SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**(10)**
	(a)	**Explain the term comfort zone.** **Ans:** Comfort zone is a state, position, situation or way of living where one feels safe or at ease.	**02**
	(b)	**Name the entrepreneurs developed under the guidance of JRD Tata.** **Ans:** Due to the supportive nature of JRD Tata, entrepreneurs such as: Sir Homi Mody, Sir Ardeshir Dalal, Sir Jehangir Ghandy, Russi Mody, Sumant Moolgaokar and Darbari Seth and others created billions in wealth for the group and the country.	**02**
	(c)	**State any two positive points of Gurmeet Singh's personality that has appealed to you.** **Ans:** The first positive point of Gurmeet Singh's personality is the love and affection he has for the abandoned people; another is his dedication towards rendering his services to them.	**02**
	(d)	**State the additional tips for proper recycling of e-waste.** **Ans:** Use a certified e-waste recycler through Basel Action Network (BAN), which is a non-profit organization. Visit civic institutions like schools, government offices, colleges etc. where citizens can donate unwanted electronics towards designated drop off location. One can also recycle their e-waste through retail options like Best Buy or donate it to trustworthy organizations like Goodwill.	**02**
	(e)	**State the full form of EQ, IQ and SQ.** **Ans:** EQ stands for Emotional Quotient, IQ stands for Intelligence Quotient and SQ stands for Situational Intelligence Quotient.	**02**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	**(f)**	**Name the awards won by Arunima Sinha.** **Ans:** Arunima Sinha is the first Indian Amputee to climb the Mount Everest. In 2015, she was awarded the Padmashri, the fourth highest civilian award in India.	**02**
	(g)	**Explain the term: Doer and Mentor.** **Ans:** Doer is a person who does something rather than merely talking or thinking. He gets things done with vigor and efficiency. Mentor is a person who trains and guides someone, he is a trusted adviser.	**02**
2.		**Attempt any THREE of the following:**	**(12)**
	(a)	**Describe the help given by Krishna Vedavyasa.** Shiva with his elder sister Yogeshwari used to sell the garlands at traffic signals and other places after their school. Despite all the hard work his family members did, money was insufficient. Therefore Shiva used to sell the newspapers. After he met Krishna Vedavyasa, he asked for his help for school fees. Krishna visited his school and after learning how intelligent Shiva is, paid his fees. Though Krishna paid Shiva's school fees, Shiva's family needed cash for rent and food among other things. So he continued working and studying hard. Krishna continued paying his school fees. He asked Shiva to opt for science in 11^{th} and 12^{th} and paid his fees there too. After his schooling, he took admission in Computer Science Engineering where Krishna signed his admission form as his guardian and paid the fees too. Krishna also trained him to speak fluently in English. He studied hard and scored good marks. On Krishna's encouragement, suggestion and financial support, he also enrolled in a CAT coaching class. Krishna prepared him for mock interviews of IIM and group discussions. Together, they spent hours preparing for IIM admission. He got admission in IIM. After his IIM, he got a job as a deputy country manager in Sri Lanka. Thus, Krishna Vedavyasa remained his mentor throughout his career.	**04**
	(b)	**Write about your career dreams.** A dream career is a combination of activity, skill or passion with a money-making opportunity. Dream jobs include any profession like acting, playing music, doctor, engineer, architect or lawyer. I know whatever I choose I will work hard, stay focused and make it big. Since my childhood my dream career is to become a successful software engineer and I was always curious about how the software functions. Each time I notice how a program is used I wonder how I can make it become faster or more efficient. Software development is a vast field and it is the one that is creative, demanding and extremely rewarding. It gives you the opportunity to learn about business as well as technology. Technology is fast moving and learning new	

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.		programming languages and adapting to the continually changing technology is something I find really challenging. This constant change is an amazing learning opportunity keeping your mind fresh and our career interesting! In order to fulfill my dream about my career, I have taken the first step towards it by taking admission to Diploma in Computer Technology.	**04**
	(c)	**Express your views/ideas on JRD Tata.** **Ans:** JRD Tata was a philanthropist who wanted India to be a happy country and did all he could to make it so. He was also a man of great sensitivity and was pained by the poverty he saw around him and wanted strongly to alleviate it. He was a patron of the sciences and the arts. As a patron of the arts, JRD was revered by India's artists, sculptors and performing artist. Under JRD's tutelage, the Tatas became the biggest buyers, promoters and supporters of the art world in India. As a philanthropist, JRD Tata built up the tremendously active Tata Charitable Trust and kept it alive. Entrepreneurs like Sir Homi Mody, Sir Ardeshir Dalal, Sir Jehangir Ghandy, Russi Mody, Sumant Moolgaokar and Darbari Seth, etc. were developed under JRD Tata's supportive climate. Scientists of international repute such as Homi Bhabha, leading lawyers such as J. D. Choksi and Nani Palkhivala and economists such as John Matthai, A. D. Shroff, D. R. Pendse and Freddie Mehta could flourish under JRD Tata's guidance.	**04**
	(d)	**State the qualities of Arunima that touched your heart.** **Ans:** Arunima is a hard working person. After completing a basic course from Nehru Institute of Mountaineering, she underwent rigorous training for 18 months to prepare herself for climbing Mount Everest. Her dream was to conquer the highest mountain from each of the seven continents of the world and till now, she has conquered six of them. Her next quality is perseverance. She climbed various smaller peaks, including Island Peak to prepare herself before conquering the Mount Everest. She was also a kind hearted and generous person. Therefore, she has established Shahid Chandrashekhar Azad Viklang Khel Academy for underprivileged handicapped children. She is fearless. When she entered the death zone- 3500 feet from the top of Mount Everest- the most difficult terrain started. She saw dead bodies of mountaineers scattered all around. But she did not give up climbing the Mount Everest. Arunima is confident. Even after the Sherpa kept on advising her to return, she did not give up and told him that she can't die before conquering Mount Everest.	**04**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.	**(a)**	**Attempt any THREE of the following:** **Develop a dialogue between two students about the timetable of final exam. (8–10 dialogues)** **Amir**: Hi Sakib, how are you? **Sakib**: I am fine, what about you? **Amir**: Yeah fine. What about the timetable of final exam? **Sakib**: It is displayed on the website and also on the notice board. The exams start on 15 June. **Amir**: Oh, is it? I am still struggling with Mathematics. But I hope I will be okay before the exam. When is Maths paper? **Sakib**: It's on 20 June. But you are really good at Maths, I hope you will be okay before the exam. **Amir**: Hope so. When is English? **Sakib**: English is on 15 June itself. Are you prepared for it? **Amir**: Yes I am but as you know, I am a bit weak in writing skills though I am working hard. **Sakib**: If you want, I can teach you English, I have completed everything. **Amir**: So nice of you, I will come to your home today afternoon. **Sakib**: Okay, then see you there. Take care, bye. **Amir**: Bye, take care. ***(Note: Dialogues may vary.)***	**12** **04**
	(b)	**Develop a dialogue between the doctor and the patient about the improvement in the patient's health. (8–10 dialogues)** **Patient**: Hello, may I come in? **Doctor**: Yes, of course. How are you feeling today? **Patient**: No change sir, the headache is the same as before. **Doctor**: Oh sorry to know, are you taking the medicine that I prescribed you? **Patient**: Yes, I am taking the medicines properly, but I am not getting relief. **Doctor**: Keep patience, it's only a week. You need to wait more and check the improvement because your problem is uncommon. **Patient**: What should I do now? **Doctor:** Have you completed the course of medicines that I prescribed? **Patient**: Yes. **Doctor**: Then, I am giving some tests here, go to the pathology and do these tests. I will prescribe a few more medicines after getting the test reports. **Patient**: Thank you, Doctor. **Doctor**: You are welcome. ***(Note: Dialogues may vary.)***	 **04**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.	**(c)**	**Write a paragraph on 'My Sweet Memories'. (75 words)** **Ans:** Sweet memories are a remarkable piece of our life. These memories develop our future and perspective. I have grown up with my senior sibling with whom I used to play a ton. I recollect every single game we used to play together. Another lovely thing I can recollect is flying kites. It used to be quite possibly the most intriguing thing of my youth. Indeed, even the senior individuals from the family took an interest in us. We used to fly kites on our porch. The kite-flying project would keep going for the whole day. Another excellent thing I can recall is my meeting at the zoo with my family. We made one zoo visit each year. They used to be those exceptionally basic yet sensational family cookout minutes. We would carry stuffed food from home that my mom used to cook. My senior sibling would click a few photos of us. At the point when I take a glance at those photos now, the memories wake up. Today, such countless things have changed yet my beloved memories are still new in my heart. It feels so invigorating to remember them over and over. My sweet memories are exceptionally near my heart and make me grin on my troublesome days. ***(Note: Content may vary.)***	**04**
	(d)	**Write a paragraph on 'Mobile Telephone'. (75 words)** **Ans:** A mobile phone is now a smartphone that can do more than other phones. They work as a computer but are mobile devices small enough to fit in a user's hand. Uses include sending and receiving emails, text, photographs and multimedia messages, registering contacts, calculator, currency, alarm, browsing the internet using a mobile browser, playing games and much more. The smartphones usually come with a large touchable display and an inbuilt QWERTY keyboard. Because smartphones are small computers, they run an operating system that is often common between devices to ensure compatibility. The majority of smartphones run on Apple iOS or Google Android but others use Windows Phone or BlackBerry OS. Most can do multitasking, running more than one program which helps the user do things quicker and easier. ***(Note: Content may vary.)***	**04**
4.		**Attempt any THREE of the following:**	**12**
	(a)	**Make sentences using the following collocations:**	
	(i)	**Save money-** One should **save money** for future.	**01**
	(ii)	**Pay attention-** The teacher asked the students to **pay attention** to the board.	**01**
	(iii)	**Do business-** We will have to find some place to **do business**.	**01**
	(iv)	**Take a seat**- All the delegates **took** their **seats** on the dais. ***(Note: Sentences may vary.)***	**01**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.	**(b)**	**Replace the underlined words with correct word and rewrite the sentences:**	
	(i)	**Ram is very <u>week</u>.** **Ans:** Ram is very **<u>weak</u>**.	**01**
	(ii)	**The goods train is <u>stationery</u>.** **Ans:** The goods train is **<u>stationary</u>**.	**01**
	(iii)	**We salute our army <u>personal</u>.** **Ans:** We salute our army **<u>personnel</u>**.	**01**
	(iv)	**<u>The principle</u> of the college was present for the meeting.** **Ans: <u>The principal</u>** of the college was present for the meeting.	**01**
	(c)	**Write the meanings of following idioms and make sentences of your own:**	
	(i)	**At the eleventh hour** **Meaning:** the last moment or almost too late Sentence: He postponed his trip **at the eleventh hour**.	**01** **01**
	(ii)	**In black and white** **Meaning:** in writing or print Sentence: She had abandoned all hope of getting her contract down **in black and white**. ***(Note: Sentences may vary.)***	**01** **01**
	(d)	**Choose the correctly spelt word from the following:**	
	(i)	**mesege, message, messege** **Ans: message**	**01**
	(ii)	**miting, meeting, metting** **Ans: meeting**	**01**
	(iii)	**keys, keyes, keies** **Ans: keys**	**01**
	(iv)	**leafs, leafs, leaves** **Ans: leaves**	**01**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.	**(e)**	**Change the voice**	
	(i)	**Grammar is taught to us by Prakash.** **Ans:** Prakash teaches us grammar.	**01**
	(ii)	**By whom was she taught French?** **Ans:** Who taught her French?	**01**
	(iii)	**Let the door be shut.** **Ans:** Shut the door.	**01**
	(iv)	**I sent the report yesterday.** **Ans:** The report was sent by me yesterday.	**01**
5.	**(a)**	**Attempt any TWO of the following:**	**08**
	(i)	**A senior faculty of your department is retiring from the job. As an HOD, draft a farewell speech for the faculty.** **Ans:** Good afternoon ladies and gentleman! Today we have gathered here for bidding farewell to Mr. Pawar, Manager of Production Department of our Apex Company, Mumbai. He has put in total 19 years of service as a worker and 05 years as a manager in the Production department of our company. He has worked with enthusiasm and devotion and contributed positively for the development of the Production department and our company as well. He shared a good rapport with workers. He will retire this month end after putting 24 years of dedicated service. I wish him good health, peace of mind and lots of happiness in the years to come. Once again I take this opportunity to wish Mr. Pawar a happy retired life. May god bless you with good health and a long life. Thank you. ***(Note: Content may vary.)***	**04**
	(ii)	**Draft a speech to introduce the chief guest for the first year induction program organized by your institute.** **Ans:** A very good morning everyone. It is my honour to introduce today's chief guest for the first year induction program, Mr. Parag Kulkarni. Mr. Parag Kulkarni is M.Tech. in Mechanical Engineering from College of Engineering, Pune. Later he pursued his MBA degree from IIM Lukhnow in 2014. Currently he is working as a 'Manager' in Agro Machines Pvt. Ltd. He has been awarded with the 'Best Employeee Award' by Agro Machines Pvt. Ltd.. He has achieved many laurels to his name. I feel proud to say Mr. Parag Kulkarni is a perfect blend of engineering and management. So faculties and students, please welcome the chief guest for today's first year induction program Mr. Parag Kulkarni. Sir, I request you to take over the proceedings. Thank you. ***(Note: Content may vary.)***	**04**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.	**(iii)**	**Prepare vote of thanks for the Annual Gathering of your institute.** **Ans:** Good evening ladies and gentlemen. I am standing before you to propose vote of thanks in this beautiful evening of 'Annual Cultural Day Celebration'. At the outset, I would like to thank our honorable Founder President for giving us an opportunity to organize this event. I am also thankful to our principal who supported and guided us for the success of this event. I thank the chief guest, Mr. Amey Moghe, a TV Actor, from the bottom of my heart for taking out some time for us and gracing the event by his presence. I express my heartfelt thanks to all the teachers who inspired and guided us during this Annual Cultural Day Celebration. I thank all the organisers, event coordinators, technicians and my colleagues; without their support the event would not have been successful. Before I conclude, I want to thank our Canteen Incharge for providing us tasty food and tea. I extend my thanks to all the students for attending the Annual Cultural Day Celebration. Thank you all. ***(Note: Content may vary.)***	**04**
	(b)	**Change into indirect speech:**	**(04)**
	(i)	**Sachin said to Janu, "Will you give me a pen?"** **Ans:** Sachin asked Janu if he/she would give him a pen.	**02**
	(ii)	**Geeta said, "I do yoga daily."** **Ans:** Geeta said that she does yoga daily.	**02**
6.		**Attempt any TWO of the following:**	**(12)**
	(a)	**Do as directed:**	
	(i)	**Ganesh was <u>an</u> only teacher in a village. (Rewrite the sentences using the correct article in place of the underlined article)** **Ans:** Ganesh was **<u>the</u>** only teacher in a village.	**02**
	(ii)	**Dr. Janhavi was <u>though</u> a lecturer and author of many famous books. (Rewrite the sentence using the correct conjunctions in place of underlined conjunctions)** **Ans:** Dr. Janhavi was **<u>not only</u>** a lecturer **<u>but also</u>** author of many famous books.	**02**
	(iii)	**Mr. Prakash received a letter <u>to</u> his daughter who had been living in Chennai <u>from</u> many years. (Rewrite the sentence using the correct prepositions in place of the underlined prepositions)** **Ans:** Mr. Prakash received a letter **<u>from</u>** his daughter who had been living in Chennai **<u>for</u>** many years.	**02**

SUMMER– 2022 EXAMINATION

Subject Name: English **Model Answer** **Subject Code**: 22101

Q. No.	Sub Q. N.	Answer	Marking Scheme
6.	**(b)**	**Read the following passage and answer the given questions:** The word victory generally reminds us wars and conquerors like Alexander, Caesar and Napoleon. Or we may think of the Allied victories in the two world wars but these victories were associated with so much destruction and devastation. Thousands of people were killed and hundreds of towns and cities destroyed, but there is another type of victory which is creative and constructive. In this category we may include the achievements of scientists and scholars, statesmen and social reformers, workers in the field and factory and all who contribute to the progress of the human race. The victories of peace are more lasting and useful to humanity than the so called victories of war. **Questions :**	
	(i)	**How many things are associated with the word victory in this passage.** **Ans:** War, conquerors, devastation and destruction are the things associated with the word victory in this passage.	**01**
	(ii)	**Name two constructive victories.** Constructive victories: Achievements of scientists, scholars, statesmen and social reformers, workers in the field and factory and all who contribute to the progress of the human race.	**01**
	(iii)	**Why the victory of peace is useful.** The victories of peace are more lasting and useful to humanity than the so called victories of war.	**02**
	(iv)	**Give the synonym for the word.** Category: group, type, class Achievement: attainment, accomplishment, success ***(Note: Any one correct synonym should be given full marks.)***	**02**
	(c)	**Do as directed:**	
	(i)	**We (go) shopping last weekend. There (be) a great crowd at the shopping centre. (Rewrite the sentence using the correct form of the verbs in the bracket)** **Ans:** We **went** shopping last weekend. There **was** a great crowd at the shopping centre.	**02**
	(ii)	**What a wonderful idea it is! (Change into Assertive)** **Ans:** It is a very wonderful idea.	**02**
	(iii)	**As soon as I (hear) the noise, I immediately (go) there. (Rewrite the sentence using the correct form of the verbs in the bracket)** **Ans:** As soon as I **heard** the noise, I immediately **went** there.	**02**

22101

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Explain the term comfort zone.

b) Name the entrepreneurs developed under the guidance of JRD Tata.

c) State any two positive points of Gurmeet Singh's personality that has appealed to you.

d) State the additional tips for proper recycling of e-waste.

e) State the full form of EQ, IQ and SQ.

f) Name the awards won by Arunima Sinha.

g) Explain the term : Doer and Mentor.

2. Attempt any THREE of the following: **12**

a) Describe the help given by Krishna Vedavyasa.

b) Write about your career dreams.

c) Express your views / ideas on JRD Tata.

d) State the qualities of Arunima that touched your heart.

P.T.O.

Marks

3. Attempt any THREE of the following: **12**

a) Develop a dialogue between two students about the timetable of final exam. (8 - 10) dialogues.

b) Develop a dialogue between the doctor and the patient about the improvement in the patient's health. (8 - 10) dialogues.

c) Write a paragraph on 'My Sweet Memories'.

d) Write a paragraph on 'Mobile telephone'. (75 words).

4. Attempt any THREE of the following: **12**

a) Make sentences using the following collocations :

i) Save money

ii) Pay attention

iii) Do business

iv) Take a seat

b) Replace the underlined words with correct word and rewrite the sentences.

i) Ram is very week.

ii) The goods train is stationery.

iii) We salute our army personal.

iv) The principle of the college was present for the meeting.

c) Write the meanings of following idioms and make sentences of your own :

i) At the eleventh hour

ii) In black and white

d) Choose the correctly spelt word from the following :

i) mesege ii) message iii) messege.

ii) miting ii) meeting iii) metting.

iii) keys, keyes, keies.

iv) leafs, leaffs, leaves.

