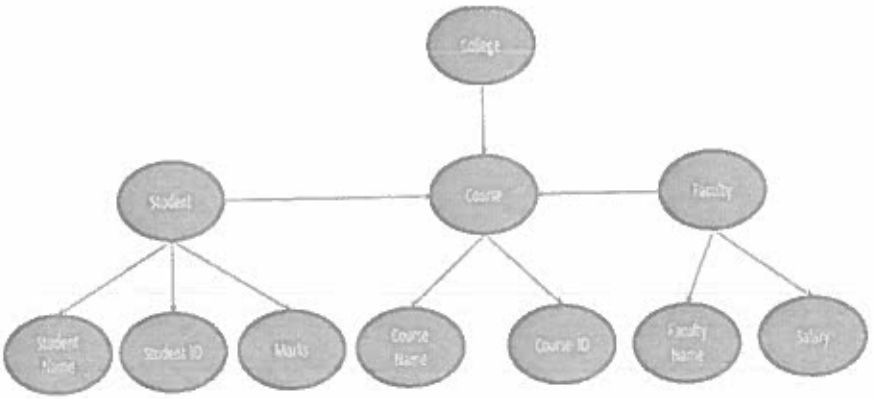
Linux is one of popular version of UNIX operating System. It is open source as its source code is freely available. It is free to use. Linux was designed considering UNIX compatibility. Its functionality list is quite similar to that of UNIX. Examples of Linux operating systems are Ubuntu, Arch Linux etc.

12	**Explain the various applications of data base systems.(12m)** There are various fields where a database management system is used. Following are some applications which make use of the database management system:  1. **Railway Reservation System:** In the railway reservation system, the database is required to store the record or data of ticket bookings, status about train's arrival, and departure. Also, if trains get late, people get to know it through database update. 2. **Library Management System:** There are lots of books in the library so; it is tough to store the record of all the books in a register or copy. So, the database management system (DBMS) is used to maintain all the information related to the name of the book, issue date, availability of the book, and its author. 3. **Banking:** Database management system is used to store the transaction information of the customer in the database. 4. **Education Sector:** Presently, examinations are conducted online by many colleges and universities. They manage all examination data through the database management system (DBMS). Inspite that student's registrations details, grades, courses, fee, attendance, results, etc. all the information is stored in the database. 5. **Credit Card Transactions:** Database Management system is used for purchasing on credit cards and generation of monthly statements. 6. **Social Media Sites:** We all use of social media websites to connect with friends and to share our views with the world. Daily, millions of peoples sign up for these social media accounts like Pinterest, Facebook, Twitter, and Google plus. By the use of the database management system, all the information of users is stored in the database and, we become able to connect with other people. 7. **Telecommunications:** Without DBMS any telecommunication company can't think. The database management system is necessary for these companies to store the call details and monthly post-paid bills in the database. 8. **Finance:** The database management system is used for storing information about sales, holding and purchases of financial instruments such as stocks and bonds in a database. 9. **Online Shopping:** These days, online shopping has become a big trend. No one wants to visit the shop and waste their time. Everyone wants to shop through online shopping websites (such as Amazon, Flipkart, Snapdeal) from home. So all the products are sold and added only with the help of the database management system (DBMS). Invoice bills, payments, purchase information all of these are done with the help of DBMS. 10. **Human Resource Management:** Big firms or companies have many workers or employees working under them. They store information about employee's salary, tax, and work with the help of database management system (DBMS). 11. **Manufacturing:** Manufacturing companies make different types of products and sale them on a daily basis. In order to keep the information about their products like bills, purchase of the product, quantity, supply chain management, database management system (DBMS) is used. 12. **Airline Reservation System:** This system is the same as the railway reservation system. This system also uses a database management system to store the records of flights departure, arrival, and delay status.
13	**Elaborate the following data base models** • **Network model(6m)** • **Relational model (6m)** There is a wide variety of Databases in Database Management System. DBMS can be classified into following: • Hierarchical Model

- Network Model
- Relational Model
- Object Oriented Model

Network DBMS:

- The network database structure was invented by Charles Bachman. Network database management systems (Network DBMSs) uses network structure to create a relationship between entities.
- Network databases are mainly used on a large network of computers.
- Network databases are similar to hierarchical databases differs with one key point that in network databases one node can have a relationship with multiple entities.
- In network databases, parents are termed as occupier and children are termed as members. Data in the network database is organized as many-to-many relationships.



Network Database Model

Relational DBMS:

- Relational Databases are the most popular among all databases.
- In this type of database, there is a relationship between data and that is stored in the form of the table of rows and columns, such that row represents record and column represents the attribute.
- Every individual field represents the data value. In order to query the Relational Databases, Structured Query Language (SQL) is used which includes insertion, deletion, manipulation and search the records.

Relational database depicts the relation between two or more tables. This relation is made through Key Fields. Every row has its unique key field and these key fields are used to connect one table to another one.

Properties of Relational Tables:

- Its values are Atomic.
- Every row is individual.
- Columns are undistinguished.
- Sequence of Rows is Insignificant.

Relational Database Model

14 **Discuss the various foundational elements of artificial intelligence and applications of AI.**

Foundations of AI(8m)

Commonly used techniques and theories are rule-based Fuzzy Logic neural networks station theory statistics probability

theory genetic algorithm etc. Since AI is interdisciplinary in nature foundation of a in various fields such as -

1. Mathematics
2. Neurosciences
3. Control Theory
4. Linguistics

Mathematics: AI system use formal logic method and Boolean logic analysis of limits to what can be computed, probability theory ,uncertainty that forms the basic for most modern approaches to Ai fuzzy logic etc

Neuroscience: This science of medicine helps in studying the functioning of brains. In early studies injured and abnormal people were used to understand what parts of brain work. Now recent studies use accurate sensors to correlate brain activity to human thought. By monitoring individual neuron monkeys can now control a computer mouse using thought alone. Moore's law state that the computers will have as many gates as human have neurons in the year 2020. Researchers are working to low as to how to have your mechanical brain. Such systems will require parallel computation remapping and interconnection to a large extent.

Control Theory: Mission can modify their behavior in response to the environment steam engine. Example, water flow regulator this theory of stable feedback system helps in building systems the transition from initial state two goals it with minimum energy.

Linguistics: Linguistics speech demonstrates so much of human intelligence. Analysis of human language reveal thought taking place in a in ways not understood in other settings. Children can create sentences they have never heard before. Languages and thoughts believed to be tightly intertwined.

Application of AI(4m)

Artificial Intelligence has various applications in today's society. It is becoming essential for today's time because it can solve complex problems with an efficient way in multiple industries, such as Healthcare, entertainment, finance, education, etc. AI is making our daily life more comfortable and faster. Following are some sectors which have the application of Artificial Intelligence:

AI in Astronomy:

- Artificial Intelligence can be very useful to solve complex universe problems. AI technology can be helpful for understanding the universe such as how it works, origin, etc.

AI in Healthcare:

- In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry.
- Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization.

AI in Gaming:

- AI can be used for gaming purpose. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

AI in Finance:

- AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

AI in Data Security:

- The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure. Some examples such as AEG bot, AI2 Platform, are used to determine software bug and cyber-attacks in a better way.

AI in Social-Media:

- Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyse lots of data to identify the latest trends, hashtag, and requirement of different users.

AI in Travel & Transport:

- AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangement to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response.

AI in Automotive Industry:

- Some Automotive industries are using AI to provide virtual assistant to their user for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant.
- Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure.

AI in Robotics:

- Artificial Intelligence has a remarkable role in Robotics. Usually, general robots are programmed such that they can perform some repetitive tasks, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.
- Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot named as Erica and Sophia has been developed which can talk and behave like humans.

AI in Entertainment:

- We are currently using some AI based applications in our daily life with some entertainment services such as Netflix or Amazon. With the help of ML/AI algorithms, these services show the recommendations for programs or shows.

AI in Agriculture:

- Agriculture is an area which requires various resources, labour, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis. AI in agriculture can be very helpful for farmers.

AI in E-Commerce:

- AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, colour, or even brand.

AI in Education:

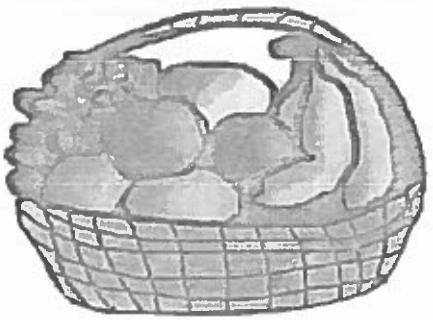
- AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant.
- AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

15 **Explain different types of machine learning with necessary illustrations.**

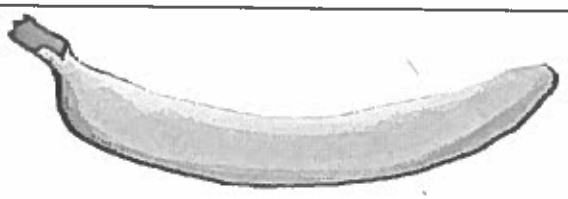
- There are different ways of how a machine learns. In some cases, we train them and, in some other cases machines learn by their own.
- Primarily, there are three types of machine learning – Supervised Learning, Unsupervised Learning and Reinforcement learning.

