

**V.S.B. ENGINEERING COLLEGE, KARUR**

**Department of Electrical and Electronics Engineering**

**Academic Year 2017-18 (Even Semester)**

**CLASS I YEAR/ II SEMESTER 2 MARK AND 16 MARK QUESTION BANK**

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**V.S.B. ENGINEERING COLLEGE, KARUR**  
**Department of English**  
**(Reg. 2017)**  
**HS8251 TECHNICAL ENGLISH**

**STUDY MATERIAL**

**TECHNICAL VOCABULARY**

Match the words with their meanings

- |                   |                               |
|-------------------|-------------------------------|
| 1. a) accelerate  | 1) feasible                   |
| b) simultaneously | 2) increase speed             |
| c) viable         | 3) extremely high             |
| d) prohibitive    | 4) occurring at the same time |

Answer: 2,4,1,3

- |                 |                               |
|-----------------|-------------------------------|
| 2. a) distort   | 1) bulky                      |
| b) cumbersome   | 2) twist out of shape         |
| c) comprehend   | 3) state of being out of date |
| d) obsolescence | 4) understand                 |

Answer: 3,1,4,2

- |             |                |
|-------------|----------------|
| 3. a) alien | 1) remove      |
| b) discard  | 2) innumerable |
| c) myriad   | 3) foreign     |
| d) advent   | 4) arrival     |

Answers : 3,1,2,4

- |                  |                                   |
|------------------|-----------------------------------|
| 4. a) priming    | 1) thing or part added to improve |
| b) indispensable | 2) preparing                      |
| c) supplement    | 3) consider before hand           |
| d) anticipate    | 4) necessary                      |

Answer: 2,4,1,3

- |                  |                  |
|------------------|------------------|
| 5. a) explore    | 1) including all |
| b) comprehensive | 2) arrangement   |
| c) array         | 3) unfit to eat  |
| d) inedible      | 4) examine       |

Answer: 4,1,2,3

- |                |                |
|----------------|----------------|
| 6. (a) Slight  | a) Temperate   |
| (b) Penny-wise | b) Generous    |
| (c) Avaricious | c) Heavy       |
| (d) Greedy     | d) Extravagant |

Answer: c,d,a,b

- |                 |              |
|-----------------|--------------|
| 7. a. Diversity | a) Negligent |
| b. Inadvertent  | b) Hindrance |

- c. Obstacle
  - d. Projection
- Answer: d, a, b, c

- c) Shooting forward
- d) Difference

8. a) Dynamism  
b) Enhance  
c) Breeder  
d) Empathy

- 1) producer
- 2) sympathy
- 3) heighten
- 4) strength

Answer: 5,3,1,2

9. a. Accurate  
b. Gigantic  
c. Elide  
d. Rapid

- 1) Swift
- 2) Precise
- 3) Huge
- 4) Omit

Answer: 2,3,4,1

- 10 a) Conventional  
b) Appropriate  
c) consume  
d) display

- 1) use up
- 2)traditional
- 3)exhibit
- 4)suitable

Answer: 2,4, 1,3

### Antonyms

I.

- 1) What's the opposite of more?  
Few, less, a lot, many
- 2) What's the opposite of alive?  
Asleep, dead, death, sick
- 3) What's the opposite of loud?  
Soft, quite, quiet, noisy
- 4) What's the opposite of happy?  
Glad, ugly, difficult, sad
- 5) What's the opposite of last?  
First, beginning, start, end
- 6) What's the opposite of now?  
Always, never, then, soon
- 7) What's the opposite of to buy?  
to take, to sell, to bring, to lend
- 8) What's the opposite of better?  
Bad, worse, good, worst
- 9) What's the opposite of dangerous?  
Easy, beautiful, safe, pleasant
- 10) What's the opposite of cool?  
Warm, hot, cold, cooler

II.

- 1) What's the opposite of many?  
Less, few, more, most
- 2) What's the opposite of deep?  
Shallow, narrow, thin, low
- 3) What's the opposite of long?  
Broad, small, thing, short
- 4) What's the opposite of clean?  
tidy up, clear, dirty beautiful
- 5) What's the opposite of empty?  
Shut, open, Ugly, full
- 6) What's the opposite of thin?  
Light, slow, fat, more
- 7) What's the opposite of beginning?  
End, start, finish, depart
- 8) What's the opposite of big?  
Huge, small, large, less
- 9) What's the opposite of modern?  
Older, ancient, new, contemporary
- 10) What's the opposite of poor?  
Wealth, rich, poverty, wise

## SUBJECT VERB AGREEMENT

1. The dog \_\_\_\_\_ when he is angry.
2. The dogs \_\_\_\_\_ when they are angry.
3. The dog, who is chewing on my jeans, \_\_\_\_\_ usually very good.
4. There is a problem with the balance sheet. Here \_\_\_\_\_ the papers you requested.
5. Does Lefty usually eat grass? Where \_\_\_\_\_ the pieces of this puzzle?
6. The cow and the pig \_\_\_\_\_ jumping over the moon
7. Red beans and rice \_\_\_\_\_ my mom's favorite dish.
8. Nonsmoking and drinking \_\_\_\_\_ allowed. Every man and woman \_\_\_\_\_ required to check in.
9. Jessica or Christian \_\_\_\_\_ to blame for the accident.
10. All of the chicken \_\_\_\_\_ gone. All of the chickens \_\_\_\_\_ gone.
11. Four quarts of oil \_\_\_\_\_ required to get the car running.
12. Dogs and cats \_\_\_\_\_ both available at the pound.
13. Do your sisters or your girlfriend \_\_\_\_\_ (wants) any pizza?
14. Everybody \_\_\_\_\_(want) to be loved
15. Few \_\_\_\_\_ left alive after the flood.
16. To walk and to chew gum \_\_\_\_\_(requires) great skill.
17. Standing in the water \_\_\_\_\_ a bad idea. Swimming in the ocean and playing drums \_\_\_\_\_ my hobbies.
18. The herd \_\_\_\_\_ stampeding.
19. The Barbs \_\_\_\_\_ a movie starring Tom Hanks.
20. The dishes \_\_\_\_\_ done and table is clear.
21. What we need \_\_\_\_\_ more pots and pans.
22. The volunteers \_\_\_\_\_(collects) many contributions a day
23. The girl \_\_\_\_\_ (run) towards him.
24. The girls \_\_\_\_\_ (runs) toward him
25. She \_\_\_\_\_ (do) the cooking
26. They \_\_\_\_\_ (do) the cooking
27. One pear \_\_\_\_\_ (have) been eaten
28. Two pears \_\_\_\_\_ (has) been eaten
29. Everybody \_\_\_\_\_ (know) the answer.
30. Nobody \_\_\_\_\_ (speak) German here.
31. A seer, so my friends tell me, (predict, predicts) events or developments.
32. The seer, together with three other psychics, (plans, plan) to make a number of startling predictions.
33. These predictions, including one about how well you will do on this practice, (is, are) not to be believed.
34. My sister, along with her husband and my parents, (is, are) driving to a wedding this weekend.
35. Inside my refrigerator (is, are) a can of Diet Pepsi *and* an old English muffin. *And* makes this plural.
36. One of my brothers (was, were) in Atlanta last weekend.
37. The teacher as well as her students (believe, believes) that practice makes perfect.
38. However, I believe that perfect practice, including long drills, (is, are) the key to success.
39. Neither of the two politicians (expect, expects) to lose the race.
40. Neither Senator Smith nor her administrative assistants (return, returns) phone calls.

41. Neither her administrative assistants nor Senator Smith (return, returns) phone calls.
42. Each of the twins (has, have) some unusual habits. (Each is singular.)
43. The first type of driver that I find annoying (is, are) the speeders.
44. She is one of the students who always (answer, answers) correctly.
45. Sara is the only one of the students who always (answer, answers) correctly.
46. Beyond the river (is/are) a dress store and a shoe store.
47. The cost of goods (vary/varies) greatly in the different states.
48. The *Seattle Times* (is/are) sold widely.
49. Neither the employers nor the union (desire/desires) strikes vote.
50. Food tests taken on Friday (confirm/confirms) my original diagnosis.

### Answers

- |             |              |             |              |             |
|-------------|--------------|-------------|--------------|-------------|
| 1. growls   | 11. was      | 21. is      | 31. Predicts | 41. returns |
| 2. growl    | 12. are      | 22. collect | 32. Plans    | 42. has     |
| 3. is       | 13. want     | 23. runs    | 33. Are      | 43. is      |
| 4. are      | 14. wants    | 24. run     | 34. Is       | 44. answer  |
| 5. are      | 15. were     | 25. does    | 35. Are      | 45. answers |
| 6. are      | 16. require  | 26. do      | 36. Was      | 46. are     |
| 7. is       | 17. was, are | 27. has     | 37. Believes | 47. varies  |
| 8. is, is   | 18. is       | 28. have    | 38. Is       | 48. is      |
| 9. is       | 19. is       | 29. knows   | 39. Expects  | 49. desires |
| 10. is, are | 20. are      | 30. speak   | 40. Return   | 50. confirm |

### COMPOUND WORD

**1st Grade Compound Words:** bedtime, bluebird, cowboy, cupcake, notepad, pigpen, popcorn, rainbow, starfish, sunset

**2nd Grade Compound Words:** barnyard, butterfly, daylight, drumstick, flagpole, jellyfish, mailbox, notebook, raincoat, suntan, bathroom, catfish, doghouse, eyeglasses, footprint, lipstick, outside, pineapple, rowboat, seashell, birthday, classmate, doorway, fireplace, homework, lovebird, peanut, ponytail, sailboat, snowfall

**3rd Grade Compound Words:** backyard, downtown, overcoat, railroad, sidewalk, stepladder, teaspoon, waterfall, workbench, baseball, earring, necktie, playpen, seafood, skyscraper, sunrise, thumbtack, windmill, yearbook, daydream, handshake, nightgown, racetrack, shoelace, spaceship, teardrop, textbook, toothbrush, windshield

**4th Grade Compound Words:** afternoon, dishwasher, fingerprint, grandmother, motorcycle, playground, suitcase, teammate, watermelon, yardstick, aircraft, downstairs, fisherman, horseback, necklace, saltwater, sunlight, thunderstorm, weekend, chalkboard, dragonfly, flashlight, keyboard, password, sandpaper, surfboard, toothpaste, worldwide

**5th Grade Compound Words:** boxcar, earthquake, firecracker, handwriting, homesick, lifeguard, newsletter, rattlesnake, skyline, swordfish, breakfast, endless, gingerbread, headphones, layout, newcomer, overdue, shipwreck, stepmother, tombstone

**6th Grade Compound Words:** broadcast, deadline, headache, mankind, meanwhile, overseas, sightseeing, straightforward, timetable, viewpoint, courthouse, guideline, landmark, marketplace, playwright, silverware, thoroughfare, trustworthy, undergraduate, weatherproof

**7th Grade Compound Words:** billboard, clockwise, greenhouse, greyhound, headquarters, heartbreak, jawbone, kingfisher, masterpiece, whirlpool

**8th Grade Compound Words:** citizenship, copywriter, counterclockwise, drawstring, darkroom, folklore, forearm, freshman, heirloom, roundabout

**9th Grade Compound Words:** knothole, offspring, outlying, rawhide, sharecropper, steeplechase, stouthearted, timberline, underestimate, underscore

**10th Grade Compound Words:** counterpart, driftwood, foreshadow, grindstone, henceforth, icebreaker, leeward, levelheaded, overwrought, threadbare

**11th Grade Compound Words:** buckskin, crackdown, fellowship, halfhearted, herewith, hindquarter, lackluster, layman, lovelorn, roughhew

**12th Grade Compound Words:** counterbalance, countersign, crestfallen, foreordain, fortnight, hairbreadth, hindsight, leeway, pigeonhole, roughshod

sailboat	watchword	timesaving	timeshare	timekeeper
salesclerk	showoff	sharecropper	sheepskin	shoelace
candlestick	newsbreak	newscaster	newsprint	newfound
butterscotch	turnabout	turnaround	turnbuckle	timetable
eyewitness	starfish	stagehand	spacewalk	sharpshooter
shoemaker	turndown	turnkey	turnoff	turncoat
horsefly	comedown	comeback	cabdriver	aboveboard
bluebird	tablespoon	tabletop	tableware	tablecloth
stoplight	sunlit	sandlot	snowbird	sundial
bluebell	wheelhouse	fishhook	fishbowl	wheelchair
stronghold	tailgate	taillight	taillike	tagalong
pinup	tailspin	takeoff	takeout	tailpiece
bellhop	taproot	target	taskmaster	taproom
steamboat	dairymaid	teaspoon	daisywheel	teammate
pinwheel	telltale	tenderfoot	tenfold	showplace
ashtray	watchword	timesaving	timeshare	fisherman
blackball	showoff	sharecropper	sheepskin	beachcomb
sunroof	newsbreak	newscaster	newsprint	washtub
upset	turnabout	turnaround	turnbuckle	snowshovel
jailbait	starfish	stagehand	spacewalk	superimpose
atchcase	turndown	turnkey	turnoff	dogwood
jetport	comedown	comeback	cabdriver	watchman
watchtower	tablespoon	tabletop	tableware	jackpot
gumball	sunlit	sandlot	snowbird	watercolor
watercraft	wheelhouse	fishhook	fishbowl	schoolbus
moonwalk	tailgate	taillight	taillike	washout
uphold	tailspin	takeoff	takeout	wastebasket
shipbottom	taproot	target	taskmaster	sunup
waterscape	dairymaid	teaspoon	daisywheel	watchband
watercooler	telltale	tenderfoot	tenfold	downbeat

### Imperative Forms

1. You / go to the supermarket.  
Go to the supermarket!
2. we / have a drink

Let's have a drink!

3. you / not to smoke (utilisez: do )  
Don't smoke!
4. we / not to take the car (utilisez: let)

Let's not take the car.

5. You/ to brush.

Let's brush

6. you/to stop

Don't stop

7. You/ not to be.

Not be

8. We/ not to complicate.

Don't complicate

9. Please you/ not to pollute.

Do n't pollute

10. Please you/to read the instructions,

Read the instructions

11. you/to turn off

Don't turn off

12. you/ to keep all medicines out of reach  
of children

Keep all medicines out of reach of children

13. We/to go and celebrate our victory.

Let's go and celebrate our victory

14. You/not to the camera get wet.

Don't let the camera get wet.

15. We/to go to the cinema.

Let's go to the cinema.

16. You / not to speak like that.

Don't speak like that.

17. You / not to pay attention to her.

Don't pay attention to her.

18. You /to go to the party tonight.

Let her go to the party tonight.

19. You / not to drive too fast.

Don't drive too fast.

20. You / to Close the door.

Close the door

21. You / to Sit down and open your book  
page 26.

Down and open your book page 26.

22. You / to listen to me.

You, listen to me.

23. You / not to say a word.

Let's not say a word

24. You/ to give me a ball.

Give me a ball!

25. Please you/ to open the window!

Open the window!

26. Please you/ to Take a book!

Take a book!

27. Please you/ to Look at this boy!  
Look at this boy!

28. Please you/ to Listen to the tape!

## EXTENDED DEFINITIONS

1. Activated Charcoal: A carbon which is porous in nature and possesses high adsorption power. It is useful for removing toxic substances from air and water.
2. Activation energy: During a chemical reaction, the minimum amount of energy which is needed by the reactants to get converted into products is known as activation energy.
3. Acyl Group: It is a functional group of organic compounds which is usually obtained by replacing the hydroxyl group ( $-OH$ ) from any carboxylic acid.
4. Addition Reaction: A type of chemical reaction in which an atom or a group of atoms is added to a double or triple bond compound, in order to change it into a single and double bond compound respectively.
5. Alcohol: An organic compound which consists of a hydroxyl group ( $-OH$ ) attached to a carbon atom of an alkyl group chain.
6. Aldehyde: A functional group of organic compounds, consisting of one atom each of carbon, hydrogen and oxygen. Here, the carbon atom forms a single bond with the hydrogen atom and is bonded to the oxygen atom with the help of a double bond.
7. Aliphatic: An organic compound in which the carbon atoms are bonded together in the form of a chain. It does not have aromatic rings.
8. Alkali Metals: Elements which belong to Group IA of the periodic table.
9. Alkaline Earth Metals: Elements which belong to Group IIA of the periodic table.
10. Alkanes: Alkanes are a series of organic compounds, consisting of carbon and hydrogen atoms, where all the carbon atoms are bonded to each other only by single bonds.
11. Alkenes (Olefins): Unsaturated organic compounds which have at least one carbon-carbon double bond.
12. Electrolyte: An electrolyte is a chemical substance that splits up into ions in aqueous state or molten state and acts as a medium to conduct electricity.
13. Electron: Electron is a negatively charged subatomic particle that revolves around the nucleus of an atom.

14. Electron Affinity: Electron affinity of an atomic or molecular particle is the energy change that takes place as a result of addition or deletion of an electron from a neutrally charged atom or molecule.

15. Electron Configuration: The arrangement of electrons in the orbitals of an atom is known as electron configuration.

16. Acceleration: The rate of change of velocity with time is called acceleration. Mathematically, the second derivative of the distance traveled by an object is called acceleration.

17. Accuracy: The measure of the closeness of a value to the actual value of a result is called accuracy.

18. Acute Angle: An angle whose measure is less than 90° is called an acute angle.

19. Acute Angled Triangle: A triangle in which all the interior angles are acute is known as an acute angled triangle.

20. Circular Cone: A cone with a circular base.

21. Circular Cylinder: A cylinder with circle as bases.

22. Circumcenter: The center of a circumcircle is called circumcenter.

22. Circumcircle: A circle that passes through all the vertices of a regular polygon and triangles is called circumcircle.

23. Circumference: The perimeter of a circular figure.

24. Circumscribable: A plan figure that has a circumcircle.

25. Circumscribed: A figure circumscribed by a circle.

26. Circumscribed Circle: The circle that touches the vertices of a triangle or a regular polygon.

27. Clockwise: The direction of the moving hands of a clock.

28. Simile: There is an obvious comparison that is made between two dissimilar things using words such as, like and as.

29. Onomatopoeia: The technique in which words that imitate sounds are used to refer to the objects, living things, or actions that they are associated with.

30. Personification: This is a figure of speech which is used when the poet or the writer wants to attribute human qualities to an inanimate object or thought.

31. Transformer: Transformer is a piece of electrical equipment, which changes the voltage of current

### USE OF SEQUENCE WORDS:

1. so / to / itchy / is / that / I / wait / My / off. / uniform / can't / take / it

**My uniform is so itchy that I can't wait to take it off**

2. Is / good / both / for / and / early / rising / old / adults

**Early rising is good for both old and adults**

3. the / weekend / I / can / love / down. / be / I / myself / because / and / dress

**I love the weekend because I can be myself and dress down.**

4. Finish / work / early / one / can / go / and / a / for walk / one's.

**One can finish one's work early and go for a walk**

5. place / our lives / music / important / has / in / an.

**Music has an important place in our lives**

6. its / urbanisation / in India / everywhere / has / tentacles / spread

**Urbanization has spread its tentacles everywhere in India**

7. light up / in every home / good / the lamp / books / magazines / and / of / knowledge

**Good books and magazines light up the lamp of knowledge in every home.**

8. 'The year of Books' / are / we / this / celebrating / year.

**This year we are celebrating "The Year of Books".**

9. I'd / thought / nervous! / the / get / interview; / I / I / through / was / never / so

**I never thought I'd get through the interview; I was so nervous!**

10. Reshma / year. / to / to / the / come / back / hopes / Disneyworld / for / next / a / holiday

**Reshma hopes to come back to the Disneyworld for a holiday next year.**

11. want / Do / me / see / you / you / at / to / the / airport? / off

**Do you want me to see you off at the airport?**

12. you/ betray / once / it's / his / fault / someone / fault / betrays / it's / he if / twice if / your / you

**If someone betrays you once, it's his fault. If he betrays you twice, it's your fault.**

13. baby / gave / apple / her / the / mother / a / red

**The mother gave her baby a red apple.**

14. that / lived in / hills / I dreamt / I / Mallabar

**I dreamt that I I lived in Mallabar hills.**

15. Mohit / and / skating / Saturday / went / on / Preeti

**Mohit and Preeti went skating on Saturday**

16. way / good / eating / cream / ice / to / off / is / a / cool

**Eating ice cream is a good way to cool off.**

17. spoil / broth / the / too / many / cooks

**Too many cooks spoil the broth**

18. money / me? / How / give / can / much / you

**How much money can you give me?**

19. the / was / that / authority / curbed / King / annoyed / his / was

**The king was annoyed that his authority was curbed**

20. strike / opportunity / the / wait / I / to / right / for / will

**I will wait for the right opportunity to strike.**

21. are harmless/to people/ most bats

**Most bats are harmless to people.**

22. unique and diverse/bats, one of/misunderstood creatures/the world's most/are wonderful.

**PURPOSE STATEMENTS**

Statements: 1

Standard of living among the middle class society is constantly going up since part of few years.  
Indian Economy is observing remarkable growth.

- A. **Statement I is the cause and statement II is its effect.**
- B. Statement II is the cause and statement I is its effect.
- C. Both the statements I and II are independent causes.
- D. Both the statements I and II are effects of independent causes.

Statements:2

The meteorological Department has issued a statement mentioning deficient rainfall during monsoon in many parts of the country.

The Government has lowered the revised estimated GDP growth from the level of earlier estimates.

- A. Statement I is the cause and statement II is its effect.
- B. Statement II is the cause and statement I is its effect.
- C. Both the statements I and II are independent causes.
- D. **Both the statements I and II are effects of independent causes.**
- E. Both the statements I and II are effects of some common cause

Statements: 3

The staff of Airport Authorities called off the strike they were observing in protest against privatization.

The staff of Airport Authorities went on strike anticipating a threat to their jobs.

- A. Statement I is the cause and statement II is its effect.

- B. Statement II is the cause and statement I is its effect.
- C. Both the statements I and II are independent causes.
- D. **Both the statements I and II are effects of independent causes.**
- E. Both the statements I and II are effects of some common cause.

Statements: 4

A huge truck overturned on the middle of the road last night.  
The police had cordoned off entire area in the locality this morning for half of the day.

- A. **Statement I is the cause and statement II is its effect.**
- B. Statement II is the cause and statement I is its effect.
- C. Both the statements I and II are independent causes.
- D. Both the statements I and II are effects of independent causes.
- E. Both the statements I and II are effects of some common cause.

Statements: 5

Importance of Yoga and exercise is being realized by all sections of the society.  
There is an increasing awareness about health in the society particularly among middle ages group of people.

- A. Statement I is the cause and statement II is its effect.
- B. **Statement II is the cause and statement I is its effect.**
- C. Both the statements I and II are independent causes.
- D. Both the statements I and II are effects of independent causes.
- E. Both the statements I and II are effects of some common cause.

5 Brian hopes to find another job. few employers are hiring,.

**Brian hopes to find another job but few employers are hiring,.**

6. Raju wants to get some additional training. he's unsure where to get it.

**Raju wants to get some additional training though he's unsure where to get it**

7. He likes to walk in the snow. it is a special winter experience.

**He likes to walk in the snow since it is a special winter experience**

8. Ravi wore his winter pants. it was snowing

**Ravi wore his winter pants because it was snowing**

9. Justin wore his winter pants. it was warm outside.

**Justin wore his winter pants though it was warm outside.**

10. The mayor declared a holiday. some people went to work anyway.

**The mayor declared a holiday yet some people went to work anyway**

11. She had a baby at thirteen . she was not protected.

**She had a baby at thirteen as she was not protected**

12. She had no access to health education or medical clinics. she was more likely to get HIV.

**She had no access to health education or medical clinics therefore she was more likely to get HIV.**

13. Vimala had no other options. she married at thirteen.

**Vimala had no other options consequently she married at thirteen.**

14. She suffered from parasites the impure water in her village. .

**She suffered from parasites on account of the impure water in her village**

15 She was fighting for survival. She had not been given a chance.

**She was fighting for survival since she had not been given a chance.**

16 We stayed out all night. We could watch a meteor storm.<sup>1</sup>

**We stayed out all night so that we could watch a meteor storm.<sup>1</sup>**

17. We took some blankets. We could keep warm

**We took some blankets so we could keep warm**

18. We stayed out late; we were able to see the meteor storm as it passed.

**We stayed out late so we were able to see the meteor storm as it passed.**

19. There was no more coffee. He asked for another cup

**Though there was no more coffee, he asked for another cup.**

20. free-flowing gas. Water could not put out the fire

**Due to free-flowing gas, water could not put out the fire.**

### REPORTED SPEECH

1. My cousin said," My room-mate snored throughout the night."

[A] *My cousin said that her room-mate had snored through out the night.*

[B] My cousin told me that her room-mate snored throughout the night

[C] My cousin complained to me that her room-mate is snoring through out the night.

[D] My cousin felt that her room-mate may be snoring throughout the night.

2. He said, "I clean my teeth twice a day."

[A] He said that he cleaned his teeth twice a day.

[B] *He said that he cleans his teeth twice a day.*

[C] He said that he used to clean his teeth twice a day.

[D] He said that he is used to cleaning his teeth twice a day.

3. He said, "The mice will play, when the cat is away."

[A] *He said that the mice will play when the cat is away.*

[B] He said that the mice would play when the cat was away

[C] He said that the mice would play when the cat would be away

[D] He said that the mice shall play, when the cat is away.

4. The sage said," god helps those who help themselves."

[A] *The sage said that god helps those who help themselves*

[B] The sage said that god helped those who helped themselves

[C] The sage said that god helps those who helped themselves

[D]The sage said that God helped those who help themselves.

5. He said, "Can you sing?" And I said "NO".

[A] He asked me that could I sing and I refused.

[B] *He asked me if I could sing and I said that I couldn't.*

[C] I denied, when he asked me if I could sing.

[D] He asked me if I could sing and I said no.

6. The teacher said, "Be quiet boys."

[A] The teacher said that they boys should be quiet.

[B] The teacher called the boys and ordered them to be quiet.

[C] *The teacher urged the boys to be quiet.*

[D] The teacher commanded the boys that they be quiet.

7. He said to them, "Don't make a noise"

[A] He told them that don't make a noise.

[B] He told them not to make noise

[C] He told them not to make a noise

[D] *He asked them not to make a noise.*

8. "Please don't go away", she said.

[A] She said to please her and not go away.

[B] She told me not to go away

[C] She begged that I not go away

[D] *She begged me not to go away.*

9. Pinki said to Gaurav, "Will you help me in my work just now?"

[A] *Pinki asked Gaurav if he would help her in her work just then.*

[B] Pinki questioned to Gaurav that will you help me in my work just now.

[C] Pinki told Gaurav whether he will help her in her work just now.

[D] Pinki asked to Gaurav that will he help her in her work just now.

10. "Are you alone, my son?" asked a soft voice close behind me.

[A] A soft voice from my back asked if I was alone.

[B] A soft voice said to me are you alone son.

[C] A soft voice asked that I was doing there alone.

[D] A soft voice behind me asked if I was alone

1. Direct speech : David : "There is an excellent band playing later on."

Reported Speech : David said there was an excellent bank playing later on.

2. Direct speech : Christine : "I saw Amy at the bank on Monday."

Reported Speech : Christine said she had seen Amy at the bank on Monday.

3. Direct speech : The driver : "I'm going to turn right at the traffic lights."  
Reported Speech : The driver said he was going to turn right at the traffic lights.
4. Direct speech : Jonathan: "I've returned the dictionary to the library".  
Reported Speech : Jonathan said he had returned the dictionary to the library.
5. Direct speech : The doctor : "I'll send you the results as soon as they arrive."  
Reported Speech : The doctor said he would send me/us the results as soon as they arrived.
6. Direct speech : Caroline : "Will you come to my party on Saturday?"  
Reported Speech : Caroline asked (me) if I would come to her party on Saturday.
7. Direct speech : Shop assistant: "Are you looking for something special?"  
Reported Speech : The shop assistant asked if I was looking for something special.
8. Direct speech : Jack : "I'll lend you my grammar book if you think it will help."  
Reported Speech : Jack said he would lend me his grammar book if I thought it would help.

#### 4. PREFIXES & SUFFIXES

##### **Prefixes**

Prefixes are added to the beginning of a word to make a new word, e.g. mis+take. Some common prefixes are 'mis', 'dis', 're', 'for', 'anti', 'ante', 'sub', 'un' and 'in'. New words are made by placing a prefix in front of a word. It is helpful to know the meanings of prefixes. Prefix 're' means **again**, therefore **reappear** means to appear **again**.

<b>Prefix</b>	<b>Suffix</b>
<p>A <b>prefix</b> is a group of letters placed before the root of a word. For example, the word "unhappy" consists of the prefix "un-" [which means "not"] combined with the root (stem) word "happy"; the word "unhappy" means "not happy."</p>	<p>A <b>suffix</b> is a group of letters placed after the root of a word. For example, the word flavorless consists of the root word "flavor" combined with the suffix "-less" [which means "without"]; the word "flavorless" means "having no flavor."</p>

**A Short List of Prefixes:**

<b>PREFIX</b>	<b>MEANING</b>	<b>EXAMPLES</b>
de-	from, down, away reverse, opposite	decode, decrease
dis-	not, opposite, reverse, away	disagree, disappear
ex-	out of, away from, lacking, former	exhale, explosion
il-	not	illegal, illogical
im-	not, without	impossible, improper
in-	not, without	inaction, invisible
mis-	bad, wrong	mislead, misplace
non-	not	nonfiction, nonsense
pre-	before	prefix, prehistory
pro-	for, forward, before	proactive, profess, program
re-	again, back	react, reappear
un-	against, not, opposite	undo, unequal, unusual

**A Short List of Suffixes:**

<b>SUFFIX</b>	<b>MEANING</b>	<b>EXAMPLES</b>
-able	able to, having the quality of	comfortable, portable
-al	relating to	annual, comical
-er	comparative	bigger, stronger
-est	superlative	strongest, tiniest
-ful	full of	beautiful, grateful
-ible	forming an adjective	reversible, terrible
-ily	forming an adverb	eerily, happily, lazily
-ing	denoting an action, a material, or a gerund	acting, showing
-less	without, not affected by	friendless, tireless
-ly	forming an adjective	clearly, hourly
-ness	denoting a state or condition	kindness, wilderness
-y	full of, denoting a condition, or a diminutive	glory, messy, victory,

**ACTIVE AND PASSIVE VOICE**

1. The wedding planner is making all the reservations.
2. For the bake sale, two dozen cookies will be baked by Susan.
3. The science class viewed the comet.
4. Who ate the last cookie?
5. The video was posted on Face book by Alex.

6. The director will give you instructions.
7. The Grand Canyon is viewed by thousands of tourists every year.
8. The homeowners remodeled the house to help it sell.
9. The team will celebrate their victory tomorrow.
10. The saltwater eventually corroded the metal beams.
11. The baby was carried by the kangaroo in her pouch.
12. Some people raise sugar cane in Hawaii.
13. A movie is going to be watched by us tonight.
14. The obstacle course was run by me in record time.
15. Mom read the novel in one day.

### Conditional Clauses

1. If you move here, \_\_\_\_\_
2. \_\_\_\_\_ if you stop smoking.
3. If Sarah didn't go with John, Anna \_\_\_\_\_
4. \_\_\_\_\_ if they play my favorite song.
5. I wouldn't buy that computer \_\_\_\_\_.
6. If she doesn't feel better tomorrow, \_\_\_\_\_.
7. I'd lend you money \_\_\_\_\_.
8. If I were you, \_\_\_\_\_
9. If Mike were not working in the dining hall, \_\_\_\_\_.
10. If Mike could find his library card, \_\_\_\_\_.
11. \_\_\_\_\_, she would have received the full ten points on it.
12. If Scott had been paying attention in class, \_\_\_\_\_.
13. If Lan had not refused to lend us his car, \_\_\_\_\_.
14. If I had the money \_\_\_\_\_.
15. If they go to Australia, \_\_\_\_\_.

16. If she had a mobile, \_\_\_\_\_.
17. If Bob were here, \_\_\_\_\_.
18. You \_\_\_ (to have) no trouble at school if you had done your homework.
19. If you (to swim) \_\_\_\_\_ in this lake, you'll shiver from cold.
20. The door will unlock if you \_\_\_\_\_ (to press) the green button.

### Numerical expressions

1. A squad of 1000 men
2. 573 K
3. 500 ppm
4. 720 kHz
5. 1500 kg/cm<sup>3</sup>
6. 500 Btu/ft<sup>3</sup>
7. 40% v/v
8. 15psi
9. a journey of 20 miles
10. a lecture for two hours
11. an interval of 5 mins
12. a stamp with a value of 5 rupees
13. a squad of 300 men
14. 250 rpm
15. A DC supply of 280 volts

**UNIT -1**

**MATRICES**

**PART –A**

1. Find the characteristic Equation of  $\begin{bmatrix} 2 & -3 & 1 \\ 3 & 1 & 3 \\ -5 & 2 & -4 \end{bmatrix}$ .

**Solution**

Let  $A = \begin{bmatrix} 2 & -3 & 1 \\ 3 & 1 & 3 \\ -5 & 2 & -4 \end{bmatrix}$ . The characteristic Equation is  $|A - \lambda I| = 0$

$$\left[ \begin{bmatrix} 2 & -3 & 1 \\ 3 & 1 & 3 \\ -5 & 2 & -4 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \right] = 0 \Rightarrow \begin{vmatrix} 2-\lambda & -3 & 1 \\ 3 & 1-\lambda & 3 \\ -5 & 2 & -4-\lambda \end{vmatrix} = 0$$

$$(2 - \lambda)[(1 - \lambda)(-4 - \lambda) - 6] + 3[3(-4 - \lambda) + 15] + 1[6 + 5(1 - \lambda)] = 0$$

$$(2 - \lambda)[-10 - \lambda + 4\lambda + \lambda^2] + 3[3 - 3\lambda] + [6 + 5 - 5\lambda] = 0$$

$$2\lambda^2 + 6\lambda - 20 - \lambda^3 - 3\lambda^2 + 4\lambda - 9\lambda + 9 + 11 - 5\lambda = 0 \Rightarrow \lambda^3 + \lambda^2 - 2\lambda = 0$$

2. Given  $A = \begin{bmatrix} -1 & 0 & 0 \\ 2 & -3 & 0 \\ 1 & 4 & 2 \end{bmatrix}$ . Find the eigen values of  $A^2$ .

**Solution**

Given matrix A is a lower triangular matrix. We know that "The eigen value of a triangular matrix is the diagonal elements". From this, the Eigen values of  $A^2$  are  $(-1)^2, (-3)^2, (2)^2$ . The Eigen values of  $A^2 = 1, 9, 4$ .

3. State Cayley – Hamilton theorem and verify it for the matrix  $A = \begin{bmatrix} 3 & -1 \\ -1 & 5 \end{bmatrix}$

**Solution** Cayley – Hamilton Theorem: Every square matrix A satisfies its own characteristic equation.

**Verification:**

$$A = \begin{bmatrix} 3 & -1 \\ -1 & 5 \end{bmatrix} \text{ The characteristic Equation is } |A - \lambda I| = 0$$

$$\begin{bmatrix} 3-\lambda & -1 \\ -1 & 5-\lambda \end{bmatrix} = 0 \Rightarrow (3-\lambda)(5-\lambda) - 1 = 0 \Rightarrow 15 - 3\lambda - 5\lambda + \lambda^2 - 1 = 0 \Rightarrow \lambda^2 - 8\lambda + 14 = 0$$

To prove  $A^2 - 8A + 14I = 0$

$$A^2 = \begin{bmatrix} 3 & -1 \\ -1 & 5 \end{bmatrix} \begin{bmatrix} 3 & -1 \\ -1 & 5 \end{bmatrix} = \begin{bmatrix} 10 & -8 \\ -8 & 26 \end{bmatrix}$$

$$A^2 - 8A + 14I = \begin{bmatrix} 10 & -8 \\ -8 & 26 \end{bmatrix} - 8 \begin{bmatrix} 3 & -1 \\ -1 & 5 \end{bmatrix} + 14 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 10 & -8 \\ -8 & 26 \end{bmatrix} - \begin{bmatrix} 24 & -8 \\ -8 & 40 \end{bmatrix} + \begin{bmatrix} 14 & 0 \\ 0 & 14 \end{bmatrix}$$

$$\Rightarrow A^2 - 8A + 14I = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \text{ Hence the given matrix satisfies Cayley - Hamilton Theorem.}$$

4. Using Cayley - Hamilton Theorem find  $A^{-1}$  if  $A = \begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix}$ .