Marks

e) Change the voice

i) Grammar is taught to us by Prakash.

ii) By whom was she taught French?

iii) Let the door be shut.

iv) I sent the report yesterday.

5. a) Attempt any TWO of the following: **08**

i) A senior faculty of your department is retiring from the job. As an H.O.D., draft a farewell speech for the faculty.

ii) Draft a speech to introduce the chief guest for the first year induction program organised by your institute.

iii) Prepare vote of thanks for the Annual Gathering of your institute.

b) Change into Indirect speech: **04**

i) Sachin said to Janu, "Will you give me a pen?"

ii) Geeta said, "I do yoga daily."

6. **Attempt any TWO of the following:** **12**

a) Do as directed:

i) Ganesh was an only teacher in a village. (Rewrite the sentence using the correct article in place of the underlined article).

ii) Dr. Janhavi was though a lecturer and author of many famous books. (Rewrite the sentence using the correct conjunctions in place of underlined conjunctions).

iii) Mr. Prakash received a letter to his daughter who had been living in Chennai from many years. (Rewrite the sentence using the correct prepositions in place of the underlined prepositions).

Marks

b) Read the following passage and answer the given questions :

The word victory generally reminds us of wars and conquerers like Alexander, Caesar and Napoleon. Or we may think of the Allied victories in the two world wars but these victories were associated with so much destruction and devastation. Thousands of people were killed and hundreds of towns and cities destroyed, but there is another type of victory which is creative and constructive. In this category we may include the achievements of scientists and scholars, statemen and social reformers, workers in the field and factory and all who contribute to the progress of the human race. The victories of peace are more lasting and useful to humanity than the so called victories of war.

Questions :

i) How many things are associated with the word victory in this passage. (01 mark)

ii) Name two constructive victories. (01 mark)

iii) Why the victory of peace is useful. (02 mark)

iv) Give the synonym for the word (02 mark)

1) Category

2) Achievement

c) Do as directed :

i) We (go) shopping last weekend. There (be) a great crowd at the shopping centre. (Rewrite the sentence using the correct form of the verbs in the bracket).

ii) What a wonderful idea it is! (Change into Assertive)

iii) As soon as I (hear) the noise, I immediately (go) there. (Rewrite the sentence using the correct form of the verbs in the bracket).

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SUMMER – 2022 EXAMINATION

Subject Name:Basic Mathematics **Model Answer** **Subject Code:** 22103

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
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6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
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8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Solve any <u>FIVE</u> of the following:**	10
	a)	Find value of $\log\left(\frac{2}{3}\right)+\log\left(\frac{4}{5}\right)-\log\left(\frac{8}{15}\right)$	**02**
	Ans	$\log\left(\frac{2}{3}\right)+\log\left(\frac{4}{5}\right)-\log\left(\frac{8}{15}\right)=\log\left(\frac{2}{3}\times\frac{4}{5}\right)-\log\left(\frac{8}{15}\right).$	1
		$=\log\left(\frac{8}{15}\right)-\log\left(\frac{8}{15}\right)$	
		$=0 \quad OR \quad =\log\left(\frac{\frac{8}{15}}{\frac{8}{15}}\right)=\log(1)=0$	1
		--	
	b)	Show that the points $(8,1)$ $(3,-4)$ and $(2,-5)$ are collinear.	**02**
	Ans	Consider $\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$	

SUMMER – 2022 EXAMINATION

Subject Name: Basic Mathematics **Model Answer** **Subject Code:** 22103

Q. No	Sub Q. N.	Answer	Marking Scheme
1.	b)	$= \begin{vmatrix} 8 & 1 & 1 \\ 3 & -4 & 1 \\ 2 & -5 & 1 \end{vmatrix}$	½
		$= 8(-4+5)-1(3-2)+1(-15+8)$	1
		$= 0$	
		$\therefore$ Points are collinear	½
	c)	Without using calculator find the value of $\sin(105^0)$	**02**
	Ans	$\sin(105^0)$	
		$= \sin(60^0 + 45^0)$	
		$= \sin 60^0 \cos 45^0 + \cos 60^0 \sin 45^0$	1
		$= \frac{\sqrt{3}}{2}\frac{1}{\sqrt{2}} + \frac{1}{2}\frac{1}{\sqrt{2}}$	½
		$= \frac{\sqrt{3}+1}{2\sqrt{2}}$ OR 0.9659	½
	d)	Find area of Rhombus where diagonals are of length 6 cm and 9 cm.	**02**
	Ans	Area of rhombus $= \frac{1}{2}(d_1 \times d_2)$	
		$= \frac{1}{2}(6 \times 9)$	1
		Area of rhombus $= 27$	1
	e)	Find surface area of cuboid whose dimensions are $8\text{cm} \times 11\text{cm} \times 15\text{cm}$	**02**
	Ans	Let $l = 8$, $b = 11$, $h = 15$	
		Total surface Area of a cuboid $= 2[lb + bh + hl]$	1
		$= 2[8 \times 11 + 11 \times 15 + 15 \times 8]$	
		$= 746$	1

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.	f)	If coefficient of variance is 5 and mean is 60.Find standard deviation.	**02**
	Ans	Coefficient of variation $= \frac{S.D}{Mean} \times 100$	
		$\therefore 5 = \frac{S.D}{60} \times 100$	1
		$\therefore \frac{5 \times 60}{100} = S.D.$	
		$\therefore S.D. = 3$	1
	g)	Find range and coefficient of range for the data: 40, 52, 47, 28, 45, 36, 47, 50	**02**
	Ans	Range $= L - S$	
		$=52 - 28$	
		$= 24$	1
		Coefficient of range $= \frac{L-S}{L+S}$	
		$= \frac{52-28}{52+28}$	½
		$= 0.3$	½
	h)	Find surface area of sphere whose volume is $\frac{4\pi}{3}$ cm^3.	**02**
	Ans	Volume of sphere $= \frac{4}{3}\pi r^3$	
		$\therefore \frac{4\pi}{3} = \frac{4}{3}\pi r^3$	
		$1 = r^3$	
		$\therefore r = 1$	1
		Surface area of sphere $= 4\pi r^2$	
		$= 4\pi(1)^2$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
		$= 4\pi$ OR $12.56\ \text{cm}^2$	1

2.		**Solve any THREE of the following :**	**12**
	a)	If $A = \begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}$ prove that $A^2 = I$	**04**
	Ans	$A = \begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}$	
		$A^2 = AA$	
		$= \begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}\begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}$	1
		$= \begin{bmatrix} 0+4-3 & 0-3+3 & 0+4-4 \\ 0-12+12 & 4+9-12 & -4-12+16 \\ 0-12+12 & 3+9-12 & -3-12+16 \end{bmatrix}$	2
		$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$	1
		$= I$	
		$\therefore A^2 = I$	
		---	
	b)	Resolve following into partial fractions : $\dfrac{x+3}{(x-1)(x+1)(x+5)}$	**04**
	Ans	$\dfrac{x+3}{(x-1)(x+1)(x+5)} = \dfrac{A}{x-1} + \dfrac{B}{x+1} + \dfrac{C}{x+5}$	½
		$\therefore\ x+3 = A(x+1)(x+5) + B(x-1)(x+5) + C(x-1)(x+1)$	

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Subject Name:Basic Mathematics **Model Answer** **Subject Code:** 22103

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.		Put $x=1$ $4=A(2)(6)$ $4=12A$ $\therefore A=\frac{1}{3}$	1
		Put $x=-1$ $-1+3=B(-2)(4)$ $2=-8B$ $\therefore B=-\frac{1}{4}$	1
		Put $x=-5$ $-5+3=C(-6)(-4)$ $-2=24C$ $\therefore C=\frac{-1}{12}$	1
		$\frac{x+3}{(x-1)(x+1)(x+5)} = \frac{\frac{1}{3}}{x-1}+\frac{-\frac{1}{4}}{x+1}+\frac{-\frac{1}{12}}{x+5}$	½
	c)	Following results are obtained as a result of experiment. Find V_1, V_2 and V_3 by using Cramer's Rule. $V_1+V_2+V_3=9;\ V_1-V_2+V_3=3;\ V_1+V_2-V_3=1$	**04**
	Ans	$D=\begin{vmatrix}1 & 1 & 1\\ 1 & -1 & 1\\ 1 & 1 & -1\end{vmatrix}=1(1-1)-1(-1-1)+1(1+1)=4$	1
		$D_{V_1}=\begin{vmatrix}9 & 1 & 1\\ 3 & -1 & 1\\ 1 & 1 & -1\end{vmatrix}=9(1-1)-1(-3-1)+1(3+1)=8$	
		$\therefore V_1=\frac{D_{V_1}}{D}=\frac{8}{4}=2$	1

Q. No.	Sub Q. N.	Answer	Marking Scheme
2.		$D_{V_2}=\begin{vmatrix}1 & 9 & 1\\ 1 & 3 & 1\\ 1 & 1 & -1\end{vmatrix}=1(-3-1)-9(-1-1)+1(1-3)=12$	
		$\therefore V_2=\frac{D_{V_2}}{D}=\frac{12}{4}=3$	1
		$D_{V_3}=\begin{vmatrix}1 & 1 & 9\\ 1 & -1 & 3\\ 1 & 1 & 1\end{vmatrix}=1(-1-3)-1(1-3)+9(1+1)=16$	
		$\therefore V_3=\frac{D_{V_3}}{D}=\frac{16}{4}=4$	1
	d)	Compute mean deviation for the mean of the data: 12, 6, 7, 3, 15, 10, 18, 5.	**04**
	Ans		

x_i	$d_i=x_i-\bar{x}$	$\lvert d_i\rvert$
3	-6.5	6.5
5	-4.5	4.5
6	-3.5	3.5
7	-2.5	2.5
10	0.5	0.5
12	2.5	2.5
15	5.5	5.5
18	8.5	8.5
$\sum x_i=76$		$\sum\lvert d_i\rvert=34$

2

where Mean $\bar{x}=\frac{\sum x_i}{N}=\frac{76}{8}$

$\bar{x}=9.5$ 1

$\therefore$ Mean deviation about mean $=\frac{\sum\lvert d_i\rvert}{N}$

$=\frac{34}{8}=4.25$ 1

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.		**Solve any THREE of the following :**	**12**
	a)	Solve Without using calculator.	**04**
	Ans	$\sin 420^0 \cos 390^0 + \sin(-330^0)\cos(-300^0)$	
		$\sin 420^0 = \sin(90^0 \times 4 + 60^0)$	
		$= \sin 60^0 = \frac{\sqrt{3}}{2}$	½
		$\cos 390^0 = \cos(90^0 \times 4 + 30^0)$	½
		$= \cos 30^0 = \frac{\sqrt{3}}{2}$	½
		$\sin(-330^0) = -\sin(330^0)$	
		$= -\sin(90^0 \times 3 + 60^0)$	½
		$= -(-\cos 60^0) = \frac{1}{2}$	½
		$\cos(-300^0) = \cos(300^0)$	
		$= \cos(90^0 \times 3 + 30^0)$	
		$= \sin 30^0 = \frac{1}{2}$	½
		$\sin 420^0 \cos 390^0 + \cos(-300^0)\sin(-330^0)$	
		$= \left(\frac{\sqrt{3}}{2}\right)\left(\frac{\sqrt{3}}{2}\right) + \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$	
		$= 1$	1
		---	
	b)	Prove that $\frac{\sin 4\theta + \sin 2\theta}{1 + \cos 2\theta + \cos 4\theta} = \tan 2\theta$	**04**
	Ans	$LHS = \frac{\sin 4\theta + \sin 2\theta}{1 + \cos 4\theta + \cos 2\theta}$	
		$= \frac{2.\sin 2\theta.\cos 2\theta + \sin 2\theta}{2\cos^2 2\theta + \cos 2\theta}$	2

Q. No.	Sub Q. N.	Answer	Marking Scheme
3.		$= \dfrac{\sin 2\theta(2\cos 2\theta + 1)}{\cos 2\theta(2\cos 2\theta + 1)}$	1
		$= \tan 2\theta$	1
		---	
	c)	Prove: $\dfrac{\sin 4A + \sin 5A + \sin 6A}{\cos 4A + \cos 5A + \cos 6A} = \tan 5A$	**04**
	Ans	$\dfrac{\sin 4A + \sin 5A + \sin 6A}{\cos 4A + \cos 5A + \cos 6A}$	
		$= \dfrac{(\sin 4A + \sin 6A) + \sin 5A}{(\cos 4A + \cos 6A) + \cos 5A}$	
		$= \dfrac{2\sin\left(\dfrac{4A+6A}{2}\right)\cos\left(\dfrac{4A-6A}{2}\right) + \sin 5A}{2\cos\left(\dfrac{4A+6A}{2}\right)\cos\left(\dfrac{4A-6A}{2}\right) + \cos 5A}$	2
		$= \dfrac{2\sin 5A\cos(-A) + \sin 5A}{2\cos 5A\cos(-A) + \cos 5A}$	1
		$= \dfrac{\sin 5A[2\cos(-A) + 1]}{\cos 5A[2\cos(-A) + 1]}$	
		$= \tan 5A$	1
		---	
	d)	Prove : $\tan^{-1}\left(\dfrac{1}{8}\right) + \tan^{-1}\left(\dfrac{1}{5}\right) = \tan^{-1}\left(\dfrac{1}{3}\right)$	**04**
	Ans	$L.H.S = \tan^{-1}\left(\dfrac{1}{8}\right) + \tan^{-1}\left(\dfrac{1}{5}\right)$	
		$= \tan^{-1}\left(\dfrac{\frac{1}{8} + \frac{1}{5}}{1 - \left(\frac{1}{8}\right)\left(\frac{1}{5}\right)}\right)$	2

Q. No.	Sub Q. N.	Answer	Marking Scheme
		$= \tan^{-1}\left(\frac{1}{3}\right)$ $= R.H.S$	2

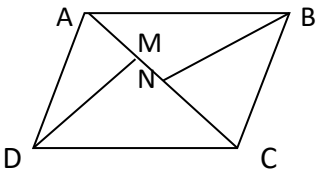
4.		**Solve any THREE of the following:**	**12**
	a)	Find x and y if $\left\{4\begin{bmatrix}1 & 2 & 0\\ 2 & -1 & 3\end{bmatrix} - 2\begin{bmatrix}1 & 3 & -1\\ 2 & -3 & 4\end{bmatrix}\right\}\begin{bmatrix}2\\ 0\\ -1\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	**04**
	Ans	$\left\{4\begin{bmatrix}1 & 2 & 0\\ 2 & -1 & 3\end{bmatrix} - 2\begin{bmatrix}1 & 3 & -1\\ 2 & -3 & 4\end{bmatrix}\right\}\begin{bmatrix}2\\ 0\\ -1\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	
		$\left\{\begin{bmatrix}4 & 8 & 0\\ 8 & -4 & 12\end{bmatrix} - \begin{bmatrix}2 & 6 & -2\\ 4 & -6 & 8\end{bmatrix}\right\}\begin{bmatrix}2\\ 0\\ -1\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	1
		$\begin{bmatrix}2 & 2 & 2\\ 4 & 2 & 4\end{bmatrix}\begin{bmatrix}2\\ 0\\ -1\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	1
		$\begin{bmatrix}4+0-2\\ 8+0-4\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	1
		$\begin{bmatrix}2\\ 4\end{bmatrix} = \begin{bmatrix}x\\ y\end{bmatrix}$	1
		$\therefore x = 2, y = 4$	
		---	
	b)	Resolve into partial fractions: $\frac{3x-2}{(x+2)(x^2+4)}$	**04**
	Ans	$\frac{3x-2}{(x+2)(x^2+4)} = \frac{A}{x+2} + \frac{Bx+C}{x^2+4}$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.		$3x-2=(x^2+4)A+(x+2)(Bx+C)$	
		Put $x=-2$	
		$-8=8A$	1
		$A=-1$	
		Put $x=0$	
		$-2=4A+2C$	1
		$\therefore C=1$	
		Put $x=1$	
		$1=5A+(3)(B+C)$	
		$1=-5+3B+3C$	1
		$\therefore B=1$	
		$\frac{3x-2}{(x+2)(x^2+4)}=\frac{-1}{x-2}+\frac{(1)x+1}{x^2+1}$	
		$\frac{3x-2}{(x+2)(x^2+4)}=\frac{-1}{x-2}+\frac{x+1}{x^2+1}$	½
		---	
	c)	Prove that $\cos 20^0.\cos 40^0.\cos 80^0=\frac{1}{8}$	**04**
	Ans	$\cos 20^0\cos 40^0\cos 80^0=\frac{1}{2}(2\cos 20°\cos 40°).\cos 80°$	½
		$=\frac{1}{2}[\cos(20°+40°)+\cos(20°-40°)]\cos 80°$	½
	-	$=\frac{1}{2}[\cos(60°)+\cos(-20°)]\cos 80°$	½
		$=\frac{1}{2}\left[\frac{1}{2}\cos 80°+\cos 20°\cos 80°\right]$	½
		$=\frac{1}{4}[\cos 80°+2\cos 20°\cos 80°]$	
		$=\frac{1}{4}[\cos 80°+\cos(20°+80°)+\cos(20°-80°)]$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
4.		$=\frac{1}{4}\left[\cos 80° + \cos(180-80°) + \frac{1}{2}\right]$	½
		$=\frac{1}{4}\left[\cos 80° - \cos(80°) + \frac{1}{2}\right]$	½
		$=\frac{1}{8}$	½
	d)	If $\tan(x+y)=\frac{3}{4}$ and $\tan(x-y)=\frac{1}{3}$. Find $\tan 2x$	**04**
	Ans	$x+y+x-y=2x$	
		$\tan(x+y+x-y)=\tan 2x$	1
		$\frac{\tan(x+y)+\tan(x-y)}{1-\tan(x+y)\tan(x-y)}=\tan 2x$	1
		$\frac{\frac{3}{4}+\frac{1}{3}}{1-\frac{3}{4}.\frac{1}{3}}=\tan 2x$	1
		$\therefore \tan 2x=\frac{13}{9}$	1
	e)	If $\sin A=\frac{1}{2}$ Find sin3A	**04**
	Ans	$\sin 3A = 3\sin A - 4\sin^3 A$	2
		$=3\left(\frac{1}{2}\right)-4\left(\frac{1}{2}\right)^3$	
		$=1$	2
5		**Solve any <u>TWO</u> of the following:**	**12**
	a)	**Attempt the following:**	**06**
	i)	Find equation of line passing through points $(6,-4)$ and $(-3,8)$.	**03**