<u>Supervised Learning:(4m)</u>

1. Supervised learning as the name indicates the presence of a supervisor as a teacher. Basically, supervised learning is a learning in which we teach or train the machine using data which is well labelled that means some data is already tagged with the correct answer. After that, the machine is provided with a new set of examples(data) so that supervised learning algorithm analyses the training data (set of training examples) and produces a correct outcome from labelled data.
2. For instance, suppose you are given a basket filled with different kinds of fruits. Now the first step is to train the machine with all different fruits one by one like this:



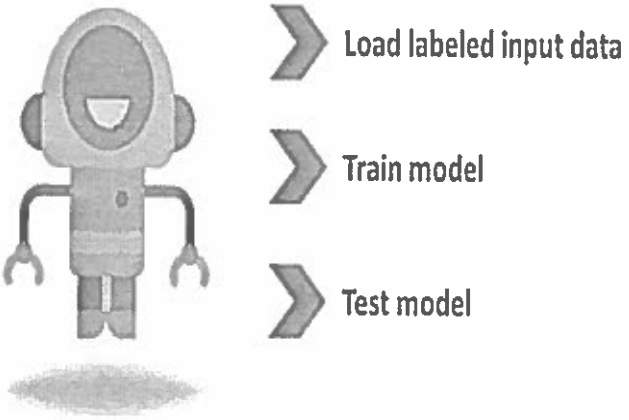
- If shape of object is rounded and depression at top having colour Red then it will be labelled as – Apple.



- If shape of object is long curving cylinder having colour Green-Yellow then it will be labelled as – Banana.

Now suppose after training the data, you have given a new separate fruit say Banana from basket and asked to identify it. Since the machine has already learned the things from previous data and this time have to use it wisely. It will first classify the fruit with its shape and colour and would confirm the fruit name as BANANA and put it in Banana category. Thus, the machine learns the things from training data (basket containing fruits) and then apply the knowledge to test data (new fruit).

Supervised Machine Learning Algorithm Works:
Step 1: The very first step of Supervised Machine Learning is to load labelled data into the system. This step is a bit time consuming, because the preparation of labelled data is often done by a human trainer. Here, the dataset is divided into train and test sets for further operations.
Step 2: The next step is to train and build connections of inputs and outputs. This step is also known as the training model.
Step 3: Then comes the step known as the testing model. As the name suggests, you test the model by introducing it to a set of new data.

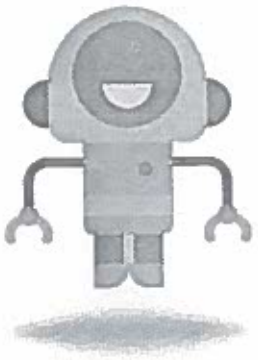


Unsupervised Learning(4m)

- Unsupervised learning is the training of machine using information that is neither classified nor labelled and allowing the algorithm to act on that information without guidance. Here the task of machine is to group unsorted information according to similarities, patterns and differences without any prior training of data.
- Unlike supervised learning, no teacher is provided that means no training will be given to the machine. Therefore, machine is restricted to find the hidden structure in unlabeled data by your-self.
- For instance, suppose it is given an image having both dogs and cats which have not seen ever.

Thus, the machine has no idea about the features of dogs and cat so we can't categorize it in dogs and cats. But it can categorize them according to their similarities, patterns, and differences i.e., we can easily categorize the above picture into two parts. First may contain all pictures having dogs in it and second part may contain all pictures having cats in it. Here you didn't learn anything before, means no training data or examples.

Unsupervised Machine Learning Algorithm Works:
When the data given is not labelled, the following steps are followed in order to learn and gain insights:
Step 1: The very first step is to load the unlabeled data into the system.
Step 2: Once the data is loaded into the system, the algorithm analyses the data.
Step 3: As the analysis gets completed, the algorithm will look for patterns depending upon the behavior or attributes of the dataset.
Step 4: Once pattern identification and grouping are done, it gives the output.



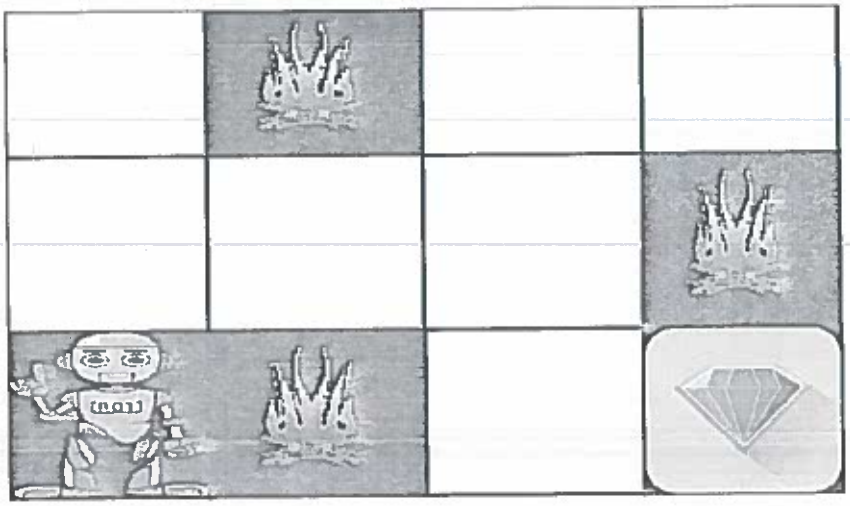
- Load unlabeled raw data
- Algorithm infers patterns on its own
- Algorithm identifies groups of data exhibiting similar pattern
- Algorithm provides output

Reinforcement Learning:(4m)

- Reinforcement learning is an area of Machine Learning Reinforcement.
- It is about taking suitable action to maximize reward in a particular situation.
- It is employed by various software and machines to find the best possible behavior or path it should take in a specific situation.
- Reinforcement learning differs from the supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning, there is no answer but the reinforcement agent decides what to do to perform the given task. In the absence of training dataset, it is bound to learn from its experience.

Example:

The problem is as follows: We have an agent and a reward, with many hurdles in between. The agent is supposed to find the best possible path to reach the reward. The following problem explains the problem more easily.



The above image shows robot, diamond and fire. The goal of the robot is to get the reward that is the diamond and avoid the hurdles that is fire. The robot learns by trying all the possible paths and then choosing the path which gives him the reward with the least hurdles. Each right step will give the robot a reward and each wrong step will subtract the reward of the robot. The total reward will be calculated when it reaches the final reward that is the diamond.

Main Points in Reinforcement Learning:

- **Input:** The input should be an initial state from which the model will start
- **Output:** There are many possible output as there are variety of solution to a particular problem
- **Training:** The training is based upon the input, The model will return a state and the user will decide to reward or punish the model based on its output.
- The model keeps continues to learn.
- The best solution is decided based on the maximum reward.

NSRIT

Semester End Regular/Supplementary Examination, February – 2023

Degree	B. Tech. (U. G.)	Program	ECE& EEE			Academic Year	2022 - 2023
Course Code	20ESX03	Test Duration	3 Hrs.	Max. Marks	70	Semester	I
Course	Basic Electrical Engineering						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Draw the series circuit and parallel circuits.	20ESX03.1	L1
2	What is the role of commutator in DC machine?	20ESX03.2	L1
3	What are the types of transformer?	20ESX03.3	L1
4	Define the term synchronous speed.	20ESX03.4	L1
5	List any three applications of single phase AC motor.	20ESX03.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Explain the classification of network elements.	6M	20ESX03.1	L2
6 (b)	Derive the star – Delta or Delta – Star transformation.	6M	20ESX03.1	L3
	OR			
7 (a)	Explain Kirchhoff's Current and Voltage Law in electric circuit with examples.	8M	20ESX03.1	L2
7 (b)	Derive the RMS value of the sinusoidal waveform.	4M	20ESX03.1	L3
8	Explain the working principle and operation of DC generator with necessary sketches.	12M	20ESX03.2	L2
	OR			
9	Derive the torque equation of a DC motor. Also, mention the various speed control technique used in a DC motor operation.	12M	20ESX03.2	L3
10	Draw the constructional diagram of a single–phase transformer and explain the role of all the parts.	12M	20ESX03.3	L2
	OR			
11	Explain open circuit and short circuit tests of transformer with neat circuit diagrams.	12M	20ESX03.3	L2
12	Explain the construction and working principle of alternator with necessary diagrams.	12M	20ESX03.4	L2
	OR			
13	Describe the working principle of 3-Φ induction motor with necessary diagrams. Also draw the speed torque or slip torque characteristics curve.	12M	20ESX03.4	L2
14	Explain the working principle of capacitor start and shaded pole types of single phase induction motor with their applications.	12M	20ESX03.5	L2
	OR			
15	Describe the working principle of AC servo motor with necessary diagrams.	12M	20ESX03.5	L2