**Solution**  $A = \begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix}$ , The characteristic Equation is  $|A - \lambda I| = 0$

$$|A - \lambda I| = \begin{vmatrix} 2-\lambda & -1 \\ 4 & 3-\lambda \end{vmatrix} = [(2-\lambda)(3-\lambda) + 4] = 6 - 2\lambda - 3\lambda + \lambda^2 + 4 = \lambda^2 - 5\lambda + 10$$

By Cayley - Hamilton Theorem  $A^2 - 5A + 10I = 0$  ..... (1)

To find  $A^{-1}$  multiply equation (1) by  $A^{-1}$ .

$$A - 5I + 10A^{-1} = 0 \Rightarrow \begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix} - 5 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + 10A^{-1} = 0 \Rightarrow \begin{bmatrix} 2 & -1 \\ 4 & 3 \end{bmatrix} - \begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix} + 10A^{-1} = 0 \Rightarrow \begin{bmatrix} -3 & -1 \\ 4 & -2 \end{bmatrix} + 10A^{-1} = 0$$

$$\Rightarrow 10A^{-1} = - \begin{bmatrix} -3 & -1 \\ 4 & -2 \end{bmatrix} \Rightarrow A^{-1} = -\frac{1}{10} \begin{bmatrix} -3 & -1 \\ 4 & -2 \end{bmatrix}$$

5. If  $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$  find  $A^3$  using Cayley – Hamilton Theorem.

**Solution** The characteristic equation is  $|A - \lambda I| = 0 \Rightarrow \begin{vmatrix} 1-\lambda & 2 \\ 3 & 4-\lambda \end{vmatrix} = 0 \Rightarrow$

$$\Rightarrow \lambda^2 - 5\lambda - 2 = 0$$

Using Cayley – Hamilton theorem we get,  $A^2 - 5A - 2I = 0$

$$A^2 = A \times A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} 7 & 10 \\ 15 & 22 \end{bmatrix} \Rightarrow A^2 = 5A + 2I$$

$$\text{Multiply both sides by } A \text{ we get, } A^3 = 5A^2 + 2A = 5 \begin{bmatrix} 7 & 10 \\ 15 & 22 \end{bmatrix} + 2 \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \Rightarrow A^3 = \begin{bmatrix} 37 & 54 \\ 81 & 118 \end{bmatrix}$$

6. Prove that the similar matrices have same Eigen values.

**Proof:** Let A, B be two similar matrices. Then there exists a non – singular matrix P such that  $B = P^{-1}AP$

$$B - \lambda I = P^{-1}AP - \lambda I = P^{-1}AP - P^{-1}\lambda I P = P^{-1}(A - \lambda I)P$$

$$|B - \lambda I| = |P^{-1}| |A - \lambda I| |P| = |A - \lambda I| |P^{-1}P| = |A - \lambda I| |I| \Rightarrow |B - \lambda I| = |A - \lambda I|$$

Therefore A and B have the same characteristic functions and hence the same characteristic roots. Therefore they have the same eigen values.

7. Check whether the matrix P is orthogonal  $P = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}$

**Solution** Condition for orthogonal matrix is  $PP^T = P^T P = I$

$$P = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix} \quad P^T = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix} \quad PP^T = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix} \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

$$PP^T = \begin{bmatrix} \cos^2 \theta + \sin^2 \theta & -\cos \theta \sin \theta + \cos \theta \sin \theta \\ -\sin \theta \cos \theta + \cos \theta \sin \theta & \sin^2 \theta + \cos^2 \theta \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = I$$

Similarly,  $P^T P = I$ . Therefore the given matrix is orthogonal.

8.State Fundamental theorem of quadratic form.

**Solution** Any quadratic form may be reduced to canonical form by means of a Non- singular transformation

9.Check whether the matrix B is orthogonal? Justify=
$$\begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

**Solution** Condition for orthogonal matrix is  $BB^T = B^T B = I$

$$B = \begin{bmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \Rightarrow B^T = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$BB^T = \begin{bmatrix} \cos^2 \theta + \sin^2 \theta & -\cos \theta \sin \theta + \cos \theta \sin \theta & 0 \\ -\cos \theta \sin \theta + \cos \theta \sin \theta & \cos^2 \theta + \sin^2 \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I$$

Similarly  $B^T B = I$ . Therefore the given matrix is orthogonal

10.Write the matrix of the quadratic form  $2x_1^2 - 2x_2^2 + 4x_3^2 + 2x_1x_2 - 6x_1x_3 + 6x_2x_3$ .

**Solution**

$$Q = \begin{bmatrix} \text{coeffi}(x_1^2) & \frac{1}{2} \text{coeffi}(x_1x_2) & \frac{1}{2} \text{coeffi}(x_1x_3) \\ \frac{1}{2} \text{coeffi}(x_2x_1) & \text{coeffi}(x_2^2) & \frac{1}{2} \text{coeffi}(x_2x_3) \\ \frac{1}{2} \text{coeffi}(x_3x_1) & \frac{1}{2} \text{coeffi}(x_3x_2) & \text{coeffi}(x_3^2) \end{bmatrix} \Rightarrow Q = \begin{bmatrix} 2 & 1 & -3 \\ 1 & -2 & 3 \\ -3 & 3 & 4 \end{bmatrix}$$

11.Write the quadratic form corresponding to the following symmetric matrix

$$\begin{bmatrix} 0 & -1 & 2 \\ -1 & 1 & 4 \\ 2 & 4 & 3 \end{bmatrix}$$

**Solution** Let  $\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} = \begin{bmatrix} 0 & -1 & 2 \\ -1 & 1 & 4 \\ 2 & 4 & 3 \end{bmatrix}$

The general quadratic form is

$$a_{11}x_1^2 + a_{22}x_2^2 + a_{33}x_3^2 + 2(a_{12})x_1x_2 + 2(a_{23})x_2x_3 + 2(a_{13})x_1x_3$$

$$= 0.x_1^2 + 1.x_2^2 + 3.x_3^2 + 2(-1)x_1x_2 + 2(4)x_2x_3 + 2(2)x_1x_3$$

$$= x_2^2 + 3x_3^2 - 2x_1x_2 + 8x_2x_3 + 4x_1x_3$$

12. Determine the nature of the following quadratic form

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

**Solution** The matrix of the Quadratic form is

$$Q = \begin{bmatrix} \text{coeffi}(x^2) & \frac{1}{2}\text{coeffi}(xy) & \frac{1}{2}\text{coeffi}(xz) \\ \frac{1}{2}\text{coeffi}(yx) & \text{coeffi}(y^2) & \frac{1}{2}\text{coeffi}(yz) \\ \frac{1}{2}\text{coeffi}(zx) & \frac{1}{2}\text{coeffi}(zy) & \text{coeffi}(z^2) \end{bmatrix} = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & 1 \\ -1 & 1 & 3 \end{bmatrix}$$

$$D_1 = |a_{11}| = |1| = 1 = +ve \quad D_2 = \begin{vmatrix} 1 & 1 \\ 1 & 2 \end{vmatrix} = 1 = +ve \quad D_3 = \begin{vmatrix} 1 & 1 & -1 \\ 1 & 2 & 1 \\ -1 & 1 & 3 \end{vmatrix} = -2 = -ve$$

Therefore the quadratic form is indefinite.

13. If the sum of two eigenvalues and trace of a  $3 \times 3$  matrix A are equal, find the value of  $|A|$ .

**Solution** Let  $\lambda_1, \lambda_2, \lambda_3$  be the eigenvalues of the given  $3 \times 3$  matrix A.

We know that Sum of the eigenvalues = trace of A

i.e.  $\lambda_1 + \lambda_2 + \lambda_3 = \text{trace of A} \dots\dots\dots(1)$

Given, trace of A = sum of two eigenvalues =  $\lambda_1 + \lambda_2$

$$\lambda_1 + \lambda_2 + \lambda_3 = \lambda_1 + \lambda_2 \Rightarrow \lambda_3 = 0$$

We know that  $|A| = \text{product of the eigenvalues} = \lambda_1 \times \lambda_2 \times 0 = 0$

14. Can  $A = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$  be diagonalized? Why?

**Solution** The given matrix A is a real symmetric and non – singular matrix. Hence A is diagonalized.

15. If the eigenvalues of A are 1, 2, 3 then what are the eigenvalues of Adj A.

**Solution** Eigen values of A are 1, 2, 3

Eigen values of  $A^{-1}$  are  $\frac{1}{1}, \frac{1}{2}, \frac{1}{3}$  We know that  $A^{-1} = \frac{adj A}{|A|} \Rightarrow adj A = |A|A^{-1}$

$|A|$  = product of eigenvalues. =  $1 \times 2 \times 3 = 6 \Rightarrow |A| = 6$

Eigen values of adj A =  $6(1), 6(\frac{1}{2}), 6(\frac{1}{3}) \Rightarrow$  Eigen values of adj A are 6, 3, 2.

16. Two of the eigenvalues of  $A = \begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$  are 3 and 6. Find the eigenvalues of  $A^{-1}$ .

**Solution** Sum eigenvalues = sum of the main diagonal elements.

$$3 + 6 + \lambda_3 = 3 + 5 + 3 \Rightarrow 9 + \lambda_3 = 11 \Rightarrow \lambda_3 = 2$$

Therefore the eigenvalues of A are 3, 6, 2.

Therefore the eigenvalues of  $A^{-1}$  are  $\frac{1}{3}, \frac{1}{6}, \frac{1}{2}$ .

17. Prove that  $A^3 - 20A + 8I = 0$  where  $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$

**Solution**  $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$  The characteristic equation of A is  $|A - \lambda I| = 0$

$$\text{i.e., } \begin{vmatrix} 1 - \lambda & 1 & 3 \\ 1 & 3 - \lambda & -3 \\ -2 & -4 & -4 - \lambda \end{vmatrix} = 0$$

$$(1 - \lambda) [(3 - \lambda)(4 - \lambda) - 12] - 1 [1(4 - \lambda) - 6] + 3 [-4 + 2(3 - \lambda)] = 0$$

$$\Rightarrow -\lambda^3 + 20\lambda - 8 = 0 \Rightarrow \lambda^3 - 20\lambda + 8 = 0$$

By Cayley – Hamilton Theorem,  $A^3 - 20A + 8I = 0$ .

18. Find the eigenvector corresponding to the eigenvalue 1 of the matrix  $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ .

**Solution** Given eigenvalue is 1. To find the eigenvector solve  $(A - \lambda I)X = 0$ .

$$\begin{bmatrix} 2 - \lambda & 2 & 1 \\ 1 & 3 - \lambda & 1 \\ 1 & 2 & 2 - \lambda \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}. \text{ Put } \lambda = 1 \text{ we get } \begin{bmatrix} 1 & 2 & 1 \\ 1 & 2 & 1 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}.$$

$$x_1 + 2x_2 + x_3 = 0 \dots\dots(1) \quad x_1 + 2x_2 + x_3 = 0 \dots\dots(2) \quad x_1 + 2x_2 + x_3 = 0 \dots\dots(3)$$

All the three equations are same  $x_1 + 2x_2 + x_3 = 0$

$$\text{Put } x_1 = 0 \text{ we get } 2x_2 + x_3 = 0 \Rightarrow 2x_2 = -x_3$$

$$\frac{x_2}{-1} = \frac{x_3}{2}.$$

Hence the eigenvectors corresponding to 1 is  $X_1 = \begin{bmatrix} 0 \\ -1 \\ 2 \end{bmatrix}$ .

19. Find the product and sum of the eigenvalues of the matrix  $A = \begin{pmatrix} 2 & -3 \\ 4 & -2 \end{pmatrix}$

**Solution** Sum of the eigenvalues = sum of the main diagonal elements =  $2 - 2 = 0$

$$\text{Product of the eigenvalues} = |A| = \begin{vmatrix} 2 & -3 \\ 4 & -2 \end{vmatrix} = -4 + 12 = 8.$$

20. Determine the matrix A for which the eigenvalues and eigenvectors are 2, 3, 5 and

$(1, -1, 0)^T, (1, 0, 0)^T, (2, 2, 1)^T$  respectively.

**Solution** Forming the modal matrix  $B = \begin{pmatrix} 1 & 1 & 3 \\ -1 & 0 & 2 \\ 0 & 0 & 1 \end{pmatrix}$

We get  $B^{-1}AB = D$  Where  $D = \begin{pmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 5 \end{pmatrix}$  is the diagonal matrix

Pre multiplying by B and post multiplying by  $B^{-1}$ , we obtain  $BB^{-1}ABB^{-1} = BDB^{-1} \Rightarrow$

$$A = BDB^{-1}$$

$$\text{Now } B^{-1} = \frac{\text{adj}B}{|B|}$$

$$\text{adj}A = \begin{pmatrix} 0 & 1 & 0 \\ -1 & 1 & 0 \\ 2 & -5 & 1 \end{pmatrix}^T = \begin{pmatrix} 0 & -1 & 2 \\ 1 & 1 & -5 \\ 0 & 0 & 1 \end{pmatrix}$$

$$|B| = \begin{vmatrix} 1 & 1 & 3 \\ -1 & 0 & 2 \\ 0 & 0 & 1 \end{vmatrix} = 1[0 \cdot 0] - 1[-1 \cdot 0] + 3[0 + 0] = 1$$

$$B^{-1} = \begin{pmatrix} 0 & -1 & 2 \\ 1 & 1 & -5 \\ 0 & 0 & 1 \end{pmatrix}$$

$$A = BDB^{-1} = \begin{pmatrix} 1 & 1 & 3 \\ -1 & 0 & 2 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 5 \end{pmatrix} \begin{pmatrix} 0 & -1 & 2 \\ 1 & 1 & -5 \\ 0 & 0 & 1 \end{pmatrix} =$$

$$\begin{pmatrix} 1 & 1 & 3 \\ -1 & 0 & 2 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 0 & -2 & 4 \\ 3 & 3 & -15 \\ 0 & 0 & 5 \end{pmatrix} = \begin{pmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{pmatrix}$$

21. If A is an orthogonal matrix show that  $A^{-1}$  is also orthogonal .

**Solution** For an orthogonal matrix, transpose will be the inverse.

$$\text{Therefore } A^T = A^{-1} \dots\dots\dots(1)$$

$$\text{Let } A^T = A^{-1} = B \dots\dots\dots(2)$$

$$\text{Then } B^T = (A^{-1})^T = (A^T)^{-1} = B^{-1} \text{ [ From ( 2 ) ]}$$

$$B^T = B^{-1} \Rightarrow \text{matrix B is orthogonal. i.e. } A^{-1} \text{ is also orthogonal.}$$

22. The Product of two eigenvalues of the matrix  $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$  is 16. Find the third eigenvalue of A.

**Solution** Let the eigen values of the matrix A be  $\lambda_1, \lambda_2, \lambda_3$ .

$$\text{Given } \lambda_1 \lambda_2 = 16$$

$$\text{We know that } \lambda_1 \lambda_2 \lambda_3 = |A| \Rightarrow \lambda_1 \lambda_2 \lambda_3 = \begin{vmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{vmatrix} = 32 \Rightarrow$$

$$\lambda_1 \lambda_2 \lambda_3 = 32 \Rightarrow 16 \lambda_3 = 32 \Rightarrow \lambda_3 = 2$$

23. For a given matrix A of order 3,  $|A|=32$  and two of its eigen values are 8 and 2. Find the sum of the eigen values.

**Solution** Given matrix A of order 3.

Let the eigen values are  $\lambda_1, \lambda_2, \lambda_3$ . W.K.T  $|A| = \text{Product of eigen values} = \lambda_1 \lambda_2 \lambda_3$

Given:  $|A|=32$  and  $\lambda_1 = 8, \lambda_2 = 2$

$\lambda_1 \lambda_2 \lambda_3 = 32 \Rightarrow (8)(2)\lambda_3 = 32 \Rightarrow \lambda_3 = 2$  Sum of the eigen values =  $\lambda_1 + \lambda_2 + \lambda_3 = 8 + 2 + 2 = 12$

24. Use- Cayley Hamilton theorem to find  $(A^4 - 4A^3 - 5A^2 + A + 2I)$  when  $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$ .

**Solution** Given  $A = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix}$ .

The characteristic equation of A is  $|A - \lambda I| = 0$  That is  $\lambda^2 - s_1\lambda + s_2 = 0$  where

$s_1 = \text{sum of the main diagonal elements} = 1+3=4$  and  $s_2 = |A| = \begin{vmatrix} 1 & 2 \\ 4 & 3 \end{vmatrix} = 3-8 = -5$

Therefore the characteristic equation of A is  $\lambda^2 - 4\lambda - 5 = 0$

By Cayley Hamilton theorem we get  $A^2 - 4A - 5I = 0$

$$A^4 - 4A^3 - 5A^2 + A + 2I = A^2(A^2 - 4A - 5I) + A + 2I = A^2(0) + A + 2I = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix} + 2 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix} + \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ 4 & 5 \end{bmatrix}$$

25. If 1 and 2 are the eigenvalues of a  $2 \times 2$  matrix A. What are the eigenvalues of  $A^2$  and  $A^{-1}$ .

**Solution** Given 1 and 2 are the eigenvalues of a  $2 \times 2$  matrix A.

By property,  $1^2$  and  $2^2=4$  are the eigenvalues of  $A^2$  and  $1$  and  $\frac{1}{2}$  are the eigenvalues of  $A^{-1}$ .

26. If the sum of the eigen values of the matrix of the quadratic form equal to zero, then what will be the nature of the quadratic form?

**Solution** Given  $\lambda_1 + \lambda_2 + \lambda_3 = 0$

Case (i) All +ve is not possible, Case(ii) All -ve is not possible, Case (iii) both positive and

negative is possible. Therefore Nature of the Quadratic form is indefinite.

27. A is a singular matrix of order three, 2 and 3 are the eigen values. Find its third eigen value

**Solution** Given  $\lambda_1 = 2, \lambda_2 = 3, \lambda_3 = \underline{\hspace{2cm}}$

Given A is singular  $\Rightarrow |A|=0$

$|A| = \text{product of the eigen values} = 0 \Rightarrow (2)(3)(\lambda_3) = 0 \therefore \lambda_3 = 0$

28. The sum of the eigen values of the matrix  $A = \begin{bmatrix} 2 & -2 & 2 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$

**Solution** Sum of the eigen values = Sum of the main diagonal elements =  $(2)+(1)+(-1)=2$

Product of the eigen values =  $|A| = \begin{vmatrix} 2 & -2 & 2 \\ 1 & 1 & 1 \\ 1 & 3 & -2 \end{vmatrix} = -8$

29. Using Cayley - Hamilton theorem, is it possible to find the inverse of all square matrices? Justify your answer.

**Solution** Not possible to find the inverse of all square matrices by using Cayley- Hamilton theorem.

Let A be any square matrix of order n.

The characteristic equation of A is by Cayley – Hamilton theorem we get

$$A^n + C_{n-1}A^{n-1} + C_{n-2}A^{n-2} + \dots + C_1A + C_0 = 0$$

$A^{-1}$  exists only if  $C_0 = |A| \neq 0$

30. Sum of the squares of the eigen values of  $\begin{bmatrix} 1 & 7 & 5 \\ 0 & 2 & 9 \\ 0 & 0 & 5 \end{bmatrix}$  is .....

**Solution** Given is an upper triangular matrix.

Hence the eigen values are 1,2,5.

$$\text{Sum of squares of eigen values} = 1^2 + 2^2 + 5^2 = 30$$

31. Find the sum and product of eigen values of the matrix  $A = \begin{bmatrix} 1 & 2 & -2 \\ 1 & 0 & 3 \\ -2 & -1 & -3 \end{bmatrix}$

**Solution:** Sum of the matrix = Sum of the diagonal elements =  $1+0-3=-2$

Product of the eigen values = determinant value of the matrix =  $1(0+3)-2(-3+6)-2(-1+0)=3-6+2=-1$ .

32. What is the diagonalisation of a symmetric matrix ?

**Solution** If a square matrix of order n has n linearly independent eigen values, then a

Matrix P can be found such that  $P^{-1}AP$  is a diagonal matrix.

33. If  $A = \begin{bmatrix} 1 & 0 \\ 4 & 5 \end{bmatrix}$ , express  $A^3$  in terms of A and I using Cayley-Hamilton theorem.

**Solution** The characteristic equation of the given matrix is

$$|A - \lambda I| = 0 \Rightarrow \begin{vmatrix} 1 & 0 \\ 4 & 5 \end{vmatrix} - \lambda \begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} = 0 \Rightarrow \begin{vmatrix} 1-\lambda & 0 \\ 4 & 5-\lambda \end{vmatrix} = 0$$
$$(1-\lambda)(5-\lambda) - 0 = 0 \Rightarrow 5 - \lambda - 5\lambda + \lambda^2 = 0 \Rightarrow \lambda^2 - 6\lambda + 5 = 0$$

By Cayley-Hamilton theorem. [Every square matrix A satisfies its own characteristic equation]

$$A^2 - 6A + 5I = 0 \Rightarrow A^2 = 6A - 5I$$

$$\text{Multiply } A \text{ on both sides} \Rightarrow A^3 - 6A^2 + 5A = 0 = 6[6A - 5I] - 5A = 36A - 30I - 5A = 31A - 30I$$

34. Find the nature of the quadratic form  $2x^2 + 2xy + 3y^2$

**Solution** The matrix of the quadratic form is

$$Q = \begin{bmatrix} \text{coeff}x^2 & \frac{1}{2}\text{coeff}.xy \\ \frac{1}{2}\text{coeff}.yx & \text{coeff}y^2 \end{bmatrix} = \begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix} \Rightarrow D_1 = |2| = 2(+ve) \text{ and } D_2 = \begin{vmatrix} 2 & 1 \\ 1 & 3 \end{vmatrix} = 6-1 = 5(+ve)$$

Therefore the QF is positive definite.

35. State the nature of the Q.F  $2xy+2yz+2zx$ .

**Solution**

$$Q = \begin{bmatrix} \text{Coeff}x^2 & \frac{1}{2}\text{Coeff}x.y & \frac{1}{2}\text{COeff}x.z \\ \frac{1}{2}\text{Coeff}z.x & \text{Coeff}y^2 & \frac{1}{2}\text{Coeff}y.z \\ \frac{1}{2}\text{Coeff}z.x & \frac{1}{2}\text{Coeff}z.y & \text{Coeff}z^2 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

36. Write the quadratic form corresponding to the following symmetric matrix

$$\begin{bmatrix} 2 & 1 & -2 \\ 1 & 2 & -2 \\ -2 & 2 & 3 \end{bmatrix}$$

**Solution** Let  $\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} = \begin{bmatrix} 2 & 1 & -2 \\ 1 & 2 & -2 \\ -2 & 2 & 3 \end{bmatrix}$

The general quadratic form is

$$a_{11}x_1^2 + a_{22}x_2^2 + a_{33}x_3^2 + 2(a_{12})x_1x_2 + 2(a_{23})x_2x_3 + 2(a_{13})x_1x_3$$

$$= 2.x_1^2 + 2.x_2^2 + 3.x_3^2 + 2x_1x_2 - 4x_2x_3 - 4x_1x_3$$

37. Find the eigen values of the matrix  $A^{-1}$  if  $A = \begin{bmatrix} 1 & 5 \\ 0 & 4 \end{bmatrix}$

**Solution** Given  $A = \begin{bmatrix} 1 & 5 \\ 0 & 4 \end{bmatrix}$  Given is a upper triangular matrix Then the property the eigen

values of A are 1,4

Therefore the eigen values of  $A^{-1}$  are  $1/1, 1/4 \Rightarrow 1, 1/4$

38. Find the eigen values of  $A^{-1}$  if the matrix A is  $\begin{bmatrix} 2 & 5 & -1 \\ 0 & 3 & 2 \\ 0 & 0 & 4 \end{bmatrix}$

**Solution** Clearly given A is an upper triangular matrix. Hence the eigen values are 2,3,4

By the property the eigen values of  $A^{-1}$  are  $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ .

39. If 2 is an eigen value of  $A = \begin{bmatrix} 2 & -2 & 2 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$  find the other two values

**Solution** Let  $\lambda_1, \lambda_2, \lambda_3$  are the eigen values of A.

Given  $\lambda_1 = 2$ , to find  $\lambda_2$  and  $\lambda_3$  We know that  $\lambda_1 + \lambda_2 + \lambda_3 = (2) + (1) + (-1) = 2 \Rightarrow$

$$\lambda_2 + \lambda_3 = 0$$

$$\lambda_1, \lambda_2, \lambda_3 = |A| = \begin{vmatrix} 2 & -2 & 2 \\ 1 & 1 & 1 \\ 1 & 3 & -2 \end{vmatrix} = -8$$

$$\lambda_1, \lambda_2 = -4 \Rightarrow \lambda_2(-\lambda_2) = -4 \Rightarrow \lambda_2^2 = -4 \Rightarrow \lambda_2 = 2 \Rightarrow 2 + \lambda_3 = -0 \Rightarrow \lambda_3 = -2$$

The other two eigen values are 2, -2.

40. Find the sum and product of eigen values of the matrix  $A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$

**Solution:** Clearly given is an upper triangular matrix. Hence the eigen values are 3,2,5.

Sum of the eigen values = 3,2,5 and Product of the eigen values = (3)(2)(5) = 30

41. Show that  $ax_1^2 - 2bx_1x_2 + cx_2^2$  is positive definite if and only if  $a > 0$  and  $ac - b^2$

**Solution** The matrix of the quadratic form is

$$Q = \begin{bmatrix} \text{coeff}x_1^2 & \frac{1}{2}\text{coeff}x_1x_2 \\ \frac{1}{2}\text{coeff}x_2x_1 & \text{coeff}x_2^2 \end{bmatrix} = \begin{bmatrix} a & -b \\ -b & c \end{bmatrix}$$

$$D_1 = |a| = a > 0 \text{ and } D_2 = \begin{vmatrix} a & -b \\ -b & c \end{vmatrix} = ac - b^2$$

Q.F is positive definite if  $a > 0$  and  $ac - b^2 > 0$  That is  $a > 0$  and  $ac > b^2$

42. Find the eigen value of the matrix of  $A = \begin{bmatrix} 1 & 1 \\ 3 & -3 \end{bmatrix}$

**Solution:** Let  $A = \begin{bmatrix} 1 & 1 \\ 3 & -3 \end{bmatrix}$

The characteristic equation of A is  $|A - \lambda I| = 0 \Rightarrow \lambda^2 - S_1\lambda + S_2 = 0$

$$S_1 = \text{Sum of the main diagonal elements} = (1) + (-1)$$

$$S_2 = |A| = \begin{vmatrix} 1 & 1 \\ 3 & -1 \end{vmatrix} = -1 - 3 = -4$$

Therefore the characteristic equation is  $\lambda^2 - 0\lambda + (-4) = 0 \Rightarrow \lambda^2 - 4 = 0 \Rightarrow \lambda^2 = 4 \Rightarrow \lambda = \pm 2$

43. The characteristic root of a triangular matrix are just the diagonal elements of the matrix .(or)

The eigen values of a triangular matrix are just the diagonal elements of the matrix .

**Proof:** Let us consider the triangular matrix.  $A = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$

Characteristic equation of A is  $|A - \lambda I| = 0$

$$A = \begin{bmatrix} a_{11} - \lambda & 0 & 0 \\ a_{21} & a_{22} - \lambda & 0 \\ a_{31} & a_{32} & a_{33} - \lambda \end{bmatrix} = 0$$

On expansion it gives  $(a_{11} - \lambda)(a_{22} - \lambda)(a_{33} - \lambda) = 0$

$\lambda = a_{11}, a_{22}, a_{33}$ , which are diagonal elements of matrix A.

44. If  $\lambda$  is an Eigen value of a matrix A, then  $1/\lambda$  , ( $\lambda \neq 0$ ) is the eigen value of  $A^{-1}$  (OR) If  $\lambda$  is an Eigen value of a matrix A, what can you say about the Eigen value of matrix  $A^{-1}$ . Prove your statement.

**Proof:** If  $X$  be the eigenvector corresponding to  $\lambda$ , Then  $AX = \lambda X$ ..... (1)

Premultiplying both sides by  $A^{-1}$ , we

$$\text{get } A^{-1}AX = A^{-1}\lambda X \Rightarrow IX = \lambda A^{-1}X \Rightarrow \frac{1}{\lambda}X = A^{-1}X \Rightarrow A^{-1}X = \frac{1}{\lambda}X$$

This being of the same form as (i), shows that  $1/\lambda$  is an Eigen value of the inverse matrix  $A^{-1}$ .

45. Find the eigen values of the matrix  $A = \begin{bmatrix} 2 & 0 & 0 \\ 1 & 3 & 0 \\ 0 & 4 & 4 \end{bmatrix}$ .

**Solution:** Given  $A = \begin{bmatrix} 2 & 0 & 0 \\ 1 & 3 & 0 \\ 0 & 4 & 4 \end{bmatrix}$

Clearly given matrix  $A$  is a lower triangular matrix, hence by the property of the eigen values of  $A$  are 2,3,4.

46. Define orthogonal matrices.

**Solution** A square matrix  $A$  is said to be orthogonal if  $AA^T = A^T A = I$  :  $AA^{-1} = A^{-1}A = I \Rightarrow A$  is

orthogonal if  $A^T = A^{-1}$

#### PART – B

1. Find the eigenvalues and eigenvectors of the matrix  $\begin{bmatrix} 3 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 3 \end{bmatrix}$ .

2. Verify Cayley-Hamilton theorem for the matrix  $A = \begin{pmatrix} 7 & 2 & -2 \\ -6 & -1 & 2 \\ 6 & 2 & -1 \end{pmatrix}$ . Hence find its inverse.

[Nov/Dec 2016]

3. Diagonalize  $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$  by an orthogonal transformation. [Nov/Dec 2016]

4. Reduce the quadratic form  $2x^2 + 5y^2 + 3z^2 + 4xy$  to canonical form by an orthogonal transformation.

Determine its nature.

5. Reduce the quadratic form  $q = 3x_1^2 + 2x_2^2 + 3x_3^2 - 2x_1x_2 - 2x_2x_3$  to its normal form by an orthogonal reduction.

6. Reduce the quadratic form  $8x_1^2 + 7x_2^2 + 3x_3^2 - 12x_1x_2 - 8x_2x_3 + 4x_3x_1$ , to the canonical form through an orthogonal transformation and hence show that it is positive semi-definite.

7. Verify Cayley-Hamilton theorem for the matrix and find  $A^{-1}$  and  $A^4$ .  $A = \begin{pmatrix} 1 & 1 & 3 \\ -1 & 0 & 2 \\ 0 & 0 & 1 \end{pmatrix}$

8. Reduce the matrix  $\begin{bmatrix} 10 & -2 & -5 \\ -2 & 2 & 3 \\ -5 & 3 & 5 \end{bmatrix}$  to diagonal form.

9. Find the eigenvalues and eigenvectors of the matrix  $A = \begin{bmatrix} 11 & -4 & -7 \\ 7 & -2 & -5 \\ 10 & -4 & -6 \end{bmatrix}$

10. Reduce the quadratic form  $x_1^2 + 2x_2x_3$  into a canonical form by means of an orthogonal transformation. Find a set of non-zero values  $x_1, x_2$  &  $x_3$  for which the above quadratic form is zero.

11.(i) Find the characteristic equation of the matrix A. Given  $A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ . Hence find  $A^{-1}$  and  $A^4$

(ii) Find the eigenvalues and eigenvectors of the matrix  $A = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$

12.(i) Use Cayley-Hamilton theorem to find the value of the matrix given by

$$(A^8 - 5A^7 + 7A^6 - 3A^5 + 8A^4 + 5A^3 + 8A^2 - 2A + I), \text{ if the matrix } A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$$

(ii) find the eigenvalues and eigenvectors of the matrix  $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$

13. Reduce the quadratic form  $x_1^2 + 2x_2^2 + x_3^2 - 2x_1x_2 + 2x_2x_3$  to the canonical form through an orthogonal transformation and hence show that it is positive semi definite. Also give a non-zero set of values  $(x_1, x_2, x_3)$  which makes this quadratic form zero.

14. Reduce the quadratic form to  $x^2 + 3y^2 + 3z^2 - 2yz$  canonical form by an orthogonal transformation.

15. Find the eigenvalues and eigenvectors of the matrix  $\begin{bmatrix} a & b \\ -b & a \end{bmatrix}$

16. Find the eigenvalues and eigenvectors of the matrix  $\begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$

17. Find the eigenvalues and eigenvectors of the matrix  $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$

18. The eigen vectors of a  $3 \times 3$  real symmetric matrix A corresponding to the eigen values 2,3,6 are  $[1,0,-1]^T$ ,  $[1,1,1]^T$  and  $[-1,2,-1]^T$  respectively find the matrix A.

19. Diagonalize  $A = \begin{bmatrix} 3 & 1 & 1 \\ 1 & 3 & -1 \\ 1 & -1 & 3 \end{bmatrix}$  by an orthogonal transformation.

20. Reduce the quadratic form  $Q = 6x^2 + 3y^2 + 3z^2 - 4xy - 2yz + 4zx$  to canonical form by an orthogonal transformation. [Nov/Dec 2016]

21. Reduce the quadratic form  $x_1^2 + 5x_2^2 + x_3^2 + 2x_1x_2 + 2x_2x_3 + 6x_3x_1$  to the canonical form through an

orthogonal transformation.

22. Reduce the quadratic form  $3x^2+5y^2+3z^2-2yz+2zx-2xy$  to the canonical form through an orthogonal transformation.

23. Reduce the quadratic form  $x^2+y^2+z^2-2yz-2zx-2xy$  to the canonical form through an orthogonal transformation. **[May/June 2012]**

24. Reduce the matrix  $\begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$  to diagonal form.

25. Verify Cayley-Hamilton theorem for the matrix and find  $A^{-1}$  if  $A = \begin{bmatrix} 1 & 2 & -2 \\ -1 & 3 & 0 \\ 0 & -2 & 1 \end{bmatrix}$  **[May/June 2016]**

## UNIT-II

### VECTOR CALCULUS

#### PART-A

1. Is the vector  $x\vec{i} + 2y\vec{j} + 3z\vec{k}$ , Irrotational?

(AU-2009)

$$\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x & 2y & 3z \end{vmatrix} = \vec{i} (0-0) - \vec{j} (0) + \vec{k} (0-0) = 0$$

$\therefore \vec{F}$  is irrotational.

2. Find the divcurl  $\vec{F} = x^2y\vec{i} + xz\vec{j} + 2yz\vec{k}$

(AU-2010)

$$\begin{aligned} \text{Curl } \vec{F} &= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^2 y & xz & 2yz \end{vmatrix} = \vec{i} \left[ \frac{\partial}{\partial y} (2yz) - \frac{\partial}{\partial z} (xz) \right] - \vec{j} \left[ \frac{\partial}{\partial x} (2yz) - \frac{\partial}{\partial z} (x^2 y) \right] + \vec{k} \left[ \frac{\partial}{\partial x} (xz) - \frac{\partial}{\partial y} (x^2 y) \right] \\ &= \vec{i}(2z - x) - \vec{j}(0) + \vec{k}(z - x^2) \end{aligned}$$

$$\begin{aligned} \text{Divcurl } \vec{F} &= \nabla \cdot \text{curl } \vec{F} \\ &= \nabla \cdot (\vec{i}(2z - x) - \vec{j}(0) + \vec{k}(z - x^2)) \\ &= \left( \vec{i} \frac{\partial}{\partial x} + \vec{j} \frac{\partial}{\partial y} + \vec{k} \frac{\partial}{\partial z} \right) \cdot (\vec{i}(2z - x) - \vec{j}(0) + \vec{k}(z - x^2)) \\ &= \left( \frac{\partial}{\partial x} (2z - x) + \frac{\partial}{\partial z} (z - x^2) \right) \\ &= -1 + 1 = 0 \end{aligned}$$

3. If  $\nabla \vec{F} = yz \vec{i} + xz \vec{j} + xy \vec{k}$  then find F (AU-2010)

$$\nabla \vec{F} = yz \vec{i} + xz \vec{j} + xy \vec{k}$$

$$\vec{i} \frac{\partial f}{\partial x} + \vec{j} \frac{\partial f}{\partial y} + \vec{k} \frac{\partial f}{\partial z} = yz \vec{i} + xz \vec{j} + xy \vec{k}$$

Equating the coefficient of  $\vec{i}$ ,  $\vec{j}$ ,  $\vec{k}$

$$\frac{\partial f}{\partial x} = yz, \quad \frac{\partial f}{\partial y} = xz, \quad \frac{\partial f}{\partial z} = xy$$

$$\int \partial f = \int yz \partial x \quad \int \partial f = \int xz \partial y \quad \int \partial f = \int xy \partial z$$

$$f_1 = xyz + f(y, z) \quad f_2 = xyz + f(x, z) \quad f_3 = xyz + f(x, y)$$

$$F = xyz + c$$

4. Find the unit normal to the surface  $x^2 + y^2 - 2z + 3 = 0$  at (1, 2, -1) (AU-2011)

$$\text{Given } \Phi = x^2 + y^2 - 2z + 3 = 0$$

$$\nabla \phi = \left( \frac{\partial \phi}{\partial x} \vec{i} + \frac{\partial \phi}{\partial y} \vec{j} + \frac{\partial \phi}{\partial z} \vec{k} \right) (x^2 + y^2 - 2z + 3)$$

$$= 2x\vec{i} + 2y\vec{j} - 2\vec{k}$$

$$(\nabla\phi)_{(1,2,-1)} = (2\vec{i} + 4\vec{j} - 2\vec{k}), |\nabla\phi| = 2\sqrt{6}$$

$$\hat{n} = \frac{\nabla\phi}{|\nabla\phi|} = \frac{2\vec{i} + 4\vec{j} - 2\vec{k}}{2\sqrt{6}}$$

5. In what direction from (3,1,-2) is the directional derivative of  $\phi = x^2y^2z^4$  maximum? Find

Also the magnitude of this maximum.