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.	Ans	Equation of line is $\frac{y-y_1}{y_1-y_2}=\frac{x-x_1}{x_1-x_2}$ $\frac{y+4}{-4-8}=\frac{x-6}{6+3}$ $\frac{y+4}{-12}=\frac{x-6}{9}$ $12x+9y-36=0$	1 1 1
	ii)	Find the distance between the parallel lines $3x+2y-5=0$ and $3x+2y-6=0$ $3x+2y-5=0$ $a=3,\ b=2,\ c_1=-5$ For $3x+2y-6=0$ $a=3,\ b=2,\ c_2=-6$ $\therefore$ distance between two parallel lines is $=\left\|\frac{c_2-c_1}{\sqrt{a^2+b^2}}\right\|=\left\|\frac{-6+5}{\sqrt{3^2+(2)^2}}\right\|$ $=\left\|\frac{-1}{\sqrt{13}}\right\|$ $=\frac{1}{\sqrt{13}}$ OR 0.277	**03** 1 1 1
	b)	**Attempt the following:**	**06**
	i)	Find equation of line passing through the point $(2,0)$ and perpendicular to $x+y+3=0$.	**03**
	Ans	Point $=(x_1,y_1)=(2,0)$ Slope of the line $x+y+3=0$. is, $m=-\frac{a}{b}=-\frac{1}{1}=-1$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.		$\therefore$ Slope of the required line is,	
		$m_1 = -\frac{1}{m} = -\frac{1}{-1} = 1$	1
		$\therefore$ equation is,	
		$y - y_1 = m_1(x - x_1)$	
		$\therefore\ y - 0 = 1(x - 2)$	½
		$\therefore\ x - y - 2 = 0$	1
		---	
	ii)	Find the acute angle between the lines $3x - y + 4 = 0$ and $2x + y = 3$.	**03**
	Ans	For $3x - y + 4 = 0$	
		slope $m_1 = -\frac{a}{b} = -\frac{3}{-1} = 3$	½
		For $2x + y = 3$	
		slope $m_2 = -\frac{a}{b} = -\frac{2}{1} = -2$	½
		$\therefore \tan\theta = \left\lvert\frac{m_1 - m_2}{1 + m_1 m_2}\right\rvert$	
		$= \left\lvert\frac{3+2}{1+3\times(-2)}\right\rvert$	1
		$\therefore \tan\theta = 1$	
		$\therefore \theta = \tan^{-1}(1) = \frac{\pi}{4}$	1
		---	
	c)	**Attempt the following:**	**06**
	i)	Find the area of ring between two concentric circles whose circumference are 77cm and 55cm	**03**
	Ans	circumference of outer circle =77	
		$2\pi r_1 = 77$	
		$r_1 = \frac{77}{2\pi}$	½

Q. No.	Sub Q. N.	Answer	Marking Scheme
5.		circumference of inner circle $= 55$ $2\pi r_2 = 55$ $r_2 = \frac{55}{2\pi}$	½
		Area of outer circle $= \pi r_1^2$ $= \pi\left(\frac{77}{2\pi}\right)^2 = 471.81$	½
		Area of inner circle $= \pi r_2^2$ $= \pi\left(\frac{55}{2\pi}\right)^2 = 240.72$	½
		Area of ring = *Area* of outer circle – *Area* of inner circle $= 471.81 - 240.72$ $= 231.09$	1
	ii)	The area of piece of land in the form of a quadrilateral ABCD. The diagonal AC is 400m long off-set to B is 220m and off-set to D is 98m.Find the area.	**03**
	Ans		
		$A(\square ABCD) = A(\Delta ABC) + A(\Delta ADC)$ $= \frac{1}{2} \times AC \times BN + \frac{1}{2} \times AC \times DM$ $= \frac{1}{2} \times 400 \times 220 + \frac{1}{2} \times 400 \times 98$	2
		$= 63600$	1
6.		**Solve any TWO of the following:**	**12**
	a)	Find the mean and standard deviation and coefficient of variance of the following data:	**06**

6.

Class-Interval	0-10	10-20	20-30	30-40	40-50
Frequency	3	5	8	3	1

Class Interval	x_i	f_i	$f_i x_i$	$d_i = \frac{x_i - a}{h}$	$f_i d_i$	d_i^2	$f_i d_i^2$
0-10	5	3	15	-2	-6	4	12
10-20	15	5	75	-1	-5	1	5
20-30	25	8	200	0	0	0	0
30-40	35	3	105	1	3	1	3
40-50	45	1	45	2	2	4	4
		20	440		-6		24

2

Mean $\bar{x} = \frac{\sum f_i x_i}{N}$

$\therefore \bar{x} = \frac{440}{20}$

$\therefore \bar{x} = 22$

1

$$S.D. = \sigma = \sqrt{\frac{\sum f_i d_i^2}{N} - \left(\frac{\sum f_i d_i}{N}\right)^2} \times h$$

$$= \sqrt{\frac{24}{20} - \left(\frac{-6}{20}\right)^2} \times 10$$

1

$$= 10.54$$

1

Coefficient of variance $= \frac{\sigma}{\bar{x}} \times 100$

$$= \frac{10.54}{22} \times 100$$

$$= 47.91$$

1

Q. No.	Sub Q. N.	Answer	Marking Scheme
6.		**OR**	

Class Interval	x_i	f_i	$f_i x_i$	x_i^2	$f_i x_i^2$
0-10	5	3	15	25	75
10-20	15	5	75	225	1125
20-30	25	8	200	625	5000
30-40	35	3	105	1225	3675
40-50	45	1	45	2025	2025
		20	440		11900

2

Mean $\bar{x} = \frac{\sum f_i x_i}{N}$

$\therefore \bar{x} = \frac{440}{20}$

$\therefore \bar{x} = 22$

1

S.D. $\sigma = \sqrt{\frac{\sum f_i x_i^2}{N} - (\bar{x})^2}$

$= \sqrt{\frac{11900}{20} - (22)^2}$

1

$\sigma = 10.54$

1

Coefficient of variance $= \frac{\sigma}{\bar{x}} \times 100$

$= \frac{10.54}{22} \times 100$

$= 47.91$

1

---

b)	Attempt the following:	**06**

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Q. No.	Sub Q. N.	Answer	Marking Scheme
6.	i)	Find range and coefficient of range for the following data:	**03**

Marks	10-19	20-29	30-39	40-49	50-59	60-69
No of students	6	10	16	14	8	4

C.I.	9.5-19.5	19.5-29.5	29.5-39.5	39.5-49.5	49.5-59.5	59.5-69.5
f_i	6	10	16	14	8	4

$\text{Range} = L - S = 69.5 - 9.5$ 1

$= 60$ 1

$\text{Coefficient of range} = \frac{L-S}{L+S}$

$= \frac{69.5-9.5}{69.5+9.5}$

$= \frac{60}{79}$ OR 0.759 1

---

ii) The two sets of observation are given below: **03**

Set-I	Set-II
$\bar{x} = 82.5$	$\bar{x} = 48.75$
$\sigma = 7.3$	$\sigma = 8.35$

Which of the two sets is more consistent?

Ans Coefficient of variance $V = \frac{\sigma}{\bar{x}} \times 100$

Q. No.	Sub Q. N.	Answer	Marking Scheme
6.	i)	For set-I $V_1 = \frac{7.3}{82.5} \times 100$ $\therefore V_1 = 8.848$ For set-II $V_2 = \frac{8.35}{48.75} \times 100$ $\therefore V_2 = 17.128$ $\therefore V_1 < V_2$ $\therefore$ Set-I is more consistent.	1 1 1
	c)	Using matrix inversion method , solve $x+y+z=3$; $x+2y+3z=4$; $x+4y+9z=6$	**06**
	Ans	Let $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & 9 \end{bmatrix}$ $\lvert A \rvert = \begin{vmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & 9 \end{vmatrix}$ $\lvert A \rvert = 1(18-12)-1(9-3)+1(4-2)$ $\therefore \lvert A \rvert = 2 \neq 0$ $\therefore A^{-1}$ exists Matrix of minors $= \begin{bmatrix} \begin{vmatrix} 2 & 3 \\ 4 & 9 \end{vmatrix} & \begin{vmatrix} 1 & 3 \\ 1 & 9 \end{vmatrix} & \begin{vmatrix} 1 & 2 \\ 1 & 4 \end{vmatrix} \\ \begin{vmatrix} 1 & 1 \\ 4 & 9 \end{vmatrix} & \begin{vmatrix} 1 & 1 \\ 1 & 9 \end{vmatrix} & \begin{vmatrix} 1 & 1 \\ 1 & 4 \end{vmatrix} \\ \begin{vmatrix} 1 & 1 \\ 2 & 3 \end{vmatrix} & \begin{vmatrix} 1 & 1 \\ 1 & 3 \end{vmatrix} & \begin{vmatrix} 1 & 1 \\ 1 & 2 \end{vmatrix} \end{bmatrix}$	1

Q. No.	Sub Q. N.	Answer	Marking Scheme
6.		$= \begin{bmatrix} 6 & 6 & 2 \\ 5 & 8 & 3 \\ 1 & 2 & 1 \end{bmatrix}$	1
		Matrix of cofactors $= \begin{bmatrix} 6 & -6 & 2 \\ -5 & 8 & -3 \\ 1 & -2 & 1 \end{bmatrix}$	1
		OR	
		$c_{11} = (-1)^{1+1}\begin{vmatrix} 2 & 3 \\ 4 & 9 \end{vmatrix} = 6,\ c_{12} = (-1)^{1+2}\begin{vmatrix} 1 & 3 \\ 1 & 9 \end{vmatrix} = -6,\ c_{13} = (-1)^{1+3}\begin{vmatrix} 1 & 2 \\ 1 & 4 \end{vmatrix} = 2,$	
		$c_{21} = (-1)^{2+1}\begin{vmatrix} 1 & 1 \\ 4 & 9 \end{vmatrix} = -5,\ c_{22} = (-1)^{2+2}\begin{vmatrix} 1 & 1 \\ 1 & 9 \end{vmatrix} = 8,\ c_{23} = (-1)^{2+3}\begin{vmatrix} 1 & 1 \\ 1 & 4 \end{vmatrix} = -3,$	
		$c_{31} = (-1)^{3+1}\begin{vmatrix} 1 & 1 \\ 2 & 3 \end{vmatrix} = 1,\ c_{32} = (-1)^{3+2}\begin{vmatrix} 1 & 1 \\ 1 & 3 \end{vmatrix} = -2,\ c_{33} = (-1)^{3+3}\begin{vmatrix} 1 & 1 \\ 1 & 2 \end{vmatrix} = 1,$	
		Matrix of cofactors $= \begin{bmatrix} 6 & -6 & 2 \\ -5 & 8 & -3 \\ 1 & -2 & 1 \end{bmatrix}$	2
		$\therefore AdjA = \begin{bmatrix} 6 & -5 & 1 \\ -6 & 8 & -2 \\ 2 & -3 & 1 \end{bmatrix}$	½
		$A^{-1} = \frac{1}{\lvert A \rvert}\text{Adj.}A = \frac{1}{2}\begin{bmatrix} 6 & -5 & 1 \\ -6 & 8 & -2 \\ 2 & -3 & 1 \end{bmatrix}$	½
		$X = A^{-1}B$	
		$\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 6 & -5 & 1 \\ -6 & 8 & -2 \\ 2 & -3 & 1 \end{bmatrix}\begin{bmatrix} 3 \\ 4 \\ 6 \end{bmatrix}$	

Q. No.	Sub Q. N.	Answer	Marking Scheme
6.		$\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 18-20+6 \\ -18+32-12 \\ 6-12+6 \end{bmatrix}$	1
		$\therefore \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{2}\begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix}$	
		$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$	
		$\therefore \quad x=2\ ,\ \ y=1\ ,\ \ z=0$	1

		Important Note	
		In the solution of the question paper, wherever possible all the possible alternative methods of solution are given for the sake of convenience. Still student may follow a method other than the given herein. In such case, first see whether the method falls within the scope of the curriculum, and then only give appropriate marks in accordance with the scheme of marking.	

22103

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Solve any FIVE of the following: **10**

a) Find value of $\log\left(\frac{2}{3}\right) + \log\left(\frac{4}{5}\right) - \log\left(\frac{8}{15}\right)$.

b) Show that the points (8, 1), (3, –4), (2, –5) are collinear.

c) Without using calculator find value of $\sin(105°)$.

d) Find area of Rhombus where diagonals are of length 6 cm and 9 cm.

e) Find surface area of cuboid whose dimensions are 8 cm × 11 cm × 15 cm.

f) If coefficient of variance is 5 and mean is 60. Find standard deviation.

g) Find range and coefficient of range for the data: 40, 52, 47, 28, 45, 36, 47, 50.

h) Find surface area of sphere whose volume is $\frac{4\pi}{3}$ cm^3.

Marks

2. Solve any THREE of the following: **12**

a) If $A = \begin{bmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{bmatrix}$ prove that $A^2 = I$.

b) Resolve following into partial fraction $\frac{x + 3}{(x - 1)(x + 1)(x + 5)}$

c) Following results are obtained as a result of experiment. Find V_1, V_2, V_3 by using Cramer's Rule.
$V_1 + V_2 + V_3 = 9$, $V_1 - V_2 + V_3 = 3$, $V_1 + V_2 - V_3 = 1$

d) Compute mean deviation for the mean of the data:
12, 6, 7, 3, 15, 10, 18, 5.

3. Solve any THREE of the following: **12**

a) Solve without using calculator,
$\sin(420°)\cos(390°) + \sin(-330°)\cos(-300°)$

b) Prove : $\frac{\sin 4\theta + \sin 2\theta}{1 + \cos 2\theta + \cos 4\theta} = \tan 2\theta$

c) Prove that : $\frac{\sin 4A + \sin 5A + \sin 6A}{\cos 4A + \cos 5A + \cos 6A} = \tan 5A$

d) Prove : $\tan^{-1}\left(\frac{1}{8}\right) + \tan^{-1}\left(\frac{1}{5}\right) = \tan^{-1}\left(\frac{1}{3}\right)$

4. Solve any THREE of the following: **12**

a) Find x and y if

$$\left\{4\begin{bmatrix} 1 & 2 & 0 \\ 2 & -1 & 3 \end{bmatrix} - 2\begin{bmatrix} 1 & 3 & -1 \\ 2 & -3 & 4 \end{bmatrix}\right\}\begin{bmatrix} 2 \\ 0 \\ -1 \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix}$$

b) Resolve into partial fractions: $\frac{3x - 2}{(x + 2)(x^2 + 4)}$

c) Prove : $\cos 20°.\ \cos 40°.\ \cos 80° = \frac{1}{8}$

Marks

d) If $\tan(x + y) = \frac{3}{4}$ and $\tan(x - y) = \frac{1}{3}$. Find $\tan 2x$.

e) If $\sin A = \frac{1}{2}$. Find $\sin 3A$.

5. Solve any <u>TWO</u> of the following: **12**

a) Attempt the following:

i) Find equation of line passing through points $(6, -4)$ and $(-3, 8)$.

ii) Find distance between parallel lines $3x + 2y - 5 = 0$ and $3x + 2y - 6 = 0$.

b) Attempt the following:

i) Find equation of line passing through point $(2, 0)$ and perpendicular to $x + y + 3 = 0$.

ii) Find acute angle between the lines $3x - y + 4 = 0$ and $2x + y = 3$.

c) Attempt the following:

i) Find the area of ring between two concentric circles whose circumferences are 77 cm and 55 cm.

ii) The area of piece of land is in the form of a quadrilateral ABCD. The diagonal AC is 400 m long off-set to B is 220 m and off-set to D is 98 m. Find the area.

Marks

6. Solve any TWO of the following: **12**

a) Find the mean and standard deviation and coefficient of variance of the following data:

Class interval	0-10	10-20	20-30	30-40	40-50
Frequency	3	5	8	3	1

b) Attempt the following:

i) Find range and coefficient of range for following data:

Marks	10-19	20-29	30-39	40-49	50-59	60-69
No. of students	6	10	16	14	8	4

ii) The two sets of observations are given below:

Set I	Set II
$\bar{x}$ = 82.5 σ = S.D = 7.3	$\bar{x}$ = mean = 48.75 σ = S.D = 8.35

Which of two sets is more consistent?

c) Solve the following equations by matrix inversion method.
$x + y + z = 3$, $x + 2y + 3z = 4$, $x + 4y + 9z = 6$.