N S RAJU INSTITUTE OF TECHNOLOGY

(AUTONOMOUS)

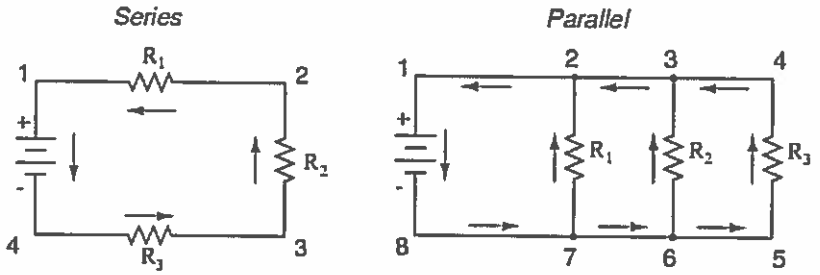
SONTYAM , ANANDAPURAM, VISAKHAPATNAM – 531 173

ANSWER KEY AND SCHEME OF EVALUATION

Part A (Short Answer Questions 5 x 2 = 10 Marks) Questions (1 through 5)

1. Draw the series circuit and parallel circuits. 2M

Ans:



2. What is the role of commutator in DC machine? 2M

Ans: The commutator on the DC generator converts the AC into pulsating DC.

3. What are the types of transformer? 2M

Ans: Core type and shell type transformers.
or Step up and step down transformers
or 1- phase and 3- phase transformers.

4. Define the term synchronous speed. 2M

Ans: Synchronous speed is a significant parameter for the rotating magnetic field-type AC motor. It is determined by the frequency and the number of magnetic poles.

5. List any three applications of single phase AC motor. 2M

Ans: Student can write any 3 applications of any type of 1-phase motor applications as below.

Single phase motors are mainly used for easily started loads such as blowers, fans, washing machines, grinders, water pumps, lathe machines, compressors, drilling machines, exhaust and intake fans, unit heaters, refrigerators, air conditioners, conveyors, ceiling fans, air circulators, fans, toy motors, blowers, hair dryers, photocopy machines, film projectors, advertising displays, the instruments that operate on servomechanism, in position controlling devices, computers, tracking systems, machine tools and robotics machinery.

Part B (Long Answer Questions 5 x 12 = 60 Marks) Questions (6 through 15)

6 (a). Explain the classification of network elements. 6M

Ans: The network elements may be classified into 4 groups.

1) Active or Passive elements 2) Unilateral or bilateral elements 3) Linear or Nonlinear elements 4) Lumped or distributed elements

1) Active or Passive elements: The circuit elements which supply energy to the circuit (delivering power) are called active element. Examples: voltage sources, current sources, and generators such as alternators, DC generators etc. The circuit elements that receive energy (or absorb energy) and either convert it into heat or store it in an electric field or a magnetic field are called passive elements. Ex: Resistor, Capacitor, Inductor

2) Unilateral or bilateral elements:

Bilateral Element: A bilateral element is one whose properties or characteristics are the same in either direction. The usual transmission line is bilateral; because it can be made to perform its function equally well in either direction. EX: Resistor, Capacitor, Inductor

Unilateral Element: It is that element whose properties or characteristics change with the direction of its operation. A diode rectifier is a unilateral circuit, because it cannot perform rectification in both directions.

3) Linear or Nonlinear elements: An element is said to be linear, if its voltage-current characteristic is at all times a straight line through the origin. For example, the current passing through a resistor is proportional to the voltage applied through it, and the relation is expressed as $V \propto I$ or $V = IR$.

An element which does not satisfy the above principle is called a nonlinear element. (EX: Diode)

4) Lumped or distributed elements: Lumped elements are those elements which are very small in size and in which simultaneous actions takes place for any given cause at the same instant of time. Typical lumped elements are capacitors, resistors, inductors and transformers.

Distributed elements, on the other hand, are those which are not electrically separable for analytical purposes. For example, a transmission line which has distributed resistance, inductance and capacitance along its length.

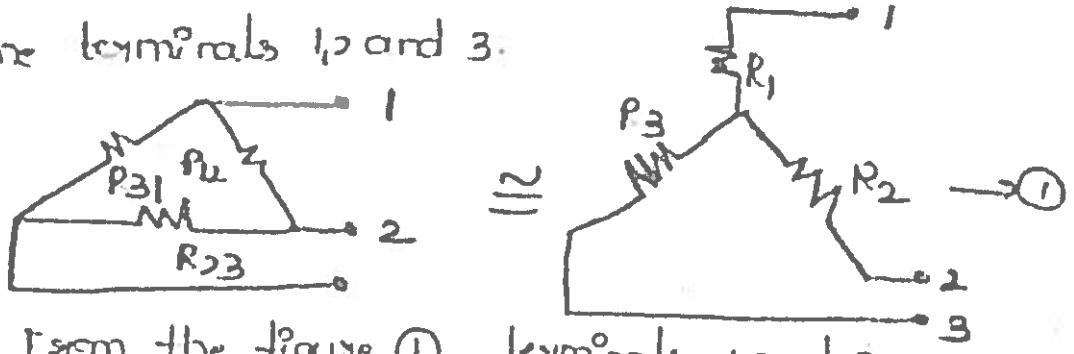
6 (b). Derive the star – Delta or Delta – Star transformations. 6M

Ans:

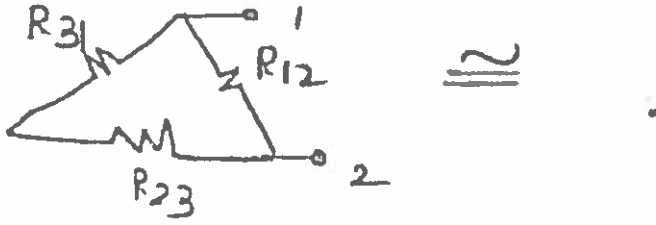
7 Derive the necessary equations for Δ-Y and Y-Δ conversion.

Delta - star transformation:-

Consider three resistances R_{12}, R_{23}, R_{31} connected in Delta as shown in the fig. The terminals between these are connected in delta are named as 1, 2 and 3. Now it is always possible to replace these delta connected resistances by three equivalent star connected resistances R_1, R_2, R_3 between the same terminals 1, 2 and 3.



From the figure ① terminals 1 and 2



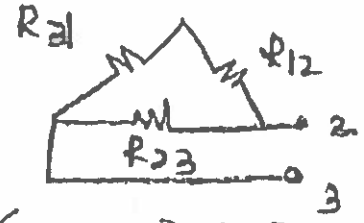
From the above figure it is observed that R_{23} and R_{31} connected in series and that combination in parallel with R_{12}. In star connection R_1 and R_2 are connected in series.

$$(R_{23} + R_{31}) \parallel R_{12} \cong R_1 + R_2$$

$$\frac{1}{R_{23} + R_{31}} + \frac{1}{R_{12}} \cong R_1 + R_2$$

$$R_{12} + R_{23} + R_{31} = R_1 + R_2 \longrightarrow ①$$

consider terminals 2 and 3

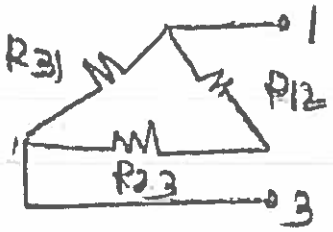


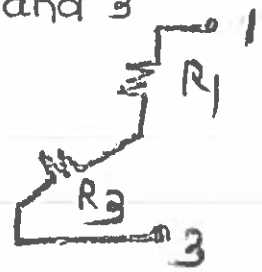
$$(R_{12}+R_{31}) \parallel R_{23} \cong R_2+R_3$$

$$\frac{1}{R_{12}+R_{31}} + \frac{1}{R_{23}} \cong R_2+R_3$$

$$\frac{R_{23}(R_{12}+R_{31})}{R_{12}+R_{23}+R_{31}} = R_2+R_3 \longrightarrow (2)$$

consider terminals 1 and 3





$$(R_{12}+R_{23}) \parallel R_{31} \cong R_1+R_3$$

$$\frac{1}{R_{12}+R_{23}} + \frac{1}{R_{31}} \cong R_1+R_3$$

$$\frac{R_{31}+R_{23}+R_{12}}{R_{31}(R_{12}+R_{23})} = R_1+R_3$$

$$\frac{R_{31}(R_{12}+R_{23})}{R_{31}+R_{23}+R_{12}} = R_1+R_3 \longrightarrow (3)$$