(AU-2015)

$$\nabla\phi = 2xy^2z^4\vec{i} + 2x^2yz^4\vec{j} + 4x^2y^2z^3\vec{k}$$

$$\text{At}(3,1,-2), \nabla\phi = 96(\vec{i} + 3\vec{j} - 3\vec{k})$$

$$\text{Direction of Maximum} = \nabla\phi = 96(\vec{i} + 3\vec{j} - 3\vec{k})$$

$$\text{Magnitude} = |\nabla\phi| = 96\sqrt{1+9+9} = 96\sqrt{19}.$$

6. Prove that  $\vec{F} = yz\vec{i} + zx\vec{j} + xy\vec{k}$  is irrotational.

(AU-2012)

$$\nabla \times \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ yz & zx & xy \end{vmatrix}$$

$$\vec{i}(x-x) - \vec{j}(y-y) + \vec{k}(z-z) = \vec{0}$$

$\therefore \vec{F}$  is irrotational.

7. Find  $\lambda$  so that  $\vec{F} = (3x - 2y + z)\vec{i} + (4x + \lambda y - z)\vec{j} + (x - y + 2z)\vec{k}$  is solenoidal

(AU-2015)-2

Given  $\vec{F}$  is solenoidal then  $\nabla \cdot \vec{F} = 0$

$$\nabla \cdot \vec{F} = \left( \frac{\partial}{\partial x} \vec{i} + \frac{\partial}{\partial y} \vec{j} + \frac{\partial}{\partial z} \vec{k} \right) \cdot \left( (3x - 2y + z)\vec{i} + (4x + \lambda y - z)\vec{j} + (x - y + 2z)\vec{k} \right)$$

$$3 + \lambda + 2 = 0$$

$$\lambda = -5$$

8. If  $\vec{A}$  and  $\vec{B}$  are irrotational, prove that  $\vec{A} \times \vec{B}$  is solenoidal. (AU-2013)

If  $\vec{A}$  and  $\vec{B}$  are irrotational.

$$\nabla \times \vec{A} = 0, \nabla \times \vec{B} = 0$$

$$\text{We know that } \nabla \cdot (\vec{A} \times \vec{B}) = (\nabla \times \vec{A}) \cdot \vec{B} - (\nabla \times \vec{B}) \cdot \vec{A} = 0 - 0 = 0$$

$\therefore \vec{A} \times \vec{B}$  is solenoidal.

9. Define solenoidal vector function. If  $\vec{V} = (x + 3y)\vec{i} + (y - 2z)\vec{j} + (x + 2\lambda z)\vec{k}$  is solenoidal, then

find the value of  $\lambda$  (AU-2013)

$$\text{Given that } \vec{V} = (x + 3y)\vec{i} + (y - 2z)\vec{j} + (x + 2\lambda z)\vec{k}$$

$$\nabla \cdot \vec{V} = 0 \text{ if } \vec{V} \text{ is solenoidal}$$

$$\nabla \cdot \vec{V} = \left( \vec{i} \frac{\partial}{\partial x} + \vec{j} \frac{\partial}{\partial y} + \vec{k} \frac{\partial}{\partial z} \right) \cdot (x + 3y)\vec{i} + (y - 2z)\vec{j} + (x + 2\lambda z)\vec{k} = 0$$

$$= \left( \frac{\partial}{\partial x}(x + 3y) + \frac{\partial}{\partial y}(y - 2z) + \frac{\partial}{\partial z}(x + 2\lambda z) \right) = 0$$

$$= 1 + 1 + 2\lambda = 0$$

$$\lambda = -1$$

10. Find the value of the constant a, b, c so that the vector

$\vec{F} = (x + 2y + az)\vec{i} + (bx - 3y - z)\vec{j} + (4x + cy + 2z)\vec{k}$  is irrotational (AU-2010)

$$\begin{aligned}\nabla \times \vec{F} &= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x+2y+az & bx-3y-z & 4x+cy+2z \end{vmatrix} \\ &= \vec{i} \left[ \frac{\partial}{\partial x}(4x+cy+2z) - \frac{\partial}{\partial z}(bx-3y-z) \right] - \vec{j} \left[ \frac{\partial}{\partial x}(4x+cy+2z) - \frac{\partial}{\partial z}(x+2y+az) \right] \\ &\quad + \vec{k} \left[ \frac{\partial}{\partial x}(bx-3y-z) - \frac{\partial}{\partial y}(x+2y+az) \right] \\ &= \vec{i}(c+1) - \vec{j}(4-a) + \vec{k}(b-2)\end{aligned}$$

Given  $\vec{F}$  is irrotational,  $\nabla \times \vec{F} = 0$ .

$$\vec{i}(c+1) - \vec{j}(4-a) + \vec{k}(b-2) = 0$$

Each component should be zero.

$$c+1=0, a-4=0, b-2=0$$

$$c=-1, a=4, b=2.$$

**11. Prove that  $\nabla \cdot r^n = nr^{n-2} \cdot \vec{r}$**

**(AU-2011)**

$$\text{Let } \vec{r} = x\vec{i} + y\vec{j} + z\vec{k} \quad |\vec{r}| = \sqrt{x^2 + y^2 + z^2},$$

$$\begin{aligned}\nabla \cdot r^n &= \vec{i} \frac{\partial}{\partial x}(r^n) + \vec{j} \frac{\partial}{\partial y}(r^n) + \vec{k} \frac{\partial}{\partial z}(r^n) \\ &= \vec{i} \left[ nr^{n-1} \frac{\partial r}{\partial x} \right] + \vec{j} \left[ nr^{n-1} \frac{\partial r}{\partial y} \right] + \vec{k} \left[ nr^{n-1} \frac{\partial r}{\partial z} \right] \\ &= nr^{n-1} \left[ \vec{i} \frac{\partial r}{\partial x} + \vec{j} \frac{\partial r}{\partial y} + \vec{k} \frac{\partial r}{\partial z} \right] \\ &= nr^{n-1} \left[ \vec{i} \frac{x}{r} + \vec{j} \frac{y}{r} + \vec{k} \frac{z}{r} \right] \\ &= nr^{n-1} \frac{1}{r} [x\vec{i} + y\vec{j} + z\vec{k}] \\ &= nr^{n-2} \vec{r}\end{aligned}$$

**12. Find the directional derivative  $\phi = x^2 + y^2 + z^2$  in the direction of the vector**

$$\vec{F} = \vec{i} + 2\vec{j} + 2\vec{k} \text{ at } (1,1,1)$$

(AU-

2014)

$$\text{Unit normal vector } \hat{n} \text{ in the direction of } \vec{i} + 2\vec{j} + 2\vec{k} \text{ is } \left( \frac{\vec{i} + 2\vec{j} + 2\vec{k}}{3} \right)$$

$$\text{Directional derivative} = \nabla \phi \cdot \hat{n}$$

$$\nabla \phi = \vec{i} \frac{\partial}{\partial x} (x^2 + y^2 + z^2) + \vec{j} \frac{\partial}{\partial y} (x^2 + y^2 + z^2) + \vec{k} \frac{\partial}{\partial z} (x^2 + y^2 + z^2)$$

$$\text{grad } \phi = 2x\vec{i} + 2y\vec{j} + 2z\vec{k}$$

$$\nabla \phi_{at(1,1,1)} = 2\vec{i} + 2\vec{j} + 2\vec{k}$$

$$\text{Directional derivative} = \nabla \phi \cdot \hat{n} = (2\vec{i} + 2\vec{j} + 2\vec{k}) \cdot \left( \frac{\vec{i} + 2\vec{j} + 2\vec{k}}{3} \right) = \frac{10}{3}$$

13. Find the unit normal vector to the surface  $x^2 + y^2 = z$  at  $(1, -2, 5)$

(AU-2014)

$$\phi = x^2 + y^2 - z$$

$$\nabla \phi = \left( \frac{\partial \phi}{\partial x} \vec{i} + \frac{\partial \phi}{\partial y} \vec{j} + \frac{\partial \phi}{\partial z} \vec{k} \right)_{x^2 + y^2 - z}$$

$$= 2x\vec{i} + 2y\vec{j} - \vec{k}$$

$$(\nabla \phi)_{(1, -2, 5)} = (2\vec{i} - 4\vec{j} - \vec{k}), |\nabla \phi| = \sqrt{21}$$

$$\hat{n} = \frac{\nabla \phi}{|\nabla \phi|} = \frac{2\vec{i} - 4\vec{j} - \vec{k}}{\sqrt{21}}$$

14. Show that  $\vec{F} = (x^2\vec{i} + y^2\vec{j} + z^2)\vec{k}$  is a conservative vector field.

(AU-2009)

$$\text{If } \hat{F} \text{ is conservative then } \nabla \times \hat{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^2 & y^2 & z^2 \end{vmatrix} = 0\vec{i} + 0\vec{j} + 0\vec{k} = 0$$

Therefore  $\hat{F}$  is a conservative vector field.

15. Prove that  $\text{curl}(\text{grad } \phi) = 0$

(AU-2014)

$$\text{curl}(\text{grad } \phi) = \text{curl}(\nabla \phi) = \nabla \times \nabla \phi = \left( \vec{i} \frac{\partial}{\partial x} + \vec{j} \frac{\partial}{\partial y} + \vec{k} \frac{\partial}{\partial z} \right) \times \left( \frac{\partial \phi}{\partial x} \vec{i} + \frac{\partial \phi}{\partial y} \vec{j} + \frac{\partial \phi}{\partial z} \vec{k} \right)$$

$$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ \frac{\partial \phi}{\partial x} & \frac{\partial \phi}{\partial y} & \frac{\partial \phi}{\partial z} \end{vmatrix} = \vec{i} \left[ \frac{\partial^2 \phi}{\partial y \partial z} - \frac{\partial^2 \phi}{\partial y \partial z} \right] - \vec{j} \left[ \frac{\partial^2 \phi}{\partial x \partial z} - \frac{\partial^2 \phi}{\partial x \partial z} \right] + \vec{k} \left[ \frac{\partial^2 \phi}{\partial y \partial x} - \frac{\partial^2 \phi}{\partial y \partial x} \right] = 0$$

16. Find  $\text{Curl } \vec{F}$  if  $\vec{F} = xy\vec{i} + yz\vec{j} + zx\vec{k}$

(AU-2014)

$$\text{Curl } \vec{F} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy & yz & zx \end{vmatrix} = \vec{i}(-y) - z\vec{j} - x\vec{k}$$

17. If  $\vec{F} = x^2\vec{i} + xy\vec{j}$  evaluate  $\int_c \vec{F} \cdot d\vec{r}$  from (0,0) to (1,1) along the line  $y = x$ .

(AU-2010)

$$\text{Given } \vec{F} = x^2\vec{i} + xy\vec{j}$$

Along the line  $y = x$ ,  $dy = dx$

$$\therefore \vec{F} = x^2\vec{i} + x\vec{j}, \quad d\vec{r} = dx\vec{i} + dy\vec{j} = dx\vec{i} + dx\vec{j}$$

$$\begin{aligned} \vec{F} \cdot d\vec{r} &= (x^2\vec{i} + x\vec{j}) \cdot (dx\vec{i} + dx\vec{j}) \\ &= x^2 dx + x^2 dx = 2x^2 dx \end{aligned}$$

$$\int_c \vec{F} \cdot d\vec{r} = \int_0^1 2x^2 dx = \frac{2}{3}$$

18. If  $\vec{F} = 5xy\vec{i} + 2y\vec{j}$ , evaluate  $\int_c \vec{F} \cdot d\vec{r}$  Where C is the part of the curve  $y = x^2$  between  $x = 1$

and  $x = 2$ .

(AU-

2012)

$$\vec{F} \cdot d\vec{r} = (5xy\vec{i} + 2y\vec{j}) \cdot (dx\vec{i} + dy\vec{j} + dz\vec{k})$$

$$= 5xydx + 2ydy$$

The curve C:  $y = x^2$

$$dy = 2xdx$$

x varies from 1 to 2

$$\int_c \vec{F} \cdot d\vec{r} = \int_1^2 5x(x^2)dx + 2x^2 \cdot 2xdx = \left[ 5 \frac{x^4}{4} + \frac{4x^4}{4} \right]_1^2$$

$$= 36 - \frac{9}{4} = \frac{135}{4}$$

19. Find  $\iint_s \vec{r} \cdot d\vec{s}$  where S the surface of the tetrahedron whose vertices are is

$(0,0,0)$ ,  $(1,0,0)$ ,  $(0,1,0)$ ,  $(0,0,1)$ .

(AU-2010)

By Gauss divergence theorem

$$\iint_s \vec{r} \cdot d\vec{s} = \iiint_v \nabla \cdot \vec{r} dv$$

$$= \iiint_v \left( \vec{i} \frac{\partial}{\partial x} + \vec{j} \frac{\partial}{\partial y} + \vec{k} \frac{\partial}{\partial z} \right) \cdot (x\vec{i} + y\vec{j} + z\vec{k}) dv$$

$$= \iiint_v (1+1+1) dv$$

$$= \iiint_v 3 dv$$

$$= 3 \int_0^1 \int_0^1 \int_0^1 dx dy dz = 3.$$

20. If  $S$  is any closed surface enclosing a volume  $V$  and  $\vec{F} = ax\vec{i} + by\vec{j} + cz\vec{k}$ , prove that

$$\iint_S \vec{F} \cdot \hat{n} ds = (a+b+c)V.$$

(AU-2011)

Gauss Divergence theorem is

$$\begin{aligned} \iint_S \vec{F} \cdot \hat{n} ds &= \iiint_V \nabla \cdot \vec{F} dV \\ &= \iiint_V \left( \vec{i} \frac{\partial}{\partial x} + \vec{j} \frac{\partial}{\partial y} + \vec{k} \frac{\partial}{\partial z} \right) \cdot (ax\vec{i} + by\vec{j} + cz\vec{k}) dv \\ &= \iiint_V (a + b + c) dv \\ &= (a+b+c) V \end{aligned}$$

21. State Green's theorem in a plane.

(AU-2010)

If  $M(x,y)$  and  $N(x,y)$  and its partial derivatives are continuous and one valued functions in the region  $R$  of the  $xy$  plane bounded by a simple closed curve  $C$ , then

$$\int_C M dx + N dy = \iint_R \left( \frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$$

Where  $C$  is the curve prescribed in the positive direction.

22. Using Green's theorem, Prove that the area enclosed by a simple closed curve  $C$

$$\text{is } \frac{1}{2} \int (x dy - y dx).$$

(AU-2011)

By Green's theorem

$$\int_C M dx + N dy = \iint_S \left( \frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$$

Let  $M = -y$   $N = x$

$$\int_C -y dx + x dy = \iint_S (1+1) dx dy$$

$$= 2 \iint_S dx dy$$

$$= 2(\text{area enclosed by } C)$$

$$\text{Therefore Area enclosed by } C = \frac{1}{2} \int (x dy - y dx)$$

**23. State Gauss Divergence theorem.**

**(AU-2012)**

If  $V$  is the volume bounded by a closed surface  $S$  and if a vector function  $\vec{F}$  is continuous and has continuous partial derivatives in  $V$  and on  $S$  then

$$\iint_S \vec{F} \cdot \hat{n} ds = \iiint_V \nabla \cdot \vec{F} dv$$

**24. State Stoke's theorem.**

**(AU-2015) (2)**

The surface integral of the normal component of the curl of a vector function  $F$  over an Open surface  $S$  is equal to the line integral of the tangential component of  $F$  around the

$$\text{Closed curve } C \text{ bounding } S. \int_C \vec{F} \cdot d\vec{r} = \iint_S \nabla \times \vec{F} \cdot \hat{n} ds$$

**PART-B**

1. a. If  $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$  and  $r = |\vec{r}|$ . Prove that  $\text{div}(r^n \vec{r}) = (n+3)r^n$  and  $\text{curl}(r^n \vec{r}) = 0$ .

**(AU-2011) (8)**

b. If  $\vec{r} = x\vec{i} + y\vec{j} + z\vec{k}$ , then prove that  $\text{div grad}(r^n) = n(n+1)r^{n-2}$ . Hence deduce

$$\text{that } \text{div grad}\left(\frac{1}{r}\right) = 0$$

**(AU-2015)-**

**2(8)**

2. a. Find the directional derivative of  $\phi = 3x^2 + 2y - 3z$  at  $(1,1,1)$  in the direction of

$$2\vec{i} + 2\vec{j} - \vec{k}$$

(AU-2012)

(8)

- b. Find the angle between the surfaces  $x^2+y^2+z^2=9$  and  $z=x^2+y^2-3$  at the point  $(2,-1,2)$ .

(AU-2012)(8)

3. a. Find the angle between the normal's to the surfaces  $x^2=yz$  at the points  $(1,1,1)$  and  $(2,4,1)$

(AU-2014)(8)

- b. Find the directional derivative of  $\phi = x^2yz + 4xz^2$  at  $P(1,-2,-1)$  that is maximum and also in the direction of PQ where Q is  $(3,-3,-2)$

(AU-2010)(8)

4. a. Evaluate  $\int_C \phi d\vec{V}$  where C is the curve  $x=t, y=t^2, z=1-t$  and  $\phi = x^2y(1+z)$  from

$t=0$  to  $t=1$

(AU-2011)(8)

(AU-2011)(8)

- b. If  $\nabla\phi = (x+2y+4z)\vec{i} + (2x-3y-z)\vec{j} + (4x-y+2z)\vec{k}$ , find the

Scalar point function  $\phi$ .

(AU-2011)(8)

5. a. Find the value of n so that the vector  $r^n \vec{r}$  is both solenoidal and irrotational

(AU-2015)-2(8)

- b. Prove that  $\vec{F} = (x^2 - y^2 + x)\vec{i} - (2xy + y)\vec{j}$  is irrotational and hence find its scalar potential.

(AU-2014)(8)

(AU-2014)(8)

6. a. Prove that  $\vec{F} = (6xy + z^3)\vec{i} + (3x^2 - z)\vec{j} + (3xz^2 - y)\vec{k}$  is irrotational .Hence find its

scalar potential  $\phi$

(AU-2015)(8)

- b. Prove that  $\vec{F} = (y^2 + 2xz^2)\vec{i} + (2xy - z)\vec{j} + (2x^2z - y + 2z)\vec{k}$  is irrotational and hence find its

scalar potential.

(AU-2014)(8)

7. a. Find the work done the force  $\vec{F} = 3xy\vec{i} - y^3\vec{j}$  moves a particle along the

Curve C:  $y=2x^2$  from (0, 0) to (1, 2) in the xy-plane.

(AU-2011)(8)

b. Evaluate  $\int_c \vec{f} \cdot d\vec{r}$  where  $\vec{f} = (2xy + z^3)\vec{i} + x^2\vec{j} + 3xz^2\vec{k}$  along the straight line

Joining (1, -2, 1) and (3, 2, 4)

2012)(8)

(AU-

8. a. Show that  $\vec{F} = (2xy + z^3)\vec{i} + x^2\vec{j} + 3xz^2\vec{k}$  is a conservative force field. Find the

Scalar potential and the work done by  $\vec{F}$  in moving an object in this field

from (1, -2, 1) to (3, 1, 4)

(AU-2009)(8)

b. Find the directional derivative of  $xy^2 + yz^3$  at (2, -1, 1) in the direction of the

normal to the surface  $x \log z - y^2 + 4 = 0$  at (-1, 2, 1)

2009)(8)

(AU-

9. a. Evaluate  $\iint_S \vec{f} \cdot \hat{n} ds$  Where  $\vec{f} = (x^2 + y^2)\vec{i} - 2x\vec{j} + 2yz\vec{k}$  and  $S$  is the surface

of the  $2x + y + 2z = 6$  in the first octant.

(AU-2010)(8)

b. Using Green's theorem in the plane evaluate  $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$

Where C is the boundary of the region enclosed by  $y = \sqrt{x}$  and  $y = x^2$ .

(AU-2009)(8)

10. a. Using Green's theorem, evaluate  $\int_C (y - \sin x)dx + \cos x dy$  where C is the triangle formed by

$$y=0, x = \frac{\pi}{2}, y = \frac{2x}{\pi}$$

(AU-2015)(8)

b. Apply Green's theorem in the plane to evaluate  $\int_C (3x^2 - 8y^2)dx + (4y - 6xy)dy$  Where C is

the boundary of the region defined by  $x = 0, y = 0$  and  $x + y = 1$ .

2)(8)

(AU-2014)-

11. a. Verify Green's theorem in a plane for  $\int (xy + y^2)dx + x^2 dy$  where C is the boundary of the

common area between  $y = x^2$  and  $y = x$  in the xoy plane

(AU-2014)(8)

b. Using Green's theorem, evaluate  $\int_C (x^2 - 2xy)dx + (x^2y + 3)dy$ , where C is the region

bounded by the curves  $y^2=8x$  and  $x=2$

(AU-2015)(8)

12.a. Verify Gauss Divergence theorem for  $\vec{F} = x^2\vec{i} + y^2\vec{j} + z^2\vec{k}$  Where S is the surface of the

Cuboid formed by the planes  $x = 0, x = a, y = 0, y = b, z = 0, z = c$ .

(AU-2014)(8)

b. Verify Gauss's divergence theorem for the function  $\vec{F} = y\vec{i} + x\vec{j} + z^2\vec{k}$

Over the cylindrical region bounded by  $x^2 + y^2 = 9, z = 0$  and  $z = 2$ .

(AU-2012)(8)

13. Verify Gauss's divergence theorem for  $\vec{F} = 4xz\vec{i} - y^2\vec{j} + yz\vec{k}$  and C is its

boundary over the cube  $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$ .

(AU-2015)-3(16)

14. Verify Gauss Divergence theorem for  $\vec{F} = x^2\vec{i} + y^2\vec{j} + z^2\vec{k}$  taken over the cube bounded by

the Planes  $x=0, y=0, z=0, x=1, y=1$  and  $z=1$

(AU-2015)(16)

15.a. Verify Stoke's theorem for  $\vec{F} = (x^2 - y^2)\vec{i} + 2xy\vec{j}$  in the rectangular region in the

xy plane bounded by the lines  $x = 0, x = a, y = 0, y = b$ .

(AU-2015)-3(8)

b. Verify Stoke's theorem for the vector field  $\vec{F} = (2x - y)\vec{i} - yz^2\vec{j} - y^2z\vec{k}$  where S is the surface

of upper hemisphere  $x^2 + y^2 + z^2 = 1$  and C is its boundary in xy-plane.

(AU-2014)(8)

### UNIT-III

#### ANALYTIC FUNCTIONS

#### PART- A

1. State the basic difference between the limit of a function of a real variable and that

of a complex variable. (AU2012)

Real variable	Complex Variable
---------------	------------------

Limit takes along x axis and y axis or parallel to both axis	Limit takes along any path (straight or curved)
--	--

**2. State the necessary condition of Cauchy-Riemann equations**

**(AU-2011)**

The necessary condition for  $f(z) = u(x, y) + iv(x, y)$  to be analytic in a region R are

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$$

$$\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$$

**3. Write 2-D Laplace equations in polar coordinates.**

**(AU-2011)**

$$\frac{\partial^2 \phi}{\partial r^2} + \frac{1}{r} \frac{\partial \phi}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \phi}{\partial \theta^2} = 0$$

**4. Show that the function  $f(z) = \bar{z}$  is nowhere differentiable.**

**(AU-2014)-2**

Given  $f(z) = \bar{z} = x - iy$

$$u = x, v = -y$$

$$\frac{\partial u}{\partial x} = 1, \frac{\partial v}{\partial x} = 0$$

$$\frac{\partial u}{\partial y} = 0, \frac{\partial v}{\partial y} = -1$$

$u_x \neq v_y$ , C-R equations are not satisfied anywhere. Hence

$f(z) = \bar{z}$  is nowhere differentiable.

**5. Find the constants a,b if  $f(z) = x + 2ay + i(3x + by)$  is analytic**

**(AU-2013)**

$$f(x) = x + 2ay + i(3x + by)$$

$$u = x + 2ay \quad \text{and} \quad v = (3x + by)$$

Where  $\frac{\partial u}{\partial x} = 1, \frac{\partial u}{\partial y} = 2a$

$$\frac{\partial v}{\partial x} = 3, \quad \frac{\partial v}{\partial y} = b$$

We know that by CR equations

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} \quad \text{and}$$

$$\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$$

$$a = \frac{3}{2}, \quad b = 1$$

**6. If  $u+iv$  is analytic , show that  $v -iu$  &  $-v +iu$  are also analytic**

**(AU-2013)**

Given  $u+iv$  is analytic

C –R equations are satisfied  $u_x=v_y$  ..... (1)

$$u_y = -v_x \dots\dots(2)$$

Since the derivatives of  $u$  &  $v$  exist it is therefore continuous

Now to prove  $v -iu$  &  $-v+iu$  are also analytic, we should prove that

(i)  $v_x = -u_y$  &  $v_y = u_x$  &

(ii)  $v_x = u_v$  &  $v_y = u_x$

(iii)  $u_x, u_y, v_x, v_y$  are all continuous . Results (i) & (ii) follows from (1) & (2) . since the

derivatives of  $u$  &  $v$  exist from (1) and (2) , the derivatives of  $u$  and  $v$  should be continuous .

Hence the result

**7. Find the value of  $a,b,c,d$  so that the function  $f(z) = (x^2 + axy + by^2) + i(cx^2 + dxy + y^2)$**

**may be analytic**

**(AU-2013)**

$$f(z) = (x^2 + axy + by^2) + i(cx^2 + dxy + y^2)$$

$$u = x^2 + axy + by^2, v = cx^2 + dxy + y^2$$

$$u_x = 2x + ay, v_x = 2cx + dy$$

$$u_y = ax + 2by, v_y = dx + 2y$$

$$f(z) \text{ is analytic, } u_x = v_y \text{ and } u_y = -v_x$$

$$a = 2, b = -1, c = -1, d = 2$$

**8. State whether or not  $f(z) = \bar{z}$  is an analytic function**

**(AU-2012)-2**

$$w = f(z) = \bar{z}$$

$$u + iv = x - iy \Rightarrow u = x \text{ and } v = -y$$

$$u_x = 1, v_x = 0$$

$$u_y = 0, v_y = -1$$

$$u_x \neq v_y$$

Hence CR equations are not satisfied

$\therefore$  The function  $f(z)$  is nowhere analytic

**9. Verify whether or not  $f(z) = e^x(\cos y - i \sin y)$  is analytic**

**(AU-2014)**

$$u = e^x \cos y \text{ and } v = -e^x \sin y$$

$$\frac{\partial u}{\partial x} = e^x \cos y \text{ and } \frac{\partial v}{\partial x} = -e^x \sin y$$

$$\frac{\partial u}{\partial y} = -e^x \sin y \text{ and } \frac{\partial v}{\partial y} = -e^x \cos y$$

$$\frac{\partial u}{\partial x} \neq \frac{\partial v}{\partial y} \text{ and } \frac{\partial u}{\partial y} \neq -\frac{\partial v}{\partial x}$$

CR equations are not satisfied. It is not an analytic function.

**10. S.T  $f(z) = e^x \sin y$  is harmonic**

**(AU-2014)**

$$u_x = e^x \sin y, u_y = e^x \cos y$$

$$u_{xx} = e^x \sin y, u_{yy} = -e^x \sin y$$

$$u_{xx} + u_{yy} = e^x \sin y - e^x \sin y = 0$$

$f(z) = e^x \sin y$  is harmonic

11. If  $f(z)$  is an analytic function whose real part is constant, Prove that  $f(z)$

is a constant function.

(AU-

2012)

Let  $f(z) = u(x, y) + iv(x, y)$  be an analytic function

Therefore by CR equations  $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ ,  $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$

Given  $u = \text{constant}$

To prove  $f(z)$  is a constant

$$u = c$$

$$\frac{\partial u}{\partial x} = 0, \quad \frac{\partial u}{\partial y} = 0$$

By CR equation  $\frac{\partial u}{\partial x} = 0 \Rightarrow \frac{\partial v}{\partial y} = 0$  and  $\frac{\partial u}{\partial y} = 0 \Rightarrow \frac{\partial v}{\partial x} = 0$

$$\therefore f'(z) = \frac{\partial u}{\partial x} + i \frac{\partial v}{\partial x} = 0 + i0$$

$$f'(z) = 0 \Rightarrow f(z) = c$$

$f(z)$  is a constant.

12. Find the image of the line  $x=k$  under the transformation  $w = \frac{1}{z}$

(AU-2013)

$$\text{Given } w = \frac{1}{z}$$

$$\text{i.e., } z = \frac{1}{w} = \frac{1}{u+iv} = \frac{u-iv}{(u+iv)(u-iv)} = \frac{u-iv}{u^2+v^2}$$

$$x+iy = \frac{u}{u^2+v^2} + i \left( \frac{-v}{u^2+v^2} \right)$$

$$\text{i.e., } x = \frac{u}{u^2+v^2} \dots\dots\dots(1), \quad y = \frac{-v}{u^2+v^2} \dots\dots\dots(2)$$

Given  $x=k$  in the  $z$  plane

$$k = \frac{u}{u^2 + v^2} \cdot by(1),$$

$$k(u^2 + v^2) = u$$

$$u^2 + v^2 - \frac{1}{k}u = 0$$

$$\left(u - \frac{1}{2k}\right)^2 + v^2 - \frac{1}{4k^2} = 0$$

$$\left(u - \frac{1}{2k}\right)^2 + v^2 = \frac{1}{4k^2} \text{ which is a circle whose centre is } \left(\frac{1}{2k}, 0\right) \text{ and radius } \frac{1}{2k}$$

**13. Find the map of the circle  $|z| = 3$  under the transformation  $w = 2z$  (AU-2012)**

$$w = 2z$$

$$u + iv = 2(x + iy)$$

$$u = 2x, v = 2y \Rightarrow x = \frac{u}{2}, y = \frac{v}{2}$$

$$\text{Given } |z| = 3 \Rightarrow |x + iy| = 3 \Rightarrow x^2 + y^2 = 9$$

$$\therefore \left(\frac{u}{2}\right)^2 + \left(\frac{v}{2}\right)^2 = 9 \Rightarrow u^2 + v^2 = 36$$

Hence the image of  $|z| = 3$  in the  $z$ -plane is transformed into

$$u^2 + v^2 = 36 \text{ in the } w\text{-plane under the transformation } w = 2z$$

**14. Find the image of the circle  $|z| = 2$  under the transformation  $w = 3z$  (AU-2012)**

$$w = 3z$$

$$u + iv = 3(x + iy)$$

$$u = 3x, v = 3y \Rightarrow x = \frac{u}{3}, y = \frac{v}{3}$$

Given  $|z| = 2 \Rightarrow |x + iy| = 2 \Rightarrow x^2 + y^2 = 4$

$$\therefore \left(\frac{u}{3}\right)^2 + \left(\frac{v}{3}\right)^2 = 4 \Rightarrow u^2 + v^2 = 36$$

Hence the image of  $|z| = 2$  in the z-plane is transformed into

$$u^2 + v^2 = 36 \text{ in the } w\text{-plane under the transformation } w = 3z$$

**15. Find the image of the circle  $|z| = \lambda$  under the transformation  $w = 5z$  (AU-2011)**

$$w = 5z$$

$$u + iv = 5(x + iy)$$

$$u = 5x, v = 5y \Rightarrow x = \frac{u}{5}, y = \frac{v}{5}$$

Given  $|z| = \lambda \Rightarrow |x + iy| = \lambda \Rightarrow x^2 + y^2 = \lambda^2$

$$\therefore \left(\frac{u}{5}\right)^2 + \left(\frac{v}{5}\right)^2 = \lambda^2 \Rightarrow u^2 + v^2 = (5\lambda)^2$$

Hence the image of  $|z| = \lambda$  in the z-plane is transformed into

$$u^2 + v^2 = (5\lambda)^2 \text{ in the } w\text{-plane under the transformation } w = 5z$$

**16. Define critical point of a transformation (AU-2010)**

A point  $z_0$  at which the mapping  $w=f(z)$  is not conformal is called the critical point .

**17. Find the invariant points of the transformation  $f(z) = z^2$  (AU-2014)**

$$f(z) = z^2$$

$$w = z^2,$$

$$z = z^2$$

$$z^2 - z = 0$$

$$z(z - 1) = 0$$

$$z = 0, z = 1$$

The invariants points are  $z=0, z=1$ .

**18. Find the critical points of the transformation  $w = 1 + \frac{2}{z}$  (AU-2013)**

$$z = 1 + \frac{2}{z} \quad z^2 - z - 2 = 0 \quad (z-2)(z+1) = 0$$

$$z = 2, z = -1$$

Critical points are  $z=2, -1$

**19. Find the invariant points of the transformation  $\omega = \frac{2z+6}{z+7}$  (AU-2013)**

The invariant points are given by  $z = \frac{2z+6}{z+7}$

$$z^2 + 7z - 2z - 6 = 0 \Rightarrow z^2 + 5z - 6 = 0$$

$$(z+6)(z-1) = 0$$

$$z = -6, 1$$

**20. Prove that a bilinear transformation has at most two fixed points. (AU-2012)**

The fixed points of the transformation  $w = \frac{az+b}{cz+d}$  is obtained from  $z = \frac{az+b}{cz+d}$

$$\text{or } cz^2 + (d-a)z - b = 0$$

These points are two in number unless the discriminant is zero in which case the number of points is one.

**21. Show that  $|z|^2$  is not analytic at any point. (AU-2015)**

$$f(z) = |z|^2 = u+iv = x^2+y^2 \text{ where } u = x^2+y^2 \text{ and } v=0, u_x=2x, u_y=2y, v_x=0, v_y=0$$

hence  $f(z)$  is not analytic.

### PART-B

1. a. If  $f(z)$  is an analytic function of  $z$ , prove that  $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right) |f(z)|^2 = 4|f'(z)|^2$  (AU-

2013)(8)

b. show that a harmonic function  $u$  satisfies the formal differential equation

$$\frac{\partial^2 u}{\partial z \partial \bar{z}} = 0 \text{ and hence P.T } \log |f^1(z)| \text{ is harmonic, where } f(z) \text{ is a regular function.}$$

(AU-2015)(8)

2. a. Show that the function  $u = e^{-x}(x \cos y + y \sin y)$  is harmonic function.

Hence find the corresponding analytic function  $f(z) = u + iv$  (AU-2014)(8)

b. Determine the analytic function  $w = u + iv$  given that  $u = e^{-2x}(x \cos y + y \sin y)$  (AU-2015)(8)  
3. a. Prove that  $u = e^y \cos x$  and  $v = e^x \sin y$  satisfy Laplace equations but that  $u + iv$  is not

an analytic function of  $z$ .

b. Find if  $\Phi = (x - y)(x^2 + 4xy + y^2)$  can represent the equipotential surface for

an electric field. Find the corresponding complex potential  $\omega = \phi + i\psi$

and also  $\psi$

(AU-2013)(8)

4.a. Find the analytic function  $f(z) = u + iv$  where  $v = 3r^2 \sin 2\theta - 2r \sin \theta$ .

Verify that  $u$  is a harmonic function.

(AU-

2013)(8)

b. Determine the analytic function whose real part is  $\frac{\sin 2x}{\cosh 2y - \cos 2x}$  (AU-2014) (8)

5.a. Prove that the function  $u = e^x(x \cos y - y \sin y)$  satisfies Laplace's equation and

find the corresponding analytic function  $f(z) = u + iv$  (AU-2013)(8)

b. Prove that the real and imaginary parts of an analytic function are harmonic

function.

(AU-2014) (8)

6.a. Find the analytic function  $w = u + iv$  if  $e^{2x}(x \cos 2y - y \sin 2y)$  and

hence find  $u$

(AU-2013)(8)

b. Find the analytic function  $f(z) = u(x, y) + iv(x, y)$  given that

$u - v = e^x(\cos y - \sin y)$  (AU-2014)(8)

7. a. If  $u = x^2 - y^2$  and  $v = \frac{-y}{x^2 + y^2}$  prove that both  $u$  and  $v$  satisfy Laplace equations, but

$u + iv$  is not a regular function of  $z$

(AU-2013)(8)

b. Find the image of the circle  $|z| = 2$  under the transformation  $w = z + 3 + 2i$  (AU-2013)(8)

8.a. Find the image of w plane of the region of the z-plane bounded by the straight line

$x=1, y=1$  and  $x+y=1$  under the transformation  $w = z^2$  (AU-2013)(8)

b. Find the image in the w-plane of the infinite strip  $1/4 \leq y \leq 1/2$  under the transformation

$w=1/z$  (AU-2015)(8)

9.a. Prove that  $w = \frac{z}{1-z}$  maps the upper half of the z-plane to the upper half of the w-plane and

also find the image of the unit circle of the z plane. (AU-2013)(8)

b. Find the image of the circle  $|z - 3i| = 3$  and the region  $1 < x < 2$  under the map  $w = \frac{1}{z}$

10.a. Find the image of  $|z+2i|=2$  under the transformation  $w=1/z$ .

b. Find the image of the following regions under the transformation  $w=1/z$ .

i) the half plane  $x > c$  when  $c > 0$

ii) the half plane  $y > c$  when  $c < 0$

11.a. S.T under the mapping  $w = i-z/i+z$ , the image of the circle  $x^2+y^2 < 1$  is the entire half of the w-plane to the right of the imaginary axis

b. Find the image of the region bounded by the lines  $x=0, y=0$ , and  $x+y=1$  under the

mappings  $w = e^{\frac{i\pi}{4}}$  and  $w = z + (2 + 3i)$  (AU-2014)(8)

12.a Show that the image of the hyperbola  $x^2 - y^2 = 1$  under the transformation

$w = \frac{1}{z}$  is the lemniscates  $r^2 = \cos 2\theta$  (AU-2012)(8)

b. Find the Bilinear transformation which maps  $z=0, z=1, z=\infty$  into the points  $w=i,$

$w=1, w=-i$  (AU-2013)(8)

13.a. Find the bilinear transformation that maps 1, i, and -1 of the z-plane onto 0, 1

and  $\infty$  on the w- plane. Also find the image of the unit circle of the z plane. (AU-2014) (8)

b. Find the Bilinear transformation that maps the points  $z=\infty,1,0$  onto the points

$w=0,i, \infty$  respectively

(AU-2012)(8)

14.a. Find the Bilinear transformation that maps the points  $z=1,i,-1$  into the points

$w=0,1, \infty$  respectively. Find also the pre-image of  $|w|=1$  under this bilinear

transformation.