SUMMER – 2022 EXAMINATION

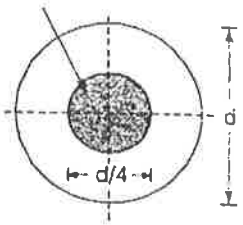
Subject Name: Strength of Materials **Model Answer** **Subject Code:** 22306

Important Instructions to examiners:

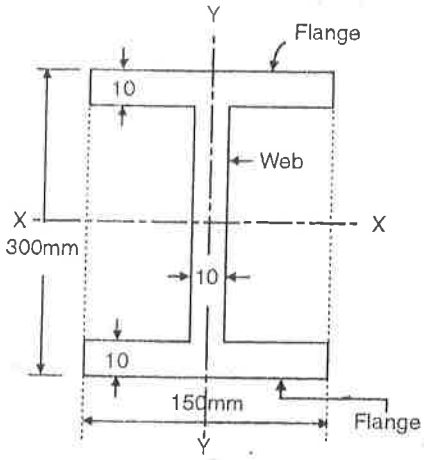
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any Five of the following:**	**10**
	a	***Define : Polar Moment of Inertia, Radius of gyration.***	
		Polar Moment of Inertia:	
		If I_{XX} and I_{YY} are the moment of inertia of a plane section about the two mutually perpendicular axes, then the moment of inertia I_{ZZ} about the third axis ZZ perpendicular to the plane and passing through the intersection of X-X and Y-Y is called as polar moment of inertia.	01
		Radius of gyration :	
		Radius of gyration is defined as the distance from the given axis at which the entire area of the given figure is supposed to be concentrated without changing the moment of inertia about the same axis.	01
	b	***Define: Temperature stress and give one field example where temp. stress produced.***	
		Temperature stress: When deformation caused due to temperature change is wholly or partly prevented, some stresses are produced in the body. Such stresses are called temperature stresses.	01

Q. No.	Sub Q. N.	Answer	Marking Scheme
		Field Example: When gap is not provided at the joint between the rails, temperature stresses are produced in rails when they are subjected to rise in temperature. (01 mark shall be given for other appropriate example)	01
	c	***Define : Creep , Toughness*** Creep : The slow and progressive deformation of a material with time under sustained load is called as creep.	01
		Toughness: The capacity of the material to absorb the impact energy before actual fracture or failure takes place is called as toughness.	01
	d	***State relation between shear force and bending moment*** $\frac{dM}{dx} = F$ The rate of change of bending moment at any section is equal to the shear force at that section	02

Q. No.	Sub Q. N.	Answer	Marking Scheme
	e	***State flexural formula with meaning of each term used.***	
		Bending equation or Flexural formula. $\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$	01
		Where, M = *Maximum bending moment* $(N.mm)$; I = *Moment of inertia about N.A.* (mm^4); σ = *Maximum bending stress* (N/mm^2); y = *Distance of extreme fiber from N.A.* (mm); E = *Modulus of elasticity* (N/mm^2); R = *Radius of curvature* (mm)	01
	f	***Define: Axial load and Eccentric load***	
		Axial Load: When line of action of load coincides with the axis of the member, it is called as axial load.	01
		Eccentric Load: When line of action of load does not coincide with the axis of the member, but acts away from the axis of the member, it is called as an eccentric load.	01
	g	***Define core of section and show it for solid circular section of dia. 'd'***	
		Core of section: A centrally located portion of the cross section of the member, within which if load line acts, there will be either compressive or tensile stresses across the entire cross section of the member, is called as core of the section.	01
		Core of the section for solid circular section	
			01

Q. No.	Sub Q. N.	Answer	Marking Scheme
2		**Attempt any THREE of the following:**	(12)
	a)	A symmetrical I-section of overall depth of 300 mm has its flanges 150 mm × 10 mm and web 10 mm thick. Calculate moment of inertia @ XX and YY centroidal axes.	



$$I_{xx} = \frac{BD^3 - bd^3}{12}$$

$$= \frac{150 \times 300^3 - 140 \times 280^3}{12}$$

$$I_{xx} = 81.393 \times 10^6 \text{ mm}^4$$ 02

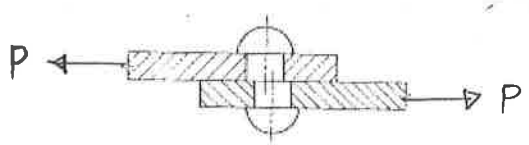
$$I_{yy} = 2 \times I_{yy} \text{ due to flange} + I_{yy} \text{ due to web}$$

$$= 2 \times \left(\frac{10 \times 150^3}{12}\right) + \frac{280 \times 10^3}{12}$$

$$= 5.625 \times 10^6 + 0.023 \times 10^6$$

$$I_{yy} = 5.648 \times 10^6 \text{ mm}^4$$ 02

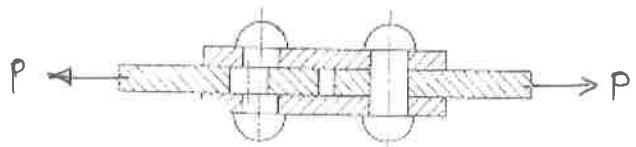
	b)	With neat sketches show the failure of rivet in single shear and double shear. Also write the formulae to calculate shear stress for each case. Assume diameter of rivet = d.	



Single shear Failure

Shear stress (τ)

$$\tau = \frac{P}{\left(\frac{\pi}{4} \times d^2\right)}$$ 01+01

Q. No.	Sub Q. N.	Answer	Marking Scheme
		 Double shear failure Shear stress (τ) $\tau = \frac{P}{2\times(\frac{\pi}{4}d^2)}$	01+01
2	c)	A steel tube of external diameter 20 mm and internal diameter 15 mm was subjected to a tensile load of 1.5 kN. It produced an elongation of 0.004 mm in a length of 80 mm while the outer diameter suffered a compression of 0.00028 mm. Calculate the value of Poissons ratio, Modulus of Elasticity and Modulus of rigidity.	

Given :- For steel tube, $D = 20\,mm$, $d = 15\,mm$, $P = 1.5\times10^3\,N$
$L = 80\,mm$, $\delta L = 0.004\,mm$, $\delta d = 0.00028\,mm$.

To find :- μ, E and G

Solution :- $A = \frac{\pi}{4}[D^2 - d^2] = \frac{\pi}{4}[20^2 - 15^2] = 137.45\,mm^2$

$Stress = \sigma = \frac{P}{A} = \frac{1.5\times10^3}{137.45} = 10.91\,N/mm^2$

$Linear\ strain = e = \frac{\delta L}{L} = \frac{0.004}{80} = 5\times10^{-5}$ 01

$Lateral\ strain = e_{Lat} = \frac{\delta d}{d} = \frac{0.00028}{20} = 1.4\times10^{-5}$

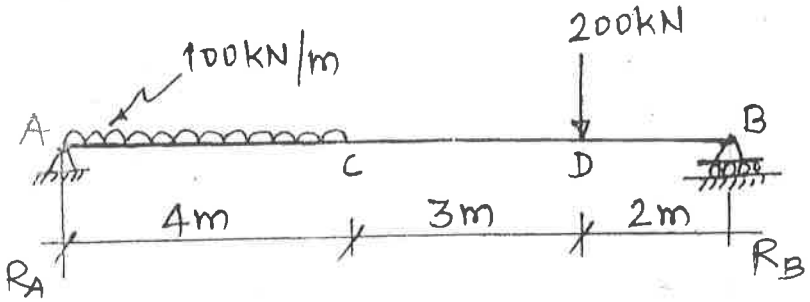
$Poisson's\ Ratio = \mu = \frac{e_{Lat}}{e} = \frac{1.4\times10^{-5}}{5\times10^{-5}} = 0.28$ 01

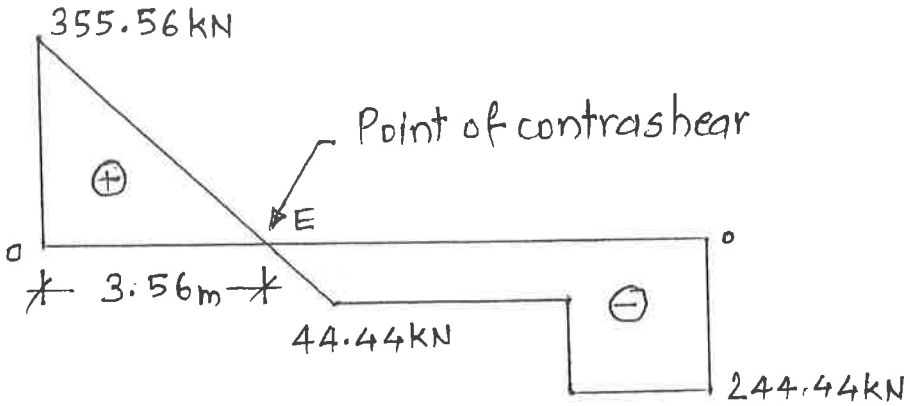
$Modulus\ of\ Elasticity = E = \frac{\sigma}{e} = 10.91/5\times10^{-5}$

$\therefore E = 2.18\times10^5\,N/mm^2$ 01

$E = 2G(1+\mu)$ $\therefore G = \frac{E}{2(1+\mu)} = \frac{2.18\times10^5}{2(1+0.28)} = 0.85\times10^5\,\frac{N}{mm^2}$ 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
2	d)	A simply supported beam is loaded as shown in Fig. No. 1. Draw shear force diagram and locate the position from support 'A' where B.M. is maximum. Also calculate value of Maximum B.M.	





Shear Force Diagram

01

To find Reactions :- Applying conditions of equilibrium

$\Sigma M_A = 0$ ↻ +ve.

$+(100 \times 4 \times 2) + (200 \times 7) - R_B \times 9 = 0$

$\therefore R_B = 244.44$ kN.

$\Sigma F_y = 0$ ↑ +ve $\quad R_A + R_B - (100 \times 4) - 200 = 0$

$\therefore R_A = 600 - 244.44 = 355.56$ kN

01

Q. No.	Sub Q. N.	Answer	Marking Scheme
		B.M. is maximum at the point of contrashear. from shear force diagram - $\frac{x}{355.56} = \frac{4-x}{44.44}$ $\therefore 44.44x = 1422.24 - 355.56x$ Solving $x = 3.56$ m from support 'A'	01
		$\therefore B.M._{max} = B.M_E = 355.56 \times 3.56 - 100 \times \frac{3.56^2}{2}$ $B.M_{max} = 632.11$ KN-m	01

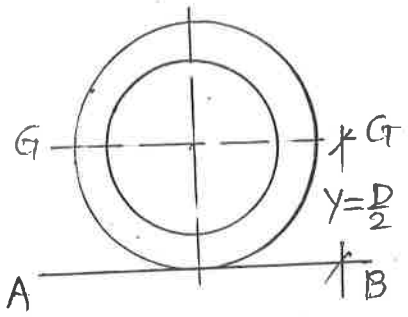
Q. No.	Sub Q. N.	Answer	Marking Scheme
3		**Attempt any THREE of the following**	(12)
	a)	A hollow circular section has external diameter 50 mm and wall thickness of 10 mm. Calculate moment of inertia about the tangent to the exernal diameter.	

Given :- for hollow circular section —

$D = 50\,mm$, $t = 10\,mm$, $d = D - 2t = 50 - 2\times10 = 30\,mm$

To find :- M.I. @ tangent to the external diameter i.e. I_{AB}.

Solution :-



$$I_G = \frac{\pi}{64}(D^4 - d^4)$$

$$= \frac{\pi}{64}(50^4 - 30^4)$$

$$I_G = 2.67\times10^5\,mm^4$$ — 01

To find I_{AB}, using parallel axis theorem.

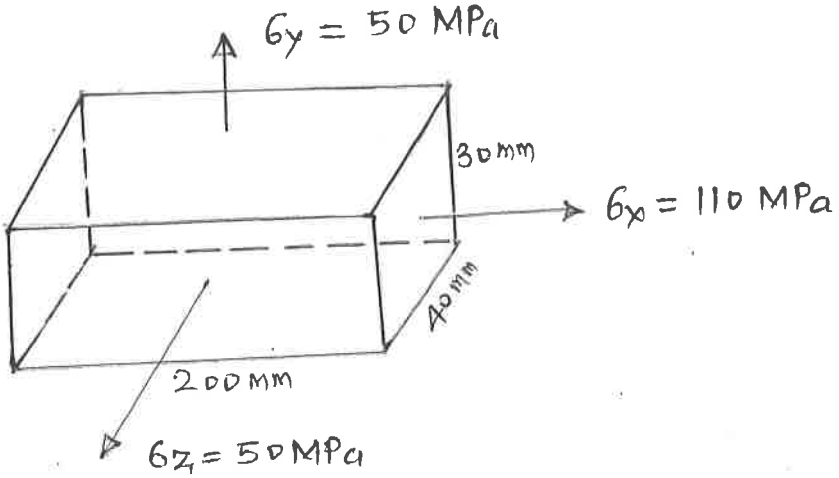
$$I_{AB} = I_G + Ay^2$$ — 01

$$= 2.67\times10^5 + \frac{\pi}{4}(50^2 - 30^2)\times(50/2)^2$$

$$= 2.67\times10^5 + 1256.64\times25^2$$

$$I_{AB} = 10.524\times10^5\,mm^4$$ — 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
3	b)	A metal bar 200 mm long, 40 mm × 30 mm in cross section is subjected to stress of 110 MPa along the length and 50 MPa on other two faces. All stresses are tensile. Calculate strains along the three direction and also the volumetric strain. Assume E = 120 MPa and μ = 0.30.	



$E = 120\ N/mm^2$, $\mu = 0.3$

Strain along X-direction

$$e_x = \frac{1}{E}(\sigma_x - \mu\sigma_y - \mu\sigma_z) = \frac{1}{120}(110 - 0.3\times50 - 0.3\times50)$$

$= +0.667$ 01

Strain along Y-direction

$$e_y = \frac{1}{E}(\sigma_y - \mu\cdot\sigma_z - \mu\sigma_x) = \frac{1}{120}(50 - 0.3\times50 - 0.3\times110)$$

$= +0.017$ 01

Strain along Z-direction

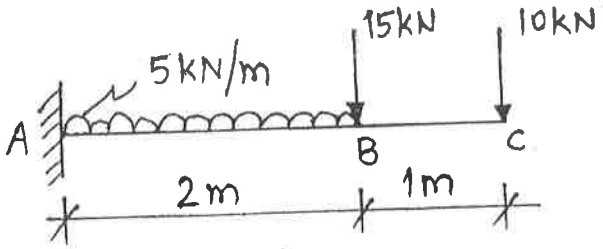
$$e_z = \frac{1}{E}(\sigma_z - \mu\sigma_x - \mu\sigma_y) = \frac{1}{120}(50 - 0.3\times110 - 0.3\times50)$$

$= +0.017$ 01

Volumetric strain $= e_v = \sigma_x + \sigma_y + \sigma_z = 0.667 + 0.017 + 0.017$

$e_v = +0.701$ 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
3	c)	Draw S.F. and B.M. diagrams with all important values for the beam loaded as shown in Fig. No. 2.	



* S.F. Calculations 1/2+ve

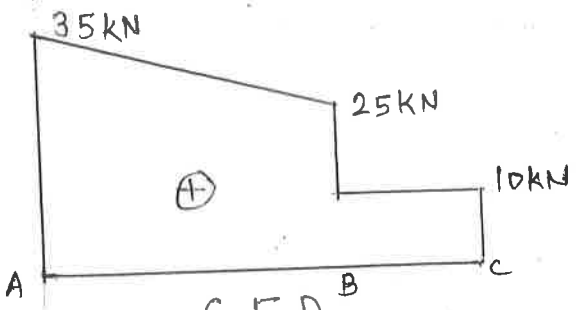
$S.F_C = +10\,kN$

$SF_B(right) = 10\,kN$

$S.F_B(left) = 10+15 = 25\,kN$

$S.F_A = 25 + 5\times2$

$= 35\,kN.$



S.F.D. 01+01

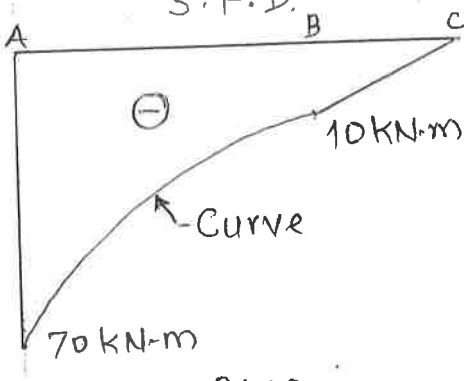
* B.M. Calculations (1/2)+ve

$BM_C = 0$

$BM_B = -10\times1 = -10\,kN\cdot m.$

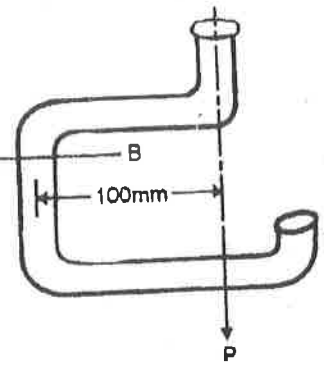
$B.M_A = -10\times3 - 15\times2 - (5\times2\times1)$

$BM_A = -70\,kN\cdot m.$



B.M.D. 01+01

Q. No.	Sub Q. N.	Answer	Marking Scheme
3	d)	A mild steel tube 50 mm external dia and 10 mm thickness is bent in the form of hook as shown in Fig. No. 3. What maximum load 'P' the hook can lift, if the stresses on the cross section 'AB' shall not exceed 90 MPa in tension and 40 MPa in compression?	



Given :- for steel tube :-

$D = 50\,mm,\ t = 10\,mm,\ d = 50 - 2\times10 = 30\,mm$

$\sigma_t = 90\ N/mm^2,\ \sigma_c = 40\ N/mm^2,\ e = 100\,mm$

To find :- 'P'

Answer :- $A = \frac{\pi}{4}(50^2 - 30^2) = 1256.64\,mm^2$

$\sigma_o = \frac{P}{A} = \frac{P}{1256.64} = 7.96\times10^{-4}P$ — 01

$I = \frac{\pi}{64}(50^4 - 30^4) = 2.67\times10^5\ mm^4,\quad y_{max} = \frac{D}{2} = \frac{50}{2} = 25\,mm$

$\sigma_b = \frac{P\cdot e}{I}\times y_{max} = \frac{P\times100\times25}{2.67\times10^5} = 9.36\times10^{-3}P$ — 01

* $\sigma_{max} = \sigma_o + \sigma_b = 7.96\times10^{-4}P + 9.36\times10^{-3}P$

$90 = 7.96\times10^{-4}P + 9.36\times10^{-3}P$ — 1/2

$\therefore P = 8861.76\,N$ —— (A)

* $\sigma_{min} = \sigma_o - \sigma_b$

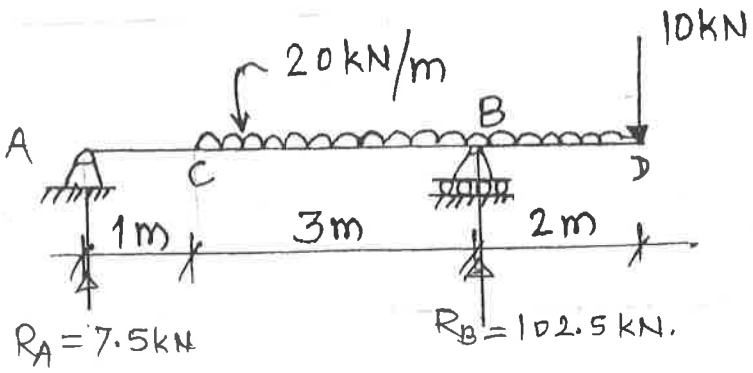
$-40 = 7.96\times10^{-4}P - 9.36\times10^{-3}P$

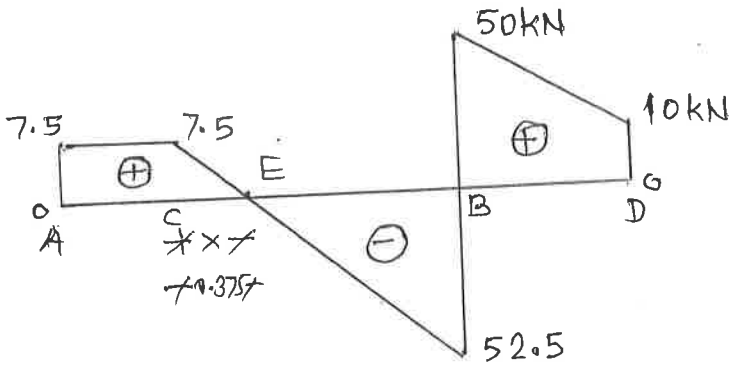
$\therefore P = 4670.72\,N$ —— (B) — 1/2

Maximum allowable load = Minimum of (A) & (B)

$P = 4670.72\,N$ — 01

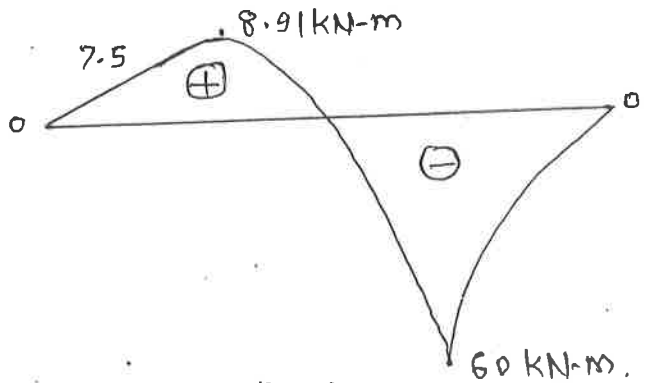
Q. No.	Sub Q. N.	Answer	Marking Scheme
4		**Attempt any THREE of the following:**	(12)
	a)	Draw S.F. and B.M. diagrams for the beam as shown in Fig. No. 4.	