Subtract eq (2) from eq (1)

$$R_2+R_3 = \frac{R_{23}(R_{12}+R_{31})}{R_{12}+R_{23}+R_{31}}$$

$$R_1+R_2 = \frac{R_{12}(R_{23}+R_{31})}{R_{12}+R_{23}+R_{31}}$$

$$R_2+R_3-R_1-R_2 = \frac{R_{23}R_{12}+R_{23}R_{31}}{R_{12}+R_{23}+R_{31}} - \frac{R_{12}R_{23}-R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$$

$$R_3 - R_1 = \frac{R_{23}R_{31} - R_{12}R_{31}}{R_{12}+R_{23}+R_{31}} \longrightarrow (4)$$

Solving eq (4) and eq (3)

$$\frac{R_{31}(R_{23}+R_{12})}{R_{12}+R_{23}+R_{31}} = R_1 + R_3$$

$$\frac{R_{23}R_{31} - R_{31}R_{12}}{R_{12}+R_{23}+R_{31}} = R_3 - R_1$$

$$R_1 + R_3 + R_3 - R_1 = \frac{R_{31}R_{23} + R_{31}R_{12}}{R_{12}+R_{23}+R_{31}} + \frac{R_{23}R_{31} - R_{31}R_{12}}{R_{12}+R_{23}+R_{31}}$$

$$2R_3 = \frac{R_{31}R_{23} + R_{31}R_{12} + R_{23}R_{31} - R_{31}R_{12}}{R_{12}+R_{23}+R_{31}}$$

$$2R_3 = \frac{2R_{31}R_{23}}{R_{12}+R_{23}+R_{31}}$$

$$\boxed{R_3 = \frac{R_{31}R_{23}}{R_{12}+R_{23}+R_{31}}}$$

Substitute R_3 in eq (1)

$$\frac{R_{31}R_{23} - R_1}{R_{12}+R_{23}+R_{31}} = \frac{R_{23}R_{31} - R_{31}R_{12}}{R_{12}+R_{23}+R_{31}}$$

$$R_1 = \frac{R_{31}R_{23} - R_{23}R_{31} + R_{31}R_{12}}{R_{12}+R_{23}+R_{31}}$$

$$\boxed{R_1 = \frac{R_{31}R_{12}}{R_{12}+R_{23}+R_{31}}}$$

Substitute R_1 in eq (1)

$$\frac{R_{31}R_{12}}{R_{12}+R_{23}+R_{31}} + R_2 = \frac{R_{12}R_{23} + R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$$

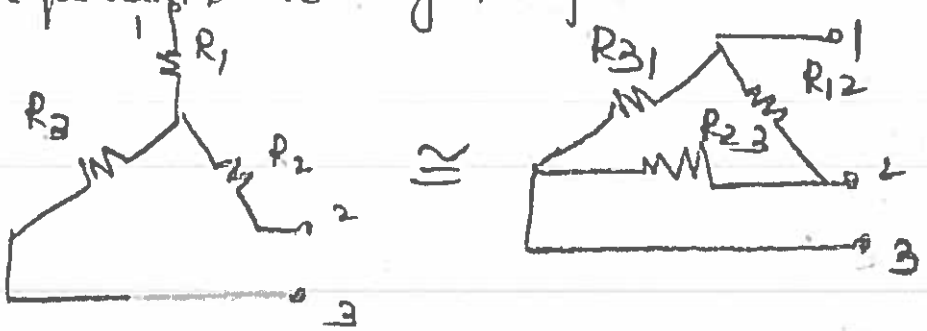
$$R_2 = \frac{-R_{12}R_{31} + R_{12}R_{23} + R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$$

$$R_2 = \frac{R_{12}R_{23}}{R_{12}+R_{23}+R_{31}}$$

Star - Delta transformation (Y - Δ)

Consider three resistances R_1, R_2 and R_3 connected in star as shown in figure.

Now by star-delta conversion, it is always possible to replace these star connected resistances by three equivalent delta of the given star.



We have $R_1 = \frac{R_{12}R_{31}}{R_{12}+R_{23}+R_{31}}$ ⟶ (1)

$$R_2 = \frac{R_{23}R_{12}}{R_{12}+R_{23}+R_{31}} \longrightarrow (2)$$

$$R_3 = \frac{R_{31}R_{23}}{R_{12}+R_{23}+R_{31}} \longrightarrow (3)$$

By multiplying eq (1) and eq (2)

$$R_1R_2 = \frac{R_{12}^2 R_{31}R_{23}}{(R_{12}+R_{23}+R_{31})^2} \longrightarrow (4)$$

By multiplying eq (2) and eq (3)

$$R_2R_3 = R_{23}^2 R_{12}R_{23} \longrightarrow (5)$$

By multiplying eq① and eq③

$$R_1 R_3 = \frac{R_{31}^2 R_{12} R_{23}}{(R_{12}+R_{23}+R_{31})^2} \longrightarrow ⑥$$

By adding ④, ⑤ and ⑥

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_{12}^2 R_{31} R_{23} + R_{23}^2 R_{12} R_{31} + R_{31}^2 R_{12} R_{23}}{(R_{12}+R_{23}+R_{31})^2}$$

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_{12} R_{23} R_{31} (R_{12}+R_{23}+R_{31})}{(R_{12}+R_{23}+R_{31})^2}$$

$$R_1R_2 + R_2R_3 + R_1R_3 = \frac{R_{12} R_{23} R_{31}}{R_{12}+R_{23}+R_{31}} \longrightarrow ⑦$$

$$R_1R_2 + R_2R_3 + R_1R_3 = R_1 R_{23} \quad [\because \text{from eq ⑦ and ①}]$$

$$R_{23} = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1}$$

$$R_{23} = R_2 + R_3 + \frac{R_2 R_3}{R_1} \longrightarrow ⑧$$

$$R_1R_2 + R_2R_3 + R_1R_3 = R_2 R_{31} \quad \because [\text{From eq ⑦ and ②}]$$

$$R_{31} = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_2}$$

$$R_{31} = R_1 + R_3 + \frac{R_1 R_3}{R_2} \longrightarrow ⑨$$

$$R_1R_2 + R_2R_3 + R_1R_3 = R_3 R_{12} \quad [\because \text{from eq ⑦ and ③}]$$

$$R_{12} = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_3}$$

$$R_{12} = R_2 + R_1 + \frac{R_1 R_2}{R_3} \longrightarrow ⑩$$

By using delta-star transformation for the following figure. Find the current 'I' supplied by the battery?

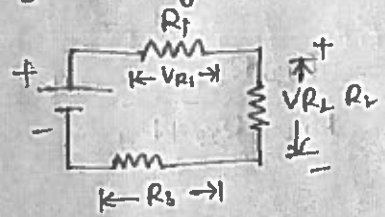
7 (a). Explain Kirchhoff's Current and Voltage Law in electric circuit with examples. 8M

Ans:

Kirchoff's voltage law: In any circuit the algebraic sum of voltages is zero in a closed loop.

(or)

The sum of voltages raise = sum of voltage drops.



$$V = V_1 + V_2 + V_3$$

$$V - V_{R_1} - V_{R_2} - V_{R_3} = 0$$

$$V = V_{R_1} + V_{R_2} + V_{R_3}$$

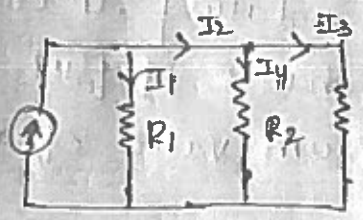
$$V = IR_1 + IR_2 + IR_3$$

$$\boxed{I = \frac{V}{R_1 + R_2 + R_3}}$$

Kirchoff's current law:

In any electric circuit the algebraic sum of currents = 0 at particular node are

sum of entering = sum of leaving currents at the particular



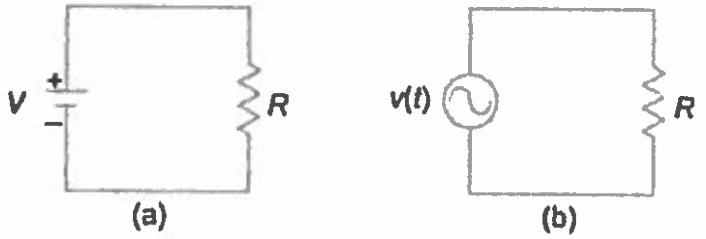
7 (b). Derive the RMS value of the sinusoidal waveform. 4M

ROOT MEAN SQUARE(RMS) VALUE OF PERIODIC WAVEFORM

(OR)

EFFECTIVE VALUE OF PERIODIC WAVEFORM

The root mean square (rms) value of a sine wave is a measure of the heating effect of the wave. When a resistor is connected across a dc voltage source as shown in Fig.(a), a certain amount of heat is produced in the resistor in a given time. A similar resistor is connected across an ac voltage source for the same time as shown in Fig. (b). The value of the ac voltage is adjusted such that the same amount of heat is produced in the resistor as in the case of the dc source. This value is called the rms value.