(AU-2014)(8)

b. Find the bilinear transformation that maps the points  $z=0,-1,i$  into the points

$w= i,0,\infty$  respectively.

(AU-2015)(8)

15. a. Find the bilinear transformation that maps the points  $1+i,-i,2-i$  of the  $z$ - plane into the points  $0,1,i$  of the  $w$ -plane.

b. Find the bilinear transformation that maps the points  $z=i,-1,1$  into the points  $w=0,1,\infty$  respectively.

#### UNIT-IV

#### COMPLEX INTEGRATION

#### PART-A

##### 1. State Cauchy's integral theorem

(AU-2015)

If  $f(z)$  is analytic inside and on a closed curve  $c$  of a simply connected region  $R$  and if 'a' is any

point within  $c$ , then  $f(a) = \frac{1}{2\pi i} \int_c \frac{f(z)}{z-a} dz$ , the integration around  $C$  being taken in the positive

direction .

2. Evaluate  $\int_c \frac{e^{-z}}{z^2} dz$ , where  $C$  is a circle  $|z|=1$ .

(AU-2012)

We know that  $\int_c \frac{f(z)}{z-a} dz = 2\pi i f(a)$ ,  $\int_c \frac{e^{-z} dz}{z^2} = \int_c \frac{e^{-z}}{(z-0)^2}$

Here  $f(z) = e^{-z}$ ,  $a=0$  is lies inside  $|z|=1$

By cauchy's integral formula we get

$$\int_C \frac{e^{-z}}{z^2} dz = 2\pi i f'(a) = 2\pi i(-1) = -2\pi i$$

3. Evaluate  $\int_C \frac{z^2 + 1}{z^2 - 1} dz$  where C is a circle of unit radius and centre at  $z=i$ . (AU-2013)

$$|z - i| = 1$$

The poles  $z=1, z=-1$  lies outside the circle

$$\therefore \frac{z^2 + 1}{z^2 - 1} \text{ is analytic inside } |z - i| = 1$$

$$\text{By Cauchy's theorem, } \int_C \frac{z^2 + 1}{z^2 - 1} dz = 0$$

4. Evaluate  $\int_C \sec z dz$  where c is the unit circle  $|z| = 1$

(AU-2014)

$$\int_C \sec z dz = \int_C \frac{1}{\cos z} dz$$

The pole are given by the solution of  $\cos z = 0$

$$\text{i.e., } z = (2n + 1) \frac{\pi}{2}, n = 0, 1, 2, \dots$$

$$z = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots$$

Hence all the poles lies outside  $|z| = 1$ ,  $\sec z$  is analytic with  $|z| = 1$

$$\text{By Cauchy's theorem } \int_C \sec z dz = 0$$

5. Evaluate  $\int_C \frac{3z^2 + 7z + 1}{(z + 1)} dz$  where C is  $|z| = 1/2$  (AU-2013)

$$\int_c \frac{3z^2 + 7z + 1}{z - (-1)} dz \quad \text{Here } z = -1 \text{ lies outside } c.$$

$\therefore f(z)$  is analytic inside and on  $c$

$\therefore f'(z)$  is continuous inside  $c$ .

Hence by Cauchy's theorem  $\int_c f(z) dz = 0$

**6. State Taylor's theorem.**

**(AU-2011)**

A function  $f(z)$ , is analytic inside a circle  $C$  with centre at  $a$ , can be expanded in the series

$$f(z) = f(a) + f'(a)(z-a) + \frac{f''(a)}{2!}(z-a)^2 + \frac{f'''(a)}{3!}(z-a)^3 + \dots + \frac{f^{(n)}(a)}{n!}(z-a)^n + \dots \text{to } \infty$$

Which is convergent at every point inside  $C$

**7. Find the Taylor series of the function  $f(z) = \sin z$  about  $z = \pi/4$**

**(AU-2013)**

$$f(z) = \sin z$$

$$f'(z) = \cos z$$

$$f''(z) = -\sin z$$

$$f'''(z) = -\cos z$$

$$\text{Here } a = \frac{\pi}{4}, f\left(\frac{\pi}{4}\right) = \sin\left(\frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$$

$$f'\left(\frac{\pi}{4}\right) = \cos\left(\frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}, f''\left(\frac{\pi}{4}\right) = -\sin\left(\frac{\pi}{4}\right) = -\frac{1}{\sqrt{2}}$$

$$f'''\left(\frac{\pi}{4}\right) = -\cos\left(\frac{\pi}{4}\right) = -\frac{1}{\sqrt{2}}$$

$$\text{Taylor's series is } f(z) = f\left(\frac{\pi}{4}\right) + \frac{z - \frac{\pi}{4}}{1!} f'\left(\frac{\pi}{4}\right) + \frac{\left(z - \frac{\pi}{4}\right)^2}{2!} f''\left(\frac{\pi}{4}\right) + \dots$$

**8. Find the Laurent's series for the function  $f(z) = z^2 e^{1/z}$  about  $z = 0$**

**(AU-2013)**

$$z^2 e^{\frac{1}{z}} = z^2 \left[ 1 + \frac{1}{z} + \frac{1}{2!} \frac{1}{z^2} + \dots \right]$$

$$= z^2 + z + \frac{1}{2} + \dots$$

**9. Define singular point.**

**(AU-2012)**

A point  $z=z_0$  at which a function  $f(z)$  fails to be analytic is called a singular point or singularity of  $f(z)$ .

**10. Identify the types of singularities of the following function  $f(z) = e^{\frac{1}{z-1}}$**

**(AU-2009)**

Here  $z=1$  is a singular point

At  $z=1$ , we get  $f(z) = e^{\frac{1}{0}} = \infty$  which is not defined.

Also  $z=1$  is not a pole or removable singularity

$z=1$  is an essential singularity.

**11. Discuss the nature of the singularities of the function  $f(z) = \frac{\sin z}{z}$**

**(AU-2012)-2**

Poles of  $f(z)$  are obtained by equating the denominator to zero

$$\text{i.e. } f(z) = \frac{\sin z}{z}$$

$z=0$  is a pole of order 1

$$\sin z = 0$$

$$z = n\pi \text{ where } n = 0, \pm 1, \pm 2, \dots$$

**12. Identify the type of singularity of function  $\sin(1/1-z)$**

**(AU-2015)**

$$\sin(1/1-z) = 1/1-z - 1/3!(1/1-z)^3 + 1/5!(1/1-z)^5 - \dots$$

The RHS is the Laurent series with infinite number of terms about the singular part

$z=1, z=1$  is an essential singularity of  $f(z)$ .

**13. Find the nature of the singularity  $z=0$  of the function  $f(z) = \frac{1 - \cos z}{z^2}$  (AU-2011)**

Poles of  $f(z)$  are obtained by equating the denominator to zero

$$\text{i.e } f(z) = \frac{1 - \cos z}{z^2}$$

$z^2=0$  is a pole of order 2

**14. State Cauchy's residue theorem. (AU-2014)**

If  $f(z)$  be an analytic at all points inside and on a simple closed curve  $C$ , except for a finite number of isolated singularities  $z_1, z_2, z_3, \dots, z_n$  inside  $C$  then

$$\int f(z) dz = 2\pi i [\text{sum of the residues of } f(z) \text{ at } z_1, z_2, z_3, \dots, z_n] = 2\pi i \sum_{i=1}^n R_i$$

where  $R_i$  is the residue of  $f(z)$  at  $z=z_i$

**15. If  $f(z) = \frac{-1}{z-1} - 2[1 + (z-1) + (z-1)^2 + \dots]$ , find the residue of  $f(z)$  at  $z=1$  (AU-2012)**

Residue of  $f(z)$  at  $z=1$  is -1 (the coefficient of  $\frac{1}{z-1}$ )

**16. Find the residue of  $\frac{1 - e^{2z}}{z^4}$  at  $z=0$  (AU-2013)**

$$\text{Given } f(z) = \frac{1 - e^{2z}}{z^4}$$

Here  $z=0$  is a pole of order 4

$$\begin{aligned} \text{Res } f(z=0) &= \frac{1}{3!} \lim_{z \rightarrow 0} \frac{d^3}{dz^3} \left[ (z-0)^4 \frac{1 - e^{2z}}{z^4} \right] \\ &= \frac{1}{6} \lim_{z \rightarrow 0} \frac{d^3}{dz^3} [1 - e^{2z}] = -\frac{4}{3} \end{aligned}$$

17. Find the residue of the function  $f(z) = \frac{4}{z^3(z-2)}$  at a simple pole

(AU-2012)

$$f(z) = \frac{4}{z^3(z-2)} = \frac{4}{(z-0)^3(z-2)}$$

Here  $z = 0$  is a pole of order 3 and  $z=2$  is a pole of order 1

$$\begin{aligned} \operatorname{Res}(z=0) &= \frac{1}{2!} \lim_{z \rightarrow 0} \frac{d^2}{dz^2} \left[ (z-0)^3 \frac{4}{(z-0)^3(z-2)} \right] \\ &= \frac{1}{2!} \lim_{z \rightarrow 0} \frac{d^2}{dz^2} \left[ \frac{4}{(z-2)} \right] = \frac{1}{2} \lim_{z \rightarrow 0} \left[ \frac{8}{(z-2)^3} \right] = \frac{1}{2} \end{aligned}$$

$$\operatorname{Res}(z=2) = \lim_{z \rightarrow 2} \left[ (z-2) \frac{4}{(z-0)^3(z-2)} \right] = \frac{1}{8}$$

18. Find the residue of  $f(z) = \frac{z+1}{(z-1)(z-2)}$  at  $z=2$

(AU-2012)

$$\operatorname{Res}(z=2) = \lim_{z \rightarrow 2} \left[ (z-2) \frac{z+1}{(z-1)(z-2)} \right] = 3$$

19. Find the residue of  $\cot z$  at the pole  $z=0$ .  
2010)

(AU-

$$f(z) = \cot z = \frac{\cos z}{\sin z} \quad \text{Poles of } f(z) \text{ are } \sin z = 0 = \sin n\pi$$

$$z = n\pi, \text{ where } n = 0, \pm 1, \pm 2, \dots$$

$$[\operatorname{Res}f(z)]_{z=n\pi} = \lim_{z \rightarrow n\pi} (z - n\pi) \frac{\cos z}{\sin z} = \lim_{z \rightarrow n\pi} \frac{-(z - n\pi) \sin z + \cos z(1)}{\cos z} \quad (\text{by L' Hospital rule})$$

$$[\operatorname{Res}f(z)]_{z=n\pi} = 1$$

20. Determine the residue of  $f(z) = \frac{z^2}{(z-1)^2(z+2)}$  at  $z=1$

(AU-2012)

Given  $f(z) = \frac{z^2}{(z-1)^2(z+2)}$

Here  $z=1$  is a pole of order 2

$$\operatorname{Res}[z = z_0] = \lim_{z \rightarrow z_0} \frac{1}{(m-1)!} \frac{d^{m-1}}{dz^{m-1}} [z - z_0]^m f(z)$$

$$\begin{aligned} \operatorname{Res}[z = 1] &= \lim_{z \rightarrow 1} \frac{d}{dz} \left[ (z-1)^2 \frac{z^2}{(z-1)^2(z+2)} \right] = \lim_{z \rightarrow 1} \frac{d}{dz} \left( \frac{z^2}{z+2} \right) \\ &= f'(z) = \frac{5}{9} \end{aligned}$$

**21. Find the residue of  $f(z) = \frac{50z}{(z+4)(z-1)^2}$  at  $z = 1$  (AU-2009)**

$z = 1$  is a pole of order 2

$$\begin{aligned} \operatorname{Res}[f(z)]_{z=1} &= \lim_{z \rightarrow 1} \frac{d}{dz} \left[ (z-1)^2 \frac{50z}{(z+4)(z-1)^2} \right] \\ &= \lim_{z \rightarrow 1} \left[ \frac{(z+4)50 - 50z}{(z+4)^2} \right] = \frac{250 - 50}{25} = 8 \end{aligned}$$

**22. Evaluate  $\int_c \frac{e^z}{z-1} dz$  if  $c$  is  $|z|=2$  (AU-2010)**

$z=1$  is a pole of order 1 which lies inside  $|z|=2$

$$\begin{aligned} \int_c \frac{e^z}{z-1} dz &= 2\pi i f(1) \\ &= 2\pi i e \end{aligned}$$

**PART-B**

1. a. Evaluate  $\int_C \frac{z}{(z-1)(z-2)^2} dz$  here  $C$  is  $|z-2| = \frac{1}{2}$  by using Cauchy's integral formula.

**2012)(8)**

**(AU-**

b. Evaluate  $\int \frac{7z-1}{z^2-3z-4} dz$  over the curve  $C: x^2+4y^2=4$  using Cauchy's integral formula.

(AU-2013)(8)

2.a. Evaluate  $\int_c \frac{z+1}{(z^2+2z+4)^2} dz$  where  $c$  is the circle  $|z+1+i|=2$  by Cauchy's integral formula.

(AU-2013)(8)

b. Evaluate  $\int_c \frac{z+4}{z^2+2z+5} dz$  where  $C$  is the circle  $|z+1+i|=2$  using Cauchy's integral formula.

(AU-2013)(8)

3.a. Using Cauchy's integral formula, evaluate  $\int_c \frac{e^z}{(z+1)^2(z+2)} dz$  where  $C$  is  $|z|=3$ . (8)

b. If  $f(a) = \int_c \frac{13z^2+27z+15}{z-a} dz$  where  $c$  is the circle  $|z|=2$  then find

$f(3), f'(1-i), f''(1-i)$  and  $f(1-i)$  (AU-2014)(8)

4.a. Evaluate  $\int_c \frac{z^3}{(2z+i)^3} dz$  where  $c$  is the unit circle  $|z|=1$  (8)

b. Obtain Taylor's series for  $f(z) = \frac{2z^3}{z(z+1)^3}$  about  $z=i$  (AU-2013)(8) 5.a.

Evaluate  $f(z) = \frac{1}{(z+1)(z+3)}$  in Laurent series valid for the regions  $|z|>3$  and  $1<|z|<3$

(AU-2013)(8)

b. Find the Laurent's series expansion of  $f(z) = \frac{7z-2}{(z-2)(z+1)}$  valid in the region

$|z+1|<1$  and  $|z+1|>3$  (8)

6.a. Expand the function  $f(z) = \frac{z^2-1}{z^2+5z+6}$  in Laurent's series  $|z|>3$  (AU-2013)(8)

b. Obtain the Laurent's series expansion of  $f(z) = \frac{z^2 - 1}{(z + 2)(z + 3)}$  in  $2 < |z| < 3$  (AU-2015)

(8)

7.a. Expand  $f(z) = \frac{1}{z^2 - 4z + 3}$  as the Laurent's series expansion of  $1 < |z| < 3$  (AU-2014) (8)

b. Obtain the Laurent's series expansion of  $f(z) = \frac{1}{z - z^2}$  in the region  $1 < |z+1| < 2$  and  $|z+1| > 2$ .

(AU-2014) (8)

8.a. Evaluate  $\int_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)} dz$  where C is  $|z|=3$  Using Cauchy's Residue theorem (AU-2013) (8)

b. Using Cauchy's residue theorem evaluate  $\int_C \frac{z-1}{(z-1)^2(z-2)} dz$

where C is  $|z-i|=2$

(AU-

2014) (8)

9.a. Evaluate  $\int_C \frac{z^2}{(z-1)^2(z+2)} dz$  where C is  $|z|=3$  (AU-2015) (8)

b. Evaluate  $\int_0^{2\pi} \frac{dx}{(x^2 + a^2)^2}$ ,  $a > 0$  using contour integration. (AU-2015) (8)

10.a. Evaluate  $\int_0^{2\pi} \frac{\cos 3\theta}{5 - 4\cos \theta} d\theta$  using contour integration (AU-2013) (8)

b. Using contour integration on unit circle, evaluate  $\int_0^{2\pi} \frac{d\theta}{5 + 4\cos \theta}$  (AU-2014) (8)

11.a. Evaluate  $\int_0^{2\pi} \frac{d\theta}{13 + 5\sin \theta}$  (AU-

2014) (8)

b. Using contour integration, evaluate the integral  $\int_0^{2\pi} \frac{\cos 2\theta}{1 - 2a\cos \theta + a^2} d\theta$  (AU-2013) (8)

12.a. Evaluate  $\int_0^{\infty} \frac{x^2 dx}{(x^2 + a^2)(x^2 + b^2)}$ ,  $a > 0, b > 0$  (AU-2013)(8)

b. Evaluate using contour integration  $\int_0^{\infty} \frac{dx}{(1+x^2)^2}$  (AU-2014)(8)-2

13.a. Using contour integration prove that  $\int_0^{\infty} \frac{x^2 dx}{(x^2 + 1)(x^2 + 4)} = \frac{\pi}{6}$  (AU-2013)(8)

b. Using contour integration on unit circle, evaluate  $\int_{-\infty}^{\infty} \frac{x^2 dx}{(x^2 + 1)(x^2 + 9)}$  (AU-2014)(8)

14.a. Evaluate  $\int_0^{\infty} \frac{\cos mx}{x^2 + a^2} dx$ , using contour integration. (AU-2012)(8)

b. Show that  $\int_{-\infty}^{\infty} \frac{x^2 - x + 2 dx}{(x^4 + 10x^2 + 9)} dx = \frac{5\pi}{2}$  (AU-2013)(8)

15.a.S.T.  $\int_0^{\infty} \frac{dx}{(1+x^4)} = \frac{\pi}{2\sqrt{2}}$  (8)

b.Evaluate  $\int_0^{2\pi} \frac{d\theta}{1 - 2x \sin \theta + x^2}$  ( $0 < x < 1$ ), using contour integration. (8)

**UNIT-V**

**LAPLACE TRANSFORMS**

**PART-A**

**1. State the sufficient condition for existence of the Laplace transform of f(t) (AU-2015)**

(i) f(t) should be continuous or piecewise continuous in the given closed interval [a, b] where a > 0

(ii) f(t) should be of exponential order.

**2. Find the Laplace transform of  $f(t) = t \cosh t$  (AU-2014)**

$$\begin{aligned} L(t \cosh t) &= \frac{-d}{ds} (L(\cosh t)) = \frac{-d}{ds} \left[ \frac{s}{s^2 - 1} \right] \\ &= - \left[ \frac{(s^2 - 1)(1) - s(2s)}{(s^2 - 1)^2} \right] = - \left[ \frac{-1 - s^2}{(s^2 - 1)^2} \right] = \frac{s^2 + 1}{(s^2 - 1)^2} \end{aligned}$$

**3. Find the Laplace transform of  $\frac{t}{e^t}$  (AU-2013)**

$$L\left(\frac{t}{e^t}\right) = L(te^{-t}) = L(t)_{s \rightarrow s+1} = \left(\frac{1}{s^2}\right)_{s \rightarrow s+1} = \frac{1}{(s+1)^2}$$

**4. State and prove change of scale property in Laplace transform. (AU-2012)**

$$\text{If } L(f(t)) = F(s), \text{ then } L(f(at)) = \frac{1}{a} F\left(\frac{s}{a}\right).$$

$$L(f(at)) = \int_0^{\infty} e^{-st} f(at) dt$$

$$at = u \quad t = 0 \quad u = 0$$

$$adt = du \quad t = \infty \quad u = \infty$$

$$L(f(at)) = \int_0^{\infty} e^{-\frac{su}{a}} f(u) \frac{du}{a}$$

$$= \frac{1}{a} \int_0^{\infty} e^{-\frac{su}{a}} f(u) du$$

$$L(f(at)) = \frac{1}{a} F\left(\frac{s}{a}\right)$$

5. State the first shifting theorem on Laplace transforms.

(AU-2012)

If  $L(f(t))=F(s)$  then  $L[e^{at}f(t)]=F[s-a]$  and

If  $L(f(t))=F(s)$  then  $L[e^{-at}f(t)]=F[s+a]$

6. Find the Laplace transform of  $\frac{e^{-2t}}{\sqrt{t}}$

(AU-2012)

$$L[t^{-1/2} e^{-2t}] = L[t^{-1/2}]_{s \rightarrow s+2}$$

$$= \left[ \frac{\sqrt{\pi}}{s} \right]_{s \rightarrow s+2}$$

$$= \left[ \frac{\sqrt{\pi}}{s+2} \right]$$

7. Find the Laplace transform of  $\sqrt{t}e^{3t}$

(AU-2012)

$$L[t^{1/2} e^{3t}] = L[t^{1/2}]_{s \rightarrow s-3}$$

$$= \left[ \frac{\sqrt{\pi}}{2s^{3/2}} \right]_{s \rightarrow s-3}$$

$$= \frac{\sqrt{\pi}}{2(s-3)^{3/2}}$$

8. Find  $L[\cos^2 3t]$

(AU-2011)

$$L[\cos^2 3t] = L\left[\frac{1 + \cos 6t}{2}\right]$$

$$= \frac{1}{2}L[1 + \cos 6t]$$

$$= \frac{1}{2} \left[ \frac{1}{s} + \frac{s}{s^2 + 36} \right]$$

9. Find  $L[(t^3 + 3e^{2t} - 5 \sin 3t)e^{-t}]$

(AU-2011)

$$\begin{aligned} L[(t^3 + 3e^{2t} - 5 \sin 3t)e^{-t}] &= L[t^3 e^{-t} + 3e^{2t} e^{-t} - 5 \sin 3t e^{-t}] \\ &= L[t^3 e^{-t} + 3e^t - 5 \sin 3t e^{-t}] \\ &= L[t^3]_{s \rightarrow s+1} + 3L(1)_{s \rightarrow s+1} - 5L[\sin 3t]_{s \rightarrow s+1} \\ &= \left[ \frac{6}{s^4} + \frac{3}{s} - \frac{3}{s^2 + 9} \right]_{s \rightarrow s+1} \\ &= \left[ \frac{6}{(s+1)^4} + \frac{3}{s+1} - \frac{3}{(s+1)^2 + 9} \right]_{s \rightarrow s+1} \end{aligned}$$

10. Find  $L\left[\frac{\sin t}{t}\right]$

(AU-2014)

$$\begin{aligned} L\left[\frac{\sin t}{t}\right] &= \int_s^\infty L(\sin t) ds = \int_s^\infty \frac{1}{s^2 + 1} ds = [\tan^{-1}(s)]_s^\infty = [\tan^{-1}(\infty) - \tan^{-1}(s)] \\ &= \frac{\pi}{2} - \tan^{-1}(s) = \cot^{-1}(s) \end{aligned}$$

11. Find the Laplace transform of the function  $f(t) = \frac{1 - e^{-t}}{t}$

(AU-

2013)

$$\begin{aligned} L(f(t)) &= L\left[\frac{1 - e^{-t}}{t}\right] = \int_s^\infty L(1 - e^{-t}) ds = \int_s^\infty L(1) - L(e^{-t}) ds = \int_s^\infty \left[ \frac{1}{s} - \frac{1}{s+1} \right] ds \\ &= [\log s - \log(s+1)]_s^\infty \\ &= \log \left[ \frac{s+1}{s} \right] \end{aligned}$$

12. Verify initial value theorem for  $f(t) = 1 + e^{-t}(\sin t + \cos t)$

(AU-2012)

Initial value theorem is, if  $L[f(t)] = F(s)$ , then  $\lim_{t \rightarrow 0} f(t) = \lim_{s \rightarrow \infty} sF(s)$

$$F(s) = L(1 + e^{-t}(\sin t + \cos t))$$

$$F(s) = \frac{1}{s} + L[\sin t + \cos t]_{s \rightarrow s+1}$$

$$F(s) = \frac{1}{s} + \frac{s+2}{(s+1)^2 + 1}$$

$$\lim_{t \rightarrow 0} f(t) = \lim_{t \rightarrow 0} 1 + e^{-t}(\sin t + \cos t) = 2$$

$$\lim_{s \rightarrow \infty} sF(s) = \lim_{s \rightarrow \infty} s \left[ \frac{1}{s} + \frac{s+2}{(s+1)^2 + 1} \right] = \lim_{s \rightarrow \infty} \left[ 1 + \frac{s^2 \left( 1 + \frac{2}{s} \right)}{s^2 \left( 1 + \frac{2}{s} + \frac{2}{s^2} \right)} \right] = 2$$

$$\lim_{t \rightarrow 0} f(t) = \lim_{s \rightarrow \infty} sF(s) = 2$$

Hence the initial value theorem is verified.

**13. Verify Initial value theorem for the function  $f(t) = ae^{-bt}$  (AU-2013)**

(AU-

$$f(t) = ae^{-bt}, F(s) = L[f(t)] = L[ae^{-bt}] = \frac{a}{s+b}$$

$$\text{Initial value theorem: } \lim_{t \rightarrow 0} f(t) = \lim_{s \rightarrow \infty} sF(s)$$

$$\text{L.H.S} = \lim_{t \rightarrow 0} f(t) = \lim_{t \rightarrow 0} ae^{-bt} = a$$

$$\text{R.H.S} \lim_{s \rightarrow \infty} sF(s) = \lim_{s \rightarrow \infty} s \left( \frac{a}{s+b} \right) = \lim_{s \rightarrow \infty} \frac{as}{s+b}$$

$$= \lim_{s \rightarrow \infty} \frac{as}{\left( 1 + \frac{b}{s} \right)} = \lim_{s \rightarrow \infty} \frac{a}{1 + \left( \frac{b}{s} \right)} = a$$

Hence the initial value theorem is verified.

14. If  $L(e^{-t} \cos^2 t) = F(s)$ , find  $\lim_{s \rightarrow 0} sF(s)$

(AU-2013)

$$\begin{aligned} F(s) &= L(e^{-t} \cos^2 t) = L[\cos^2 t]_{s \rightarrow s+1} \\ &= L\left[\frac{1 + \cos 2t}{2}\right]_{s \rightarrow s+1} \\ &= \frac{1}{2} L[1 + \cos 2t]_{s \rightarrow s+1} = \frac{1}{2} \left[ \frac{1}{s} + \frac{s}{s^2 + 4} \right]_{s \rightarrow s+1} \end{aligned}$$

$$L(e^{-t} \cos^2 t) = \frac{1}{2} \left[ \frac{1}{s+1} + \frac{s}{(s+1)^2 + 4} \right]$$

15. Define periodic function with an example.

(AU-2010)

A function  $f(t)$  is said to have a period  $T$  or to be periodic with period  $T$  if for all  $t$ ,  $f(t+T) = f(t)$  where  $T$  is a positive constant. The least value of  $T > 0$  is called the period of  $f(t)$ .

$$\begin{aligned} f(t) &= \sin t \\ f(t + 2\pi) &= \sin(t + 2\pi) \end{aligned}$$

Eg. Consider  $\sin t$

$$i.e. f(t) = f(t + 2\pi) = \sin t$$

$\therefore \sin t$  is a periodic function with period  $2\pi$

16. Evaluate  $L^{-1}\left[\frac{1}{s^2 + 6s + 13}\right]$

(AU-2014)

$$L^{-1}\left[\frac{1}{s^2 + 6s + 13}\right] = L^{-1}\left[\frac{1}{s^2 + 6s + 9 + 4}\right] = L^{-1}\left[\frac{1}{(s+3)^2 + 2^2}\right] = e^{-3t} \frac{\sin 2t}{2}$$

17. Find the Laplace inverse transform of  $\frac{1}{(s+1)(s+2)}$

(AU-2012)

$$\frac{1}{(s+1)(s+2)} = \frac{A}{s+1} + \frac{B}{s+2}$$

A=1 and B=1 (using partial fraction)

$$L^{-1}\left[\frac{1}{(s+1)(s+2)}\right] = L^{-1}\left[\frac{1}{s+1}\right] + L^{-1}\left[\frac{1}{s+2}\right]$$

$$L^{-1}\left[\frac{1}{(s+1)(s+2)}\right] = e^{-t} + e^{-2t}$$

18. Find the inverse Laplace transform of  $\log\left(\frac{s+1}{s-1}\right)$

(AU-2012)

We know that  $L^{-1}[F(s)] = -\frac{1}{t} L^{-1}[F'(s)]$

$$\begin{aligned} L^{-1}\left[\log\left(\frac{s+1}{s-1}\right)\right] &= -\frac{1}{t} L^{-1}\left[\frac{d}{ds}\left[\log\left(\frac{s+1}{s-1}\right)\right]\right] \\ &= -\frac{1}{t} L^{-1}\left[\frac{d}{ds}[\log(s+1) - \log(s-1)]\right] \\ &= -\frac{1}{t} L^{-1}\left[\frac{1}{s+1} - \frac{1}{s-1}\right] = -\frac{1}{t} [e^{-t} - e^t] = \frac{2}{t} \sinh t \end{aligned}$$

19. Find the Laplace transform of  $\int_0^t te^{-t} dt$

(AU-2015)

$$\begin{aligned} L\left[\int_0^t te^{-t} dt\right] &= \frac{1}{s} L[te^{-t}] \\ &= \frac{1}{s} \left[-\frac{d}{ds} L[e^{-t}]\right] \\ &= \frac{1}{s} \left[-\frac{d}{ds} \left(\frac{1}{s+1}\right)\right] \\ &= \frac{-1}{s} \left(\frac{1}{(s+1)^2}\right) = \frac{-1}{s(s+1)^2} \end{aligned}$$

20. Find the inverse Laplace transform of  $\frac{e^{-\pi s}}{(s-1)^2}$

(AU-

2014)

$$L^{-1}\left(\frac{1}{s^2}\right) = t \quad \text{and} \quad L^{-1}\left(\frac{1}{(s-1)^2}\right) = te^t$$

$$L\left(\frac{e^{-\pi s}}{(s-1)^2}\right) = (t-\pi)e^{(t-\pi)}$$

**PART-B**

1. a. Find  $L(t^2 e^{-3t} \sin 2t)$  **(AU-2013)(8)**

b. Find  $L\left[\frac{\cos at - \cos bt}{t}\right]$  **(AU-2015)(8)**

2. a. Find the Laplace transform of the square-wave function (or Meander function) of

Period  $a$  defined as  $f(t) = \begin{cases} 1, & \text{when } 0 < t < \frac{a}{2} \\ -1, & \text{when } \frac{a}{2} < t < a \end{cases}$  **(AU-2013)(8)**

b. Find the Laplace transform of the following triangular wave function given by

$$f(t) = \begin{cases} t & 0 \leq t \leq c \\ 2c - t & c \leq t \leq 2c \end{cases} \quad \text{and} \quad f(t+2c) = f(t).$$
 **(AU-2015)(8)**

3. a. Find the Laplace transform of the periodic function defined on the interval by  $0 \leq t \leq 1$

$$f(t) = \begin{cases} -1, & 0 \leq t \leq \frac{1}{2} \\ 1 & \frac{1}{2} \leq t < 1 \end{cases} \quad \text{and} \quad f(t+1) = f(t).$$
 **(AU-2014)(8)**

b. Find the Laplace transform of  $f(t)=t^2$ ,  $0 < t < 2$  and  $f(t+2)=f(t)$  for all  $t > 0$  **(AU-2013)(8)**

4. a. Find the inverse Laplace transform of  $\frac{4s+7}{s^2(2s+3)(3s+5)}$  **(AU-2013)(8)**

b. Find  $L^{-1}(s/(s^2+1)(s^2+4))$  **(AU-2015)(8)**

5.a. Find the Laplace transforms of the following functions 1)  $e^t \cos t$  2)  $1 - \cos t/t$  n/w

**(AU-2014)(8)**

b. Find the Laplace transform of  $f(t) = te^{-3t} \cos 2t$ .

(AU-2014)(8)

6. a. Find the Laplace transforms of  $f(t) = \begin{cases} t & 0 < t < a \\ 2a - t & a < t < 2a \end{cases}$ ,

where  $f(t+2a) = f(t)$

(AU-2014)(8)

b. Find the Laplace transform of  $f(t)$  where

$$f(t) = \begin{cases} \sin \omega t & \text{for } 0 < t < \frac{\pi}{\omega} \\ 0 & \text{for } \frac{\pi}{\omega} < t < \frac{2\pi}{\omega} \end{cases}, f\left(t + \frac{2\pi}{\omega}\right) = f(t)$$

(AU-2014)(8)

7. a. Find the Laplace transform  $f(t) = \begin{cases} \cos t & 0 < t < \pi \\ 0 & \pi < t < 2\pi \end{cases}, f(t+2\pi) = f(t)$

b. Find  $L^{-1} \left[ \frac{3s^2 + 16s + 26}{s(s^2 + 4s + 13)^2} \right]$

(AU-

2013)(8)

8. a. Find  $L^{-1} \left[ \frac{s^2}{(s^2 + a^2)^2} \right]$  and find  $L^{-1} \left[ \frac{1}{(s^2 + a^2)^2} \right]$  hence find  $L^{-1} \left[ \frac{1}{(s^2 + 9s + 13)^2} \right]$

(AU-

2013)(8)

b. Use convolution theorem to find the inverse of  $\frac{s}{(s^2 + 4)(s^2 + 9)}$

(AU-2013)(8)

9. a. Find the Laplace transform of  $f(t) = \frac{\cosh t \cos t}{t}$  and  $g(t) = \sin \sqrt{t}$

(AU-2013)(8)

b. Using convolution theorem to find the inverse Laplace transform of the function

$$\frac{s}{(s^2 + 1)^2}$$

(AU-2014)(8)

10.a. Using convolution theorem to find the inverse Laplace transform of the function

$$\frac{s^2}{(s^2 + a^2)(s^2 + b^2)}$$

(AU-2014)-2(8)

b. Using convolution, solve the initial value problem,  $y'' + 9y = \sin 3t$ ,  
 $y(0) = 0, y'(0) = 0$ .

11. a. Verify initial and final value theorem for  $f(t) = 1 + e^{-t}(\sin t + \cos t)$

(AU-2014)(8)

b. Verify initial and final value theorem for  $f(t) = 1 + e^{-2t}$

12.a. Solve  $y'' + y' = t^2 + 2t$ ,  $y(0) = 4$ ,  $y'(0) = -2$  by using Laplace transform.

(AU-2013)(8)

b. Solve the differential equation  $y'' - 3y' + 2y = 4t + e^{3t}$  where  $y(0) = 1$  and  $y'(0) = -1$

using Laplace transforms

(AU-2015)(8)

13.a. Solve  $y'' - 6y' + 9y = t^2 e^{3t}$ ,  $y(0) = 2$ ,  $y'(0) = 6$  by Laplace transform method

(AU-

2014)(8)

b. Solve the following differential equation, using Laplace transform

$$y'' + 2y' + 2y = 8e^t \sin t, y(0) = y'(0) = 0$$

(AU-2013)(8)

14.a. Using Laplace Transform, solve  $\frac{d^2 y}{dt^2} + 4y = \sin 2t$  given  $y(0) = 3$ ,  $y'(0) = 4$

(AU-2014)(8)

b. Use Laplace transform to solve  $(D^2 - 3D + 2)y = e^{3t}$  with  $y(0) = 1$ ,  $y'(0) = 0$

(AU-2014)(8)

15.a. Using Laplace transform method, solve  $d^2 y / dt^2 + 9y = 18t$  given that

$$y(0) = 0, y(\pi/2) = 0.$$

b. Using Laplace transform, find the solution of  $y' + 3y + 2 \int_0^t y dt = t$   $y(0) = 0$

## UNIT 1

### ELECTRICAL PROPERTIES OF MATERIALS

**1. Define Mobility of electrons.**

It is defined as the velocity acquired by the electron per unit electric field  $\mu = v/E$

**2. Define Wiedemann- Franz law. Give the value of Lorentz number.**

The ratio between the thermal conductivity and the electrical conductivity of a metal is directly proportional to the absolute temp of the metal.

**3. Define Fermi energy level and Fermi energy with its importance.**

It is the highest reference energy level of a particle at absolute zero. It is the state at which the probability of electron occupation is 50% at any temp.