S.F.D

01



B.M.D.

01

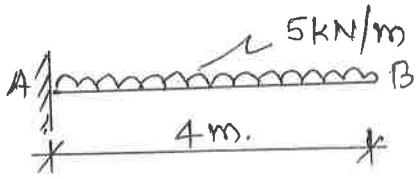
Q. No.	Sub Q. N.	Answer	Marking Scheme
		To find reactions. $\Sigma M_A = 0$ ⟲ +ve $\quad 20 \times 5 \times 3.5 + 10 \times 6 - R_B \times 4 = 0$ $\therefore R_B = 102.5$ kN. $\Sigma F_y = 0$ ↑ +ve $\quad R_A + R_B - (20 \times 5) - 10 = 0$ $\therefore R_A = 110 - 102.5 = 7.5$ kN * S.F. Calculations 1/2 +ve. $S.F_A = 7.5$ kN $S F_C = 7.5$ kN $S F_B$ (left) $= 7.5 - (20 \times 3) = -52.5$ kN $S.F_B$ (right) $= -52.5 + 102.5 = 50$ kN. $S.F_D$ (left) $= 50 - (20 \times 2) = 10$ kN. $S F_D$ (right) $= 10 - 10 = 0$ * B.M. Calculations C/D +ve. $B.M._A = 0$ $BM_C = 7.5 \times 1 = 7.5$ kN.m. $BM_B = 7.5 \times 4 - 20 \times 3 \times 1.5 = -60$ kN.m $BM_D = 0$ * Position of point of contrashear $\frac{x}{7.5} = \frac{3-x}{52.5}$ Solving $x = 0.375$ m from C * Maximum B.M. @ E $B.M._{max} = 7.5 \times 1.375 - 20 \times \frac{0.375^2}{2}$ $= 8.91$ kN.m.	01 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	b)	A cantilever rectangular metal section is 4 m in length. It is subjected to all inclussive UDL of 5 kN/m. If permissible bending stress in the material is 5 N/mm^2, determine the size of the section. Assume depth to width ratio = 2.	

Given : $\sigma_{b,max} = 5\ N/mm^2$, $\frac{d}{b} = 2$, Span = L = 4 m.

To find : b and d

Solution :-



* B.M$_{max}$ $= \frac{wL^2}{2} = \frac{5 \times 4^2}{2}$

$= 40\ kN\cdot m = 40 \times 10^6\ N\cdot mm.$ 01

* M.I. of section $= I = \frac{bd^3}{12} = \frac{b \times (2b)^3}{12} = \frac{2}{3}b^4\ mm^4$

* $y_{max} = \frac{d}{2} = \frac{2b}{2} = b.$

Using the relation

$$\frac{M}{I} = \frac{\sigma_{b,max}}{y_{max}}$$

$$\therefore M = \sigma_{b,max} \times \frac{I}{y_{max}}$$

$$40 \times 10^6 = 5 \times \frac{2}{3}\frac{b^4}{b}$$

$$\therefore b^3 = \frac{3 \times 40 \times 10^6}{2 \times 5}$$

$\therefore b = 228.94$ mm Say 230 mm 02

$d = 2 \times b = 2 \times 230 = 460$ mm

Provide Section of 230 mm × 460 mm. 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	C	Calculate the power transmitted by a solid shaft of 60 mm diameter running at 240 RPM. Permissible shear stress is 70 N/mm^2 and the maximum torque is likely to exceed the mean torque by 30%.	

Given :- for solid circular shaft

$d = 60mm$, $N = 240$ rpm, $\tau = 70\ N/mm^2$

$T_{max} = 1.3\ T_{mean}$.

To find :- Power transmitted.

Solution :- from the torsional equation

$$\frac{T}{J} = \frac{\tau}{R} \quad \therefore T = \frac{J}{R} \times \tau$$

$$= \frac{\pi}{16} d^3 \times \tau \qquad 01$$

$$\therefore T = \frac{\pi}{16} \times 60^3 \times 70 = 2.968 \times 10^6\ N\text{-}mm.$$

$$\therefore T = T_{max} = 2.968 \times 10^3\ N\text{-}m \qquad 01$$

$$\therefore T_{mean} = \frac{T_{max}}{1.3} = \frac{2.968 \times 10^3}{1.3} = 2.283 \times 10^3\ N\text{-}m$$

$$\therefore Power = \frac{2\pi N T_{mean}}{60} = \frac{2\pi \times 240 \times 2.283 \times 10^3}{60} \qquad 01$$

$$= 57378\ Watts$$

$$P = 57.38\ kW \qquad 01$$

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	d)	Calculate the strain energy stored in a bar 4m long and 5cm in diameter when it is subjected to suddenly applied tensile load of 200 kN. Also determine the instantaneous elongation produced. Assume E = 210 GPa.	

Given : $l = 4m = 4000\ mm$, $d = 5cm = 50\ mm$

$P = 200 \times 10^3\ N$ (suddenly applied), $E = 2.1 \times 10^5\ N/mm^2$

To find : U and δL

Solution :-

$$A = \frac{\pi}{4}(d^2) = \frac{\pi}{4} \times (50^2) = 1963.5\ mm^2$$

$$\text{Stress} = \sigma = \frac{2P}{A} = \frac{2 \times 200 \times 10^3}{1963.5} = 203.72\ N/mm^2 \quad 01$$

$$\text{Strain Energy} = U = \frac{\sigma^2}{2E} \times A \times L \quad 01$$

$$\therefore U = \frac{203.72^2}{2 \times 2.1 \times 10^5} \times 1963.5 \times 4000$$

$$= 775886.75\ N\text{-}mm$$

$$U = 775.89\ N\text{-}m. \quad 01$$

* Instantaneous elongation $= \delta L = \frac{\sigma \cdot L}{E}$

$$\therefore \delta L = \frac{203.72 \times 4000}{2.1 \times 10^5}$$

$$\therefore \delta L = 3.88\ mm \quad 01$$

Q. No.	Sub Q. N.	Answer	Marking Scheme
4	e)	A solid aluminium shaft 1 m long and 50 mm diameter is to be replaced by hollow steel shaft of same length and outside diameter. Determine the inner diameter of hollow steel shaft for the same torque. Take, For aluminium Shaft, $G_A = 2.8 \times 10^4$ N/mm^2 for steel shaft, $G_s = 8.5 \times 10^4$ N/mm^2	

Given . For Aluminium solid shaft
$l = 1000$ mm, $d = 50$ mm, $G_A = 2.8 \times 10^4$ N/mm^2

. for hollow steel shaft
$l = 1000$ mm, $D = 50$ mm, $G_s = 8.5 \times 10^4$ N/mm^2

To find: Inner dia of hollow steel shaft.

Polar M.I. of aluminium shaf = $I_p = \frac{\pi}{32} d^4 = \frac{\pi}{32} \times 50^4$

$\therefore I_p = 6.14 \times 10^5$ mm^4 01

Torsional equation is – $\frac{T}{I_p} = \frac{G\theta}{L}$

$\therefore T = \frac{G\theta}{L} \times I_p$ —— (1)

Applying eqn (1) to both shafts –

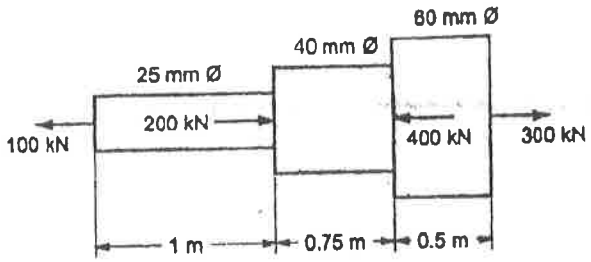
$\frac{G_A \cdot \theta_A}{L_A} \times (I_p)_A = \frac{G_s \cdot \theta_s}{L_s} \times (I_p)_s$ 01

But $\theta_A = \theta_s$ and $L_A = L_s$

$\therefore G_A \cdot (I_p)_A = G_s \times (I_p)_s$ 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
		$\therefore 2.8\times10^4\times 6.14\times10^5 = 8.5\times10^4\times \frac{\pi}{32}(50^4-d^4)$	
		$= 8.5\times10^4\times 0.098\,(50^4-d^4)$	
		$\therefore (50^4-d^4) = \frac{2.8\times10^4\times 6.14\times10^5}{8.5\times10^4\times 0.098}$	
		$= 2.06\times10^6$	
		$\therefore d^4 = 4.19\times10^6$	
		$\therefore d = 45.24\ mm$	01

Q. No.	Sub Q. N.	Answer	Marking Scheme
5		Attempt any TWO of the following.	(12)
	a)	A steel bar is subjected to axial loads as shown in Fig. No. 5. Calculate deformation of the bar. Take E = 210 GPa.	



Force in AB = + 100 kN
Force in BC = +100 − 200 = − 100 kN
Force in CD = +100 − 200 + 400 = +300 kN. — 01

$A_{AB} = \frac{\pi}{4} \times 25^2 = 490.87\ mm^2$, $A_{BC} = \frac{\pi}{4} \times 40^2 = 1256.64\ mm^2$
$A_{CD} = \frac{\pi}{4} \times 60^2 = 2827.43\ mm^2$ — 01

$\delta L = PL/AE$.

$\therefore \delta_{AB} = \frac{+100 \times 10^3 \times 1000}{1256.64 \times 210 \times 10^3} = +0.970\ mm.$ — 01

$\delta_{BC} = \frac{-100 \times 10^3 \times 750}{1256.64 \times 210 \times 10^3} = -0.284\ mm$ — 01

$\delta_{CD} = \frac{+300 \times 10^3 \times 500}{2827.43 \times 210 \times 10^3} = +0.252\ mm.$ — 01

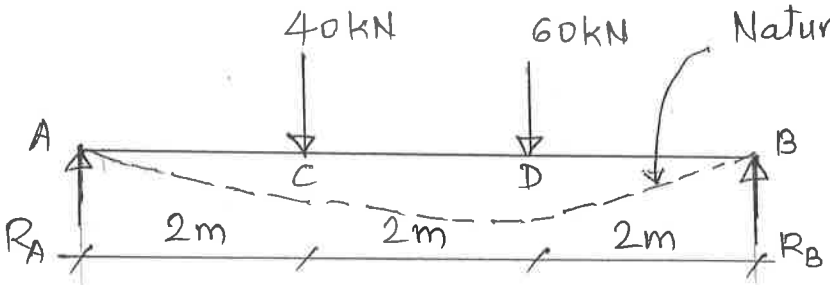
$\delta_{Total} = +0.970 - 0.284 + 0.252\ mm$

$\therefore \delta_{Total} = +0.938\ mm$ (Elongation). — 01

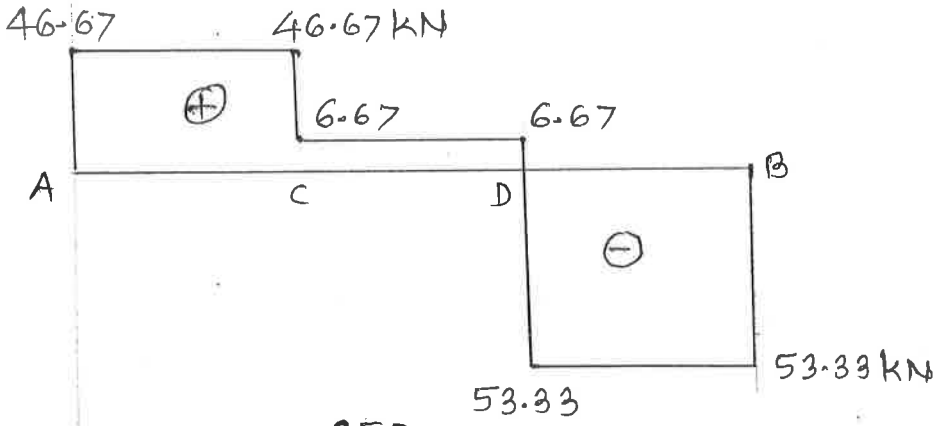
SUMMER – 2022 EXAMINATION

Subject Name: Strength of Materials **Model Answer** **Subject Code:** 22306

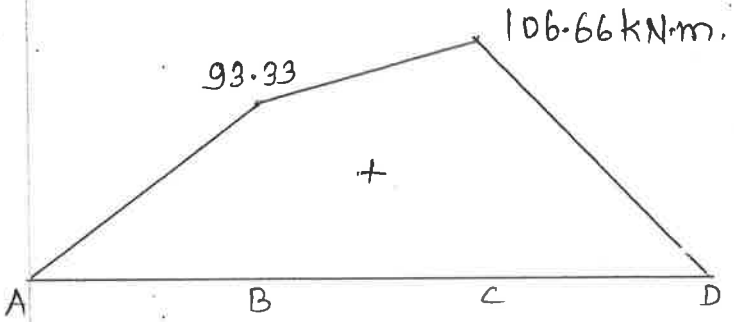
Q. No.	Sub Q. N.	Answer	Marking Scheme
5	b)	A simply supported beam of 6m span is subjected to two point loads of 40kN and 60 kN at 2m and 4m from left had support respectively. Draw S.F., B.M. diagrams. Also draw the nature of deflected curve of the beam.	



deflected curve 01



SFD. 01



B.M.D. 01

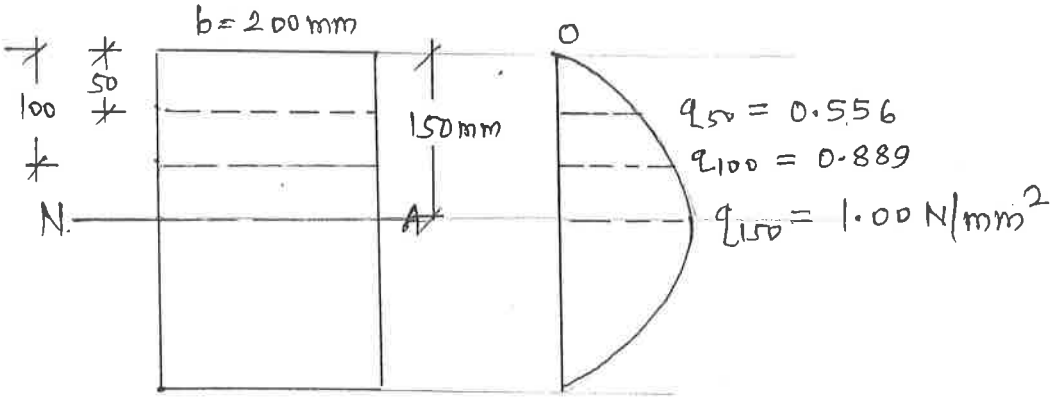
Q. No.	Sub Q. N.	Answer	Marking Scheme
		To find reactions –	
		$\Sigma M_A = 0$ | ↻ +ve. $\quad 40\times 2 + 60\times 4 - R_B \times 6 = 0$	01
		$\therefore R_B = \frac{320}{6} = 53.33$ kN.	
		$\Sigma F_y = 0$ | ↑ +ve. $\quad R_A + R_B - 40 - 60 = 0$	
		$\therefore R_A = 100 - 53.33 = 46.67$ kN.	
		* S.F. Calculations ||| +ve.	
		$S.F_A = +46.67$ kN	
		$S.F_B$ (left) $= +46.67$ kN	
		$S.F_C$ (right) $= +46.67 - 40 = 6.67$ kN	
		$S.F_D$ (left) $= 6.67$ kN	
		$S.F_D$ (right) $= 6.67 - 60 = -53.33$ kN	
		SF_B (left) $= -53.33$ kN	
		SF_B (right) $= -53.33 + 53.33 = 0$	01
		* B.M. Calculations (↻ +ve	
		$BM_A = BM_B = 0$ ∵ Simple support	
		$BM_C = 46.67 \times 2 = 93.33$ kN.m.	
		$BM_D = 53.33 \times 2 = 106.66$ kN.m.	01

Q. No.	Sub Q. N.	Answer	Marking Scheme
5	C.	A rectangular beam 200 mm wide × 300 mm deep is subjected to shear force of 40 kN. Calculate the shear stresses at top layer and at distances of 50 mm, 100 mm and 150 mm from the top layer. Sketch the shear stress distribution.	

Given for rectangular beam, $b = 200$ mm, $d = 300$ mm

$S = V = 40 \times 10^3$ N

To find q at top, at 50 mm, at 100 mm & at 150 mm from top layer. & shear stress distribution.



C/s of beam Shear stress distribution.

Diagram 01

$$I_{xx} = \frac{bd^3}{12} = \frac{200 \times 300^3}{12} = 450 \times 10^6 \text{ mm}^4$$ 01

$b = 200$ mm.

q at top $= 0$.

Shear stress at any layer is given by 01

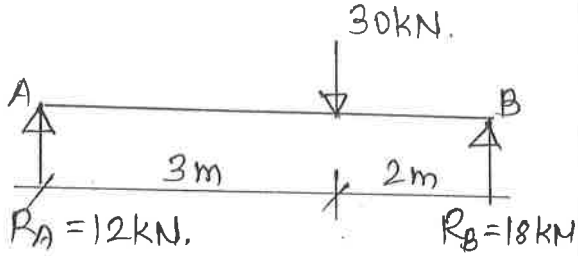
$$q = \frac{S a \bar{y}}{b I}$$

Q. No.	Sub Q. N.	Answer	Marking Scheme
		* q at 50mm below the top layer. $q_{50} = \frac{Sa\bar{y}}{bI} = \frac{40\times10^3\times(200\times50)\times(100+50/2)}{200\times450\times10^6}$ $q_{50} = 0.556\ N/mm^2$	01
		* q at 100 mm below the top layer $q_{100} = \frac{Sa\bar{y}}{bI} = \frac{40\times10^3\times(200\times100)\times(50+100/2)}{200\times450\times10^6}$ $q_{100} = 0.889\ N/mm^2$	01
		* q at 150 mm below the top layer. $q_{150} = \frac{Sa\bar{y}}{bI} = \frac{40\times10^3\times(200\times150)*75}{200\times450\times10^6}$ $q_{150} = q_{N.A.} = 1.00\ N/mm^2$	01

Q. No.	Sub Q. N.	Answer	Marking Scheme
6		Attempt any TWO of the following;	(12)
	a)	A circular beam has simply supported span of 5m and subjected to a point load of 30 kN at a distance 3m from left hand support. The shear stress across the beam is limited to 2 N/mm^2. Design the minimum section for the beam and hence determine the magnitude of average shear stress.	