(a) (b)

That means the rms value of a sine wave is equal to the dc voltage that produces the same heating effect. In general, the rms value of any function with period T has an effective value given by

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v(t)^2\, dt}$$

Consider a function $v(t) = V_P \sin \omega t$

The rms value, $$V_{rms} = \sqrt{\frac{1}{T}\int_0^T (V_P \sin \omega t)^2\, d(\omega t)}$$

$$= \sqrt{\frac{1}{T}\int_0^{2\pi} V_P^2 \left[\frac{1-\cos 2\omega t}{2}\right] d(\omega t)}$$

$$= \frac{V_P}{\sqrt{2}} = 0.707\, V_P$$

If the function consists of a number of sinusoidal terms, that is

$$v(t) = V_0 + (V_{c1}\cos \omega t + V_{c2}\cos 2\,\omega t + \cdots) + (V_{s1}\sin \omega t + V_{s2}\sin 2\,\omega t + \cdots)$$

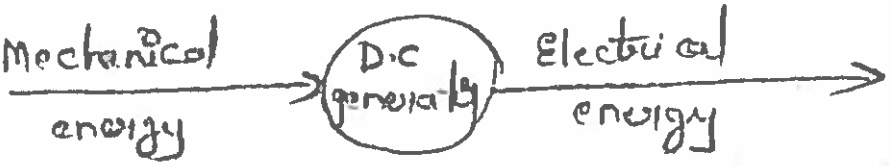
The rms, or effective value is given by

$$V_{rms} = \sqrt{V_0^2 + \frac{1}{2}(V_{c1}^2 + V_{c2}^2 + \cdots) + \frac{1}{2}(V_{s1}^2 + V_{s2}^2 + \cdots)}$$

8. Explain the working principle and operation of DC generator with necessary sketches. 12M

Explain the principle of operation of DC generator.

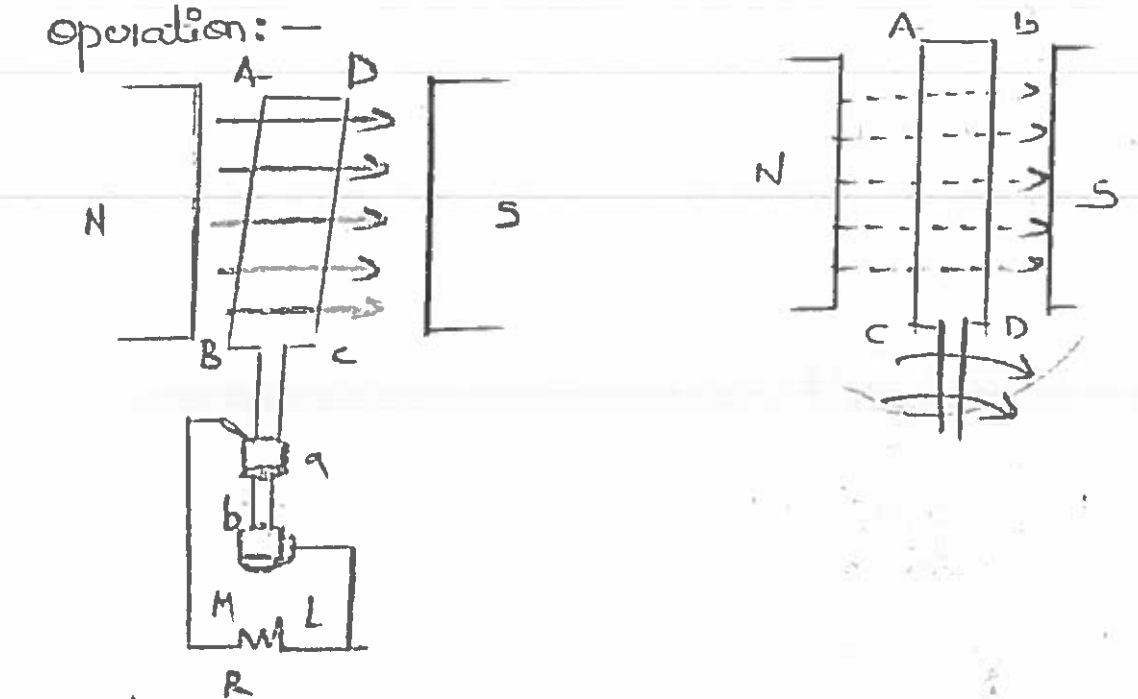
Generator:-



A D.C generator is a machine which converts mechanical energy into electrical energy.

Principle: Whenever there is a rate of change of flux linkage with the conductor the emf induced in it according to faraday law of electromagnetic induction.

operation:-



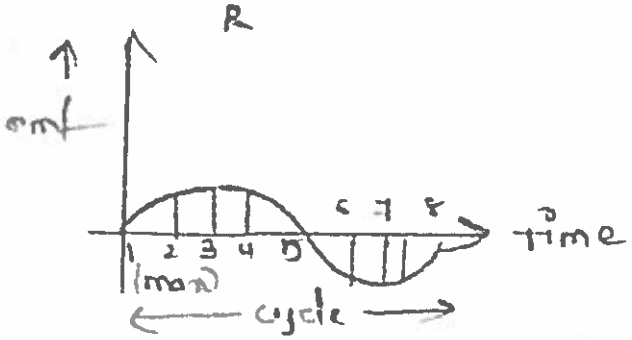
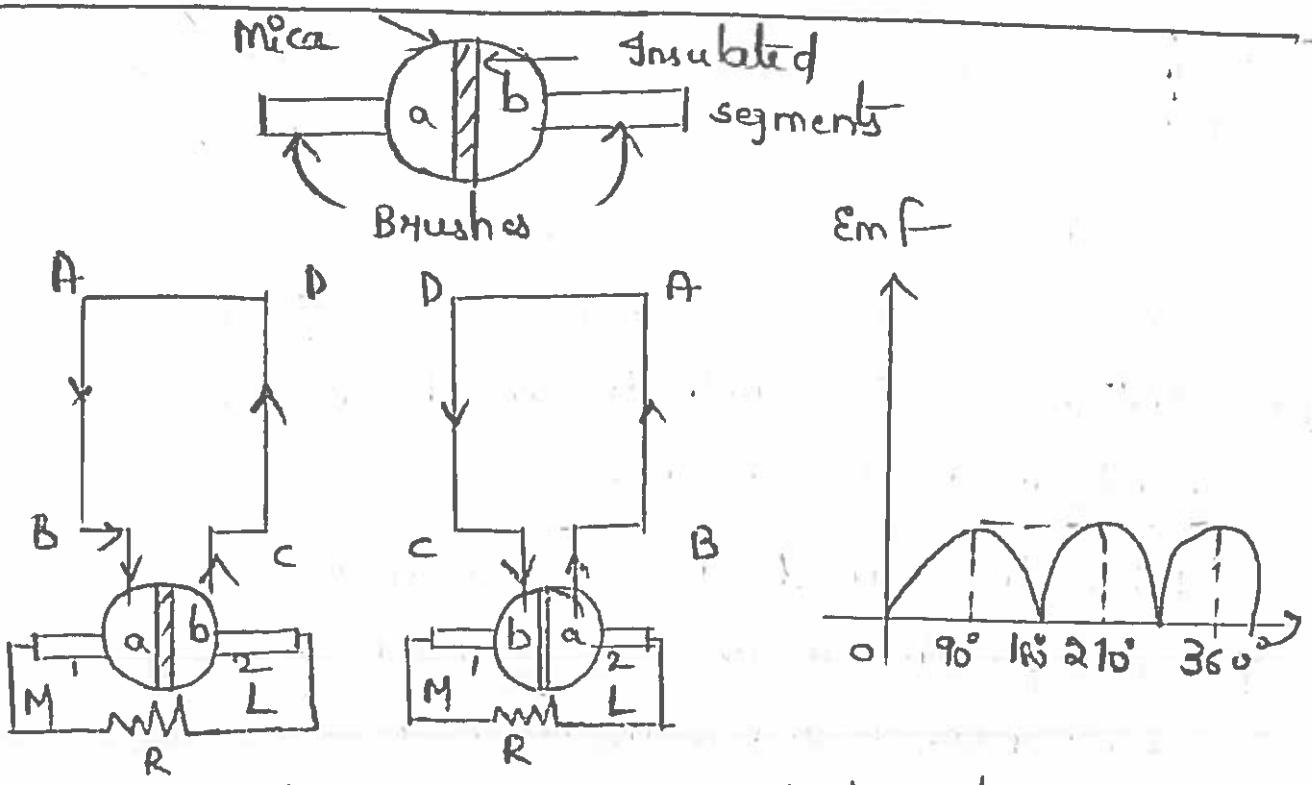


Figure1 source :

1. A Single turn Rectangular copper coil ABCD rotating above its own axis in a magnetic field.
2. Imagine the coil is rotating in clock-wise direction as the coil assumes successive positions in the field.
3. The flux linked with the coil changes hence the Induced emf is also changes.
4. When the plane of the coil is right angles to the lines of the flux that means at position 1 the rate of change of flux linkages is minimum hence the Induced emf is also minimum.
5. As the coil continuously rotating in clock-wise direction the rate of change of flux linkage increases and its maximum value occurs at position 3.
6. In the next quarter revolution 3 to 5 the flux linked with the coil decreases upto 5th position.
7. so in the first half Revolution the Induced emf is positive and the direction of the current is AB ML CD.
8. In the next half Revolution the variations in magnitudes of emf are similar to its first half revolution but it is just opposite to first half we find the emf which is obtained from this generator is A.C.