**4. Define electrical conductivity.**

It is defined as the quality of electricity flowing per unit area per unit time maintained at unit potential gradient.

**5. What are the drawbacks of classical free electron theory?**

It is a macroscopic theory. ü This theory cannot explain the Compton, photo – electric effect, paramagnetic, ferromagnetism, etc. The Lorentz number by classical theory does not have good agreement with the experimental value and is rectified by quantum theory.

**6. Write the Fermi- Dirac distribution function.**

Fermi-dirac distribution function represents the probability of an electron occupying a given energy level.

**7. Define density of states and given an example and state its importance.**

Density of states  $Z(E)dE$  is defined as the number of available energy states per unit volume in an energy interval  $dE$ .

**8. Define mean free path.**

The average distance travelled between two successive collisions is called mean free path. It is denoted by the letter. ( $\lambda$ )

**9. Define Drift velocity and give its formula.**

It defined as the average velocity acquired by the free electron in a particular direction, due to the application of electric field and is denoted by the letter  $v_d$ .

**10. Drawbacks of classical free electron theory**

1. Classical theory states that all free electrons absorb the supplied energy. But quantum theory states that only a few electron absorb the supplied energy.
2. The electrical conductivity of semiconductor and insulator cannot be explained by this theory.
3. The concept of photo - electric effect, Compton effect and black body radiation cannot be explained on the basis of this theory because these phenomenon are based on quantum theory.

4. The susceptibilities of a paramagnetic material is inversely proportional to the temperature. But, experimental result shows that para-magnetism of a metal is independent of temperature. Moreover, the ferro-magnetism cannot be explained by this theory.

**11. What is forbidden energy gap?**

The space between the valence and conduction band is said to be forbidden energy gap.

**12. What are the source of resistance in metals?**

The resistance in metals is due to

- Impurities present in the metals
- Temperature of the metal
- Number of free electrons

**13. What are the importance of Fermi Energy level?**

It is the reference energy level which separates the filled energy level and vacant energy level. It is the highest reference energy level of a particle at absolute zero. It is the state at which the probability of electron occupation at 50% at any temperature.

**14. Difference between electrical and thermal conductivity.**

- In thermal conduction, the heat is transferred by the oscillation of atoms inside the material. In electrical conduction, the electrons themselves move in order to create the current.
- Most of the thermal conductors are good electrical conductors. Both thermal conductivity and the electrical conductivity depend on the material.
- In thermal conductivity, energy is transferred but in electrical conductivity electrons are transferred.

**15. What is Fermi factor? Discuss its variation with temperature and energy.**

Fermi factor is the probability of occupying an electron into a given energy level when the material is in thermal equilibrium. Probability of energy state with energy  $E$  is occupied by electron at a steady temperature  $T$  is given by Fermi factor  $f(E)$  and is given by  $f(E) = \frac{1}{1 + e^{(E - E_f)/kT}}$  Where  $E_f$  is Fermi energy,  $k = \text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ JK}^{-1}$  and  $T$  is temperature in Kelvin. The Fermi factor varies with temperature and energy. Its variation is as shown in the figure and is discussed as follows

**Variation of  $f(E)$  with temperature  $T=0K$**

Case (i): At  $T = 0K$  and  $E < E_f$

Case (ii): At  $T = 0K$  and  $E > E_f$

**16. Define Thermal velocity**

A conductor consists of large number of free electrons of about  $10^{29}$  electrons/ $m^3$ . Due to thermal energy these electrons are moving in between the ions with a speed of  $10^6$  m/s and collide with ion cores of the conductor. After each collision velocity of the electron becomes zero. There after start moving in random direction. Thus in the absence of applied electric field,

there is a kind of randomness in the motion of electrons. Though the free electrons are in motion, the net flow of current is zero or does not give rise to any current.

“The average velocity with which the free electrons move inside the conductor due to thermal energy is called thermal velocity”.

### 17. Define Mean collision time

The average time interval between two consecutive collisions of an electron with the lattice cores in a conductor under the influence of applied electric field is called mean collision time.  $\tau = \lambda/v_{th}$

Where „ $\lambda$ ” is the mean free path,  $v \approx v_{th}$  is velocity same as combined effect of thermal & drift velocities.

### 18. What is meant by degenerate and non degenerate states.

**Degenerate** :The number of different states corresponding to a particular energy level is known as the degree of degeneracy of the level. It is represented mathematically by the Hamiltonian for the system having more than one linearly independent eigen state with the same energy  $e_i$  genvalue.

**Non degenerate** : The quantum state of a given system is described by probability wave function, which depends on a set of quantum coordinates. The absolute square of the wave function determines the probability of finding the particle in the given quantum state.

### 19. Define scattering power of potential barrier.

Define scattering power of potential barrier is defined as the strength with which the electrons are attracted by the positive ions is given by  $P = mV_0ba/\hbar^2$

### 20. What is meant by brillouin zones?

These are the boundaries that are marked by the values of propagation vector  $k$  in which the electrons can have the allowed energy levels without diffraction.

## PART-B

1. (i) Define Density of States.  
(ii) Derive an expression for the density of states in metal.
2. (i) State the assumption of the classical free electron model.  
(ii) Obtain expressions for the electrical conductivity and thermal conductivity of a metal on the basis of classical free electron theory.
3. What is fermi function? Discuss how the Fermi function varies with temperature.
4. Derive the electrical conductivity of a metal based on classical free electron theory.
5. Derive the thermal conductivity of a metal based on classical free electron theory.
6. State and Prove Wiedemann-Frantz law. What is Compton effect ? Give the theory of Compton effect and Show that the Compton shift  $\Delta\lambda = h \cdot (1 - \cos\theta)/m_0c$ .
7. Explain the application of Schrodinger wave equation to a one Dimensional Potential well.

8. Derive Time independent Schroedinger wave equation and hence deduce the time dependent Schroedinger equation.
9. Describe the energy band theory of solids with the help of neat band diagram.
10. Deduce the mathematical expressions for electrical conductivity and thermal conductivity of a material and hence obtain widemann - franz law.
11. Derive an expression for the density of states and based on that calculate the carrier concentration in metals .
12. Write Fermi-Dirac distribution function. Explain how Fermi function varies with temperature. Evaluate the Fermi function for energy  $KT$  above the fermi energy.

## UNIT-II SEMICONDUCTOR PHYSICS

### 1. State the properties of a semiconductor.

They have negative temp coefficient of resistance. The resistivity lies between  $10^{-4}$  to  $0.5$  ohm-meter. At OK they behave as insulators.

### 2. Define Hall effect?

If a metal or semiconductor carrying current  $I$  is placed in a transverse magnetic field  $B$  , an electric field  $E$  is induced in the direction perpendicular to both  $I$  and  $B$  This phenomenon is known as Hall effect.

### 3. Give some application of Hall Effect.

i). Hall Effect can be used to measure the strength of a magnetic field in terms of electrical voltage.ii).It is used to determine whether the semiconductor is p – type or n- type materialiii).It is used to determine the carrier concentration

### 4. Compare elemental semiconductors and compound semiconductor?

S.No.	Elemental semiconductor	Compound semiconductor
1.	They are made of single element Ge,Si	Made of compounds GaP,MgO
2.	They are indirect band gap semiconductors	They are called as direct bandgap semiconductors
3.	Heat is produced due to recombination	Photons are emitted during recombination

### 5. What is meant by intrinsic semiconductor and extrinsic semiconductor?

S.No.	Intrinsic semiconductor	Extrinsic semiconductor
1.	Semi conductor in a pure form	Semiconductor which are doped with impurity
2.	They have low electrical conductivity	They have high electrical conductivity
3.	They have low operating temp	They have high operating temp

## 6. Compare n-type and p-type semiconductor.

S.No.	n- type	p- type
1.	Pentavalent impurity	Trivalent impurity
2.	Here electrons are majority and holes are minority	Here holes are majority and electrons are minority
3.	Donor energy levels very to conduction band	acceptor energy levels very to valence band

## 7. What is Extrinsic Semiconductor?

If certain amount of impurity atom is added to intrinsic semiconductor the resulting semiconductor is Extrinsic or impure Semiconductor.

## 8. What are the types of Extrinsic Semiconductor?

1. P-type Semiconductor 2. N- Type Semiconductor.

## 9. What is P-type Semiconductor?

The Semiconductor which are obtained by introducing pentavalent impurity atom (phosphorous, antimony) are known as P-type Semiconductor.

## 10. What is N-type Semiconductor?

The Semiconductor which is obtained by introducing trivalent impurity atom (gallium, indium) are known as N-type Semiconductor.

## 11. What is doping?

Process of adding impurity to a intrinsic semiconductor atom is doping. The impurity is called dopant.

## 12. Which charge carriers is majority and minority carrier in N-type Semiconductor?

majority carrier: electron and minority carrier: holes.

24. which charge carriers is majority and minority carrier in P-type Semiconductor?

Majority carrier: holes and minority carrier: electron

## 13. Why n - type or pentavalent impurities are called as Donor impurities?

n- type impurities will donate the excess negative charge carriers ( Electrons) and therefore they are referred to as donor impurities.

## 14. Why P – type or trivalent impurities are called as acceptor impurity?

p- type impurities make available positive carriers because they create holes which can accept electron, so these impurities are said to be as acceptor impurity.

## 15. Give the relation for concentration of holes in the n- type material?

$p_n = n_i^2 / N_D$  Where  $p_n$  - concentration of holes in the n – type semiconductor  $N_D$  - concentration of donor atoms in the n – type semiconductor

## 16. Give the relation for concentration of electrons in the p - type material?

$n_p = n_i^2 / N_A$  Where  $n_p$  - concentration of electrons in p- type semiconductor  $N_D$  - concentration of acceptor atoms in the p – type semiconductor

**17. Define drift current?**

When an electric field is applied across the semiconductor, the holes move towards the negative terminal of the battery and electron move towards the positive terminal of the battery. This drift movement of charge carriers will result in a current termed as drift current.

**18. Define mean life time of a hole or and electron.**

The electron hole pair created due to thermal agitation will disappear as a result of recombination

.Thus an average time for which a hole or an electron exist before recombination can be said as the mean life time of a hole or electron.

**19. What is zener breakdown?**

Zener break down takes place when both sides of the junction are very heavily doped and Consequently the depletion layer is thin and consequently the depletion layer is thin. When a small value of reverse bias voltage is applied , a very strong electric field is set up across the thin depletion layer. This electric field is enough to break the covalent bonds. Now extremely large number of freecharge carriers are produced which constitute the zener current. This process is known as zener break down.

**20. What is avalanche break down?**

When bias is applied , thermally generated carriers which are already present in the diode acquire sufficient energy from the applied potential to produce new carriers by removing valence electron from their bonds. These newly generated additional carriers acquire more energy from the potential and they strike the lattice and create more number of free electrons and holes. This process goes on as long as bias is increased and the number of free carriers get multiplied. This process is termed as avalanche multiplication. Thus the break down which occur in the junction resulting in heavy flow of current is termed as avalanche break down.

**21.What is a transistor (BJT)?**

Transistor is a three terminal device whose output current, voltage and /or power is controlled by input current.

**22. What are the terminals present in a transistor?**

Three terminals: emitter, base, collector.

**23.What is FET?**

FET is abbreviated for field effect transistor. It is a three terminal device with its output characteristics controlled by input voltage.

**24.Why FET is called voltage controlled device?**

The output characteristics of FET is controlled by its input voltage thus it is voltage controlled.

**25.What are the two main types of FET?**

1. JFET 2. MOSFET.

**26. What are the terminals available in FET?**

1). Drain, 2).Source and 3). Gate

**27. What is JFET?**

JFET- Junction Field Effect Transistor.

**28. What are the types of JFET?**

N- Channel JFET and P- Channel JFET

**29. What are the two important characteristics of JFET?**

1. Drain characteristics 2. Transfer characteristics.

**30. What is transconductance in JFET?**

It is the ratio of small change in drain current to the corresponding change in drain to source voltage.

**31. What is amplification factor in JFET?**

It is the ratio of small change in drain to source voltage to the corresponding change in Gate to source voltage.

**32. Why do we choose q point at the center of the loadline?**

The operating point of a transistor is kept fixed usually at the center of the active region in order that the input signal is well amplified. If the point is fixed in the saturation region or the cut off region the positive and negative half cycle gets clipped off respectively.

**33. List out the different types of biasing.**

Voltage divider bias, Base bias, Emitter feed back bias,

1. (i) Derive an expression for the concentration of electron in the conduction band of an intrinsic Semiconductor.
2. (ii) Write the necessary theory, describe the method of determining the band gap of an intrinsic Semiconductor. derivation experimental set up
3. Derive an expression for density of holes in the valance band of P type semiconductor.
4. Derive an expression for density of electrons in the conduction band of n type semiconductor.
5. (i) What is Hall Effect? Give the theory of Hall Effect and hence justify how Hall coefficient depends on the doping concentration. Describe an experimental set up to determine the Hall Co efficient.
6. (iii) A sample of silicon is doped with 1023 phosphorous atom/m<sup>3</sup>. Find the Hall voltage in a sample with thickness = 100μm, Current I<sub>x</sub> =1 mA and magnetic field B =0.1 Wb/m<sup>2</sup>(Assume electron Mobility, μ = 0.07 m<sup>2</sup>/V.S)
7. Distinguish between metals insulator and semiconductor on the basis of band theory.
8. Derive the expression for Planck's theory of Black body radiation.
9. Obtain and expression for the carrier concentration in an intrinsic semi conductor.  
Calculate the intrinsic concentration of charge carriers at 300°K, given  $m_e = 0.12m_0$ ,

10. Discuss electrical conductivity of intrinsic semi-conductor and hence derive an expression for the band gap energy.
11. Derive an expression for carrier concentration in an N-type semi conductor (Density of electrons in the conduction band).
12. Derive an expression for the density of holes in the valence band of an P-type semi conductor.
13. Discuss the variation of Fermi-level with temperature in N-type and P-type semi conductors.
14. Discuss the variation of carrier concentration with temperature for N-type and P-type semiconductors.
15. Explain the determination of Hall co-efficient, carrier concentration and mobility of charge carriers of a semi conduct.
16. Derive an expression for the density of electrons and holes in an intrinsic semi conductor.
17. Discuss the variation of Fermi level with temperature in an intrinsic semi conductor
18. Describe the method of determining the band gap of an intrinsic semiconductor
19. Discuss the carrier concentration, variation of Fermi level with temperature in case of p-type and n-type semiconductors for high and low doping levels.

What is Hall Effect? Derive an expression for hall coefficient. Describe an experimental setup for determining the hall coefficient.

### UNIT-III

#### MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS

#### 1. Explain Meissner effect.

When a super conducting material is kept in an external magnetic field under the condition when  $T \leq T_c$  and  $H \leq H_c$  the magnetic flux lines are completely excluded from the material and this phenomenon is called meissner effect.

#### 2. What are soft and hard magnetic materials?

S.No.	Soft	Hard
1.	They can be easily magnetised and demagnetized.	They cannot be easily Magnetized
2.	Movement of domain wall is easy	Movement of domain wall is not easy
3.	Hysteresis loop is very steep	Hysteresis loop is very broad

#### 3. What are ferrites?

They are made by two or more different kinds of atoms. Its general formula is given by  $X^{2+} Fe^{3+} O_4$ .

#### 4. Define energy product

The product of retentivity and the coercivity is known as energy product. It represents the maximum amount of energy stored in the specimen.

**5. State the applications of ferrites.**

They are used in two port devices such as circulator. They are used in computers and data processing circuits. They are used in switching circuits and parametric amplifiers.

**6. Define Bohr magneton.**

The orbital magnetic moment and the spin magnetic moment of an electron in an atom can be expressed in terms of atomic unit of magnetic moment

**7. What are the four types of magnetic domains?**

Exchange energy      Anisotropy energy      Domain wall energy      Magneto-strictive energy.

**8. Define electronic polarization.**

When a dielectric material is kept in external field, the positive and negative charges in the dielectrics move in opposite directions, thereby creating a dipole moment.

**9. Define Local field (or) internal field.**

Long range of coulomb forces which are created due to the dipoles are called internal field or local field.

**10. What is meant by dielectric loss?**

The dielectric and certain amount of electrical energy is dissipated in the form of heat energy, this loss in energy in the form of heat is called dielectric loss.

**11. What is meant by dielectric break down?**

When external field applied to a dielectric material is greater than the critical field, the dielectric loses its insulating property and becomes conducting. Therefore a large current flows through the material.

**12. List out the applications of ferro-electrics.**

It is used to produce ultrasonics. It is used in SONAR. It is used to bond the bones in the human body. It is used in production of piezo-electric materials.

**13. Define ionic polarization.**

The process of displacement of cations and anions in the opposite directions, of a dielectric material kept in external electric field.

**14. What is meant by ferroelectricity?**

When a dielectric material exhibits electric polarization even in the absence of external field, it is known as ferroelectricity and these materials are termed as ferroelectrics.

**15. What are differences between polar and non-polar molecules?**

S.No.	POLAR	NON POLAR
1.	Molecules have permanent dipole moments	Molecules do not have permanent dipole moments

2.	Molecules are highly temp dependent	Molecules are independent of temperature
3.	HCl	CCl4

### 16. Define dielectric constant?

It is the ratio between the absolute permittivity of the medium ( $\epsilon$ ) and the permittivity of free space ( $\epsilon_0$ ).

$$\text{Dielectric constant } \epsilon_r = \text{Absolute permittivity } (\epsilon) / \text{Permittivity of free space } (\epsilon_0)$$

### 17. Define polarization of a dielectric material.

The process of the producing electrical dipoles inside the dielectric by the application an external electrical field is called polarization in dielectrics.

Induced dipole moment ( $\mu$ ) =  $\alpha E$   $E \rightarrow$  Applied electrical field  
 $\alpha \rightarrow$  Polarizability

### 18. Name the four polarisation mechanisms.

- Electronic polarisation.
- Ionic polarisation.
- Orientational polarisation.
- Space- charge polarisation.

### 18. What is electronic polarisation?

Electronic polarisation means production of electric dipoles by the applied electric field .It is due to shifting of charges in the material by the applied electric field.

### 19. What is ionic polarisation?

Ionic polarisation is due to the displacement of cations (negative ions) and anions (positive ions) in opposite direction due to the application of an electrical field. This occurs in an ionic solid.

### 20. What is orientation polarisation?

When an electrical field is applied on the dielectric medium with polar molecules, the dipole align themselves in the field direction and thereby increases electric dipole moment.

Such a type of contribution to polarisation due to the orientation of permanent dipoles by the applied field is called orientation polarisation.

### 21. What is space- charge polarisation?

In some materials containing two or more phases, the application of an electrical field causes the accumulation of charges at the interfaces between the phases or at the electrodes.

As result of this, polarisation is produced. This type of polarisation is known as space charge polarisation.

### 22. Define dielectric loss and loss tangent.

When a dielectric material is subjected to an A.C voltage, the electrical energy is absorbed by the material and is dissipated in the form of heat. This dissipation of energy is called

dielectric loss. In a perfect insulator, polarisation is complete during each cycle and there is no consumption of energy and the charging current leads the applied voltage by  $90^\circ$ . But for commercial dielectric, this phase angle is less than  $90^\circ$  by an angle and is called dielectric loss angle.  $\tan \delta$  is taken as measure of dielectric loss and is known as loss tangent.

### **23. Define dielectric breakdown and dielectric strength.**

Whenever the electrical field strength applied to a dielectric exceeds a critical value, very large current flows through it. The dielectric loses its insulating property and becomes conducting. This phenomenon is known as dielectric breakdown. The electrical field strength at which dielectric breakdown occurs is known as dielectric strength.

### **24. Mention the various breakdown mechanisms.**

- Intrinsic breakdown and avalanche breakdown
- Thermal breakdown
- Chemical and Electrochemical breakdown
- Discharge break down
- Defect breakdown

### **25. What is intrinsic breakdown?**

For a dielectric, the charge displacement increases with increasing electrical field strength. Beyond a critical value of electrical field strength, there is an electrical breakdown due to physical deterioration in the dielectric material.

### **26. What is thermal breakdown?**

When an electrical field is applied to a dielectric material, some amount of heat is produced. This heat must be dissipated from the material. In some cases, the amount of heat produced is very large as compared to the heat dissipated. Due to excess of heat the temperature inside the dielectric increases and may produce local melting in the dielectric material. During this process, a large amount of current flows through the material and causes their dielectric to breakdown. This type of breakdown is known as thermal breakdown.

### **27. What is chemical and electrochemical breakdown?**

Electro chemical breakdown is similar to thermal breakdown. When the temperature of a dielectric material increases, mobility of ions increases and hence the electrochemical reaction may take place. This leads to leakage current and energy loss in the material and finally dielectric breakdown occurs.

### **28. What is discharge break down?**

Discharge breakdown occurs when a dielectric contains occluded gas bubbles. When this type of dielectric is subjected to electric field; the gases present in the material will easily ionize and thus produces large ionization current. The gaseous ions bombard the solid dielectric. This causes electrical deterioration and leads to dielectric breakdown.

### **29. What is defect breakdown?**

The surface of the dielectric material may have defects such as cracks, porosity and blowholes. Impurities like dust or moisture may collect at these discontinuities (defects). This will lead to a breakdown in a dielectric material.

**30. What are requirements of good insulating materials?**

The good insulating materials should have

- High electrical resistivity to reduce leakage current.
- High dielectrical strength to with stand higher voltage.
- Smaller dielectric loss
- Sufficient mechanical strength.

**31. What are ferro-electric materials? Give examples.**

Materials which exhibit electronic polarization even in the absence of the applied electrical field are known as ferro-electric materials. Example. Barium Titanate ( $\text{BaTiO}_3$ )  
Potassium Dihydrogen Phosphate ( $\text{KH}_2\text{PO}_4$ )

**PART-B**

1. (i) Draw the B-H curve for a Ferro magnetic material and explain the same on the basis of domain theory  
(ii) Differentiate between hard and soft magnetic materials.
2. With neat sketch explain preparation, structure, properties and applications of ferrites.
3. explain dia, para and ferromagnetic
4. Derive an expression for local field in a dielectric material and hence deduce Clausius – Mosotti equation.
5. (i) Give a detailed discussion on the various types of dielectric breakdown in dielectric material.  
(ii) What are the remedies to avoid breakdown mechanism?
6. Distinguish between dia, para, ferro and anti ferro magnetic materials. Mention their properties and applications
7. Explain domain theory of ferromagnetism. Using that how will you explain the properties of ferromagnetic materials.
8. Explain the different types of polarization mechanisms involved in dielectric materials.
9. What is meant by local field in a dielectric and how it is calculated for cubic structure? Deduce the Clausius- Mosotti equation.
10. What are the different types of dielectric breakdown occurs in a dielectric medium? Discuss in detail, the various types of dielectric breakdown.
13. (i) Draw the B-H curve for a Ferro magnetic material and explain the same on the basis of domain theory  
(ii) Differentiate between hard and soft magnetic materials.
14. With neat sketch explain preparation, structure, properties and applications of ferrites.
15. explain dia, para and ferromagnetic
16. Derive an expression for local field in a dielectric material and hence deduce Clausius – Mosotti equation.

17. (i) Give a detailed discussion on the various types of dielectric breakdown in dielectric material.  
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18. Distinguish between dia, para, ferro and anti ferro magnetic materials. Mention their properties and applications
19. Explain domain theory of ferromagnetism. Using that how will you explain the properties of ferromagnetic materials.
20. Explain the different types of polarization mechanisms involved in dielectric materials.
21. What is meant by local field in a dielectric and how it is calculated for cubic structure? Deduce the Claussius- Mosotti equation.
22. What are the different types of dielectric breakdown occurs in a dielectric medium? Discuss in detail, the various types of dielectric breakdown.

## UNIT-IV

### OPTICAL PROPERTIES OF MATERIALS

#### **1. What is solar energy?**

Solar energy takes advantage of the sun's rays to generate heat or electricity. It is an infinitely renewable resource and unique for its ability to generate energy in a quiet, clean, and consistent manner.

#### **2. What's the difference between solar photovoltaic and solar hot water systems?**

Solar photovoltaic systems use photovoltaic panels to produce electricity. Solar hot water, or thermal, systems capture sunlight to heat water. SunPeak does not offer solar thermal systems.

#### **3. What is the principle of semiconductor.**

When a p-n junction diode is forward biased, the electrons from n – region and the holes from the p- region cross the junction and recombine with each other.

During the recombination process, the light radiation (photons) is released from a certain specified direct band gap semiconductors like Ga-As. This light radiation is known as recombination radiation.

#### **4. Mention any four advantages of led in electronic display**

- This is useful in battery powered or energy saving devices.
- This is more efficient and can lower initial costs.
- Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner.
- When used in applications where dimming is required, LEDs do not change their color tint as the current passing through them is lowered, unlike incandescent lamps, which turn yellow.

### 5. How is a light emitting diode differ from semiconductor laser?

specification	Light Emitting Diode	Laser Diode
Output power	linearly proportional to drive current	Proportional to current above the threshold
Current	Drive Current (50 to 100 mA) (Peak)	Threshold current (5 to 40 mA)
Coupled power	Moderate	High

### 6. What is Laser Diode?

Laser is derived from Light Amplification by the Stimulated Emission of Radiation. It produces a very intense beam of light or infrared radiation which is having following properties.

- Monochromatic ( meaning consists of one wavelength)
- Coherent (meaning all parts are in phase)
- Collimated (meaning all parts travel in one and same direction)

### 7.What is holography?

Holography deals with image construction by means of interference techniques without using lenses .here the distribution of amplitude and phase is recorded in 3D manner so as to get complete information of the object to be photographed.

### 8.What are the difference between holography and photography?

S.No	Photography	Holography
1.	Ordinary light is used	Laser light is used
2.	The variation of amplitude alone is recorded	The distribution of amplitude and phase is recorded
3.	It gives 2D picture	It gives 3D picture
4.	Lens is used	No Lens is used

### 9. What are optical materials and give its types

Materials which are sensitive to light are called optical materials. In general there are 3 types of optical materials.

- Transparent materials: They transmit more light

ii) Translucent materials: they transmit light partially

iii) opaque materials: they will not transmit any light.

#### **10. What is an opto electric device?**

Optoelectronics is the communication between optics and electronics which includes the study, design and manufacture of a hardware device that converts electrical energy into light and light into energy through semiconductors. This device is made from solid crystalline materials which are lighter than metals and heavier than insulators.

#### **11. Explain the term delayed transmission?**

When photons are made to incident on the optical material , it creates oscillatory dipoles. These oscillatory dipoles when return to ground state by emitting the same frequency as that of its excitation, without any loss in energy, it is termed as delayed transmission.

#### **12. Define skin depth and skin layer.**

When light passes through the metal it produces conduction current. The maximum distance upto which it can travel in the metal is called skin depth and last layer inside the metal upto which the conduction current passes is called skin layer.

#### **13. Define luminescence and give its types.**

When an atom in an excited state returns to ground state by emitting diode it is called luminescence. Based on the types of excitation, luminescence can be classified into many types

- i) photo- luminescence
- ii) cathode- luminescence
- iii) electro- luminescence
- iv) thermo- luminescence
- v) injection – luminescence

#### **14. Write principle and operations of solar cell**

A solar cell is a basically a large area photo diode which converts sunlight directly into electrically ,with larger efficiency of photon absorption.

#### **15. What is meant by optical data storage?**

Optical storage devices use a laser to burn small, dark pits into the surface of a disk . the pits are dark and the places without pits remain shiny and smooth . binary codes can be stored to dark and shiny places on a storage medium. Since information can be stored by optical meant, it is called optical data storage.

## 16. List out the recent application of OLED

- OLED's are widely used in cell phones, digital cameras etc.
- They are also used in TV screens ,computer monitors.
- They are nowadays used in automotive dash boards and backlight in cars.
- In future ,newspaper also may have OLED display to refresh us with the latest or breaking news.

## 17. Define trap its origination and types.

Trap is an intermediate energy level present in energy band gap. These trap arises due to the presence of impurity atoms and imperfection in the crystal. There are two types and trap

i)trapping center

ii)recombination center

## 18. What is the effect of optical absorption in semiconductor?

The optical absorption in semiconductor produces the following effects.

i)It forms excitons.

ii)It produce photo-conductivity

iii)It excites the crystal lattice vibrations.

iv)It also excites free electron and holes.

## PART-B

1. Discuss the absorption of light by Semi-conductors and define the terms of Phosphorescence and Florescence
2. What are Color Centers and explain the different types and how they are generated?
3. Explain the phenomena of absorption, dispersion and refelection on the basis of polarisation?
4. Explain optical absorption in metals, di-elcetrics and semiconductors
5. Describe the principle, construction and working of Photodiode
6. Explain about traps and excitons with it's types
7. Describe about the principle and working of Photo-detector
8. What do you mean by active and passive display units and explain any one of them in detail.
9. Explain the theory and working of LED's, what are the different types, it's advantages, disadvantages, applications.

10. Describe the principle, construction and working of Solar-Cell types, its advantages, disadvantages, applications.
11. Mention the difference between LED and Liquid OLED and compare the differences between Photodiode and LASER diode.
12. What do you mean by OLED, Discuss them in details with their Construction, working of OLED.
13. Describe the principle and working of LASER diode.
14. Describe the principle, construction and working of Hetero-Junction LASER diode.
15. Describe about the principle and working of Quantum LASER diode

## UNIT V NANOELECTRONIC DEVICES

### **1. What are the properties of nano particles?**

The energy bands in these materials will be very narrow. In nano materials a large number of atoms will be present at the surface. Interparticle spacing is very less in nano-materials.

### **2. List out any recent applications of nano-materials.**

It is used in ICs, optical switches, mass sensors etc.

Recently nano-robots were designed, which are used to remove the damaged cancer cells

It is used in the production of DNA-chips, bio-sensors etc.

### **3. What are Bloch oscillations**

A Particle in a periodic potential with an additional constant force performs oscillations and these oscillations are called as Bloch oscillations

### **4. Define Resonant Tunnelling**

Resonant Tunnelling refers to the tunneling in which electron transmission Coefficient through a structure is sharply peaked about certain energies.

### **5. What are spintronics?**

Spintronics is a nano-technology which deals with spin-dependent Properties of electrons instead of Charge-dependent properties.

### **6. Define coulomb blockade.**

The resistance to electron transport caused by electrostatic coulomb forces in certain electronic structures, including quantum dots and single electron transistor is called coulomb blockade.

### **7. What is meant by tunneling?**

The phenomenon in which a particle like an electron encounters an energy barrier in an electronic structure and suddenly penetrates is known as tunneling.

### **8. What will we observe when we decrease the size of the particle to nano size?**

If we decrease the size of the particle to nano size, the decrease in confining size creates the energy level discrete. The formation of discrete energy level increases or widens up the bandgap and finally band gap energy also increases.

**9. What is meant by single electron transistor?**

A transistor made from a quantum dot that controls the current from source to drain one electron at a time is called a single electron transistor.

**10. Write any two applications of quantum dot?**

Quantum dot may be used as a basic building block in making a quantum computer.

The quantum dot application in various fields include blue laser diode, single electron transistor, light emitting diode.

**11. List out the applications of quantum well?**

Quantum wells are widely used to make semiconductor layers and other important devices.

Quantum well important photo detectors are also based on quantum wells and are used for infra red imaging.

**12. Define density of energy states?**

Density of energy is defined as the number of available energy states per unit volume per unit energy in a solid.

**13. Define Quantum confinement.**

The effect achieved by reducing the volume of solid so that the energy level within it becomes discrete is called as Quantum confinement.

When we decrease the volume of solid to such an extent, that the energy levels inside become discrete, we have achieved Quantum confinement.

**14. Define density of states in quantum dot.**

In zero dimension system such as quantum dot, the density of states are truly discrete and they do not form a quasi continuum.

**PART-B**

1. Describe the structure, fabrication, properties and applications of carbon nano tubes.
2. Derive an expression for density of States for Quantum confinements
3. Explain the phenomena for BLOCH Zener Oscillations
4. Give a brief description of Spintronics
5. Explain about Magnetic Semi-conductors? List out the properties and applications of Magnetic semi-conductors
6. Explain about Quantum well, Quantum wire and Quantum dots.

7. Describe about the principle and working of single electron transistors
8. Write a short notes on (i) GMR (ii) Spin valve
9. Describe about the principle and working of Carbon Nano-tubes
10. Derive an expression for density of States in Quantum well and in two dimensions
11. Explain about Resonant Tunneling diode with neat diagrams
12. Describe about coulomb blockade with the single electron

## **BE 8252 BASIC CIVIL AND MECHANICAL ENGINEERING**

### **TWO MARK QUESTIONS AND ANSWERS**

#### **UNIT I**

#### **SCOPE OF CIVIL AND MECHANICAL ENGINEERING**

##### **1. What are the contributions of Civil Engineering to the welfare of Society?**

Because of Civil Engineering and Civil Engineers, we have many amenities that make civilization possible.

- ✓ Water piped to our homes and other places.
- ✓ Sewage taken away to treatment plants.
- ✓ Roads that make easy driving possible and reduce the likelihood of accidents.
- ✓ Bridges and connect people who formerly were divided by water.
- ✓ Layout and construction of schools, public buildings and parking lots that make the best use of land.

##### **2. List the sub-discipline or branches in Civil Engineering?**

Civil Engineering is the broadest of the engineering fields. It comprised of many related specialties.

Sub-disciplines of Civil Engineering are:

- ❖ Coastal Engineering
- ❖ Construction Engineering
- ❖ Environmental Engineering
- ❖ Geotechnical Engineering
- ❖ Structural Engineering
- ❖ Transportation Engineering
- ❖ Water Resources Engineering

##### **3. What is meant by Coastal Engineering?**

Coastal engineering is a branch of civil engineering concerned with the specific demands posed by constructing at or near the coast, as well as the development of the coast itself.

Typical coastal engineering application areas include: beach protection and nourishment, coastal structures, coastal erosion, near shore circulation, marine renewable energy (wind, wave, and tide), natural hazard impacts on coastal infrastructure, development of water resources, and instrumentation for coastal and offshore measurements.

#### **4. What is meant by Construction Engineering?**

Construction Engineering is considered a professional sub-practice area of civil engineering or architectural engineering. Construction Engineering is a professional discipline that deals with the designing, planning, construction, and management of infrastructures such as roads, tunnels, bridges, airports, railroads, facilities, buildings, dams, utilities and other projects.

#### **5. What is meant by Environmental Engineering?**

Environmental engineering is the branch of engineering concerned with the application of scientific and engineering principles for protection of human populations from the effects of adverse environmental factors; protection of environments, both local and global, from potentially deleterious effects of natural and human activities; and improvement of environmental quality.

Environmental engineers are called upon to resolve the problems of providing safe drinking water, cleaning up contaminated sites with hazardous materials, disposing of waste water and managing solid wastes.

#### **6. What is the role of Civil Engineer in the society?**

Civil engineers create, improve and protect the environment in which we live. They plan, design and oversee construction and maintenance of building structures and infrastructure, such as roads, railways, airports, bridges, harbours, dams, irrigation projects, power plants, and water and sewerage systems. They also design and build tall buildings and large structures that can withstand all weather conditions.

#### **7. Which is the oldest engineering discipline?**

Civil engineering is a professional engineering discipline and it is the oldest discipline after military engineering. It deals with the design, construction and maintenance of the physically and naturally built buildings.

#### **8. What is meant by Transportation Engineering?**

Civil engineers that specialize in transportation engineering will work with the planning, construction and management of transportation facilities. They will design and implement the infrastructures that deal with transportation in order to provide a safe, comfortable, convenient, economical and environmentally compatible mode of transport. There are six divisions related to transportation engineering: highway, air transportation, and waterway, aerospace, coastal & ocean and urban transportation.

### **9. What is meant by Geotechnical Engineering?**

In geotechnical engineering the engineer studies soil, foundations and bearing capacities. The engineer will study the behavior of the earth materials and how they will affect a structure that is to be constructed. They will also evaluate pre-existing structures that are showing signs of problems with the earth materials under or near the structure.

### **10. What is meant by Water Resources Engineering?**

It concerns collection and management of water; the branch is connected with hydrology, environmental science, meteorology, geology, resource management; it is closely related to the design of pipelines, water supply network, drainage facilities and canals.

These engineers deal with the design and construction of hydraulic structures. These structures include dams, canals and water distribution system. The engineer is responsible for the design of the structure as well as the implementation and safety precautions that must be closely adhered to when dealing with hydraulic structures.

### **11. What is meant by Structural Engineering?**

This branch of civil engineering encompasses the structural analysis and design of structures. It is the responsibility of the structural engineer to analyze and design a structure that will safely bear or resist the stresses, forces and loads. The design must satisfy the project specifications while meeting all safety regulations. The structure must endure massive loads as well as natural disasters and climate changes.

### **12. What is the aim of Civil Engineering?**

The Civil Engineering program aims to prepare students with a breadth and depth in the technical knowledge so they can work immediately in most areas of the profession, including geotechnical engineering, hydraulics, hydrology and water resources, etc.