Given:

$q_{max} = 2\ N/mm^2$



To find:

i) dia. of circular beam

ii) q_{avg}.

Solution :- Max. S.F = Max reaction.

$\Sigma M_A = 0 = 30 \times 3 - R_B \times 5 = 0 \quad \therefore R_B = \frac{90}{5} = 18\ kN.$

$\Sigma F_y = 0, \quad R_A + R_B - 30 = 0 \quad \therefore R_A = 30 - 18 = 12\ kN$ } 01

$\therefore$ Max. Shear force = $R_B = 18\ kN$ 01

for circular section, $q_{avg} = \frac{q_{max}}{1.33} = \frac{2}{1.33} = 1.5\ \frac{N}{mm^2}$ 01+01

$q_{avg} = \frac{P}{A} \quad \therefore A = \frac{P}{q_{avg}} = \frac{18 \times 10^3}{1.50}$

$A = 12000\ mm^2$

$A = \frac{\pi}{4} \times d^2 = 12000$

$\therefore d^2 = 12000 \times 4/\pi = 15.28 \times 10^3$

$\therefore d = 123.61\ mm$ Say $125\ mm$. 01

$q_{avg} = \frac{P}{A_{provided}} = \frac{18 \times 10^3}{\left(\frac{\pi}{4} \times 125^2\right)} = 1.467\ N/mm^2$ 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
6	b)	A propeller shaft, 400 mm external and 200 mm internal diameters is subjected to twisting moment of 4650 N.m. Calculate maximum shear stress developed in shaft. Also calculate angle of twist in degrees in a length 20 times the external diameter. Take G = 82 GPa.	

Given :- for shaft, $D = 400\,mm$, $d = 200\,mm$,

$T = 4650\ N\cdot m = 4650\times10^3\ N\cdot mm$, $l = 20\times D = 20\times400\ mm$

$G = 82\times10^3\ N/mm^2$

To find: q_{max} and θ in degrees.

Solution :- $R = D/2 = \frac{400}{2} = 200\ mm.$

* Polar M.I $= I_p = \frac{\pi}{32}(D^4 - d^4) = \frac{\pi}{32}(400^4 - 200^4)$

$I_p = 2.36\times10^9\ mm^4$ — 01

* Using torsional equation,

$$\frac{T}{I_p} = \frac{G\theta}{L} = \frac{q_{max}}{R}$$

$$\therefore q_{max} = \frac{T}{I_p}\times R = \frac{4650\times10^3}{2.36\times10^9}\times200 = 0.39\ N/mm^2$$ — 01+01

and $\theta = \frac{T\times L}{G\times I_p} = \frac{4650\times10^3\times8000}{82\times10^3\times2.36\times10^9}$ — 01+01

$\theta = 1.92\times10^{-4}$ radians.

$\theta = 1.92\times10^{-4}\times180/\pi$ degrees

$\theta = 0.011^\circ$ — 01

Q. No.	Sub Q. N.	Answer	Marking Scheme
6	C	A short mild steel column of external diameter 200 mm and internal diameter 150 mm carries an deccentric load. Determine the gretest eccentricity which the load can have so as to avoid reversal of stresses in the section of column.	

For steel column, $D = 200\,mm$, $d = 150\,mm$

To find: e_{max}

Solution:

$$e_{max} \leq Z/A$$

* $A = \frac{\pi}{4}(D^2 - d^2) = \frac{\pi}{4}(200^2 - 150^2) = 13.75 \times 10^3\ mm^2$ — 01

* $Z = \frac{\pi (D^4 - d^4)}{32 D} = \frac{\pi (200^4 - 150^4)}{32 \times 200}$ — 01+01

$Z = 5.37 \times 10^5\ mm^3$

$\therefore e_{max} \leq \frac{Z}{A}$ — 01

$e_{max} = \frac{Z}{A} = \frac{5.37 \times 10^5}{13.75 \times 10^3}$

$e_{max} = 39.06\ mm$ — 02

22306

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define : Polar Moment of inertia, radius of gyration.

b) Define : Temperature stress and give one field example where temp stress produced.

c) Define : Creep, Toughness.

d) State relation between shear force and bending moment.

e) State flexural formula with meaning of each term used.

f) Define : Axial load and Eccentric load.

g) Define core of section and show it for solid circular section of dia. 'D'.

Marks

2. Attempt any THREE of the following: **12**

a) A symmetrical I-section of overall depth of 300 mm has its flanges 150 mm × 10 mm and web 10 mm thick. Calculate moment of inertia @ XX and YY centroidal axes.

b) With neat sketches show the failure of rivet in single shear and double shear. Also write the formulae to calculate shear stress for each case. Assume diameter of rivet = d.

c) A steel tube of external diameter 20 mm and internal diameter 15 mm was subjected to a tensile load of 1.5 kN. It produced an elongation of 0.004 mm in a length of 80 mm while the outer diameter suffered a compression of 0.00028 mm. Calculate the value of Poissons ratio, Modulus of Elasticity and Modulus of rigidity.

d) A simply supported beam is loaded as shown in Fig. No. 1. Draw shear force diagram and locate the position from support 'A' where B.M. is maximum. Also calculate value of Maximum B.M.

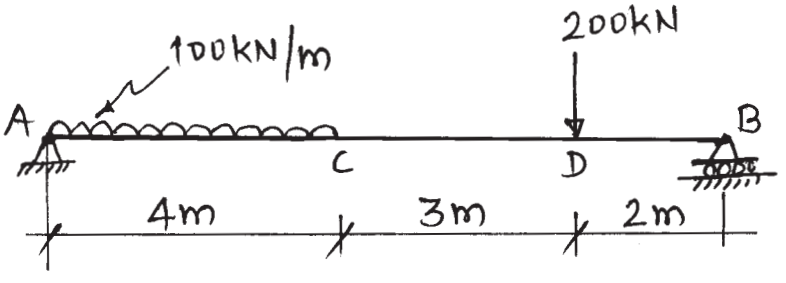


Fig. No. 1

3. Attempt any THREE of the following: **12**

a) A hollow circular section has external diameter 50 mm and wall thickness of 10 mm. Calculate moment of inertia about the tangent to the exernal diameter.

b) A metal bar 200 mm long, 40 mm × 30 mm in cross section is subjected to stress of 110 MPa along the length and 50 MPa on other two faces. All stresses are tensile. Calculate strains along the three direction and also the volumetric strain. Assume E = 120 MPa and μ = 0.30.

Marks

c) Draw S.F. and B.M. diagrams with all important values for the beam loaded as shown in Fig. No. 2.

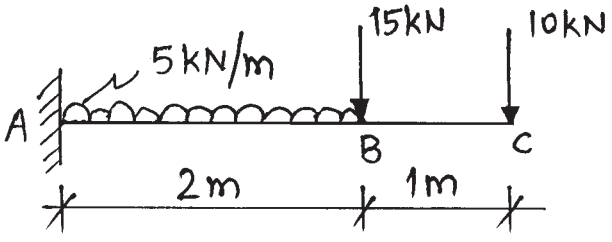


Fig. No. 2

d) A mild steel tube 50 mm external dia and 10 mm thickness is bent in the form of hook as shown in Fig. No. 3. What maximum load 'P' the hook can lift, if the stresses on the cross section 'AB' shall not exceed 90 MPa in tension and 40 MPa in compression?

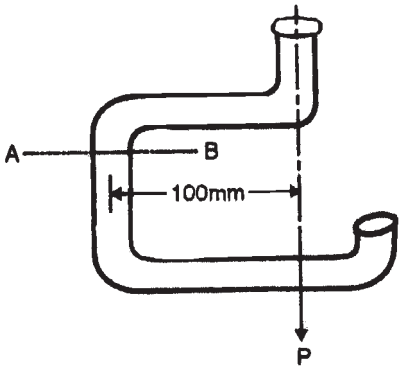


Fig. No. 3

4. Attempt any THREE of the following: **12**

a) Draw S.F. and B.M. diagrams for the beam as shown in Fig. No. 4.

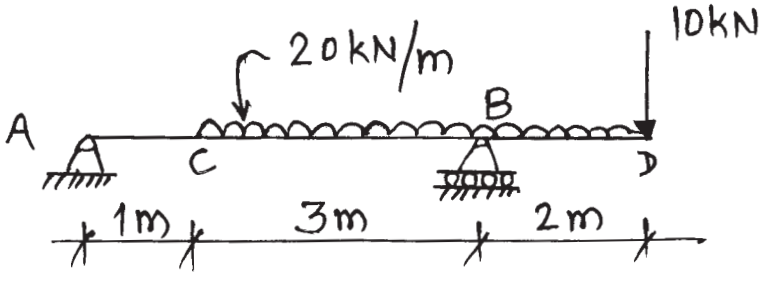


Fig. No. 4

Marks

b) A cantilever rectangular metal section is 4 m in length. It is subjected to all inclussive UDL of 5 kN/m. If permissible bending stress in the material is 5 N/mm^2, determine the size of the section. Assume depth to width ratio = 2.

c) Calculate the power transmitted by a solid shaft of 60 mm diameter running at 240 RPM. Permissible shear stress is 70 N/mm^2 and the maximum torque is likely to exceed the mean torque by 30%.

d) Calculate the strain energy stored in a bar 4 m long and 5 cm in diameter when it is subjected to suddenly applied tensile load of 200 kN. Also determine the instantaneous elongation produced. Assume E = 210 GPa.

e) A solid aluminium shaft 1 m long and 50 mm diameter is to be replaced by hollow steel shaft of same length and outside diameter. Determine the inner diameter of hollow steel shaft for the same torque.

Take, For aluminium Shaft, $G_A = 2.8 \times 10^4$ N/mm^2

for steel shaft, $G_s = 8.5 \times 10^4$ N/mm^2

5. Attempt any TWO of the following: **12**

a) A steel bar is subjected to axial loads as shown in Fig. No. 5. Calculate deformation of the bar. Take E = 210 GPa.

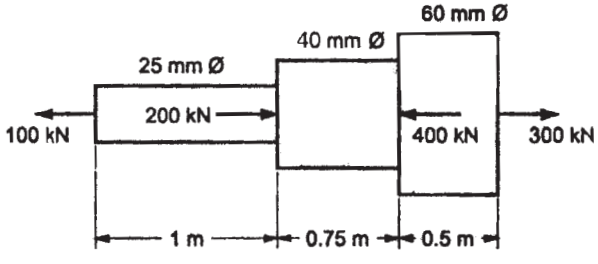


Fig. No. 5

b) A simply supported beam of 6 m span is subjected to two point loads of 40 kN and 60 kN at 2 m and 4 m from left had support respectively. Draw S.F., B.M. diagrams. Also draw the nature of deflected curve of the beam.

Marks

c) A rectangular beam 200 mm wide × 300 mm deep is subjected to shear force of 40 kN. Calculate the shear stresses at top layer and at distances of 50 mm, 100 mm and 150 mm from the top layer. Sketch the shear stress distribution.

6. Attempt any TWO of the following: **12**

a) A circular beam has simply supported span of 5 m and subjected to a point load of 30 kN at a distance 3 m from left hand support. The shear stress across the beam is limited to 2 N/mm^2. Design the minimum section for the beam and hence determine the magnitude of average shear stress.

b) A propeller shaft, 400 mm external and 200 mm internal diameters is subjected to twisting moment of 4650 N.m. Calculate maximum shear stress developed in shaft. Also calculate angle of twist in degrees in a length 20 times the external diameter. Take G = 82 GPa.

c) A short mild steel column of external diameter 200 mm and internal diameter 150 mm carries an deccentric load. Determine the gretest eccentricity which the load can have so as to avoid reversal of stresses in the section of column.

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WINTER-19 EXAMINATION

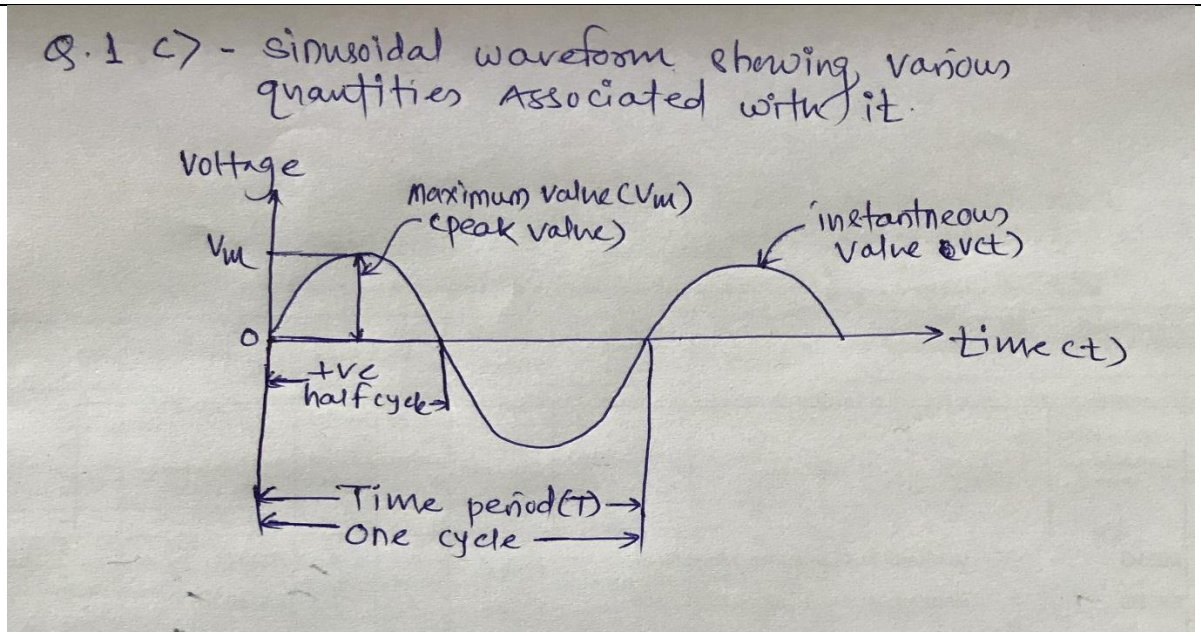
Subject Name: Basic Electrical and Electronics Engineering **Subject Code:** 22310

Model Answer

Important Instructions to examiners:

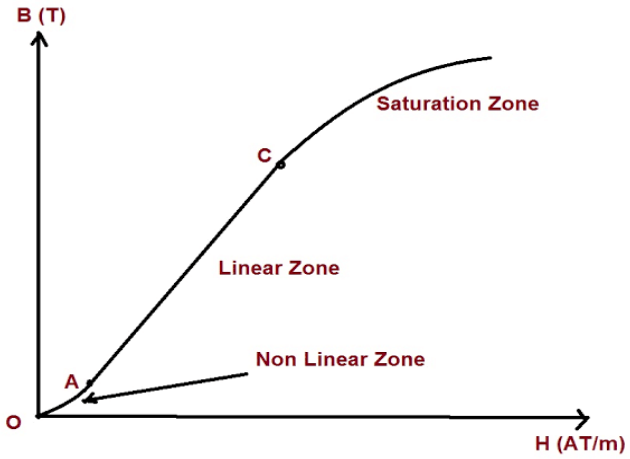
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
		SECTION -I	
1	**(A)**	**Attempt any SIX of the following:**	**12- Total Marks**
	(a)	**Define self induced Emf. Write equation of self induced Emf.**	**2M**
	Ans:	**Definition**: Self-induced emf is the e.m.f induced in the coil due to the change of flux produced by linking it with its own turns. Or Self induced emf is that which is induced in a coil, due to the change in its own current or flux. Self induced emf equation. E = - N (dΦ/dt) volts	**1M def** **1M eq.**

	(b)	**State Lenz's law.**	**2M**
	Ans:	**Lenz's Law:** It states that the direction of electromagnetically induced emf is such that it always opposes the main cause of its production. **Or** **It is expressed by equation** E = - N (dΦ/dt) volts Where – sign indicate the direction EMF is induced opposite to rate of change of flux.	**2m**
	(c)	**Draw sinusoidal waveform showing various quantities associated with it.**	**2M**
	Ans:		**2m**
	(d)	**Define RMS value and Average value of AC waveform.**	**2M**
	Ans:	1. **RMS value:-** For an alternating current, the RMS value is defined as that value of steady current (DC) which produces the same heat or power as is produced by the alternating current during the same time under the same conditions. Irms = 0.707 Imax 2. **Average value:-** The average value is defined as "the average of all instantaneous	**1m each def.**

		values during one alternation. **Or** **Average value:-**average value is that value is obtained by averaging all the instantaneous values of its wave over a period of half cycle. Iav=0.637 Imax	
	e)	**State applications of single phase AC motors.**	**2M**
	Ans:	• Water pumps • ceiling fan & air conditioners. • lathe machine • washing machines. • Blowers • Mixers & grinders • Compressors • Conveyers • Refrigerators. [Note:any other relevant application can consider]	**(any two of such applications)**
	f)	**Write the Emf equation of transformer. State the meaning of each term in it.**	**2M**
	Ans:	EMF equation of Transformer:- E1 = 4.44 f ϕmN1 OR E1 = 4.44 f BmAN1 E2 = 4.44 f ϕmN2 OR E2 = 4.44 f Bm AN2 Let, E1 = Primary emf E2 = Secondary emf N1= Number of turns in the primary N2= Number of turns in the Secondary Øm= Maximum flux in core (wb) Bm= Flux density (wb/m2 /Tesla) A= Area of cross section of core m2 F = Frequency	**1M for each equation**

	g)	**Define-** **(i) Current** **(ii) Potential difference**	**2M**
	Ans:	**i) Current :-** electric current is defined as the movement of electronics or **flow** of electronics inside the conducting material. Unit-ampere(A) **ii) Potential Difference:** The difference between the electrical potentials at any two given points in the electrical circuit is known as potential difference between those points. Unit:- volt (V)	**1m each definitio n**
	h)	**State Faradays laws of electromagnetic inductions.**	**2M**
	Ans:	**First Law: -**Whenever change in the magnetic flux linked with a coil or conductor, an EMF is induced in it. OR Whenever a conductor cuts magnetic flux, an EMF is induced in conductor. **Second Law:** The Magnitude of induced EMF is directly proportional to (equal to) the rate of change of flux linkages.	**First law 1 Mark** **Second law 1 Mark**
Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total Marks**
	a)	**Draw and explain B-H curve.**	**4M**