Importance of commutator:-

1. For making AC into DC we have to use a device



2. Commutator is a conducting cylinder which is cutting into two half segments those are insulated from each other by using mica.

3. In first half revolution currents flows in the direction of ABMLCD that means brush 1 is in contact with segment A.

4. In the next half revolution the direction of the current in the coil is reversed but at the same time the positions of segment A and B are also reversed and as a result the brush no 1 is in contact with the segment B.

5. Hence, the current in the load resistance in both first half and second half revolutions flows from M to L.

6. Hence in this way the commutator converts Ac into

9. Derive the torque equation of a DC motor. Also, mention the various speed control technique used in a DC Motor operation. 12M

Torque equation of a D.C motor:

→ Torque is a rotating or twisting moment of a force about an axis. It is measured by

$T = F \times r$

$\omega = 2\pi N$ rad/sec

→ The power developed $= T_a \omega$

$P_{mech} = T_a \omega$

$= T_a 2\pi N$ —①

→ we also know that electrical power is converted into mechanical power in the armature is

$P_{elec} = E_b I_a$ —②

By equating equations ① & ②

$T_a 2\pi N = E_b I_a$

$T_a 2\pi \frac{N}{60} = \frac{\phi Z P}{A} I_a$

$T_a 2\pi = \frac{\phi Z P}{A} I_a$

$T_a = \frac{\phi Z I_a}{2\pi} \frac{P}{A}$

$T_a = \frac{\phi Z I_a}{2\pi} \frac{P}{A}$

$T_a = 0.159 \phi Z I_a \left(\frac{P}{A}\right)$

$T_a = K \phi I_a$

$T_a \propto \phi I_a \quad \left[\because K = 0.159 Z \left(\frac{P}{A}\right)\right]$

1) Armature control method:

We know that

$N \propto \frac{E_b}{\phi}$ —①

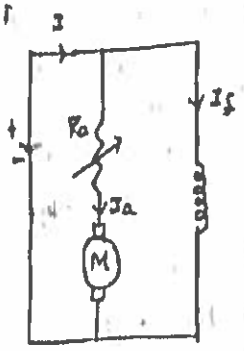
$E_b = V - I_a R_a$ —②

From eqn ① it is observed that speed of a dc motor is directly proportional to back emf E_b.

From eqn ② it means when supply voltage V and armature resistance Ra are kept constant then the speed is directly proportional to armature current (I).

Thus if we add resistance in series with the armature, armature current I_a decreases and hence speed also decreases.

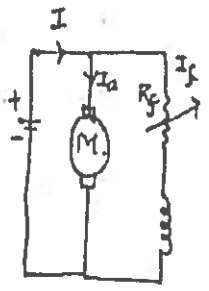
Greater the resistance in series with the armature greater the decrease in field



2) Flux control method:

We know that speed is proportional to E_b/ϕ

$N \propto E_b/\phi$



→ From the above relation it is observed that the speed of a dc motor is inversely proportional to the flux per pole.

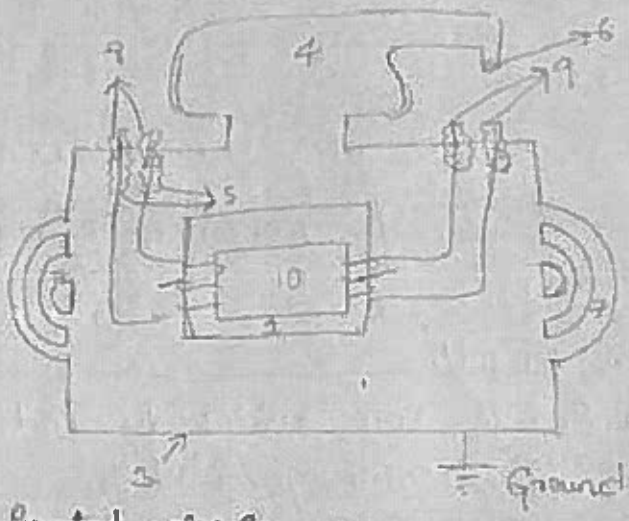
→ Thus by decreasing the flux the speed can be increased by vice versa.

→ To control the flux the reostat is added in series with the field winding as shown in the circuit diagram.

→ Adding more resistance in series with the field winding will increase the speed as it decreases the flux.

10. Draw the constructional diagram of a single–phase transformer and explain the role of all the parts. 12M

Ans:



→ **Laminated core**: core of the transformer is made up of silicon steel (or) sheet steel with 4% of silicon. The sheets are laminated and core coated with an oxide layer to reduce the eddy current losses.

→ **Winding**: Transformer has two windings. The winding which receives the electrical energy is called primary winding and winding which delivers the electrical energy is called secondary winding which delivers the secondary winding. Windings are generally made up of high grade copper for carrying currents. The windings are provided with insulators for avoiding short circuits. so, any one turn will not coming into contact with other turns.

Conservator tank:

when a transformer is oil filled and self cooled the oil in the tank is heated and will expand due to variations in the load current. The conservator

tank provides for the oil to settle down by expanding under the heavy loads. without such a tank very high pressure will be developed in it which could lead to the bursting the tank.

→ Bushing: The purpose of the bushings is to provide proper insulation for the incoming and outgoing leads.

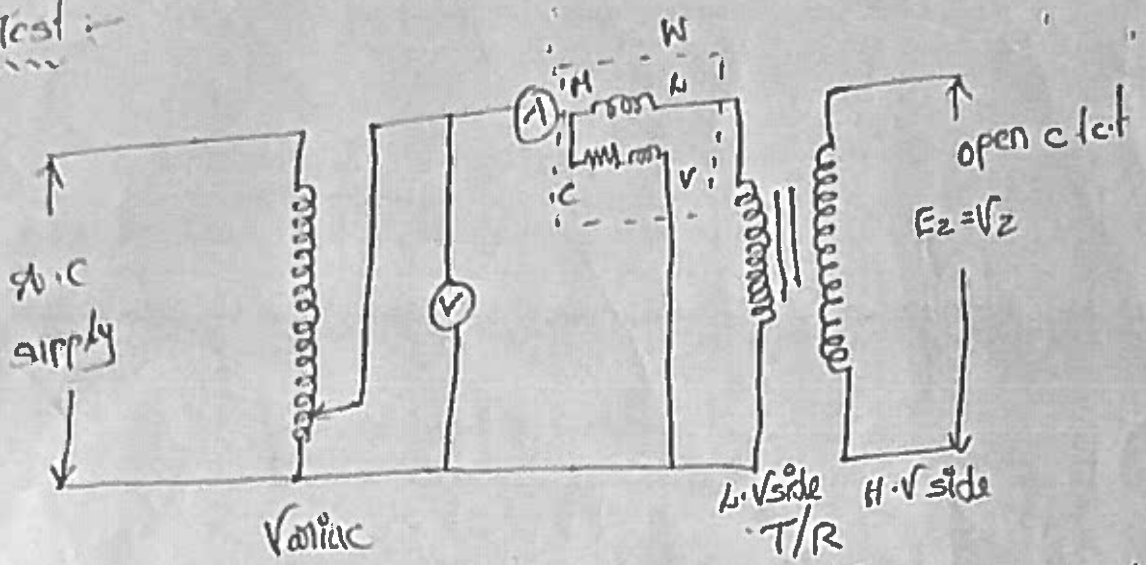
→ Breather:- The breather completely prevents the moisture and dust coming into contact with the oil in the conservator when it expands depending on the variations in the load.

→ Radiator:- Thin metal structures are connected around the transformer tank which acts as heat -sink. The function of this radiators is to cool the transformer tank gradually.

→ Transformer oil:- The transformer oil is a mineral based oil (Naphthelin oil) That is commonly used in transformer its chemical properties and dielectric strength. This oil in transformer acts as insulator and cooling agent.