### **13. What are the advanced branches of Civil Engineering?**

- Remote Sensing and GIS
- Urban Engineering
- Construction Engineering and Management
- Irrigation Water Management
- Geoinformatics
- Soil Mechanics and Foundation Engineering

#### 14. Differentiate between Civil and Mechanical Engineering.

While both disciplines are a form of engineering, each one requires specific things for the person to be successful. Here are 10 differences between civil engineering and mechanical engineering.

<b>Civil Engineering</b>	<b>Mechanical Engineering</b>
Involves the design and construction of buildings and other structures	Involves inventing and re-inventing machinery
Projects are longer in duration	Projects are shorter in duration
Projects are generally on a large scale	Projects are smaller and require more precision
Must ensure that structures will be stable and efficient in its environment, i.e. the framework of the structure	Works with the living functions of the object or structure, i.e. the mechanics of elevators and such
Works with large team including construction manager, architect, and construction workers	Works with mainly with other engineers

#### **PART-B**

1. Explain the contributions of Civil Engineering to the welfare of Society?
2. Explain the sub-discipline or branches in Civil Engineering?
3. Explain in detail about Coastal Engineering and Construction Engineering?
4. Briefly explain the importance of study on Environmental Engineering and Transportation Engineering?
5. Explain in detail about Geotechnical Engineering and Water Resources Engineering?
6. What are the advanced branches of Civil Engineering and explain them?
7. Differentiate between Civil and Mechanical Engineering in detail.

## UNIT II

### SURVEYING AND CIVIL ENGINEERING MATERIALS

#### **1. Define Surveying.**

It is defined as the art of determining the relative positions of points on above or below the earth surface by means of direct or indirect measurement of distance, direction and elevation.

#### **2. What is meant by Objectives of Surveying?**

- ❖ The data obtained by surveying are used to prepare the plan or map showing the ground features.
- ❖ When the area surveyed is small and the scale to which its result plotted is large, then it is known as Plan.
- ❖ When the area surveyed is large and the scale to which its result plotted is small, then it is called as a Map.
- ❖ Setting out of any engineering work like buildings, roads, railway tracks, bridges and dams involves surveying.

#### **3. Define Plane Surveying.**

The surveying where the effect of curvature of earth is neglected and earth's surface is treated as plane, is called surveying. The degree of accuracy in this type of surveying is comparatively low. Generally when the surveying is conducted over the area less than 260 Sq. Km., they are treated as plane surveying. Plane surveying is conducted for the purpose of engineering projects.

#### **4. Define Geodetic Surveying.**

The effect of curvature is taken into account. It is also known as "Trigonometrical Surveying". It is a special branch of surveying in which measurements are taken with high precision instruments. Calculations are also made with help of spherical trigonometry. It is general adopted by the Great Trigonometrical Survey Department of India".

#### **5. What are the Classification of surveying based on instruments used?**

1. Chain Surveying
2. Compass Surveying
3. Theodolite surveying
4. Plane Surveying
5. Tacheometric Surveying

**6. What are the classifications of survey based on the purpose?**

- i. Engineering Survey
- ii. Defence Survey
- iii. Geological Survey
- iv. Geographical Survey
- v. Mine Survey
- vi. Archeological Survey
- vii. Route Survey

**7. Mention the Advantages and disadvantages of chain surveying?**

**Advantages:**

- It is simple
- It does not require any costly equipment
- It is adopted for preparing plans for small area

**Disadvantages**

- It cannot be used for large areas

**8. Define Magnetic Bearing.**

1. It is the angle between the magnetic meridian and the line.
2. The angle is always measured in the clockwise direction
3. It is the direction shown by a freely suspended magnetic needle
4. The magnetic meridian is also called bearing.

**9. Define Whole Circle Bearing.**

- The bearing of lines measured from the North is called Whole Circle Bearing.
- The angle is reckoned in the clockwise direction from 0° coinciding with the north.

**10. Define fore Bearing and back bearing.**

- Every line has two bearing namely fore bearing and back back bearing
- Fore bearing is the bearing taken in the direction of surveying and Back bearing is the bearing taken in the reverse direction.

**11. List the four major operations involved in brick manufacturing.**

- (i) Preparation of brick earth.
- (ii) Moulding of bricks
- (iii) Drying of bricks
- (iv) Burning of bricks

**12. How to prepare the brick earth for manufacturing?**

- (i) Loose soil which contains impurities, is removed for about 20 cm depth. (ii) Earth is then dug out from the ground, spread and weathering is done for a week time. (iii) The clay is then mixed with suitable ingredients by tilting the clay and ingredients up and down in a kiln. (iv) Water is added to clay to make the whole mass of clay homogeneous and plastic.

**13. What are various classification of hand moulding? Write short notes on each.**

Hand moulding is classified into, (a) Table moulding (b) Ground moulding

**(a) Table moulding**

- Done by the experienced supervisor
- Bricks are moulded on the table and sent to next stage.

**(b) Ground Moulding**

- Small portion of ground is cleaned and leveled.
- Fine sand is sprinkled over it.
- Mould is dipped in water and kept on the ground and the clay is pressed by hand.

#### **14. Write short notes on machine moulding.**

- Machine moulding is used in mass production of bricks (huge quantity)
- These machines contain a rectangular opening of size equal to length and breadth of the brick.
- The tempered clay is placed in the machine.
- The tempered clay comes out as through the opening under pressure, hence it is cut to the required shape.

#### **15. What are the various constituents of a brick?**

Alumina is the chief constituent of a brick. A good brick should have a content of 20-30% of alumina. Silica is another constituent that exist in a brick. A brick should contain 50-60% of silica. Up to 5% of lime is preferable for a good brick. Hence Alumina, Silica and lime are the major contents of a good brick.

#### **16. What are the qualities of a good brick?**

(i) A good brick should have perfect edges, well burnt in kilns, copper coloured and free from cracks. (ii) Bricks should not break when dropped from a height of 1m. (iii) Bricks should have low thermal conductivity and should be sound proof. (iv) The minimum crushing strength of bricks must be 3.5 N/mm<sup>2</sup>. (v) Bricks must be homogeneous and free from voids.

#### **17. How the rocks are classified?**

Rocks are classified into igneous rocks, sedimentary rocks and metamorphic rocks. Igneous rocks are formed by the cooling of molten material from beneath the earth's surface. Sedimentary rocks are formed by the deposition of weathering products on existing rocks. Metamorphic rocks are formed by the change in character of the preexisting rocks.

#### **18. List the qualities of a good stone.**

(i) Stones must be decent in appearance and be of uniform colour. (ii) Stones must be durable. (iii) A good building stone should have a wear less than 3%. (iv) A good building stone should have a specific gravity greater than 2.2. (v) A good building stone must be acid resistant and free from soluble matter.

### **19. What is meant by quarrying of stones?**

Quarrying is the process of extracting stone blocks from existing rocks. It is done at some depth below the top surface of rock where the effects of weathering are not found. Quarrying is done by digging, heating and wedging for soft rocks like marble, lime stone etc. For hard and dense rocks, blasting is done using explosives.

### **20. Write short notes on dressing of stones.**

Stones obtained by quarrying will have irregular shapes and sizes. Dressing is the process of cutting the stones to a regular shape and size and the required surface.

### **21. Write short notes on any three major testing on stones.**

*Acid test* : A stone specimen is kept for a week time in the solution of sulphuric acid and hydrochloric acid. The corners of stones with high alkaline content changes to round shape and the particles will get deposited at the bottom.

*Hardness test* : A penknife is used for this test. It is used for producing a scratch on the hard stone. If the stone appears then the quality of the stone is low.

*Abrasion test* : Deval's test machine is used to carryout this test. It is used to test the percentage of wear of stones.

### **22. Write briefly how the cement is produced?**

A mixture of calcareous and argillaceous materials is burnt at very high temperature to produce the cement. The calcined powder is also known as clinker. A small percentage of gypsum is also added with the clinker.

### **23. What are the qualities of a good cement?**

(i) A good cement should be uniform in colour and free from lumps. (ii) If a small quantity of cement is thrown into a vessel of water, the cement powder should sink. (iii) The total sulphur content of the cement should not be greater than 2.75 percent.

**24. Write briefly any three types of cement.**

**Rapid hardening cement:** This type of cement is an ordinary Portland cement with an additional property of developing its strength rapidly. It is used where high strength is required instantly in initial stages. **Quick setting cement :** This type of cement takes lesser time for setting. Since the gypsum content is lesser in this cement, it settles very quickly. It is mainly used in underwater construction. **White cement :** The cement is named as white cement, as it appears white in colour. It is used for architectural and flooring purposes.

**25. Write short notes on mortar.**

Mortar is a paste prepared by adding required quantity of water to a mixture of cement (or lime) and fine aggregate (sand). The durability, quality and strength of mortar depends on the quantity and quality of the ingredients.

**26. What are the various properties of a good mortar?**

(i) A mortar should be easily workable (ii) It should set quickly for speedy construction (iii) The joints formed by mortar should not develop cracks. (iv) It should resist the penetration of rain water.

**27. How sand is classified?**

(i) Natural sand : Natural sand is carried by the river water and quarried from river bed, when there the river becomes dry. (ii) Artificial sand : Artificial sand is obtained by crushing and breaking stones into different sizes of stone aggregates.

**28. What are the qualities of a good sand?**

(i) A good sand should be clean, free from foreign matters, durable and dry during construction. (ii) It should be free from mica, chemical salts, organic and inorganic impurities. (iii) The fineness modulus of sand shall be from 1.6 to 3.5.

**29. What is cement concrete?**

It is a mixture of cement, sand, crushed rock and water in a proper proportion. It becomes hard like a stone, when it is allowed to cure.

### **30. What are the properties of a concrete?**

(i) Cement concrete should have a high compressive strength. (ii) It is free from corrosion. (iii) It should be capable of resisting abrasion. (iv) A good concrete should shrink initially due to the loss of water.

### **31. What is RCC? What is the advantage of RCC over a cement concrete?**

The expansion of RCC is Reinforced Cement Concrete. Plain concrete is very weak in tension and cannot be used directly in the construction of lintels, roofs, slabs etc., because the bottom fibres are subject to tensile stresses. A combination of concrete and steel is known as reinforced cement concrete and is widely used in construction.

### **32. List the advantages of reinforced cement concrete.**

(i) RCC is tough and durable. (ii) RCC construction is easy and fast. (iii) The ingredient materials used for preparing RCC are easily available. (iv) Maintenance of RCC roofs, slabs are easy.

### **33. Write short notes on light weight concrete.**

Light weight concrete has a density ranging from 300 – 1850 kg/m<sup>3</sup>. It has a low cellular porous and light weight aggregate. Natural light weight aggregates are pumice, diatomite, scoria, volcanic cinders, sawdust and rice husk.

### **34. Write short notes on steel sections used in construction.**

Since the steel has ductile and has elastic properties, mild steel having a carbon content of 0.1 – 0.25 percent is used for structural work. The various shapes of steel sections used are SHS : Square Hollow Section; RHS : Rectangular Hollow Section.

### **35. Write short notes on “Timber – in construction”.**

Timber is obtained from trees. It is the form of wood used in construction. For construction purpose, wood derived from deciduous trees is used. Deciduous trees are broad leaf trees which yields hard wood. *Example : teak, sal etc.*

## **PART-B**

1. Explain in detail about chain surveying with neat sketches.
2. Briefly explain about compass surveying with neat sketch.
3. Explain the various instruments used in leveling.
4. Briefly explain the operations involved in brick manufacturing.
5. What are the various classifications of brick and explain?
6. Explain the test conducted for checking the quality of bricks.
7. What are the requirements of good building stone & state important varieties of Building stones?
8. Write brief notes on any three major testing on stones.
9. Write briefly how the cement is produced?
10. Write briefly the types of cement.
11. Explain in detail about the manufacturing of concrete.
12. Explain the following (i) Quality of Concrete (ii) Types of Concrete
13. What are the different types of steel? Explain the properties and uses?
14. What are the requirements of good building stone & state important varieties of Building stones.
15. The following staff readings were observed successively with level, the instrument having been shifted after second and fifth readings 0.870; 1.635; 2.135; 1.280; 2.980 3.125; 0.120; 1.825; 2.765; 2.015 the first reading was taken with the staff held upon a bench mark of elevation + 100.00. Enter the readings in level book and final reduced levels. Apply the usual checks. Find also the difference in level between the first and last points.

## UNIT III

### BUILDING COMPONENTS AND STRUCTURES

#### **1. Define Objectives of foundation:**

- To distribute the total load coming on the structure on a larger area
- To support the structures
- To give enough stability to the structure against various disturbing forces, such as wind and rain.

#### **2. What is meant by Deep foundation?**

Deep foundation consists of pile and pier foundation. Pier foundations are rarely used for buildings. This consists in carrying down through the soil huge masonry cylinder which may be supported on solid rock.

#### **3. What are the types of foundation?**

Foundation may be broadly classified into

1. Shallow foundation (depth  $\leq$  width)
2. Deep Foundation (depth  $\geq$  width)

#### **4. Which types of Failures occur in foundation?**

1. Unequal settlement of soil
2. Unequal settlement of masonry
3. Withdrawal of moisture from sub soil.

#### **5. How to select the site for foundation?**

- i) Soil at the building site should not be of artificially made-up type.
- ii) Site should not be undulating since this leads to increase in cost for leveling the ground.
- iii) The site should have its general slope and the ground water table in the site should not be high.

## 6. Define Bearing capacity, Ultimate bearing capacity and Safe bearing capacity.

**Bearing capacity:** It is defined as the maximum load per unit area which the soil will resist safely without displacement.

**Ultimate bearing capacity:** It is the gross pressure intensity at the base of the foundation at which the soil fails in shear.

**Safe bearing capacity:** It is the maximum pressure which the soil can carry safely without risk of shear failure. 
$$SBC = \frac{\text{Ultimate bearing capacity}}{\text{Factor of Safety}}$$

## 7. How to improve the bearing capacity of soil?

- i) By increasing depth of foundation
- ii) By cement grating
- iii) By draining the sub soil water
- iv) By compacting the soil

## 8. What are the loads acting on foundation?

- i) Live load i) Dead load i) Wind load

## 9. List out the requirements of good foundation?

The foundation should be so located that it is able to resist any unexpected future influence which may adversely affect its performance

## 10. Mention the different types of shallow foundation.

- i) Isolated column footing i) Wall footing i) Combined footing iv) Cantilever footing v) Continuous footing vi) Inverted arch footing vi) Stepped footing

## 11. Mention the different types of deep foundation?

- i) Pile foundation i) Pier foundation i) Wel foundation

## 12. What are the causes of failure of foundation?

- i) Unequal settlement of the sub-soil
- ii) Shrinkage of the sub-soil due to the variations in the depth of water table
- iii) Sudden earthquake and heavy rains

**13. What are the remedial measures for the failure of foundation?**

- i) Foundation should be takendown to a depth where no ground water movement occurs.
- ii) The soil moisture content is maintained constant.
- iii) The sides of the foundation should be protected by proper drainage.

**14. Distinguish between Sub structure and Superstructure.**

- ❖ Sub structure consists of foundation, footings and basements upto plinth level.
- ❖ Superstructure mainly consists of walls, doors windows and lintels. The purpose of superstructure is to provide the necessary utility of the building, structural safety, fire safety, sanitation and ventilation

**15. Define English Bond:**

English bond consists of headers and Stretchers in alternative courses of elevation. A queen closer is placed next to the quoin header in each header course to the full thickness of wall. Each alternative header lies centrally over a stretcher of the stretcher course.

**16. What are the different types of Bonds in Brick Masonry?**

The most commonly used types of bonds in brick masonry are:

- ❖ Stretcher bond
- ❖ Header bond
- ❖ English bond and
- ❖ Flemish bond

**17. What are the other types of Bonds in Brick Masonry?**

- ❖ Facing bond
- ❖ Dutch bond
- ❖ English cross bond
- ❖ Brick on edge bond
- ❖ Raking bond
- ❖ Zigzag bond
- ❖ Garden wall bond

**18. Compare stone masonry and brick masonry.**

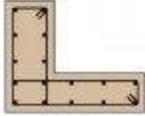
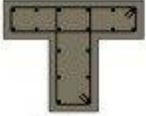
<b>STONE MASONRY</b>	<b>BRICK MASONRY</b>
Stone masonry is stronger than brick masonry	Brick masonry is not as strong as stone masonry
In stone masonry, all stones may not be of the same size	In brick masonry the brick size is standard for all bricks
Normally wall thickness of the stone masonry is more	Normally wall thickness of the brick masonry is less
Here plaster is not mandatory	Here plaster is mandatory
Stone masonry is more durable than brick masonry	Brick masonry is less durable than stone masonry
Stone masonry is costlier than brick masonry	Brick masonry is cheaper than stone masonry

**19. What are the essential requirements of a good flooring?**

Following are the functional requirements of floors in building:

- ❖ Strength and stability
- ❖ Resistance to weather and ground moisture
- ❖ Durability and free from maintenance
- ❖ Fire resistance
- ❖ Resistance to passage of heat
- ❖ Resistance to passage of sound

**20. Differentiate a beam and column.**

BEAM	COLUMN
Generally a horizontal member of a structure that resists transverse load is called beam.	Generally a vertical member of a structure that resists axial/eccentric load is called column.
It carries load perpendicular to longitudinal axis.	It carries load parallel to longitudinal axis.
<p>Its shape can be square, rectangular, T shape, I shape, H shape.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>[ Rectangular- Section ]</p> </div> <div style="text-align: center;">  <p>[ T- Section ]</p> </div> <div style="text-align: center;">  <p>[ I- Section ]</p> </div> </div>	<p>Its shape can be rectangular, circular, square, T shape, L shape, C shape, elliptical etc.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Square- Section</p> </div> <div style="text-align: center;">  <p>Rectangular- Section</p> </div> <div style="text-align: center;">  <p>Circular- Section</p> </div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;">  <p>L- Section</p> </div> <div style="text-align: center;">  <p>T- Section</p> </div> <div style="text-align: center;">  <p>+ -Section</p> </div> </div>
It carries weight of slabs, ceiling, floor, roof of a building and transfers it to columns.	It carries load transferred by beam and ultimately transfer it to footing and ground.
A building can be made without Beam.	A building cannot be made without Column.

**21. Define Plastering. List the types of plasters?**

Plaster is a method of protective and/or decorative coating of rough and uneven surface of various components of a building like walls and ceilings and for moulding and casting decorative elements.

The most common types of plaster mainly contain either gypsum, lime, or cement.

**22. List the different types of Flooring.**

**01. Tile Flooring:**

Tile flooring is very old, common and popular types of flooring. The tiles are mostly coloured and glazed. They are available in many types like vitrified tiles, ceramic tiles, etc.

## **02. Stone Flooring:**

Stone flooring is natural, beautiful, and always stylish. Natural stone tiles also come in different types like limestone, granite, marble, sandstone, slate, travertine, etc. The naturally cool, hard surface is ideal for warm climates.

## **03. Wood Flooring or Timber Flooring:**

Wood flooring is a very old type of floor, but it has never been outdated. It is used under special circumstances such as in hilly areas and in damp places. With proper care and maintenance, wood flooring can last a long time.

## **04. Terrazzo (Marble Chips) Flooring:**

Terrazzo flooring is other types of popular flooring, commonly recommended for bathrooms, dining rooms, offices, hospitals, etc. Terrazzo is a concrete surface with a special type of marble chips embedded in it.

## **05. Marble Flooring:**

Marble is a natural stone, and when properly finished it can be transformed into beautiful flooring. Marble flooring is one of the most luxurious and sophisticated floorings to install in a home.

## **06. Mosaic Flooring:**

Mosaic flooring is very old types of flooring. Floor mosaics are made from small round pieces of stones. They form design pattern and give a beautiful look to the room.

## **07. Glass Flooring:**

Glass flooring types of the floor are not very common, but can be used in aristocratic buildings both residential and public particularly to have smooth and pleasing surface. Glass flooring is generally bacteria and dirt-resistant.

## **08. Laminate Flooring:**

Laminate flooring is created by fusing several layers of material together. It is easy to clean and more durable and can resist scratches and chipping. Laminate flooring is stain free and fades resistant.

## **09. Carpet Flooring:**

In carpet flooring, the carpet is made from wool or from synthetic fibers, such as polypropylene, nylon, or polyester. It is the most versatile of all flooring options, featuring more colours and textures than any other types of flooring. It resists moisture, crushing, mildew, etc.

## 10. Brick Flooring:

Brick flooring is one of the oldest types of flooring materials. It is used in courtyards, stores, godowns, etc. Brick flooring is durable and provides sufficiently hard floor surface. It provides a non-slippery and fire resistant surface.

## 11. Concrete Flooring:

Concrete flooring is one of the most important floors. It is very commonly used throughout the world for all types of buildings. Concrete flooring is extremely strong and is able to withstand the pressure from very heavy equipment such as cars, trucks, etc.

## 12. Mud Flooring:

Mud flooring is most suitable for Indian conditions and climates. It is commonly constructed in villages. Mud flooring is cheap and hard. It is fairly impervious, easy to construct and easy to maintain.

## 13. Rubber Flooring:

Rubber flooring is not common in India. It is noiseless, comfortable in walking, and very durable. The initial cost of rubber flooring is a little bit high. It gives excellent wearing surface.

## 23. Define Factor of Safety.

It is defined as the ratio of ultimate stress to the working stress or safe stress or permissible stress. Its value should be always greater than 1. 
$$FOS = \frac{\text{Ultimate Stress}}{\text{Working Stress}}$$

## 24. What are the basic components of bridge?

The bridge structure consists of the following components:

- |                    |                |
|--------------------|----------------|
| ❖ Foundation       | ❖ Bearings     |
| ❖ Piers            | ❖ Decks        |
| ❖ Abutments        | ❖ Hand rails   |
| ❖ Bank Connections | ❖ Approachable |

## 25. What are the different types of dam?

### 1. Rigid Dams

- Solid gravity dam
- Arch Dam

- Buttress dam
- Timber and steel dam

## **2. Non rigid dams**

- Earth Dams
- Rockfill dams.

## **26. What are the different types of bridges?**

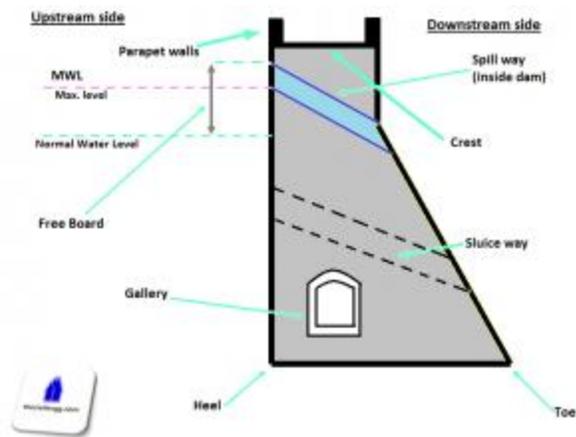
- Permanent bridges
- Back bridges
- Through bridges.
- Semi through bridges
- Straight bridges
- Skew bridge
- Arch Bridge
- Slab Bridge
- T beam and slab bridge
- Bow string and girder bridge
- Steel Arch bridge

## **27. What are the various purposes of Dam?**

Most of the dams are single-purpose dams, but there is now a growing number of multipurpose dams. They are having various purposes.

- ❖ Irrigation
- ❖ Hydropower
- ❖ Water supply for domestic and industrial use
- ❖ Inland navigation
- ❖ Flood control

## **28. What are the basic components of dam?**



**Crest:** The top of the Dam. These may in some cases be used for providing a roadway or walkway over the dam.

**Parapet walls:** Low Protective walls on either side of the roadway or walkway on the crest.

**Heel:** Portion of Dam in contact with ground or river-bed at upstream side.

**Toe:** Portion of dam in contact with ground or river-bed at downstream side.

**Spillway:** It is the arrangement made (kind of passage) near the top of dam for the passage of surplus/ excessive water from the reservoir.

**Abutments:** The valley slopes on either side of the dam wall to which the left & right end of dam are fixed to.

**Gallery:** Level or gently sloping tunnel like passage (small room like space) at transverse or longitudinal within the dam with drain on floor for seepage water. These are generally provided for having space for drilling grout holes and drainage holes. These may also be used to accommodate the instrumentation for studying the performance of dam.

**Sluice way:** Opening in the dam near the base, provided to clear the silt accumulation in the reservoir.

**Free board:** The space between the highest level of water in the reservoir and the top of the dam.

**Dead Storage level:** Level of permanent storage below which the water will not be withdrawn.

**Diversion Tunnel:** Tunnel constructed to divert or change the direction of water to bypass the dam construction site. The dam is built while the river flows through the diversion tunnel.

## **PART-B**

### **UNIT III**

#### **BUILDING COMPONENTS AND STRUCTURES**

1. Explain in detail about different types of foundation.
2. Explain in detail about selection of site for foundation?
3. Briefly explain How to improve the bearing capacity of soil?
4. What are the causes of failure of foundation and give remedial measures for the failure of foundation?
5. Explain the different types of Bonds in Brick Masonry?
6. Briefly explain the Comparison between stone masonry and brick masonry.
7. What are the essential requirements of a good flooring and explain them?
8. Explain in detail about Differentiation of a beam and column.
9. Briefly explain the different types of Flooring.
10. Explain the basic components of bridge?
11. Explain the different types of dam?
12. What are the different types of bridges and explain them?
13. Explain the various purposes of Dam?

## UNIT IV

### INTERNAL COMBUSTION ENGINES AND POWER PLANTS

#### PART-A (2 Marks)

1. What are the types of power plant?
2. What are the parts of thermal power plant?
3. What is the purpose of Surge tank in hydro power plant?
4. Classify the hydro power plant.
5. What is the function of Draft tube?
6. Define Nuclear Fission. Write chain reaction.
7. What is the function of Moderator?
8. Write down the Merits and Demerits of Diesel engine power plant.
9. List out the parts of the Gas turbine power plant.
10. Define Pump and Turbine.
11. Define Priming in Centrifugal Pump.
12. What is impulse turbine? Give example
13. What is Reaction turbine? Give example.
14. What is heat engine?
15. Define I.C Engine and E.C. Engine
16. Classify the I.C engine.
17. List out the Part of the I.C. Engine
18. Define the terms: Top Dead Center, Bottom Dead Center.
19. Define the term: Compression Ratio.
20. What do you understand by Scavenging?
21. Classify Boilers.

22. Define fire tube boiler and water tube boiler.
23. List out the Boiler Mountings and Accessories.
24. What is the Purpose of a fusible Plug?

**PART-B (16 Marks)**

1. Explain working principle of thermal Power plant With Neat sketch.
2. Explain working principle of Nuclear Power plant With Neat sketch.
3. a) Explain working principle of Hydro Electric Power plant With Neat sketch.  
3. b) Write its advantages and Disadvantages
4. a) Explain working principle of Diesel Engine Power plant With Neat sketch.  
4. b) Write its advantages and Disadvantages
5. a) Explain working principle of Gas turbine Power plant With Neat sketch.  
5. b) Write its advantages and Disadvantages
6. a) With the help of a neat sketch explain the working of Reciprocating Pump  
6. b) With the help of a neat sketch explain the working of Impulse Turbine
7. a) With the help of a neat sketch explain the working of Centrifugal Pump  
7. b) With the help of a neat sketch explain the working of Impulse Turbine
8. Describe the principal parts and functions of a Four Stroke Diesel engine with neat sketch
9. Describe the principal parts and functions of a Four Stroke Petrol engine with neat sketch
10. Describe the principal parts and functions of a Two Stroke Diesel engine with neat sketch

11. Describe the principal parts and functions of a Two Stroke Petrol engine with neat sketch
12. Describe the principal parts and functions of any one high pressure boiler with neat sketch
13. Describe the principal parts and functions of Babcock Wilcox boiler with neat sketch.

#### UNIT V

#### REFRIGERATION & AIR CONDITIONING

#### PART-A (2 Marks)

1. Define Refrigeration.
2. Define refrigerant
3. Define C.O.P.
4. Define refrigerant. Give some examples of refrigerant.
5. Give some properties of good refrigerant.
6. Mention some of the applications of refrigeration.
8. Define psychrometry.
9. Define DBT and WBT.
10. What is a dew point temperature?
11. Define humidity
12. Mention the classification of air conditioning system.
13. Define year-round air conditioning system

**PART-B (16 Marks)**

1. Explain the principle and working of vapour compression refrigeration system
2. Explain the principle and working of the vapour absorption refrigeration system
3. Give the comparison of vapour absorption with vapour compression refrigeration system
4. Explain the summer air-conditioning system for hot and dry weather
5. With the neat sketch explain the layout of a window room air conditioning
6. Explain the layout of the split type air conditioning system
7. Mention and explain the different types of refrigerant used
8. Explain the advantages and disadvantages of the window air conditioning unit

## CIRCUIT THEORY

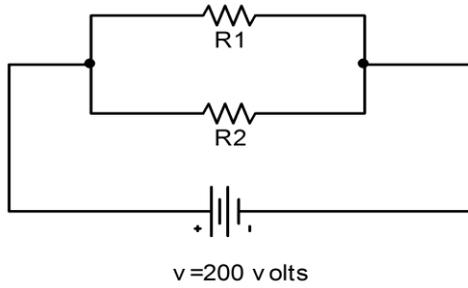
### QUESTION BANK

#### UNIT I

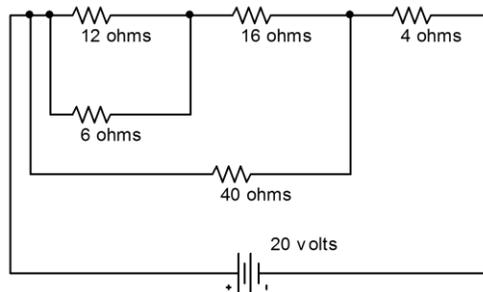
#### BASIC CIRCUITS ANALYSIS

##### PART A

1. State ohm's law.
2. State kirchoff's law.
3. Which law is applicable for branch current method?
4. What is the matrix formation equation for mesh and nodal method?
5. Compare series and parallel circuits.
6. A  $5\ \Omega$  and  $15\ \Omega$  resistors are connected in series to the 50 V battery and  $20\ \Omega$  and  $15\ \Omega$  resistors are connected in parallel to the same battery. Determine the total resistance value?
7. Draw the phasor diagram for RL and RC circuits
8. What is meant by network?
9. What is called branch?
10. What is called node?
11. Define power factor?
12. Mention the application of electrical circuits?
13. List the methods for writing the circuit equation?
14. What is the drawback in mesh method?
15. What is the application of series circuits?
16. Differentiate mesh and nodal analysis.
17. What is meant by active element?
18. Is the silicon diode, is unilateral element? Why?
19. Give examples of passive elements?
20. Differentiate active and passive elements?
21. Two resistors are connected in parallel and a voltage of 200volts is applied to the terminals. The total current taken is 25A and the power dissipated in one of the resistors is 1500Watts. What is the resistance of each element?



22. Calculate the equivalent resistance of the following combination of resistor and source current.



23. Compare AC and DC circuit

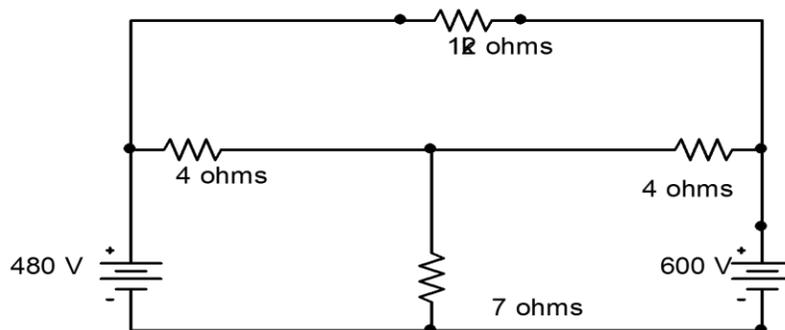
24. Let  $Z = (8 + j6) \Omega$ , convert this into polar form.

25. Define active and reactive power in AC circuits.

### Part-B

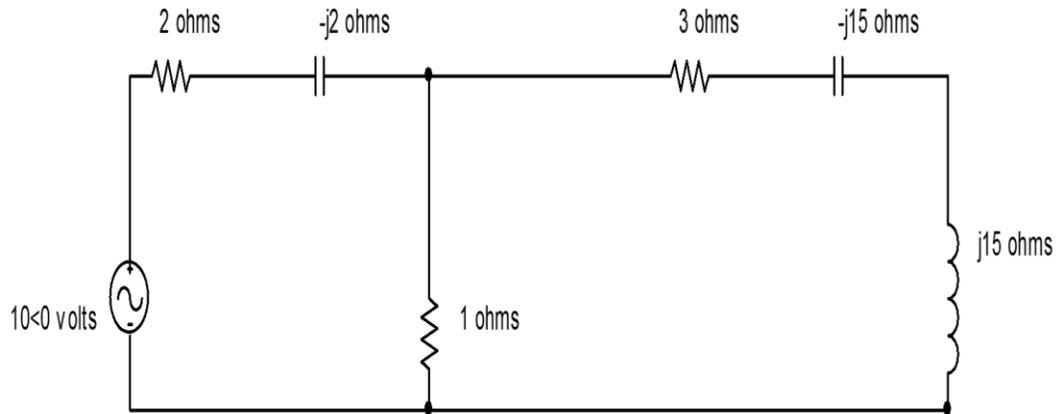
1. Write the mesh equations for the circuit shown in the figure.

the current in  $12\Omega$



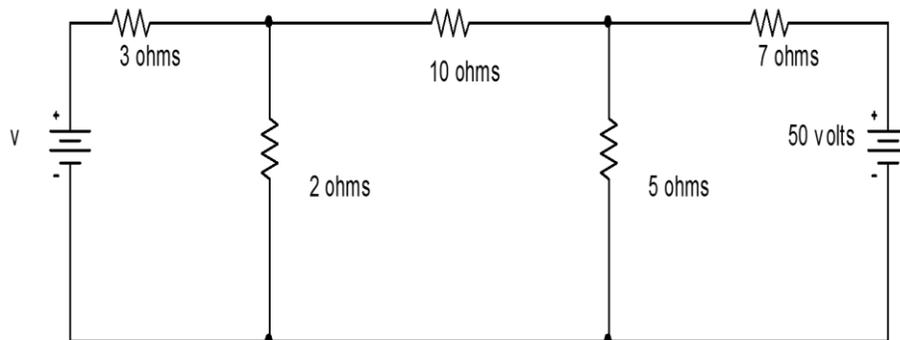
(12)

2. Apply mesh current method and determine currents through the resistors of the network shown in figure.



(12)

3) Find the voltages  $V$  in the circuit shown in figure which makes the current in the  $10\ \Omega$  resistor to be zero by using nodal analysis

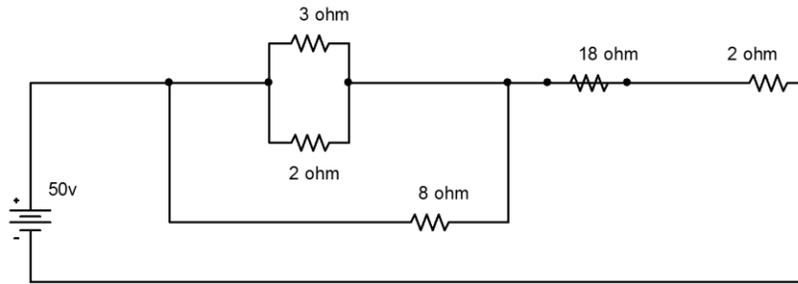


4) A Wheat stone bridge circuit is made up of the following resistors  $AB=3\ \Omega$   $BC=6\ \Omega$  and  $CD=15\ \Omega$  and  $DA=7\ \Omega$  .A  $30\ \text{V}$  battery is connected between A&C.find the current through a  $10\ \Omega$  galvanometer connected between B&D using loop method.

5) (i) Compare series and parallel method

. (ii) Derive the equation of nodal voltage method by using 3 nodes and form the matrix.

6. (i) Find the Equivalent resistance and the current in each resistance.



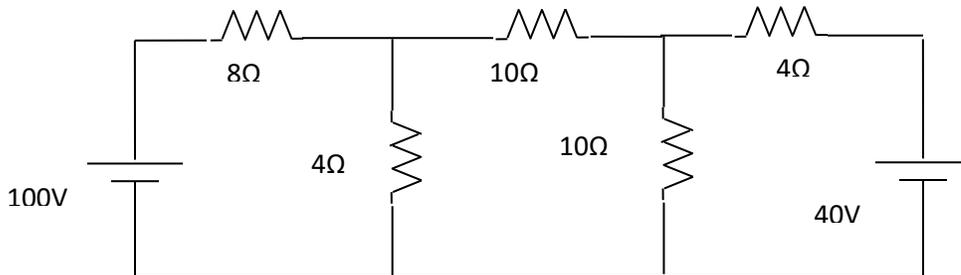
(ii) Derive the equation of 2 loop circuit and form the matrix using mesh current method.