	Ans:	**Key points** The B-H curve is the relation between Flux density B in Wb/m^2(on Y Axis) and H in AT/m (onX axis)It is also known as magnetization characteristics.  know the characteristics of magnetic material which is generally used to construct pole of an electric machine. It also gives the behavior of the material to get magnetized with rise of current (AT) Initially the material doesn't have any flux, hence the curve starts at point o. As the process of magnetization starts & current increases, the flux density in the material also increases in proportion with the rise in current. The rise in flux density with rise in current will continue up to point 'A' till maximum flux density occurs. At point 'A' material gets magnetically saturated and the curve becomes flat (parallel to X axis)	**Diagram : 2M** **Explanation : 2M**

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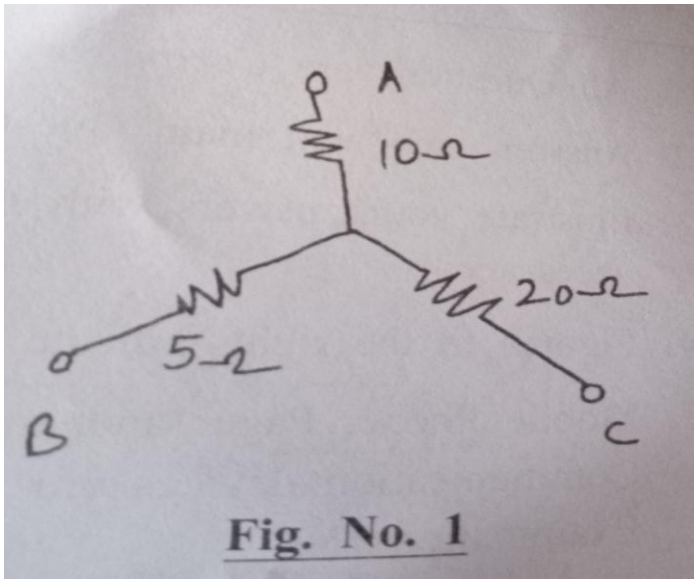
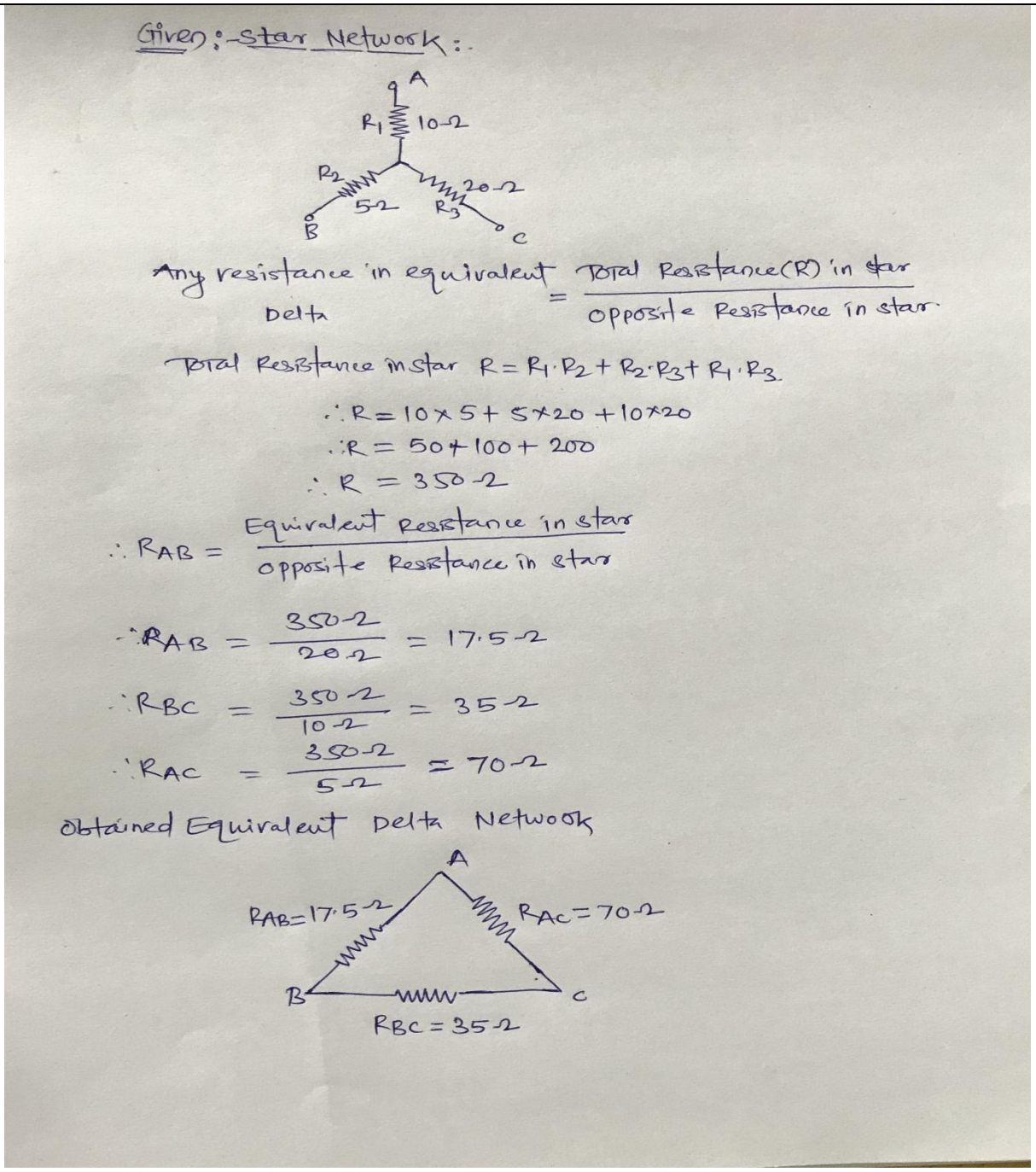
Model Answer

	b)	**Obtain the delta connected equivalent for the star connected circuit (fig no. 1)**  Fig. No. 1	**4M**

	Ans:		Each resister 1m Eqv. Network .1m
	c)	Draw and describe power triangle. State its significance.	4M
	Ans:	Power Triangle:	Diagram : 2M

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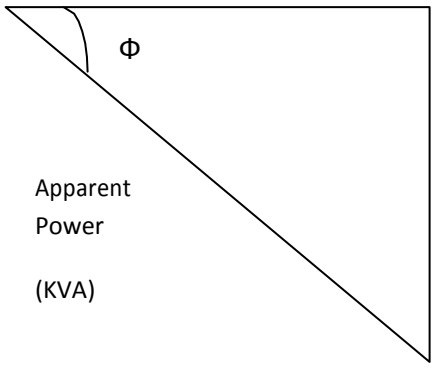
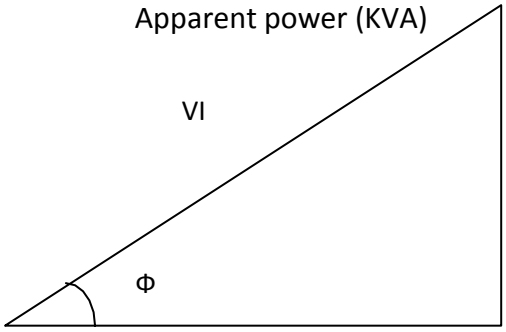
Model Answer

		Active power(Kw)  **OR** Apparent power (KVA)  VI Cos Φ (Active power(Kw)) Power Triangle is a right angled triangle whose sides represent the active, reactive and apparent power. It is obtained by multiplying the circuit current I, active current (IcosØ) and reactive	**Description : 1M** **Significance : 1M**

current(IsinØ) by voltage V. Multiplication of voltage V with circuit current I, active current IcosØ and reactive current IsinØ gives apparent power (S), active power (P) and reactive power (Q) respectively.

Significance of Power triangle: (Any two point expected)

1. P.F. increases current reduce so; cross section of conductor decreases hence its cost is educes.

2. P.F. increases current reduce so, cross section of conductor decreases hence weight decreases. So design of supporting structure becomes lighter.

3. Copper losses Decreases, Hence transmission efficiency increases.

4. Voltage drop reduces, hence voltage regulation becomes better 5. Handling capacity (KW) of each equipment increases as p.f. increases.

6. Less capacity (KVA) rating of equipment's are required so capital cost decreases.

7. Cost per unit (KWH) decreases.

OR

Significance of Power triangle :

Power triangle is simply schematic representation of phasor diagram of inductive or capacitive power (reactive power) contain in load, which make power factor calculation simple. Power factor tell us the energy loss due to different load. This is very important for designing the energy efficient electrical system.

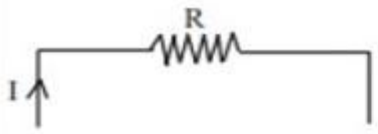
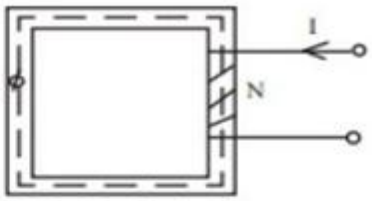
d) Compare magnetic and electric circuits (four points) **4M**

Ans:

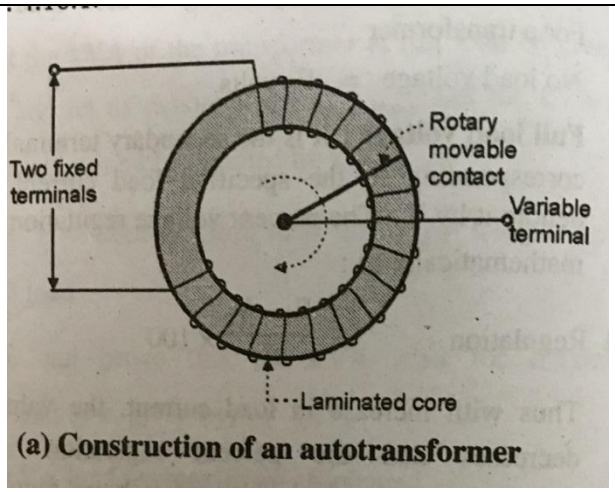
SR.NO	Magnetic circuits	Electric circuits
1	The magnetic circuit in which magnetic flux flow	Path traced by the current is known as electric current.

(Any

		2	MMF is the driving force in the magnetic circuit. The unit is ampere turns.	EMF is the driving force in the electric circuit. The unit is Volts.	**Four Point expected : 1 Mark each)**
		3	There is flux ϕ in the magnetic circuit which is measured in the weber.	There is a current I in the electric circuit which is measured in amperes	
		4	The number of magnetic lines of force decides the flux.	The flow of electrons decides the current in conductor.	
		5	Reluctance (S) is opposed by magnetic path to the flux. The Unit is ampere turn/weber	Resistance (R) oppose the flow of the current. The unit is Ohm	
		6	S = l/ (μ0μra). Directly proportional to l. Inversely proportional to μ = μ0μr & Inversely proportional to a	R = ρ. l/a. Directly proportional to l. Inversely proportional to a. Depends on nature of material.	
		7	The Flux = MMF/ Reluctance	The current I = EMF/ Resistance	
		8	The flux density	The current density	
		9	Kirchhoff mmf law and flux law is applicable to the magnetic flux.	Kirchhoff current law and voltage law is applicable to the electric circuit.	
		OR			

Electric Circuit	Magnetic Circuit
	
2)E.M.F is the source to pass current	2) MMF is the source to pass flux (MMF is caused by flow of current)
3) Current in Amperes; current density in A/m^2	3) ϕ is in webbers; flux density wb/m^2
4) current $\frac{EMF}{\text{Resistance}}$	4) Flux = $\frac{\text{MMF}}{\text{Reluctance}}$
5) Resistance = R = $\frac{\delta l}{a}$ and is constant	5) Reluctance = $\frac{L}{\mu_0 \mu_r A}$ It veries as μ_r is variable
6) Conductance = 1/ R	6) Permeanance = 1 / Reluctance
7) Energy is wasted as long as the current lasts	7) Energy is required to establish the flux only and not for maintaning it.

e)	**Describe the construction and working principle of auto transformer.**	**4M**
Ans:	An auto transformer has single winding which is used as primary and secondary winding. This winding is wound on laminated enameled magnetic core.	**(Construction (diagram) - 2 marks,**



(a) Construction of an autotransformer

OR

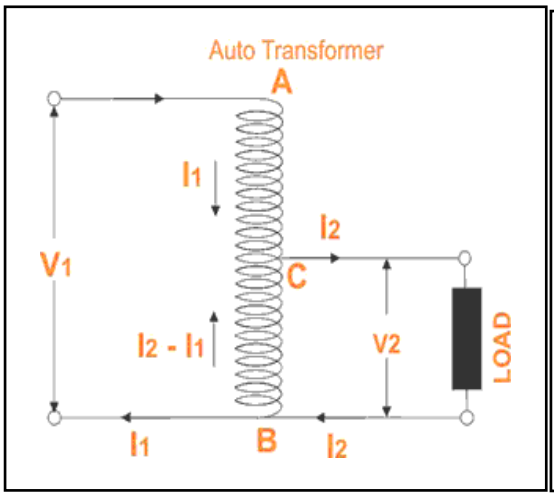


Fig. 1 Step Down auto transformer

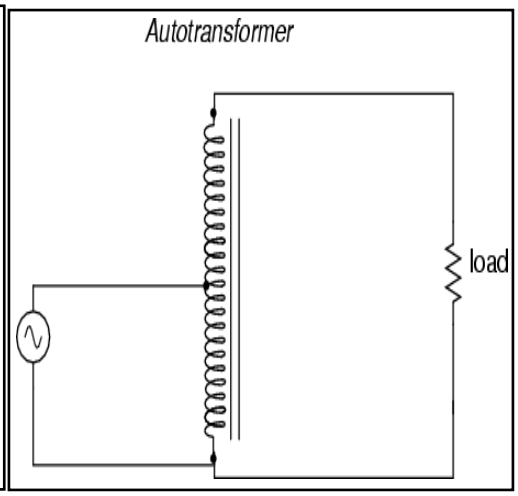


Fig. 2 Step Up auto transformer

As shown in fig. 1 the input is given to winding worked as primary and output is taken from the part of the same winding. Thus the one winding serves as primary and secondary. This transformer is known as step down autotransformer

As shown in fig.2 the input is given to the part of winding and output is taken across the whole winding. So the part of winding acts as a primary winding and the whole winding acts as a secondary winding. With this construction we can step up the voltage. So this transformer known as step up autotransformer.

Working – 2 Marks)

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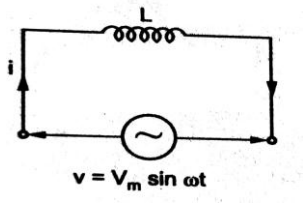
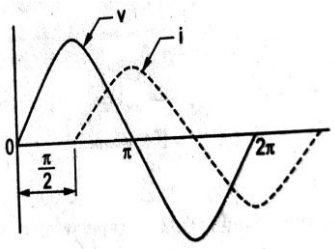
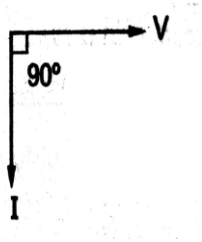
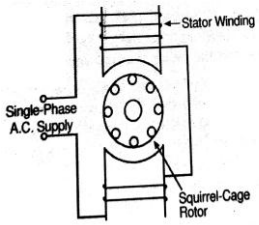
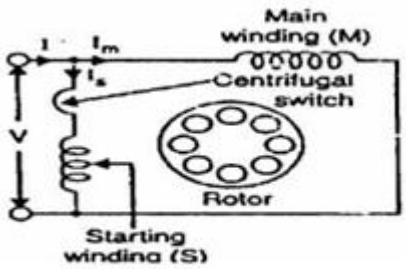
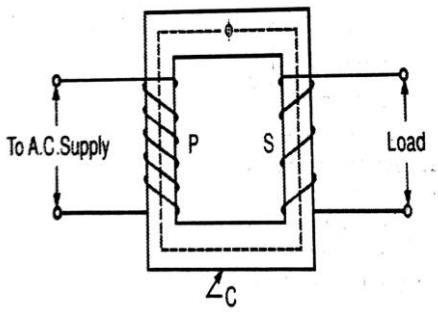
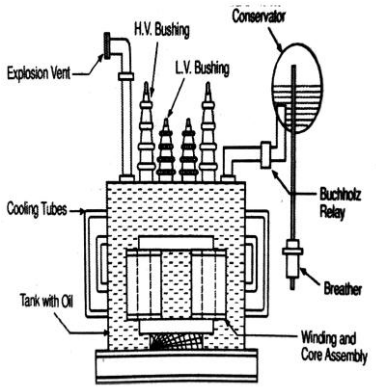
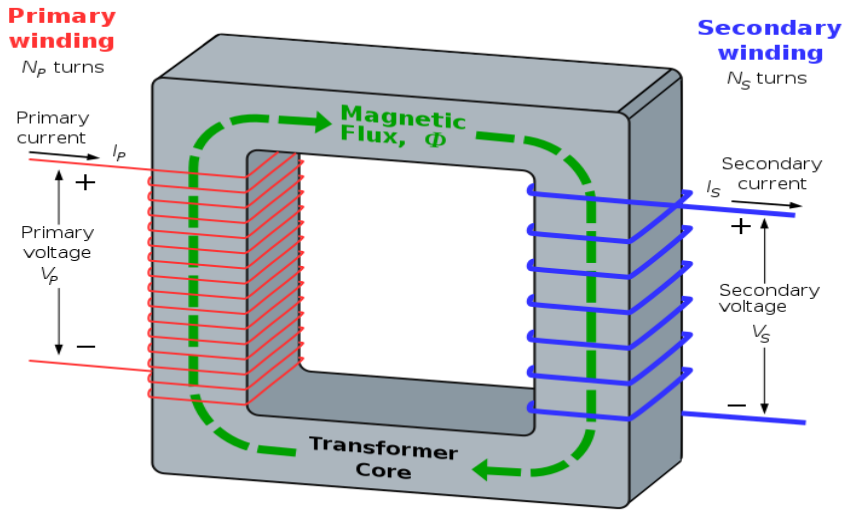
Model Answer

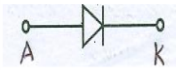
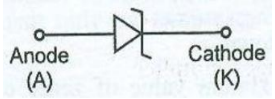
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**Describe the operation of inductor with sinusoidal AC voltage as input. Draw waveform for voltage across and current through the inductor. Draw its phasor representation.**	**6M**
	Ans:	An alternating voltage is applied to a purely inductive coil, a back e.m.f. is produced due to self-inductance of the coil. The back e.m.f. at every step, opposes the rise of fall of current through the coil. As there is no ohmic voltage drop, the applied voltage has to overcome this self induced e.m.f. only.  If applied voltage is represented by $v = V_m Sin\omega t$, then current flowing in a purely inductive circuit is given by $$i = I_m Sin(\omega t - \frac{\pi}{2})$$ Wave form of purely inductive circuit :  Phasor diagram :	**2 Marks for Description** **2 Marks for voltage and current eqution** **1Marks for waveform** **1Marks for**

			**Phasor diagram**
	b)	**Describe the construction and working principle of single phase AC motor.**	**6M**
	Ans:	construction and working principle of single phase AC motor Single phase induction motors have a phase distributed winding on the stator and a squirrel cage short-circuited winding on the rotor. When this single phase winding is connected to an alternating voltage source, an alternating field is produced varying only with time. Such an alternating field acting on a stationery squirrel cage rotor cannot produce rotation. But, if once the rotor is moved, the rotor produces a cross flux that is in both space and time quadrature with the stator flux. There are two necessary conditions to produce a rotating field. Hence, once the motor is started, the single phase motor will continue to rotate as long as the load torque is not excessive.  OR 	**2 Marks for Description** **2 Marks for working principle** **2 Marks for any relevant diagram**

		[any other diagram showing AC motor can be consider] This particulate behavior of motor has been explained in two ways i) by two field or double field revolving theory and ii) by cross field theory Single phase induction motor is not inherently self-starting. However, if rotor is given an initial rotation in any direction, the single phase induction motor develops torque and rotor continues to pick up speed in that particular direction. However, they are made self starting providing the various special arrangements such as split-phasing (with the help of resistance or capacitor) or using shaded poles which enable them to have a rotating magnetic field atleast at starting. OR ▪ Alternating flux is produced around the stator winding due to AC supply. This alternating flux revolves with synchronous speed. The revolving flux is called as "Rotating Magnetic Field" (RMF). ▪ The relative speed between stator RMF and rotor conductors causes an induced emf in the rotor conductors, according to the Faraday's law of electromagnetic induction. The rotor conductors are short circuited, and hence rotor current is produced due to induced emf. That is why such motors are called as induction motors. (This action is same as that occurs in transformers, hence induction motors can be called as rotating transformers.) ▪ Now, induced current in rotor will also produce alternating flux around it. This rotor flux lags behind the stator flux. The direction of induced rotor current, according to Lenz's law, is such that it will tend to oppose the cause of its production. ▪ As the cause of production of rotor current is the relative velocity between rotating stator flux and the rotor, the rotor will try to catch up with the stator RMF. Thus the rotor rotates in the same direction as that of stator flux to minimize the relative velocity. However, the rotor never succeeds in catching up the synchronous speed. This is the basic working principle of induction motor of either type, single phase of 3 phase.	