11. Explain open circuit and short circuit tests of transformer with neat circuit diagrams. 12M

→ O.C Test :-



The experimental o.k.t to conduct o.c test is shown in the fig. The T/R primary is connected to A.C supply through ammeter, wattmeter, and Variac. The secondary of the T/R is kept open. Usually L.V side is used as primary and high voltage side as secondary to conduct o.c test.

The primary is excited by rated voltage, which is adjusted precisely with the help of a Variac. The wattmeter measures I/P power. The ammeter measures I/P current. The voltmeter gives the value of rated primary voltage.

when the primary voltage is adjusted to ⑥ it's rated value with the help of Variac readings of ammeter, voltmeter and wattmeter are to be recorded.

V_0 = Rated Voltage

W_0 = i/p power

I_0 = i/p current = No load current.

The current drawn by the primary is no load current I_0. The components of this no load current

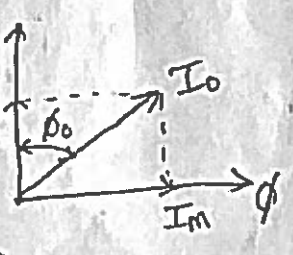
$$I_m = I_0 \sin\phi_0$$

$$I_w = I_0 \cos\phi_0$$

where $\cos\phi_0$ = No load P.f

i/p power can be written as $W_0 = V_0 I_0 \cos\phi_0$

The phasor diagram is shown in fig.



The T/R no load current is very small, hardly 2 to 4% of its full load value hence copper loss also very very low thus these losses are negligible in O.C test.

as o/p power is zero and cu.. losses are very low the total i/p power is used to supply iron losses. This power is measured by wattmeter i,e W_0. Hence the wattmeter in o.c test gives iron losses which is remains constant for all loads.

calculations:-

we know that $W_0 = V_0 I_0 \cos\phi_0$.

$$\cos\phi_0 = \frac{W_0}{V_0 I_0} = \text{No load p.f}$$

once $\cos\phi_0$ is known we can obtain

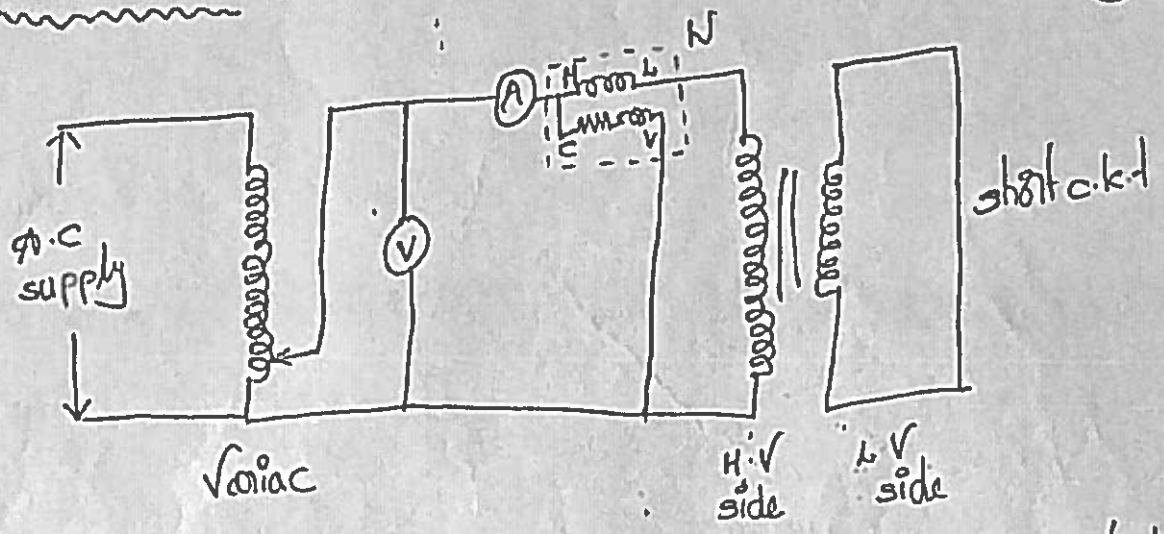
$$I_m = I_0 \sin\phi_0 \; ; \; I_w = I_0 \cos\phi_0$$

once I_m & I_w are known we can determine exciting o.c.t parameters as

$$R_0 = \frac{V_0}{I_N}\,\Omega \; ; \; X_0 = \frac{V_0}{I_m}\,\Omega$$

Thus o.c test gives iron losses, no load current (I_0), no load p.f $\cos\phi_0$ & I_w & I_m.

→ short c.k.t test :-



In this test primary is connected to a.c supply through Variac, ammeter and voltmeter as shown in fig..

The secondary is short c.k.ted with the help of thick copper wire. As high voltage side is always low current side, it is convenient to connect high voltage side to supply and short.c.k.ting L.V side.

As secondary is shorted, it's resistance is very very small and on rated voltage it may draw very large current. To limit this large current primary is supplied with low voltg

which just enough to cause rated current flow through primary which can be observed on ammeter. Hence this test is also called low voltage test or reduced voltage test. The wattmeter, ammeter and voltmeter readings are recorded.

Now current flow through the windings are rated currents hence total copper loss is full load cu.. loss. The iron losses are function of applied voltage, iron losses are very small because applied voltage is low. Hence wattmeter indicates full load cu.. loss of the T/R.

Calculations:- $W_{sc} = V_{sc} I_{sc} \cos\phi_{sc}$

$$\cos\phi_{sc} = \frac{V_{sc} I_{sc}}{W_{sc}}$$

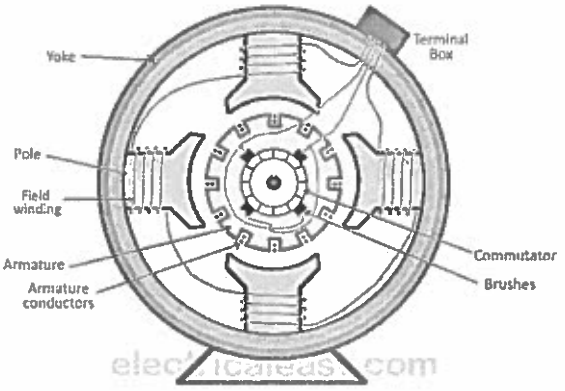
$$W_{sc} = I_{sc}^2 R_{1e} \quad ; \quad R_{1e} = \frac{W_{sc}}{I_{sc}^2}$$

$$Z_{1e} = \frac{V_{sc}}{I_{sc}} = \sqrt{R_{1e}^2 + X_{1e}^2}$$

$$X_{1e} = \sqrt{Z_{1e}^2 - R_{1e}^2}$$

12. Explain the construction and working principle of alternator with necessary diagrams. 12M

Ans: Construction:



The above figure shows constructional details of an alternator.

Yoke: The outer frame of a dc machine is called as yoke. It is made up of cast iron or steel. It not only provides mechanical strength to the whole assembly but also carries the magnetic flux produced by the field winding.

Poles and pole shoes: Poles are joined to the yoke with the help of bolts or welding. They carry field winding and pole shoes are fastened to them. Pole shoes serve two purposes; (i) they support field coils and (ii) spread out the flux in air gap uniformly.

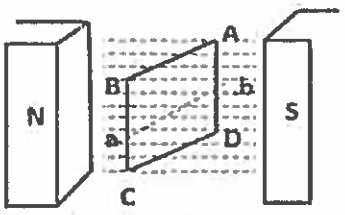
Field winding: They are usually made of copper. Field coils are former wound and placed on each pole and are connected in series. They are wound in such a way that, when energized, they form alternate North and South poles.

Armature core: Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding. The armature is built up of thin laminated circular steel disks for reducing eddy current losses. It may be provided with air ducts for the axial air flow for cooling purposes. Armature is keyed to the shaft.

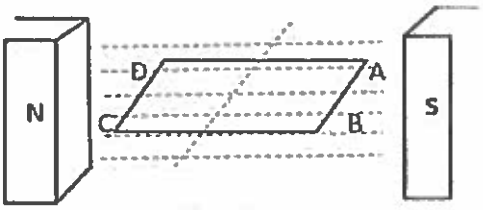
Armature winding: It is usually a former wound copper coil which rests in armature slots. The armature conductors are insulated from each other and also from the armature core. Armature winding can be wound by one of the two methods; lap winding or wave winding. Double layer lap or wave windings are generally used. A double layer winding means that each armature slot will carry two different coils.

Principle of operation:

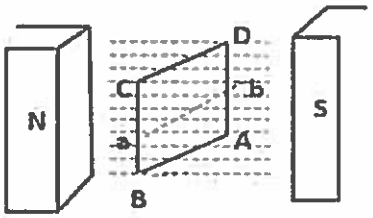
The working principle of alternator depends upon Faraday's law of electromagnetic induction which says the current is induced in the conductor inside a magnetic field when there a relative motion between that conductor and the magnetic field. For understanding working of alternator let's assume a single rectangular turn placed in between two opposite magnetic pole as shown.