7. Explain the following

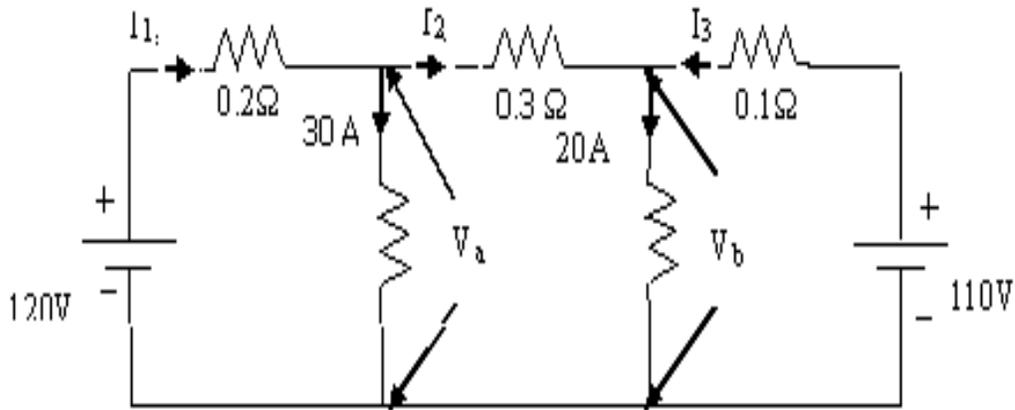
- (i) active elements
- (ii) passive elements
- (iii) bilateral & uni lateral
- (iv) open circuit
- (v) short circuit
- (vi) network

8. Derive the matrix equation for 3 loop circuit?

9. Write the mesh equation for the network shown in figure by inspection and find the power absorbed by  $8\Omega$  resistor.



10. Find the currents  $I_1$ ,  $I_2$ ,  $I_3$  and the voltages  $V_a$  and  $V_b$  in the network of figure by using nodal analysis.

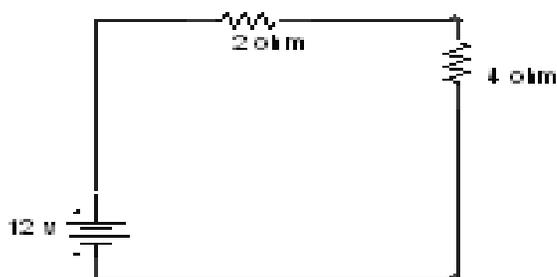


**Unit -2:**

**NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS**

**PART-A**

1. State Super Position Theorem
2. State Thevenins Theorem
3. State Norton's Theorem
4. State Maximum power transfer theorem
5. State Millman's Theorem
6. State Reciprocity Theorem
7. For the network shown in the following fig, convert the voltage source into current source



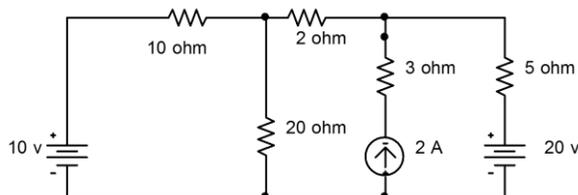
8. Draw the equivalent circuit for Norton's theorem
9. Compare Thevenin's theorem and Norton's theorem
10. How to change the (a) current source into voltage source (b) voltage source into current source?
11. Give one example problem of voltage to current source transformation?
12. Which theorem is used to find the maximum power for a linear/nonlinear network?
13. With example explain the transformation of three voltage source is in series with three resistance combination?

14. Write the formula for star to delta transformation.
15. Write the formula for delta to star transformation.
16. Draw the phase angle diagram of R, Y, B in star connection?
17. Write the formula for finding the Thevenin's resistance
18. What is the formula for load current in Norton's Theorem?
19. Draw the equivalent circuit of Norton's Theorem
20. What is the current formula for Maximum power transfer theorem?
21. Draw the equivalent circuit for Thevenin's theorem
22. What are the steps followed in Compensation Theorem?
23. When the maximum power transfer will occur?
24. Which theorem is valid for linear circuit?
25. Which theorem is applicable for linear / bilateral networks?

#### PART-B

1. (a) Find the Voltage Across the  $2\Omega$  resistor by using super position theorem

(8)



- (b) Write the steps involved in the superposition theorems

(4)

2. Two generators with emfs 200 V and 250 V and armature resistance of  $2\Omega$  and  $1\Omega$  respectively are in parallel supplying a load resistance of  $10\Omega$ . find (a) current

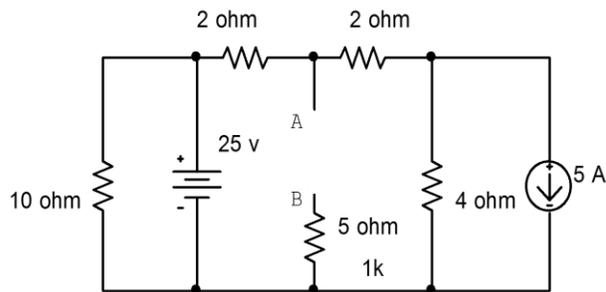
Supplied by each generator (b) load current and (c) load voltage. Use super

Position theorem

(12)

3. (a) For the circuit shown below find the Thevenin's equivalent circuit, preserving terminals A and B. Calculate the current through a  $2\ \Omega$  resistor connected across the terminals AB

(8)



- (b) Write the steps involved in the Thevenin's theorem

(4)

4. (a) Explain reciprocity theorem

(6)

- (b) Write the steps involved in the Norton's theorem

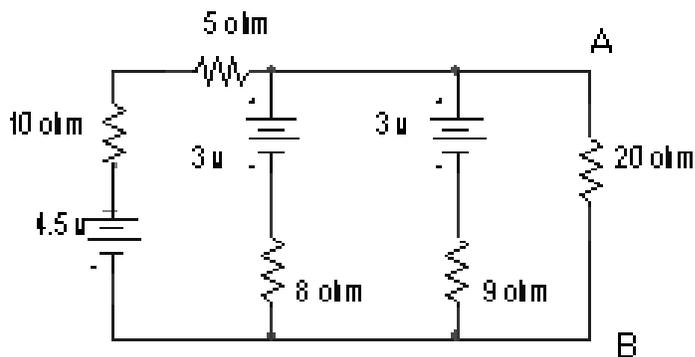
(6)

5. (a) Write short notes on Maximum power transfer theorem

(4)

- (b) Find the voltage between points A & B in the fig below using Norton's theorem

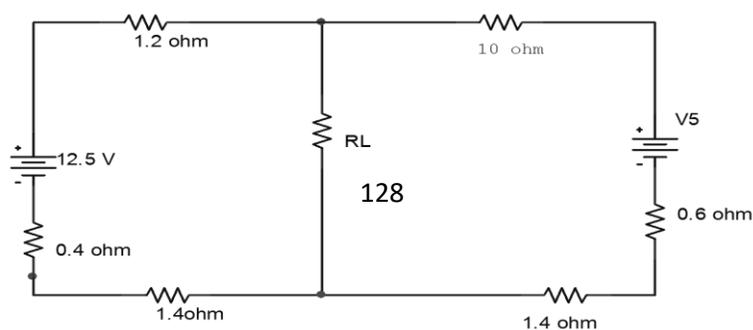
(8)



6. (a) For the circuit of the fig find the value  $R_L$  for maximum power delivered to it.

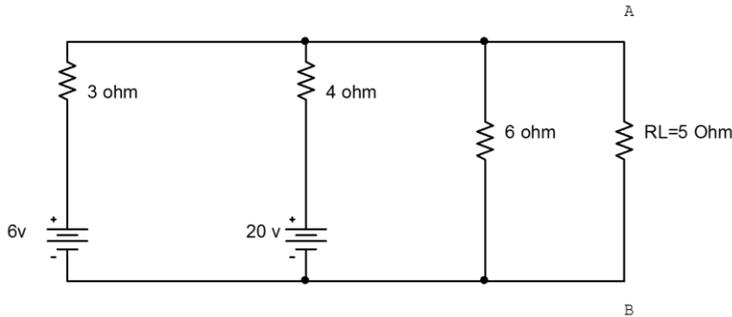
Calculate also the maximum load power.

(8)



(b) State the condition of Millman's theorem for voltage source (4)

7. Use superposition theorems to find the voltage across the terminals A and B and also the current through  $R_L = 5 \Omega$  (12)



8. Write short notes on (i) Star to Delta conversion (6)

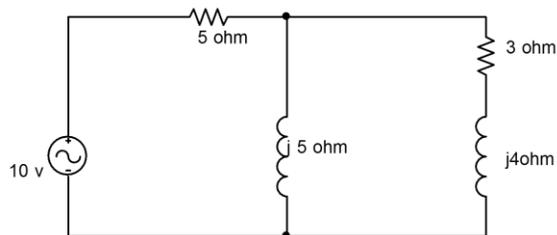
(ii) Delta to Star conversion (6)

and also derive the conditions

9. (i) Write short notes on substitution theorem (4)

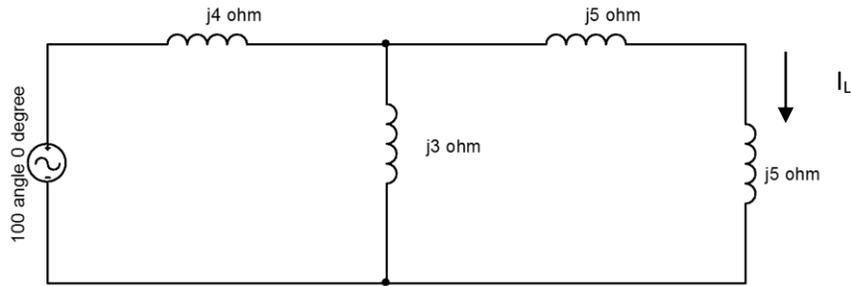
(ii) In the network shown in the fig (a) the  $5 \Omega$  resistor is changed to  $8 \Omega$  determine the change in the current through  $(3+j4) \Omega$  impedance using Thevenin's theorem.

(8)



10. For the circuit shown in figure, determine the load current by applying Thevenin's theorem.

(12)



### Unit-3

## TRANSIENT RESPONSE ANALYSIS

### Part-A

1. Define transient response.
2. Define forced response.
3. Compare steady state and transient state
4. Define transient state and transient time
5. Draw the DC response of R-L circuit and the response curve.
6. Draw the DC response of R-C circuit and the response curve
7. Draw the DC response of R-L –C circuit and the response curve
8. Draw the sinusoidal response of R-L circuit and write the differential equation.
9. Draw the sinusoidal response of R-C circuit and write the differential equation.
10. Draw the sinusoidal response of R-L -C circuit and write the differential equation.
11. Define Laplace transform.
12. Write 2 properties of Laplace transformations.
13. Give an example for forced response
14. Define source – free response
15. Define Zero- Input response
16. Define Zero – State response
17. Write the boundary conditions for the inductance
18. Write the boundary conditions for the capacitance
19. What are the effects of switching on resistor
20. Write the steps to be involved in the determination of initial conditions
21. Define damping ratio?
22. Sketch the current given by  $i(t) = 5 - 4 e^{-20t}$
23. What are the three cases involved in R-L-C transients

24. Distinguish between free response and forced response

25. Define a time constant?

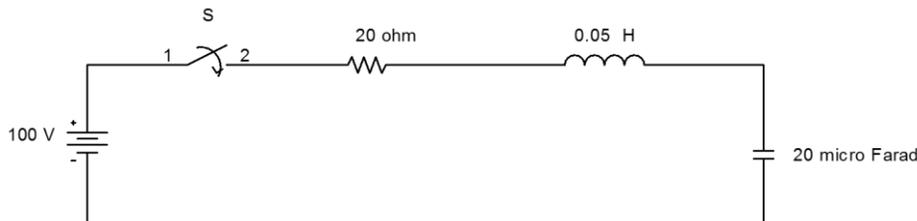
### Part-B

1. (i) Draw the DC response of R-L circuit and derive the power equation of resistor and inductor. . (6)

(ii) Draw the DC response of R-C circuit and derive the power equation of resistor and capacitor. . (6)

2. Draw the DC response of R-L-C circuit and derive the equation of over damped, under damped and critically damped. (12)

3. The circuit shown in figure consists of resistance, inductance and capacitance in Series with a 100 V constant source. When the switch is closed at  $t = 0$ , find the Current transient. (12)



4. Draw the sinusoidal response of R-L circuit and determine the current equation. (12)

5. Draw the sinusoidal response of R-C circuit and determine the current equation (12)

6. Draw the sinusoidal response of R-L-C circuit and determine the current equation (12)

7. The circuit consisting of a series RLC elements with  $R=10 \Omega$ ,  $L=0.5 \text{ H}$  and  $C=200 \mu\text{F}$  has a sinusoidal voltage  $V=150 \sin (200t+ \Phi)$ . If the switch is closed when  $\Phi =30^\circ$ . Determine the current equation. (12)

8.(i) The circuit consists of series RL elements with  $R= 150 \Omega$  and  $L=0.5H$ . The switch is closed when  $\Phi=30^\circ$ . Determine the resultant current when voltage= $150 \cos (100t+ \Phi)$  V.

(6)

(ii) Write short notes on transient analysis.

(6)

#### Unit-4

#### THREE PHASE CIRCUITS

#### Part-A:

1. What is the difference between balanced and unbalanced circuits?
2. In the measurement of three phase power using two wattmeter method, when both the wattmeter read same values, what is the value of power factor of the load?
3. Explain how to solve unbalanced neutral isolated three phase load connected to a balanced supply?
4. Give the relation connecting the power factor angle with the two wattmeter readings.
5. What is floating neutral?
6. Write the types of unbalanced load?
7. Write about symmetrical component method?
8. What is meant by positive sequence component?
9. What is meant by negative sequence component?
10. What is zero sequence component?
11. The two line currents taken by an unbalanced delta connected load are  $I_a=10 \angle 120^\circ$  A,  $I_b=5 \angle 150^\circ$  A. What is the line current  $I_c$ ?
12. What is meant by phase sequence?
13. Define positive phase sequence
14. What are the identification colours of RYB?
15. What are the main objectives of interconnection of the phases?
16. What are the types of interconnections?
17. Write the relation between phase voltage and line voltage in star connected system.
18. Write the relation between phase voltage and line voltage in delta connected system.
19. Write the condition for balanced star connected load

20. Draw the circuit diagram for balanced delta connected load
21. A balanced star connected load of  $(3-j4\Omega)$  impedance is connected to 400 V three phase supply. What is the real power consumed?
22. A symmetrical three phase, 400 V system supplies a balanced mesh connected load. The current in each branch circuit is 20A and the phase angle is 40 degree lag. Find (a) the line current (b) the total power
23. What are the four methods can be analyzed in unbalanced star connected load
24. Define three phase balance load
25. Explain balance supply system

#### Part-B

1. Explain three phase power measurement by 2 wattmeter method for star and delta connected load and determine the power equation and draw the phasor diagram. (12)
2. (i) Explain three phase power measurement by 3ammeter and 3 volt meter method (6)  
(ii) Give the short notes on balanced star-delta and delta-star conversion. (6)
3. (i) Derive the expression for balanced star connected load and draw the phaser diagram. (6)  
(ii) Give the short notes on symmetrical components and un-symmetrical components. (6)
4. (i) Explain three phase power measurement by 2 wattmeter method and determine the power factor equation (6)  
(ii) Two wattmeter method is used to measure power in a 3 phase load, the wattmeter readings are 400 W and -35 W .Calculate (i) total active power (ii) power factor and (iii) reactive power (6)

5. (i) Derive the expression for balanced delta connected load and draw the phasor diagram. (6)

(ii) A balanced star connected load of  $(3-j4) \Omega$  impedance is connected to 400 V three phase supply. What is the real power consumed? (6)

6. (a) Derive the expression for unbalanced star connected load and draw the phasor diagram. (6)

(b) A balanced star connected load of  $(8+j6) \Omega$  /phase is connected to a 3 phase, 230 V, 50c/s supply. Find the line current, power factor and power (6)

7. (a) Derive the expression for unbalanced delta connected load and draw the phasor diagram. (6)

(b) Derive the expression for total power in a 3 phase balanced circuit. (6)

8. (i) A balanced delta connected load takes a line current of 15 A when connected to a balanced 3 phase 400 V system. A wattmeter with its current coil in one line and Potential coil between the two remaining lines read 2000W. Describe the load Impedance. (6)

(ii) In a balanced 3 phase system, the power is measured by 2 wattmeter method and the Ratio of two wattmeter method is 2:1. Determine the power and power factor. (6)

9. (a) Derive the expression for 3 wire star connected unbalanced load. (6)

(b) Derive the expression for 4 wire star connected unbalanced load. (6)

## Unit-5:

### RESONANCE AND COUPLED CIRCUITS

#### PART-A

1. Write the condition of resonance.
2. Define band width.
3. Draw the series resonance circuit and the phasor diagram.
4. Draw the parallel resonance circuit and the phasor diagram.
5. Compare series and parallel resonance circuits.
6. Two inductively coupled coils have self inductance  $L_1=45$  mH and  $L_2=150$  mH. If the co-efficient of coupling is 0.5, (i) find the value of mutual inductance between the coils and (ii) what is the maximum possible mutual inductance?
7. Define mutual inductance.
8. Determine the value of capacitive reactance and impedance at resonance. When  $R = 10\text{ohm}$ ,  $C = 25\mu\text{F}$  and  $L = 10\text{mH}$
9. Define of quality factor.
10. Define coefficient of coupling?
11. Write about coupled circuits.
12. For which condition, the net reactance is capacitive?
13. Write the equation for maximum power absorption
14. When the series A.C circuit is at resonance?
15. Mention the relationship between Q-factor and bandwidth
16. A coil of resistance  $2\text{ohm}$  and inductance  $0.01\text{H}$  is connected in series with capacitor C. If maximum current occurs at  $25$  Hz find C?
17. What is resonance frequency and Bandwidth of a series RLC circuit in which  $R=5\text{ohm}$ ,  $L=40\text{mH}$ ,  $C=1\mu\text{F}$ ?
18. Define Series Resonance
19. What is meant by parallel resonance?
20. Draw the reactance curves for inductive load
21. In rectangular form, what is the value of impedance and admittance
22. Draw the frequency response of R-L circuit and explain

23. In a parallel RL circuit  $R=3\text{ohm}$  and  $X_L=4\text{ohm}$ .What is the value of admittance?
24. What do you understand by damped frequency?
25. What is the maximum possible mutual inductance of two inductively coupled coils with self inductance  $L_1=25\text{mH}$  and  $L_2=100\text{mH}$ ?

PART –B

1. (i) Derive the resonant frequency of series circuit. (6)
- (ii) Short notes on Q- factor and its effect on band width. (6)
2. (i) Compare series and parallel resonance circuits (6)
- (ii) Give the short notes on (a) co-efficient of coupling and (b) dot convention (6)
3. (i) Derive the band width of RLC circuit. (6)
- (ii) A coil having a resistance of  $50\ \Omega$  and an inductor of  $0.2\ \text{H}$  is connected in series with a variable capacitor across a  $60\ \text{V}$ ,  $50\ \text{Hz}$  supply .Calculate the capacitance required to produce resonance and the corresponding values of (a)current (b)voltage across the coil and the capacitor (c)the power factor (d)Q-factor. (6)
4. (i) Derive the Q-factor of parallel resonance circuit. (4)
- (ii) One RLC circuit has  $R= 30\ \Omega$ ,  $L=40\ \text{mH}$  and  $C= 50\ \mu\text{F}$ . Find the resonant frequency .Under resonant conditions, Calculate the current and voltage drops across the R, L, and C if applied voltage is  $120\ \text{V}$ . (8)
5. (i) A  $50\ \Omega$  resistor is connected in series with an inductor having internal resistance ,a Capacitor and  $100\ \text{V}$  variable frequency supply as shown in fig. At a frequency of  $200\text{Hz}$ , the maximum current of  $0.7\text{A}$  flows through the circuit and voltage across the C is  $200\ \text{V}$  .Determine the circuit constants. (8)
- (ii) Derive the resonant frequency of parallel circuit. (4)
6. (i) A series RLC circuit consists of  $50\ \Omega$  resistance , $0.2\ \text{H}$  inductance and  $10\ \mu\text{F}$  capacitor with the applied voltage of  $20\ \text{V}$  .Determine the resonant frequency, Q-factor of the circuit and compute the lower and upper frequency limits and also find the band width of the circuit. (8)

(ii) Write a short notes on multi winding coupled circuit. (4)

7. (i) Give the short notes on coupled circuit and inductively coupled circuit. (6)

(ii) Explain Q-factor and band width.. (6)

8. A series circuit consisting of a  $12\Omega$  resistor,  $84.4\mu\text{F}$  capacitor and a variable inductor is connected to a 100V, 50 cycle source. a) For the condition of resonance, determine the inductance current and voltage drop across the inductor, b) determine the inductance current and the voltage drop across the inductor when this voltage drop is a maximum,

(12)

9. A series RLC circuit with  $R=10\Omega$ ,  $L=10\text{ mH}$  &  $C=1\mu\text{F}$  has an applied voltage of 200 V at resonant frequency. Calculate the resonant frequency, the current in the circuit and the voltages across the elements at resonance. Find also the quality factor and bandwidth.

(12)

10. A current source is applied to a parallel combination of R, L & C, where  $R=10\Omega$ ,

$L=1\text{H}$ , &  $C=1\mu\text{ F}$ .

A) Compute the resonant frequency.

B) Find the quality factor.

C) Calculate the value of the bandwidth.

Compute the lower and upper half frequency points of the band width . (12)

## UNIT-I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

### Environment

#### PART-A

##### 1. Define environment.

'Environment' is derived from the French word *Environ* which means to encircle or surround. All the biological and non-biological things surrounding an organism are thus included in environment. Thus environment is sum total of water, air and land, inter-relationships among themselves and also with the human beings, other living organisms and property.

##### 2. Write down the components of environment. (May-June 2013) (Nov-Dec 2014)

The components of environment can be broadly divided into two

- a) Abiotic components - composed of all the non living components like temperature, water, minerals and gases etc. It includes 1. Lithosphere 2. Hydrosphere 3. Atmosphere
- b) Biotic components - composed of all the living components (plants, animals & micro-organisms) It includes 1. Producers 2. Consumers 3. Decomposers

##### 3. Write the classification of biological environment.

Floral/Plant Environment  
Faunal /Animal Environment  
Microbial environment

### ECOSYSTEMS

##### 1. What are the components of Eco system?

An Eco system has two major components.

Biotic (or) Living components  
Abiotic (or) Non living components

##### 2. What are nutrient cycles (or) Bio-geochemical cycle?

The cycle flow of nutrients between the biotic and abiotic components is known as

Nutrient cycle (or) biogeochemical cycle

##### 3. What is hydrological cycle? (Nov-Dec 2013)

Movement of water in a cyclic manner is known as hydrological cycle.

##### 4. What is ecological succession? Mention their types. (Nov-Dec 2008) (Nov-Dec 2013)

The progressive replacement of one community by another till the development of stable community in a particular area is called ecological succession.

Types:

a) Primary succession

ii) Xerosere

i) Hydro sere

b) Secondary succession

5. Why are plants called as producers?

The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compounds namely water and carbon dioxide. As the green plants manufacture their own food they are known as Autotrophy.

6. What are food chains? (Nov-Dec 2009) (April-May2015) (Nov-Dec 2015)

The sequence of eating and being eaten in an ecosystem is known as food chains

7. What is food web? (Nov-Dec 2009) (April-May2010)

The interlocking pattern of various food chains in an ecosystem is known as food web.

8. What is ecological pyramid? (April-May2010)

Graphical representation of structure and function of trophic levels of an ecosystem starting with producers at the bottom and each successive trophic levels forming the apex is known as ecological pyramids.

9. What are called Producers?

Producers are mainly the green plants, which can synthesize their food themselves by making use of CO<sub>2</sub> present in the air and water in the presence of sunlight by involving chlorophyll, through the process of photosynthesis. They are also known as photo autotrophs.

10. Name the four ecosystems. (April-May 2010)

- Forest ecosystems
- Grass land ecosystems
- Desert ecosystems
- Pond ecosystems

11. Explain the concept of an ecosystem. (Nov-Dec 2013)

A group of organisms interacting among themselves and with environment is known as ecosystem.

12. Define the terms a) Producers and b) Consumers. (April-May 2008)

a) Producers synthesize their food themselves through photosynthesis.

b) Consumers are organisms which cannot prepare their own food and depends on food directly or indirectly on the producers.

13. What is meant by keystone species?

Within a habitat each species connects to and depends on other species. But while each species contribute to habitat functioning, some species do more than others in the overall scheme of things. Without the work of these key species, the habitat changes significantly. These

Species are called keystone species. When a keystone species disappears from its habitat, that Habitat changes dramatically.

14. What are the characteristics of desert ecosystem? (April-May 2010)

- Air is dry and climate is hot.
- Annual rain fall is less than 25 cm.
- Soil is poor nutrients and organic matter.
- Vegetation is poor

15. What are autotrophic and heterotrophic components of an ecosystem? Give examples. (Nov-Dec 2008)

Autotrophic component: The members of autotrophic components are producers which are autotrops (self – nourishing organisms). They derive energy from sun light and make organic components from inorganic substances. Eg: Green plants, Algae, Bacteria etc

Heterotrophic components: The members of heterotrophic components are consumers and decomposers, which are heterotrops (depend on others for food). They consume autotrops (Producers).

16. Define primary production and secondary production. (Nov-Dec 2009)

Primary production: It is defined as the conversion of radiant energy into organic substances by photosynthesis by the primary producers (Plants)

Secondary production: .It is defined as distribution of energy in the form of food to the consumer (or) the energy stored by the consumer.

17. How does biome differ from an ecosystem?

The kind of organisms which can live in a particular ecosystem depends on their physical and metabolic adoptions to the environment of that place. On earth there are many sets of ecosystems which are exposed to same climatic conditions and having dominant species with similar life cycle, climatic adoptions and physical structure. This set of ecosystem is called a biome.

18. Define decomposer and give their significance. (Nov-Dec 2012)

The microorganism which feeds on dead organs is known as decomposer. Examples: bacteria and fungi.

19. Define ecology. (May-June 2014)

Ecology is the [scientific](#) study of interactions among organisms and their environment.

20. Mention two and secondary consumers in grassland ecosystem. (May-June 2016)

Primary consumers – Giraffe, Deer.

Secondary consumers – Snake, Lizard.

21. How is nitrogen fixed in soil? (April-May 2017)

They contain symbiotic bacteria called rhizobia within nodules in their root systems, producing nitrogen compounds that help the plant to grow and compete with other plants. When the plant dies, the fixed nitrogen is released, making it available to other plants; this helps to fertilize the soil.

## BIODIVERSITY

1. What is In-situ conservation? (Nov-Dec 2012)(Nov-Dec 2017)

It involves protection of fauna and flora within its natural habitat, where the species normally occurs is called in-situ conservation.

2. What is Ex-situ conservation? (Nov-Dec 2012) (Nov-Dec 2017)

It involves protection of fauna and flora from the outside natural habitats.

3. Enumerate the human activities which destroy the biodiversity.

- The farmers prefer hybrid seeds; as a result, many plant species become extinct.
- For the production of drugs, pharmaceutical companies collect medicinal plants, become extinct.
- Tropical forest is the main sources of world's medicine. Every year these forests are disappearing due to agriculture, mining, logging.

4. Define the terms a) genetic diversity and b) species diversity (Ap-May2008) (Nov-Dec 2007) (April-May 2017)

a) Genetic diversity: It is the diversity within species

b) Species diversity: It is the diversity between different species. The sum of varieties of all the living organisms at the species level is known as species diversity.

5. What do you understand by the terms flora and fauna?

Flora: Plants present in a particular region or period.

Fauna: Animal present in a particular region or period.

6. India is a mega diversity nation-Account. (Nov-Dec 2009)

India is one among the 12 mega diversity countries in the world. It has 89450 animal species accounting for 7.31% of the global faunal species and 47000 plants species accounting for 10.8% of the global floral species. The loss of biodiversity is about 33%.

7. What are the two important bio-diversity hot spots in India?

1. Eastern Himalayas
2. Western Ghats

8. Give few examples for endangered and endemic species.

Endangered species:

- Reptiles : Tortoise, Python.  
Mammals : Indian wolf, Red fox, Tiger.  
Primates : Golden monkey.

Plants : Santalum.

Endemic species:

Flora: Sapria Himalayan, Ovaria lusida

Fauna: Monitor lizards, Indian salamander

9. Define biodiversity and mention its significance. (April-May2015) (Nov-Dec 2015)

It is defined as the variety and variability among all groups of living organism and the ecosystem in which they occur.

Significance:

- It is very important for human life, as we depend on plants, microorganisms, earth's animals for our food, medicine and industrial products.
- It protects the fresh air, clean water and productive land.

10. Write the classification of biodiversity. (May-June 2014) (Nov-Dec 2016)

The concept of biodiversity may be analyzed in 3 different levels.

1. Ecosystem diversity
2. Species diversity
3. Genetic diversity

Ecosystem diversity: (Nov-Dec 2016)

- The richness and complexity of a biological community, including tropic levels, ecological processes food webs and material recycling.

Species diversity:

- The number of kinds of organisms within individual communities or ecosystems.

Genetic diversity:

- It is a measure of the variety of versions of same gene within individual species.

11. What are called endangered species? (Nov-Dec 2014) (Nov-Dec 2017)

A species said to be endangered species, when its number has been reduced to a critical level. Unless it is protected and conserved it is in immediate danger of extinction.

12. What are the major threats to biodiversity? (Nov-Dec 2014)

- Habitat loss.
- Poaching.
- Man – wild conflicts.

13. Explain vulnerable species.

A species said to be vulnerable species when its population is facing continuous decline due to habitat destruction or over exploitation. Such a species is still abandoned.

14. Write note on nitrogen cycle. (Nov-Dec 2017)

The nitrogen cycle is the biogeochemical cycle by which nitrogen is converted into various chemical forms as it circulates among the atmosphere, terrestrial, and marine ecosystems. The conversion of nitrogen can be carried out through both biological and physical processes. Important processes in the nitrogen cycle include fixation, ammonification, nitrification, and denitrification. The majority of Earth's atmosphere (78%) is nitrogen, making it the largest source of nitrogen. However, atmospheric nitrogen has limited availability for biological use, leading to a scarcity of usable nitrogen in many types of ecosystems.

15. Mention two invasive species. (Nov-Dec 2017)

An invasive species is a plant, fungus, or animal species that is not native to a specific location (an introduced species), and which has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health

Eg. Flat worms, jelly fish, bony fish, sharks, rays, amphibians, reptiles.

16. What is called endemic species? (Nov-Dec 2017)

These species which are found only in a particular region are known as endemic species.

Eg. Endemic flora species- *Sapria himalayana*, *Ovaria lurida*,

Endemic fauna species- Monitor lizards, reticulated python.

## UNIT-I

### PART-B

#### ENVIRONMENT

1. Discuss the structure of atmosphere.
2. Explain the community participation in environment management programmes.
3. What are the components of the environment? Explain their role. (May - June 2016)

#### ECOSYSTEM

- Describe the types, characteristic features, structure and function of
4. Forest eco system (April-May2010) (Nov-Dec 2012) (Nov-Dec 2011) (Nov-Dec 2013) (Nov-Dec 2015)
  5. Aquatic eco system (Ap-May2010) (Nov-Dec 2011) (April-May2015) (Nov-Dec 2015)
  6. Grass land ecosystem. (Nov-Dec 2009) (Nov-Dec 2012) (Nov-Dec 2014) (Nov/Dec 2015) (April-May 2017)
  7. Describe the types, characteristic features, structure and function of
    - i) Desert ecosystem (May-June 2013)
    - ii) Estuarine ecosystem.
  8. Explain energy flow in eco system, food chain and food web. (Ap-May2008)(Nov-Dec 2008, 2013)
  9. Explain ecological pyramids and their types. (Nov-Dec 2008) (Nov-Dec 2007) (May/June 2014) (April-May2015) (Nov-Dec 2015).
  10. Discuss the structure and function of an eco system in detail. OR Discuss the components of ecosystem. (Nov-Dec 2009) (Ap-May2010) (Ap-May2008) (Nov/Dec 2014) (May - June 2016) (Nov-Dec 2016)
  11. Give the types and process of ecological succession. (May-June 2013) (April-May2015) (Nov-Dec 2015) (Nov-Dec 2016)
  12. Explain briefly in energy flow through ecosystem. (Nov-Dec 2015)
  13. Write short notes on following
    - Food web
    - Food chain (May/June 2014)

#### BIODIVERSITY

1. Discuss the threat faced by Indian bio diversity. (Nov-Dec 2013) (April-May2015) (Nov-Dec 2015)
2. Explain the conservation of biodiversity. (April-May2010) (Nov-Dec 2008, 2009, 2013 and 2014) (April-May 2017)
3. Write a note on measuring biodiversity.
4. Explain the role of biodiversity at global, national and local levels. (May-June 2014)
5. Explain in-situ and ex-situ conservation along with their merits and limitations. (Nov-Dec 2009) (Ap-May2008) (Nov-Dec 2008) (May - June 2016) (Nov-Dec 2016)
6. Describe the term hotspot in biodiversity. (Ap-May2008) (Nov-Dec 2007)(Nov-Dec 2012 , 2014) (Nov-Dec 2017)
7. Discuss endangered and endemic species of India. (Nov-Dec 2009)

8. Discuss the status of India as a mega diverse nation of bio diversity. (May-June 2013) (Nov-Dec 2016) (April-May 2017)
9. Describe the structural features of ecosystem. (Nov-Dec 2009)
10. Discuss the importance of biodiversity. (Nov-Dec 2009) (Nov-Dec 2013)
11. Explain the values of biodiversity. (Ap-May2010) (May-June 2013) (Nov-Dec 2014)
12. Identify and explain the major threats to the biodiversity of India. (Nov-Dec 2013) (May - June 2016) (Nov-Dec 2017)
13. Discuss uniqueness of different ecosystems; Forest ecosystem, Grassland ecosystem, Desert ecosystem and aquatic ecosystem. (Nov-Dec 2017)
14. Discuss human animal conflicts with special reference to media coverage. (Nov-Dec 2017)

## uNIT - II ENVIRONMENTAL POLLUTION

### PART-A

1. Define pollution.

Pollution may be defined as the excessive discharge of undesirable substances into the natural quality of the environment and causing damage to humans, plants and animals.

2. What are suspended particulate matters? Give examples.

Suspended Particulate matters are the substances which cause undesirable effects on man and his environment. eg. Smoke, dust, soot, fumes, aerosols, liquid droplets, pollen grains etc.

3. What is photochemical smog? (Nov-Dec 2012)

- It is a mixture of brownish smoke and fog that frequently forms on clear, sunny days over large cities with significant amount of automobile traffic.
- It is mainly due to chemical reactions among nitrogen oxides and hydrocarbon by sunlight.

4. How will you control Air pollution?

Air pollution can be minimized by

- Using low sulphur coal in Industries.
- Removing NO<sub>x</sub> during the combustion process.
- Using mass transport system, bicycles.etc.
- Planting more trees etc.,

5. What is PAN? Give its detrimental effects. (May - June 2016)

Definition: PAN is Peroxy Acetyl Nitrates formed by the photochemical reaction between hydrocarbons, nitrogen oxides and light.

Effects: Damages plants and art, React explosively and produce chemical smog.

6. Define BOD and COD. (Nov-Dec2008) (Nov-Dec 2012) (Nov-Dec 2013)

*BOD-Biological Oxygen Demand* is the quantity of dissolved oxygen required by bacteria for

the oxidation of organic matter under aerobic conditions.

*COD- Chemical Oxygen Demand* is the measure of both biologically oxidisable & inert organic materials present in the sewage.

7. What are point sources and non-point sources of pollution?

*Point sources*- Point sources are discrete discharges from pipes and other conduits such as sewage treatment plants and Industrial facilities.

*Non-Point sources*- It is broad, unconfined area from which pollutants enter a body of water.  
eg., urban storm water run-off, run-off from farm fields, acid rain etc.,

8. Give the source of radioactivity.

*Natural sources*- Cosmic ray from outer space, radioactive radon-222, soil, rocks, air, water and food which contains one or more radioactive substances.

*Anthropogenic sources*- Nuclear power plants, nuclear accidents, X-rays diagnostic kits, test laboratories etc.

9. What are the important physical and chemical parameters affecting the quality of water? (OR) Mention the water quality parameters. (Nov-Dec 2016)

*Physical parameters*: Colour, Taste and odour, Turbidity and sediments.

*Chemical parameter*:  $\text{pH}$ , Acidity, Alkalinity, Fluoride, Nitrogen Nitrates, Sulphates, Chloride.

10. What is the role of Citizen in reducing pollution? (Nov-Dec 2009)

Help more in pollution prevention than control.  
Use ecofriendly products.  
Cut down the use of CFC's.  
Adopt and popularize renewable energy resources.

11. What is meant by air pollution?

*Air pollution* may be defined as the presence of impurities in excessive quantity and duration to cause adverse effects on plants, animals, human beings and materials.

12. List the types of air pollutants. (Nov-Dec 2008)

*Particulate pollutants*- Dust, Smoke, Fly ash, Smog, etc.  
*Gaseous pollutants* -  $\text{SO}_2$ ,  $\text{SO}_3$ ,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{H}_2\text{S}$ , aerosols, etc.  
*Internal Combustion Engines* -  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{SO}_2$ ,  $\text{NO}_2$  and hydrocarbons

13. Define thermal pollution. (Nov-Dec 2009)

Addition of excess of undesirable heat to water that makes it harmful to aquatic life and cause significant changes of normal activities of aquatic communities.