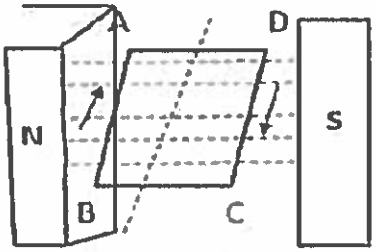
Figure(a)



Figure(b)



Figure(c)



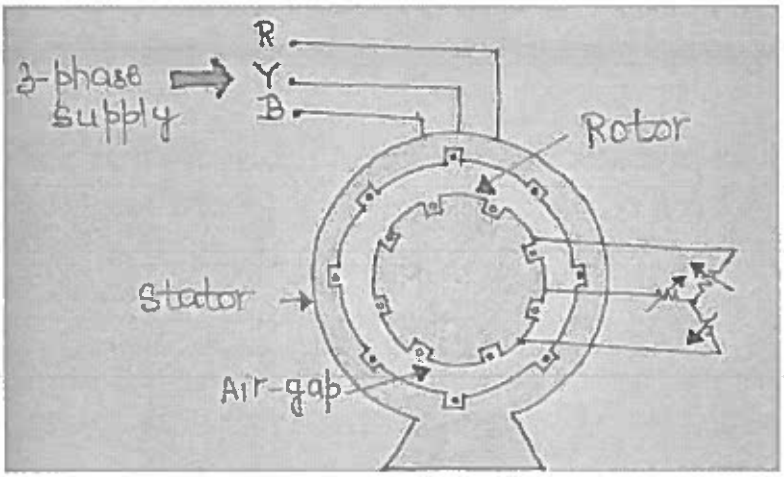
Figure(d)

13. Describe the working principle of 3-Φ induction motor with necessary diagrams. Also draw the speed Torque or slip torque characteristics curve. 12M

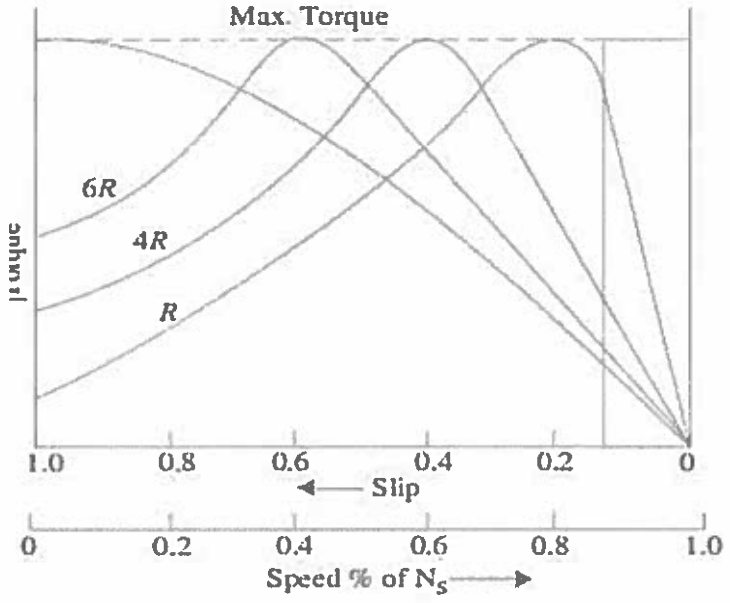
Ans:

3- phase induction motor principal:

- 3-phase ac supply voltage is given to 3 phase winding.
- Then current flows through the windings.
- Flux will be produced around three phase windings. That flux is variable flux that is called as rotating flux. This flux links with rotor windings.
- According to mutual induction principal there is a flux produced in the rotor windings.
- This flux is trying to match the speed with stator flux.
- Due to this there is a difference will be produced between the two fluxes because of slip.
- Due to slip torque will be produced.
- Due to this torque rotor will starts rotate. That rotation is mechanical energy.
- In this way induction motor will be operated.
- Because of rotating flux based on three phase's 3-phase induction motor is also called as self starting motor.

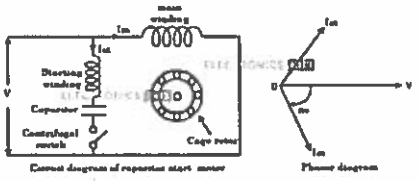


Speed Torque or slip torque characteristics curve



14. Explain the working principle of capacitor start and shaded pole types of single phase induction motor with their applications. 12M

Ans: **Capacitor Start Induction Motor:**



This motor is similar to the split phase motor, but in addition a capacitor is connected in series to auxiliary winding. This is a modified version of split phase motor.

Since the capacitor draws a leading current, the use of a capacitor increases the phase angle between the two currents (main and auxiliary) and hence the starting torque. This is the main reason for using a capacitor in single phase induction motors.

Due to the presence of a capacitor, the current through auxiliary winding will leads the applied voltage by some angle which is more than that of split case type.

Thus, the phase difference between main and auxiliary currents is increased and thereby starting torque.

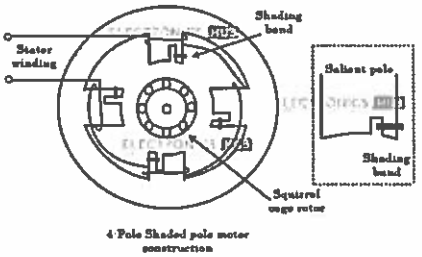
These motors have very high starting torque up to 300% full load torque.

The power factor is low at rated load and rated speed.

These motors are used in domestic as well as industrial applications such as water pumps, grinders, lathe machines, compressors, drilling machines, etc.

Shaded pole motors:

This motor doesn't use any auxiliary winding or even it doesn't have a rotating field, but a field that sweeps across the pole faces is enough to drive the motor. So the field moves from one side of the pole to another side of the pole.



4 Pole Shaded pole motor construction

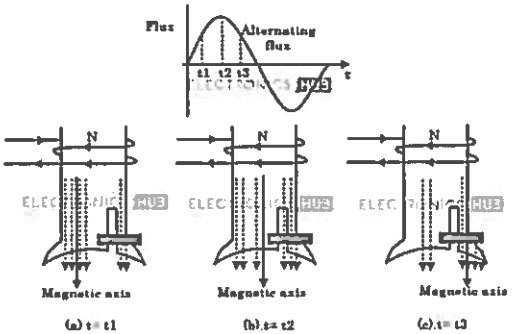
A shaded pole motor consists of a stator having salient poles (or projected poles), and a rotor of squirrel cage type. In this, stator is constructed in a special way to produce moving magnetic field.

Stator poles are excited with its own exciting coils by taking the supply from a single phase supply. A 4-pole shaded pole motor construction is given in below figure.

Each salient pole is divided into two parts; shaded and un-shaded. This part where shading coil is placed is generally termed as shaded part of the pole and remaining portion is called as un-shaded part as shown in figure.

When an alternating supply is given to the stator coils, an alternating flux will be produced. The distribution of flux in the pole face area is influenced by the presence of copper shading band.

Let us consider the three instants, t1, t2, and t3 of alternating flux for an half cycle of the flux as shown in figure.

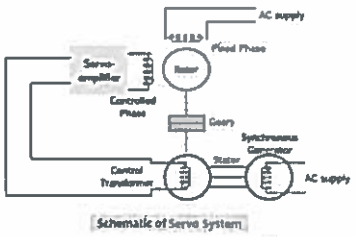


(a) t = t1 (b) t = t2 (c) t = t3

These motors are used in low starting torque applications such as fans, toy motors, blowers, hair dryers, photocopy machines, film projectors, advertising displays, etc.

15. Describe the working principle of AC servo motor with necessary diagrams. 12M

Ans:



Schematic of Servo System

Initially, a constant ac voltage is provided at the main winding of the stator of the ac servomotor. The other stator terminal of the servomotor is connected to the control transformer through the control winding.

Due to the provided reference voltage, the shaft of the synchro generator rotates with a particular speed and attains a certain angular position.

Also, the shaft of the control transformer has a certain specific angular position which is compared with the angular position of the shaft of the synchro generator.

Further, the comparison of two angular positions provides the error signal. More specifically, the voltage levels of the corresponding shaft positions are compared which generates the error signal.

This error signal corresponds to the voltage level present at the control transformer. This signal is then provided to the servo amplifier which generates variable control voltage.

With this applied voltage, the rotor again attains a specific speed and starts rotation and sustains until the value of the error signal reaches 0, thereby attaining the desired position of the motor in the AC servomotors.

Applications: AC servomotors, these majorly find applications in the instruments that operate on servomechanism, in position controlling devices, computers. Along with this these also find applications in tracking systems, machine tools and robotics machinery.

(K.S. Ramasubbu)

HOD 24/2/25