14. Write any four major water pollutants.

Infectious agents, Organic wastes, In-organic wastes and Demand of O<sub>2</sub>

15. Name the sources of soil pollution. (May/June - 2013)

Biotic agents, Industrial waste, Urban wastes, Domestic wastes, Radioactive wastes and Agricultural wastes.

16. Write briefly how human activities can introduce thermal pollution in Streams.

The addition of heat to water that changes the physical, chemical and biological characteristics of water and also harmful to man, animal and aquatic life. The atomic and

Thermal power plants may utilize water for cooling the reactor and resultant warmed water is often discharged into streams or lakes that cause thermal pollution.

17. What are the sources of thermal pollution? (May - June 2016)

Nuclear power plants, Thermal power plants, Hydro electric power plants, Industrial effluents, Domestic sewage, Hydro electric power

18. What is marine pollution? Mention few reasons / sources for marine pollution.(Nov-Dec2014) (April-May 2017)

Dumping of waste and oil spillage in the ocean cause threat to marine system is called marine pollution. Dumping of wastes and Oil Spilling.

19. What is noise pollution? How it is caused? (or) Define the term noise pollution.(Nov/Dec 2013) (April-May2015) (Nov-Dec 2015) (Nov-Dec 2010)

It is an unwanted sound created by human activities is called noise pollution. Blaring loudspeaker, bursting of crackers, road traffic, aircraft taking off, massive industries and from entertainment centers.

20. What is disposal?

*Disposal* is the discharge, deposit, injection, dumping, spilling, leaking or placing of waste into or any land, water or air.

21. Differentiate between recycling and reuse.

S.No.	Recycling	Reuse
1.	Reprocessing of the discarded materials into new useful products	Usage of discarded materials

2.	Eg. Preparation of cellulose insulation from paper Aluminium cans and glass bottles are melted and recast into new cans and bottles	Discarded refillable containers can be reused Discarded cycle tubes can be reused to manufacture rubber rings.
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22. What is composting?

The decomposition and stabilization of solid wastes taken place by biochemical bacteriological process under the controlled conditions is called composting. It occurs in 2 ways.

Aerobic decomposition

Anaerobic decomposition

23. What are the sources of Urban and Industrial waste?

*Urban waste* consists of medical waste from hospitals, municipal solid wastes from homes, offices, markets, small cottage units and horticulture wastes from park, garden, orchards etc.,

*Industrial waste* consist of a large no: of materials including factory rubbish, packaging materials organic wastes, acids, alkalis, metals etc.,

24. When is a waste said to be hazardous? (Nov-Dec 2009)

A waste is said to be *hazardous* if it possess one or more of the following characteristics,

Toxicity b)Reactivity c)Ignitability d)Radioactivity

25. What are the general methods to removal of heavy metals by adsorption?

Using coconut shell carbons

Using fly ash

Using clay and coal based adsorbents.

26. What are the major causes of earthquake? (May/June 2014)

Underground nuclear testing.

Volcanic eruptions

Pressure of manmade dams, reservoir and lakes

Movement of plates of earth.

27. Define hazardous waste (Nov-Dec 2014)

Radio active and toxic wastes which poses substantial or potential threats or illness to human health and the environment is called as hazardous waste.

28. Differentiate between sound and noise. (Nov-Dec 2014)

S.No	Sound	Noise
1	Below 120 dB	Above 120 dB
2	It doesn't make pollution	It makes pollution

29. How does ozone layer depletion take place? (Nov-Dec 2014)

It occurs due to the presence of CO<sub>2</sub>, CFC in the atmosphere.

30. What is the role of individual in preventing pollution? (Nov-Dec 2015)

Plant more trees.

Use water, energy and other resources efficiently.

Reduce deforestation.

Use CFC free refrigerators.

31. Mention the measures to control thermal pollution caused by industry. (Nov-Dec 2016)

Cooling towers (Wet cooling tower & Dry cooling tower)

Cooling Ponds

Cooling Sprays

Artificial Lake

32. Mention the effects of nuclear wastes in humans. (April-May 2017)

- The waste released from chemical industries and from explosives are dangerous to human life.
- The dumped waste degrade soil and make unfit for irrigation.

33. What are landslides? (Nov/Dec 2008) (Nov-Dec 2014)

The movement of earthy materials like coherent rock, mud, soil and debris from higher region to lower region due to gravitational pull is called landslides.

34. Define floods.

Whenever the magnitude of water flow exceeds the carrying capacity of the channel within its banks, the excess of water over flows on the surroundings causes floods.

## UNIT-II

### PART-B

1. Write brief notes on solid waste management. State the measures recommended for proper management of the solid wastes. (Nov-Dec2008) (Nov-Dec 2012) (Nov-Dec 2010) (Nov-Dec 2013) (May/June 2014) (April-May2015) (Nov-Dec 2016)

2. Explain the causes, effects and control measure of water pollution.(Ap-May2008) (Nov-Dec 2012) (Nov-Dec 2013) (May/June 2013) (May-June 2014) (Nov/Dec 2014) (Nov-Dec 2015) (May - June 2016)

3. Explain the causes, effects and various methods of controlling air pollution. (Ap-May2008) (May - June 2016) (May-June 2013) (Nov/Dec 2014) (Nov-Dec 2009) (April-May2015) (Nov-Dec 2015)

4. Explain the concept of source, path receiver in the control of noise pollution. (Nov-Dec2009) (Nov-Dec 2011) (Nov-Dec 2014) (Nov-Dec 2016) (April-May 2017)

5. Explain the causes, effects and control measure of marine pollution. (Nov-Dec 2009) (Nov/Dec 2014) (Nov-Dec 2015) (May - June 2016) (Nov-Dec 2016)
6. Explain the causes, effects and control measure of nuclear hazards and explain any two case studies on nuclear pollution. (April-May2015) (Nov-Dec 2015)
7. Discuss the major soil pollution and their impact.
8. Explain any one disaster management in detail. (Nov-Dec 2009)
9. Discuss the role of individual in preventing pollution. (Nov-Dec 2009) (Nov-Dec 2011) (Nov-Dec 2014) (April-May2015)
10. Explain the causes, effects and control measure of thermal pollution. (Nov-Dec 2009) (Nov-Dec 2013) (May/June 2014) (May-June 2013) (Nov-Dec 2015)
11. 12. Write informative notes on water treatment processes. (Nov-Dec 2014)
13. Discuss the significance of any six parameters of drinking water quality standards. (Nov/Dec 2014)
- 14.
15. What are the effects of heavy metals in aquatic environment? (April-May 2017)
16. What is a particulate matter? How is it controlled by using equipment? (April-May 2017)
17. Discuss physical, chemical, biological parameters to ensure drinking water quality.(Nov-Dec 2017)

### UNIT-III NATURAL RESOURCES

#### PART-A

1. What are renewable and non-renewable energy resources? Give examples. (Nov-Dec 2008-09)
 

Renewable energy resources are natural resources which can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.
2. State the environmental effects of extracting and using mineral resources. (May - June 2016)
 

Devegetation and defacing of landscape	Air pollution
Ground water contamination	Subsidence of land
Surface water pollution	
3. Define sustainable forestry.
 

It is the optimum use of forest resources which meet the needs of the present without compromising the ability of future generations to meet their own needs.

4. Define overgrazing.

Overgrazing is a process of eating away the forest vegetation without giving it a chance to regenerate.

5. What is desertification? Give two reasons for it. . (Nov-Dec 2009), (Apr-May 2008)

It is a progressive destruction or degradation of arid or semi arid lands to desert.

Reasons:

Deforestation, Overgrazing, Mining and quarrying

6. What is water logging? Mention about the problems in water logging.

Water logging is the land where water stand for the most of the year.

Problems: During water logged conditions, pore-voids in the soil get filled with water and the soil-Air gets depleted. In such condition the roots of the plants do not get adequate for respiration. So, mechanical strength of the soil decreases and the crop yield fails.

7. What do you mean by environmental impact? (Nov-Dec 2009) (Nov-Dec 2014)

Environmental impact is nothing but the effect on the natural environment caused by various human actions.

8. Define soil leaching. List the effects of soil leaching.

The process in which materials in or on the soil gradually dissolve and are carried by water seeping through the soil.

Effects of soil leaching:

It removes valuable nutrients from the soil.

It may carry buried wastes into ground water and contaminates it.

9. Write any four functions of forests.

Forests perform very important functions both to humans and to nature.

They are habitats to millions of plants, animals and wildlife.

They recycle rain water and remove pollutants from air.

They control water quality and quantity

10. What are the causes of deforestation? (Nov-Dec 2010)

Developmental projects, Mining operations, Raw materials for industries, Fuel Requirements

Shifting cultivation and Forest fires.

11. Compare merits and problems of dams.

Merits of dams:

- Dams are built to control flood and store flood water
- Its used for diverting part or all of the water from river into a channel
- Dams are used mainly for drinking and agricultural purposes
- Dams are built for generating electricity

Problems of dams:

- Displacement of tribal people
- Loss of non-forest land
- Loss of forests, flora and fauna
- Water logging and salinity due to over irrigation
- Reduced water flow and silt deposition in rivers
- Salt water intrusion at river mouth

12. What is meant by soil erosion?

Soil erosion is the process of removal of superficial layer of the soil from one place to another. Soil erosion also removes the soil components and surface liter.

13. Differentiate between deforestation and forest degradation. (Nov-Dec 2007)

Forest degradation	Deforestation
It is the process of deterioration of forest materials.	It is the process of destruction of forest materials.
Slow process	Rapid process
Can be recovered	Cannot be recovered

14. Enumerate the desired qualities of an ideal pesticide. (Nov-Dec 2007)

It must kill only the target species

It must be a biodegradable

It should not produce any new pests

It should not produce any toxic pesticide vapour

Excessive synthetic pesticide should not be used

Chlorinated pesticides and organophosphate pesticides are hazardous, so they should not be used.

15. Write any two adverse effects caused by overgrazing. (Apr-May 2008)

Land degradation, soil erosion and loss of useful species.

16. Differentiate between renewable and non-renewable energy resources. (Nov-Dec 2012)

S.No.	Renewable energy	Non-renewable energy
1	It is regenerated continuously	Cannot be regenerated
2	Inexhaustible	exhausted
3	It can be used again and again	Cannot be used again
4	It is pollution-free	Pollutes the atmosphere
5	It is developed in a long period	It is developed in a short period

17. Mention the various causes of desertification.

Deforestation, overgrazing, water management, mining and quarrying, climate change and pollution.

18. What are the effects of dams on tribal people?

Due to continuous removal of minerals, forest covers, the trenches are formed on the ground leading to the water logged area, which in turn contaminates the ground water.

During mining operations, the vibrations are developed, which leads to earthquake.

When materials are disturbed in significant quantities during mining process, large quantities of sediments are transported by water erosion.

19. What is eutrophication? (Nov-Dec 2012)

A large proportion of N and P fertilizers used in crop fields is washed off by the runoff water and reaches the water bodies causing over nourishment of the lakes. The process of accumulation of nutrients in the water bodies is called eutrophication.

20. What is green chemistry?

Green chemistry is the use of chemical products and processes that reduced or eliminate substances hazards to human health or the environment.

21. Wood is renewable resources but not coal. Why?

Wood is renewable resources because we can get new wood by growing a sapling into a tree within 15-20 years. But the formation of coal from trees has taken million of years and cannot be regenerated in our life time.

23. Mention the major environmental impacts of mining. (Nov-2013)

Mining reduces the shape and size of forest areas.  
It produces noise pollution.

It develops the vibration and hence earthquake will occur.  
Water surface will pollute due to discharge of wastages.

24. What are the changes caused by overgrazing? (Nov-2013)

Land degradation  
Soil erosion  
Loss of useful species

25. State the use of bio-energy as a non-conventional source of energy.

The cost of obtaining bio-energy through bio-gas plant is less than the cost of obtaining energy from fossil fuels.

Bio-mass consumes more CO<sub>2</sub> than is released during combustion of bio-mass.

It provides a stored form of energy and in many cases in a form suitable for vehicle propulsion.

26. What is energy conversion?

It is a process of changing energy from one form to another form.

27. What is environmental ethics? (Nov/Dec-2013)

It refers to the issues, principles and guidelines relating to human interactions with their environment.

28. What is bio-gas? Mention its uses. (Nov-Dec 2016)

It is a mixture of various gases formed by an aerobic degradation of biological matter in the absence of free oxygen.

Composition of biogas:

Compound	%
Methane	50-75
CO <sub>2</sub>	25-50
N <sub>2</sub>	0-10
H <sub>2</sub>	0-1
H <sub>2</sub> S	0-3

O <sub>2</sub>	0
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Uses:

- It is used for cooking, heating water.
- It is used to run engines.
- It is used for running tube well and water pump set engine.
- It is used as an illuminant in villages.

29. State the reasons of over exploitations of forest. (May-June 2013)

Increasing agricultural production  
Increasing industrial activities  
Increase in demand of food resource

30. Write the ways of drought management. (May-June 2013)

Modern irrigation technology (drip irrigation) is very much useful to conserve water

Rain water harvesting programme is another fruitful method to conserve more water and to control drought.

31. Write the economic importance of forests. (Nov/Dec-2013)

Commercial uses (fuel, pulp, paper, gums, dyes, medicines, drugs, mining)

Ecological uses (production of O<sub>2</sub>, reducing global warming)

Aesthetic value

Touristic value (ecotourism)

32. Write the problems due to constructions. (May/June-2014)

Deforestation, Pollution, Soil erosion, Devegetation.

33. Define non-renewable energy resources. (May/June-2014) (April-May2015) (Nov-Dec 2015)

Non renewable energy resources are natural resources which cannot be regenerated once and are exhaustible. They cannot be used again and again in an endless manner.

34. Define the term nuclear energy. (Nov-Dec 2014)

Energy release from nuclear fission reaction is known as nuclear energy.

35. Define renewable energy resources. (Nov-Dec 2014) (April-May2015) (Nov-Dec 2015)

Renewable energy resources are natural resources which can be regenerated. They can be used again and again in an endless manner.

36. Write the preventive methods of deforestation. (Nov-Dec 2014)

Planting more trees, Use of wood for fuel should be discouraged.

37. What do you meant by land degradatation? What are the reasons for land degradatation? (Nov-Dec 2015) (May - June 2016)

Definition: It is the process of deterioration / destroys soil or loss of fertility of the soil.

Causes: Population, Urbanization, Fertilizers and pesticides, Damage of top soil, Soil erosion, Water logging and Salination.

38. What is desertification? (April-May2015)

The progressive destruction of arid or semiarid lands to desert is known as desertification.

39. Write any two problems caused by high saline soils? (April-May 2017)

➤ Due to high saline soils, the soil becomes alkaline and crop yield decreases.

### UNIT-III

#### PART-B

1. Discuss the consequences of overdrawing surface and ground water. (Nov-Dec 2013) (Nov-Dec 2016)
2. Explain how the alternate energy sources play an important role in environmental impact.
3. Explain the environmental impacts of Mineral extraction/mining and use. (Apr-May 2008), (Apr-May 2008), (Apr-May 2010) (May/June-2013) (April-May2015) (Nov-Dec 2015)
4. Explain renewable and non-renewable energy resources with examples. Explain the merits and demerits of any two renewable energy resources. Why are non renewable energy resources preferred for energy utilization now-days? (Nov-Dec 2009), (Apr-May 2010), (Apr-May 2010) (Nov-Dec 2011) (May-2014) (Nov-Dec 2013) (May - June 2016)
5. Explain the major causes and ill effects of deforestation. (Nov-Dec 2009), (Nov-Dec 2008), (Apr-May 2008) (Nov-Dec 2012) (Nov-Dec 2013) (Nov-Dec 2014) (April-May2015) (Nov-Dec 2015) (Nov-Dec 2016) (April-May 2017)
6. Explain briefly the various methods of harvesting solar energy. (Nov-Dec 2009)
7. Discuss the merits and demerits of wind energy and tidal power. (May/June-2013)
8. Describe the benefits and problems of constructing dams. (Nov-Dec 2008) (Nov-Dec 2012) (Nov-Dec 2011) (Nov/Dec-2013) (Nov-Dec 2015)
9. Explain the environmental impacts of modern agriculture (Nov-Dec 2009), (Nov-Dec 2007), (Nov-Dec 2008), (Apr-May 2008) (Nov-Dec 2012) (May-June 2013, 2014) (Nov/Dec 2014) (Nov-Dec 2015) (May - June 2016) (Nov-Dec 2016) (April-May 2017)(Nov-Dec 2017)
10. Explain any two conflicts over water confining to our nation. (Nov-Dec 2009)
11. Discuss in detail the causes and consequences of over exploitation of forest resources. (Nov-Dec 2009), (Apr-May 2010)
12. What are the ecological benefits of forests? (Nov-Dec 2007)
13. Discuss the effects of dams on forest and tribal people. (Apr-May 2008) (Nov-Dec 2012)
14. Discuss the timber extraction on forest and tribal people. (Nov/Dec-2013)
15. Discuss the role of individual in conservation of natural resources. (Nov/Dec-2013)
16. Write short notes on different types of energy sources. (May/June 2014)
17. Discuss the following (i) Land resources (ii) land degradation (iii) soil erosion and desertification.(Apr-May 2010) , (Nov-Dec 2010) (Nov/Dec-2013) (May/June-2013)(Nov-Dec 2014) (Nov-Dec 2016)
18. What are the changes caused by agriculture and overgrazing? (Nov-Dec 2014)

19. Write note on i). Food resources ii). Mineral resources. (April-May 2015)

20. Discuss the renewable sources of energy with respect to solar, wind and tidal power.(Nov-Dec 2017)

#### UNIT-IV SOCIAL ISSUES AND THE ENVIRONMENT

##### PART-A

1. Define sustainable development. (OR) Explain the term sustainability. (OR) Define sustainable life style. (Nov-Dec 2007) (Nov-Dec 2012) (Nov-Dec 2013) (May - June 2016) (Nov-Dec 2016)

Sustainable development can be summarized as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'.

2. Explain the concept of sustainable development. (Nov-Dec 2009) (Nov-Dec 2008)

The concept of sustainable development has the following underlying promises.

A symbiotic relationship between the consumer human race and the producer natural system.  
Compatibility between ecology and economics.

3. What is the aim of national committee of environmental planning and co-ordination?

Conservation of natural resources.  
Control of environmental pollution.  
Environmental education.  
Environmental laws.

4. What are the major constitutional provisions in India for environmental protection?

Article 47  
Article 48-A  
Article 51-A (g)  
Article 253.

5. State the Article-47 of the Indian Constitution.

Article 47 of the Constitution states that, "The State is to ensure as its primary duty of,

Raising standard of living of its people,  
To increase the level of nutrition of the people,  
To bring improvement in public health".

6 State the Article 48-A of the Indian Constitution.

Article 48-A of the Constitution states that, "the State shall endeavor for protection and improvement of the environment and for safeguarding the forest and wild life and improving the natural environment of the country".

7. State the Article 51-A (g) of the Indian Constitution.

According to Article 51-A (g) of the Constitution, it shall be the duty of every citizen of India 'to protect and improve the natural environment including forests, lakes, rivers, and wild life and to have compassion for living creatures'.

8. State the Article 253 of the Indian Constitution.

Article 253 of the Constitution empowers the parliament to make laws regarding preserving the environment. It states 'The parliament has power to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body'.

9. What are the causes and effects of ozone layer depletion? (Nov-Dec 2008)

Causes: Chlorofluoro carbon and Hydro Chlorofluoro carbon

Effects: Increases the average temperature of the earth. It also affects the aquatic forms.

10. Mention the effects of ozone on plants. (Nov-Dec 2014)

Ozone effects on plants are most pronounced when soil moisture and nutrients are adequate and ozone concentrations are high. Under good soil moisture and nutrient conditions the ozone will enter through openings into the leaf and damage the cells that produce the food for the plants.

11. List the major environmental conventions of 20th century.

World summit on sustainable development, The Earth Summit, World conference on women.

12. Name some of the acts enacted by the Indian Government to protect the environment.

The Water (prevention and control of pollution) Act 1974, 1978

The Water (prevention and control of pollution) amended Act, 1987

The Air (prevention and control of pollution) Act 1981 amended in 1987.

The Environment (protection) Act 1972

The Public Liability Insurance Act 1991.

13. What are the common objectives of environmental legislation?

All the Acts were enacted to achieve the following:

To control further damage to the environment and ecosystem

To conserve the environment

To create authorities to administer the policy and contents of the legislation.

To provide penalties and prosecution for violation of laws.

14. List the major environmental protocols of 20th century.

Kyoto protocol

Montreal protocol.

15. Write notes on NGOs.

The groups working for social changes are called Non-Governmental Organizations (NGOs). When the activities are concerned with environmental issues they are called environmental NGOs.

16. Write notes on 'Green Peace':

'Green peace' is one of the largest NGOs in the world with 1.6 million contributing members, carries out well-published confrontations with toxic waste dumpers, seal hunters and others who threaten very specific and visible resources.

17. List some of the NGOs available in India.

World Wide Fund for Nature India.  
Indian Environmental Association, Mumbai.  
Environmental Society of India (ESI), Chandigarh.  
Sastrakalayatha, Kerala.  
C. P. Ramaswami Ayer Environmental Education Centre.

18. How does the community participation involve in protecting the environment?

Community participation requires involvement in several areas:  
Better theoretical knowledge about the environmental information (both Scientific and traditional)  
Better practical guidelines and tools are need.  
Better educational support.

19. Write short notes on the history of implementation of international treaties and conventions.

- Intercontinental shipping of hazardous waste
- Reforestation
- Over-fishing

Trade in endangered species

20. Write down the purpose / objectives of The Water (Prevention and Control of Pollution)

Act, 1974. (Nov-Dec 2014)

The purpose of The Water Act is "to provide for the prevention and control of water pollution and the maintenance or restoring wholesomeness of water for the establishment, with a view to and carrying out the purpose of aforesaid of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith".

21. What is meant by rain water harvesting? (Nov-Dec 2012) (Nov-Dec 2014)

Rain water harvesting is a technique of capturing and storing of rain water for further utilization.

22. What is environmental ethics? (Nov/Dec-2013)

It refers to issues, principles and guidelines related to human interactions with their environment. (or) Ethics is a branch of philosophy. It deals with morals and values. An ethic is a principle for value that we use to decide whether an action is good or bad.

23. List the objectives of forest conservation act. (Nov/Dec-2013)

Protect and conserve the forest.  
To ensure judicious use of forest products.

24. What is cyclone? (Nov/Dec 2013) (April-May 2017)

Cyclone is meteorological phenomena, intense depressions forming over the open oceans and moving towards the land.

25. What are the advantages of rain water harvesting? (Nov-Dec 2015)

To increase the ground water level.  
To avoid the contamination of water.

26. Define consumerism. (April-May2015) (Nov-Dec 2015) (Nov-Dec 2016)

Consumption of resources by the people is known as consumerism.

27. What do you meant by disaster management? (April-May2015)

Disaster Management can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

28. What is nuclear holocaust? (Nov-Dec 2017)

It means destruction of biodiversity by nuclear equipments and nuclear bombs. In a holocaust a large number of living beings are totally destroyed. Usually these kind of destructions are happened in a nuclear war.

29. Write on EIA? (Nov-Dec 2017)

EIA (Environmental impact assessment) is defined as a formal process of crediting the environmental consequences of any development projects. It is used to identify the environmental, social and economic impacts of the project prior to decision making.

30. What is a watershed? (Nov-Dec 2017)

Watershed is defined as the land area from which water drains under the influence of gravity into a stream, lake, reservoir or other body of surface water.

31. Define Acid rain. Write its type. (Nov-Dec 2013) (April-May 2015)

Excess amount of acid present in the rain is called acid rain. It has two types,

Wet deposition: It involves acid rain or snow or dew

Dry deposition: It is the particles such as polluting gases, dust particles and gaseous elements are just absorbed by the surface of the earth or the plant bodies.

32. Define green house effect. (Nov-Dec 2014)

The progressive warming up of earth surface due to blanketing effect of manmade CO<sub>2</sub> in the atmosphere

UNIT-IV

PART - B

1. What is meant by rain water harvesting? Name and discuss in brief the types of rainwater harvesting? (Nov-Dec 2008) (Nov-Dec 2013) (Nov-Dec 2014) (April-May 2015)
2. Explain forest conservation act. (Apr-May 2008) (May-June 2013) (Nov-Dec 2014) (April-May 2017)
3. Write the factors influence the unsustainable to sustainable development. (Or) Discuss the recent approaches to achieve sustainable development. (May-June 2013) (May - June 2016)
4. Discuss the phenomenon of global warming and the factors contributing to it. (Nov-Dec 2007) (Apr-May 2007) (Nov-Dec 2013)

Write a note on watershed management. (Nov-Dec 2012) (Nov/Dec-2013)

5. Discuss briefly on The Environment protection act 1986 and The Air Act. (Nov-Dec 2007) (Nov-Dec 2008) (Nov/Dec-2013) (Nov-Dec 2013) (May/June 2014) (April-May 2015) (Nov-Dec 2015) (Nov-Dec 2016) (April-May 2017) (Nov-Dec 2017)
6. Explain the important provision in the wild life protective act (Nov-Dec 2014), air protection act, water protection act (May/June 2014) (May - June 2016) and environment protection acts. (Apr-May 2008) (April-May 2010) (Nov-Dec 2010) (Apr-May 2015) (Nov-Dec 2015)
7. Discuss the issues involved in the enforcement of environmental legislation. (Nov-Dec 2008)
8. Explain the powers and functions of state pollution control board. (Nov-Dec 2010)
9. Discuss the energy requirement in detail for sustaining urban life. (Nov-Dec 2010)
10. Describe the measures to conserve water. (Nov-Dec 2009)
11. Write a note on waste land reclamation. (Nov-Dec 2009) (May-June-2013) (May-June 2014)  
(April-May 2015) (Nov-Dec 2015)
12. Write about resettlement and rehabilitation of people. (Apr-May 2010) (Nov-Dec 2014)
13. What are the major urban problems related to energy? (Nov/Dec-2013) (May-June 2013)
14. Write short notes on nuclear accidents and holocaust with case studies. (Nov/Dec-2013) (May-June 2013) (April-May 2015)
15. Explain the Water (prevention and control of pollution act) 1974. (May-2014) (Nov/Dec 2014)
16. Explain the following

Floods

Earthquake (Nov-Dec 2013) (May/June 2014) (Nov-Dec 2014) (Nov-Dec 2015)  
Cyclone (Nov-Dec 2015) (Nov-Dec 2016)  
Landslides (May-June 2013)

17. Explain the following (May-June 2013)

i).Consumerism ii).Waste products

18. Describe the various chemical and photochemical reactions in the atmosphere. (Nov-Dec2014) (May - June 2016) (April-May 2017)

19. Discuss about the causes, impacts and control measures of ozone depletion in the atmosphere. (Nov-Dec 2016)

## UNIT-V HUMAN POPULATION AND THE ENVIRONMENT

### PART-A

1. List the problems of population growth.

Increasing demands for food and natural resources.  
Inadequate housing and health services.  
Loss of agricultural lands.  
Unemployment and socio-political unrest.  
Environmental pollution.

2. Define doubling time. (Nov – Dec 2013)

Population explosion can be better understood by considering the doubling time.

i.e., the number of years needed for a population to double in size.

$$T_d (\text{Doubling time}) = 70/r$$

Where, r = annual growth rate

If a nation has 2% annual growth, its population will double in next 35 years.

3. What is total fertility rate?

It is the average number of children delivered by a woman in her life time.

The TFR value varies from 2 in developed countries to 4.7 in developing countries.

4. Define population explosion. (Nov-Dec 2010)(Nov-Dec 2009)(Nov-Dec 2008) (Ap-May2008)

(Nov-Dec 2012) (Nov-Dec 2013) (April-May2015) (Nov-Dec 2015) (May - June 2016)

The enormous increase in population, due to low death rate (mortality) and high birth rate (Natality) is termed as population explosion. The human population is not increasing at a uniform rate in all parts of the world.

5. Differentiate between HIV and AIDS. ( Nov-Dec 2007)

HIV	AIDS
Human Immuno deficiency Virus	Acquired Immune Deficiency Syndrome
It is a virus	It is a disease

6. What are the reasons behind the increased population growth in the less developed nations compared with developed nations?

The rapid population growth is due to decrease in death rate and increase in birth rate.

The availability of antibiotics, immunization, increased food production, clean water and air decreases the famine- related deaths and infant mortality. In agricultural based countries, children are required to help parents in the fields that is why population increases in the developing countries.

7. Define population equilibrium.

A state of balance between birth rate and death rate in a population is known as population equilibrium.

8. What are the major precautions to avoid AIDS? (Ap-May2008)

Avoid indiscriminate sex and encourage the use of condoms and also avoid the use of shaving razors, needles and syringes.

Prevention of blood born HIV transmission.

Aids awareness programmes should be encouraged.

Counseling services should be provided.

9. What are the causes of population explosion? (Nov-Dec 2009) (Nov-Dec 2014)

Invention of modern medical facilities reduces the death rate (mortality) and increases the birth rate (Natality) which leads to population explosion.

Increase of life expectancy is another important reason for the population explosion.

10. What are the objectives / advantages of family welfare programme? (April-May2015)

Slowing down the population explosion by reducing the fertility.

Pressure on the environment due to over exploitation of natural resources is reduced.

11. Define immigration and emigration.

Immigration: It denotes the arrival of individuals from neighboring population.

Emigration: It denotes the dispersal of individuals from the original population to new areas.

12. What are the factors which do not influence transmission of HIV?

Tears, food and air, cough, handshake, mosquito, flies, insect bites, urine, saliva during normal kissing, sharing of utensils, cloths, toilet, bathroom, etc.

13. How does HIV functions in human body?

White blood cells (WBC) responsible in the formation of antibodies are called T helper cells. T helper cells are the key infection fighters in the immune system. The HIV enter into the human body and destroys the T cells, as a result of which various types of infection diseases occur.

14. Define population equilibrium.

A state of balance between birth rate and death rate in a population is known as population equilibrium.

15. State the role of information technology in environment.

Information technology plays a vital role in the field of environmental education. Information technology means collection, processing storage and dissemination of information. A number of software has been developed to study about the environment.

16. Mention some ill effects of HIV/AIDS.

Large number of death occur which affect environment and natural resources.  
Due to large number of deaths there is loss of labour and level of production decreases  
More water is required for maintaining hygiene in AIDS affected locality.  
The people affected by HIV cannot perform work well due to lack of energy.

17. What is meant by NIMBY syndrome?

NIMBY means Not In My Back Yard, which describes the opposition of residents to the nearby location of something they consider undesirable, even if it is clearly a benefit for many.

18. Define population density.

It is expressed as the number of individuals of the population per unit area (or) unit volume.

19. Define population equation. ( Nov-Dec 2009)

$$P_{t+1} = P_t + (B-D) + (I-E)$$

Where,  $P_t$  and  $P_{t+1}$  = sizes of population in an area at two different points in time  $t$  and  $t+1$   
 $B$  = birth rate,  $D$  = death rate,  $I$  = immigration and  $E$  = emigration

20. Write the objectives/importance of value education. (Apr-May 2010) (Nov-Dec 2012)

(Nov-Dec 2014)

To improve the integral growth of human beings.  
To create attitudes and improvement towards sustainable lifestyle.  
To increase awareness about our national history, our cultural heritage, constitutional rights,  
To create and develop awareness about the values and their significance and role.

21. What are human rights?

Human rights are the fundamental rights, which are possessed by all human beings, irrespective of their caste, nationality, sex and language.

22. Name any two schemes of human health program initiated by Indian Government on

effects of population growth. (Apr-May 2010)

National Vector borne Disease Control Program  
National Iodine Deficiency Disorders Control Program  
National Cancer Control Program  
National Aids Control Program

23. What is meant by human demography? (Apr-May 2010)

The study of statistics on human populations including elements such as growth rate, age and sex ratios, distribution, density and their effects on socioeconomic and environmental conditions.

24. What are the reasons for declining Birth rate?

The non-availability of anti-biotic, immunization, decreased food production, cleans water and air.

25. Why is variation important within a population?

In order to improve the economic status of the people and decrease of population growth, the variation is important within a population. Generally the following variation must be present within a population.

Pre-productive population (0-14 Years)  
Re-productive population (15-44 years)  
Post reproductive population (Above 45 years)

26. What are the various schemes of various organizations towards women welfare?

The National Network for Women and Mining  
United Nations Decade for Women  
International Convention on the Elimination of All forms of Discrimination against women.  
NGO's as Mahila Mandals.  
Ministry for Women and Child development.

27. State the human right to food and environment.

All human beings have the right to get sufficient healthy food, safe drinking water and healthy environment.

28. Mention about the applications of remote sensing in forestry.

Sustainable forest management requires reliable information on the type, density and extent of forest cover, wood volume and biomass, forest fire, pest and disease induced losses, encroachment etc., remote sensing provides all such information clearly.

29. What is NEDS?

NEDS is National Emission Data System and is developed by the Environmental Protection Agency of USA. This NEDS works for coding, storage, retrieval and analysis of nationwide air emission data.

30. Give some Examples for Bell shaped variation of population.

France, UK, USA, Canada, etc.,

31. What is meant by remote sensing? (May/June-2013)

It is used more commonly to denote identification of earth features by directing the characteristics electromagnetic radiation that is reflected/emitted by the earth.

32. What is value education? (Nov/Dec-2013) (May/June-2014) (April-May 2017)

It is an instrument used to analyze our behaviour and provide proper direction to our youth. It teaches to youth the distinction between right and wrong, to be helpful loving, generous and tolerant.

33. Write the reason for child labour. (May/June-2014)

Poverty  
Want of money

34. What are the sources of HIV infection? (Nov-Dec 2014)

HIV from infected person can pass to normal person through blood contact.  
Using needles or syringes, contaminated with small quantities of blood from infected person.

35. State the role of information technology in environmental. (Nov-Dec 2015)

It means data collection, processing, reporting and dissemination of the environment.

36. Mention any two family welfare programs adopted in India. (May - June 2016)

National population policy  
National health policy

37. What are the objectives of women welfare systems? (Nov-Dec 2016)

- To improve employment opportunities.
- To provide educations.
- To generate awareness about the environment.
- To restore dignity and status.

38. What is mitigation? (Nov-Dec 2017)

The implementation of measures designed to reduce the undesirable effects of a proposed action on the environment

39. What is child abuse? (Nov-Dec 2017)

Child abuse is when a parent or caregiver, whether through action or failing to act, causes injury, death, emotional harm or risk of serious harm to a child. There are many forms of child maltreatment, including neglect, physical abuse, sexual abuse, exploitation and emotional abuse.

UNIT-V

PART-B

1. Discuss briefly on the reasons and effects of the population explosion. ( Nov/Dec 2008, 2013)  
(Nov-Dec 2015) (Nov-Dec 2016)
2. What are the modes of transmission of HIV how it can be prevented? ( Nov/Dec 2007, 2013) (April-May 2017) (Nov- Dec 2015) {OR} Write a note on AIDS in developing countries. (Nov-Dec 2012) (May-June 2013) (May/June-2014) (Nov-Dec 2013) (Apr-May 2015) (May - June 2016) (April-May 2017)
3. Women and child welfare. (Nov-Dec 2009) (Ap-May2008) (Nov/Dec-2013) (May/June-2014) (Nov- Dec 2014) (Apr-May 2015) (Nov-Dec 2015) (May - June 2016)
4. Write a note on the various methods of family planning. (Nov/Dec 2007) ( Nov/Dec 2009) (Nov/Dec 2013) (May/June-2014)
5. Define Human rights and discuss the salient features of the universal declaration of Human rights by UN? (Nov-Dec 2009) (Nov-Dec 2007) (Apr-May 2015) (Nov-Dec 2015)
6. Write a short note on Value education. (Nov-Dec 2009) (Nov-Dec 2008) (Ap-May2008)  
(May-June 2013) (Nov-Dec 2014) (Apr-May 2015) (Nov-Dec 2015) (Nov-Dec 2016)
7. Discuss the influence of environmental parameters on human health. (OR) Discuss the factors influencing human health under current environmental conditions. (Nov-Dec 2008)(Nov-Dec 2009) (Nov-Dec 2012) (Nov-Dec 2016)
8. Explain the role of information technology in environment protection and Human Health Protection. (Nov-Dec2008, 2009) (Apr-May 2010) (Apr-May 2011) (Nov/Dec-2012, 2013 and 2014) (Apr-May 2015) (Nov-Dec 2016) (April-May 2017) (Nov-Dec 2017)
9. Write a neat diagram and explain the variation in population growth among various nations.  
(Or) What are sparsely populated areas? Give examples and reasons for poor population in those areas. (Nov-Dec 2007) (Nov- Dec 2013) (Nov-Dec 2014) (May - June 2016)
10. Discuss the linkages among population explosion, development and environment. ((Nov-Dec 2017)