		Note : Any relevant answer should be considered.	
	c)	**State the different types of transformers. Describe the construction and general principle of transformer.**	**6M**
	Ans:	Different types of transformer are core type shell type Berry type Construction of transformer:  (OR)  OR  OR Shell Type construction can be consider for diagram	**2 marks for types of transformer** **1 mark for any relevant diagram** **2 marks for Construction**

		Transformer consists of two windings that are electrically isolated from each other. When a time varying voltage is applied to one winding, it sets up an alternating flux in the magnetic core. Due to the high permeability of the core, most of the flux links the other winding and induces and alternating e.m.f. in that winding. The frequency of the induced e.m.f. in the winding is same as that of the voltage in the first winding. If the other winding is connected to the load, the induced e.m.f. in the winding circulate a current in it. Thus, the power is transferred from one winding to the other through the magnetic flux in the core. [This answer is enough for explaining construction of transformer] [The transformer consists of following i) magnetic circuit consisting of links (core), yokes and clamping structures (providing the flux path) ii) Electric circuit consisting of primary and secondary windings iii) dielectric circuit consisting of insulation in different forms and used at different places in the transformer (core to the primary winding, primary winding to secondary winding etc). iv) Tank and accessories] this is optional answer. Principle of transformer: The operation of the transformer is based on the principle of mutual induction between two circuits linked by a common magnetic field.	**1 mark for Principle of transformer**
Q. No.	Sub Q. N.	Answers	Marking Scheme
		SECTION - II	
4		**Attempt any FIVE of the following :**	**10- Total Marks**
	(a)	**Define active components. Give two examples.**	**2M**

	Ans:	The component which requires power supply for its operation is called as Active component. e.g. Diode, Transistor, ICs, SCRs. OR **Active Component:** The component which rely on source of energy and used DC source they can amplify or rectify the signal is called active component example diode , transistor, FET, and so on. They are semiconductor component	**1mark for definition** **1 mark for any two examples**
	(b)	**State any four specifications of resistor.**	**2M**
	Ans:	specifications of resistor: 1. Resistance value 2. Tolerance 3. Power rating 4. Maximum operating temperature 5. Maximum operating voltage 6. Frequency range 7. Temperature coefficient of resistance 8. Wattage	**2 marks for any four specifications**
	(c)	**Draw symbol of –** **(i) PN junction diode** **(ii) Zener diode**	**2M**
	Ans:	**PN junction diode** **Zener diode**  	**1 mark for each symbol**
	(d)	**State the need for filter circuits in power supply.**	**2M**
	Ans:	Ripple must be kept away from the load and it should be removed from the rectified output. Therefore , there is a necessity of filter circuit for removing i.e. smoothing or filtering the	**2 marks for stateme**

		ripple and allowing the (pure or steady) d.c. voltage to reach the load.	**nt**
	(e)	**Define α. Give the relationship between α and β.**	**2M**
	Ans:	Alpha (**α**)– It is ratio of collector current I_C to emitter current I_E of a transistor. Alpha (**α**)= I_c/ I_E **relationship between α and β** **α** =$\frac{\beta}{1-\beta}$ and **β** =$\frac{\alpha}{1-\alpha}$	**1 mark for definiton** **1 mark for relationship**
	(f)	**Define the following with respect to BJT.** **(i) Input resistance** **(ii) Output resistance**	**2M**
	Ans:	**Input resistance:** It is the ratio of small change in emitter –to-base voltage(ΔV_{EB}) to the resulting change in emitter current (ΔI_E) for a constant collector to base voltage(V_{CB}) $R_i = \frac{\Delta V_{EB}}{\Delta I_E}$ / V_{CB} = constant **Output resistance:** It is the ratio of small change in collector –to-base voltage(ΔV_{CB}) to the resulting change in collector current (ΔI_c) for a constant emitter current(I_E). $R_o = \frac{\Delta V_{CB}}{\Delta I_C}$ /I_E= constant OR Input Resistance Depending on type of configuaration of BJT input resistance of BJT is ratio of voltage between input terminal and common terminal to current through input terminal. Output resistance Depending on type of configuaration of BJT output resistance of BJT is ratio of voltage between output terminal and common terminal to current through output terminal.	**1 marks** **Input resistance** **1 marks** **output resistance**

	(g)	**Compare between active and passive components.**	**2M**
	Ans:		**2 marks for any two points**

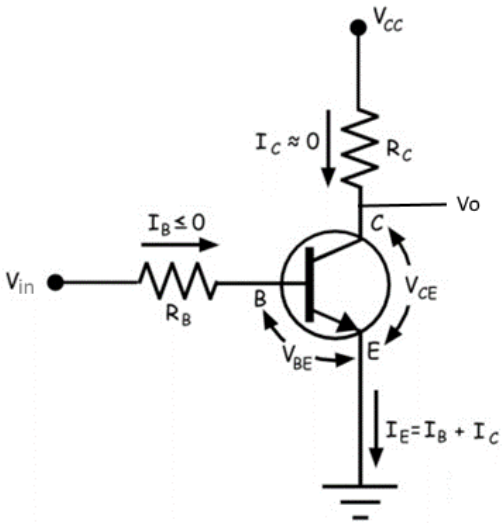
active component	passive component
It is a device which amplify by producing an output signal with more power in it than that of input signal	It is a device which controls or modifies the output of electronics circuit without playing an active role in its performance.
It includes the component such as diodes, transistors, ICs, battery etc.	It includes the component such as resistors, capacitors and inductors, conductors and transformers.
It may introduce the gain	It does not introduce any gain
It has generally unidirectional function	It has bidirectional function
semiconductor materials are used	Non-semiconductor or semiconductor material is used

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any THREE of the following:**	**12- Total Marks**
	a)	**Describe the operation of transistor as a switch with suitable diagram.**	**4M**
	Ans:	In Bipolar Transistor as a Switch the biasing of the transistor, either NPN or PNP is arranged tooperate the transistor at both sides of the " I-V " characteristics curves. The areas of	**Diagram -**

operation fora transistor switch are known as the Saturation Region and the Cut-off Region

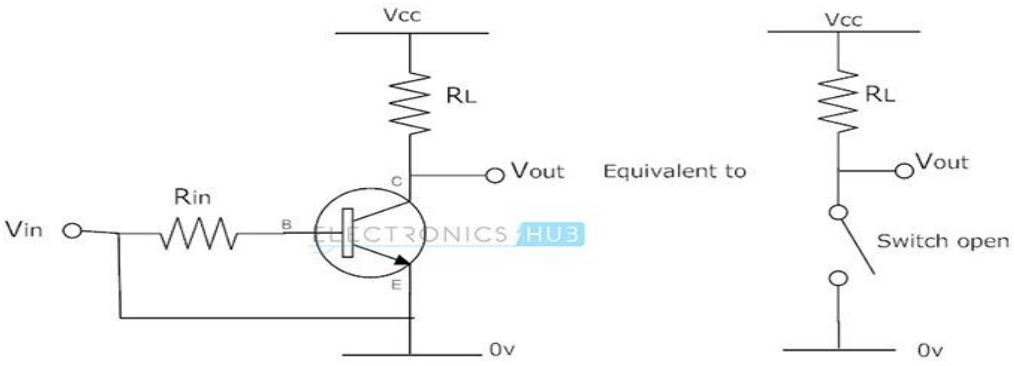
Working: Control input Vin is given to base through a current limiting resistor R_B and Rc is the collector resistor which limits the current through the transistor .When a sufficient voltage V is given to input, transistor becomes ON & it goes into saturation. During this condition the Collector Emitter voltage V_{CE} will be approximately equal to zero, ie the transistor acts as a short circuit & Vo = 0.

When input voltage V=0, transistor becomes OFF & it goes into cutoff. The transistor acts as an open circuit. During this condition the Collector Emitter voltage V_{CE}=Vcc. Therefore Vo = Vcc.



OR

Open switch



1mark,operation -3marks

Closed switch

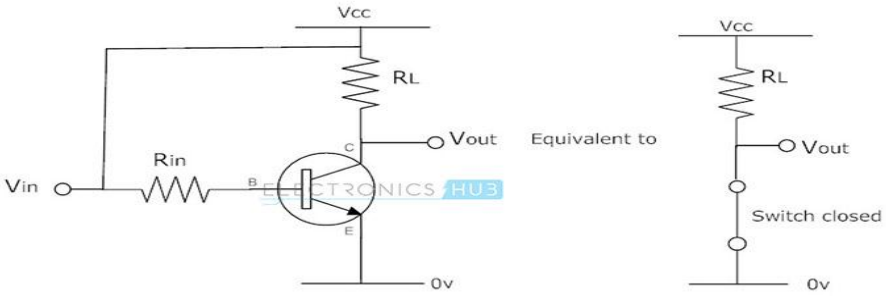


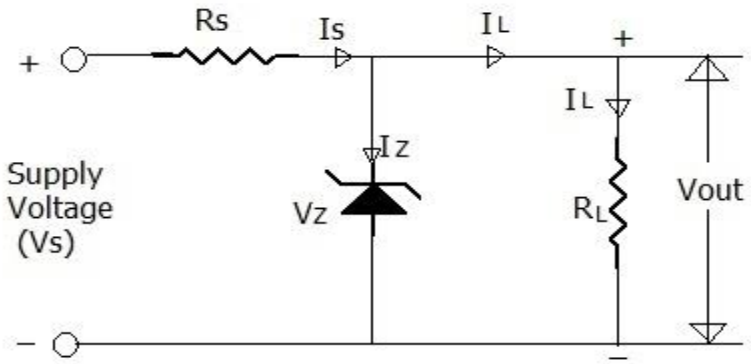
Table indicating transistor as switch

switch	Ib	Ic	VCE	LED	Transistor
open	0	0	Vcc	off	cuoff
closed	max	max	0	on	saturation

[NOTE: Table with two diagram also sufficient to explain transistor as switch 2mark for diagram and 2mark for table.]

b) **Draw and explain the operation of zener as a voltage regulator.** **4M**

Ans:



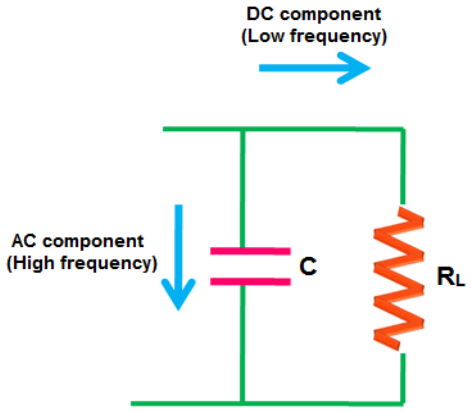
Zener diode Voltage Regulator

Diagram -2marks,

operation- 2marks

The function of a regulator is to provide a constant output voltage to a load connected in parallel with it in spite of the ripples in the supply voltage or the variation in the load current

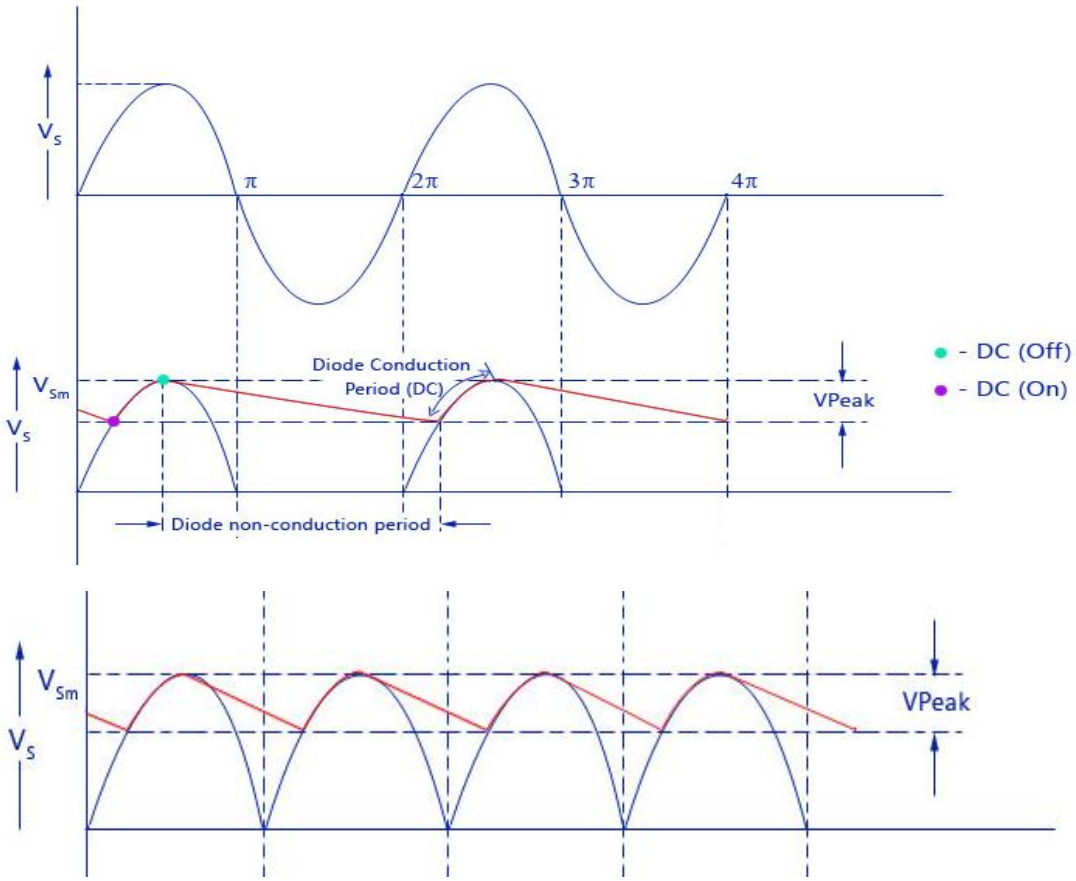
		and the zener diode will continue to regulate the voltage until the diodes current falls below the minimum $I_{Z(min)}$ value in the reverse breakdown region. It permits current to flow in the forward direction as normal, but will also allow it to flow in the reverse direction when the voltage is above a certain value - the breakdown voltage known as the Zener voltage. The purpose of a voltage regulator is to maintain a constant voltage across a load regardless of variations in the applied input voltage and variations in the load current. The resistor is selected so that when the input voltage is at $V_{IN(min)}$ and the load current is at $I_{L(max)}$ that the current through the Zener diode is at least $I_{z(min)}$. Then for all other combinations of input voltage and load current the Zener diode conducts the excess current thus maintaining a constant voltage across the load. Shunt regulators have an inherent current limiting advantage under load fault conditions because the series resistor limits excess current. A zener diode of break down voltage V_z is reverse connected to an input voltage source V_i across a load resistance R_L and a series resistor R_S. The voltage across the zener will remain steady at its break down voltage V_Z for all the values of zener current I_Z as long as the current remains in the break down region. Hence a regulated DC output voltage $V_0 = V_Z$ is obtained across RL, whenever the input voltage remains within a minimum and maximum voltage.	
	c)	**Define filter. State its types. Draw any one filter with input and output waveform.**	**4M**
	Ans:	Defination : Filter is a circuit which remove or filtered out the AC component (ripple) Types of filter 1. Shunt Capacitor filter (C filter) 2. Series Inductor filter (L filter) 3. LC filter 4. π filter (CLC filter) Shunt Capacitor filter (C filter)	**Definati on- 1mark,** **diagram -1 mark,** **types- 1mark,** **wavefor m- 1mark**



OR

[Any one type filter circuit diagram is enough]

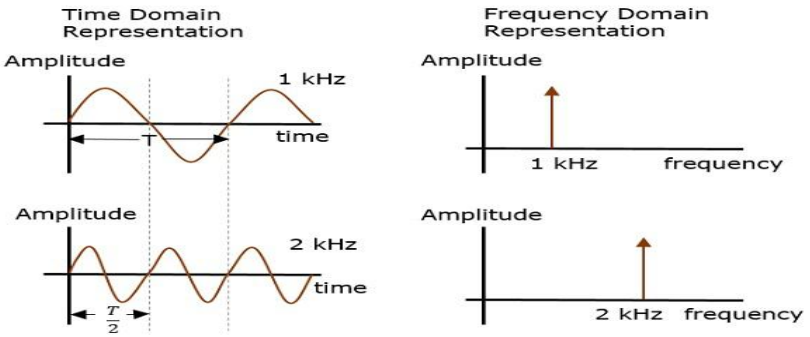
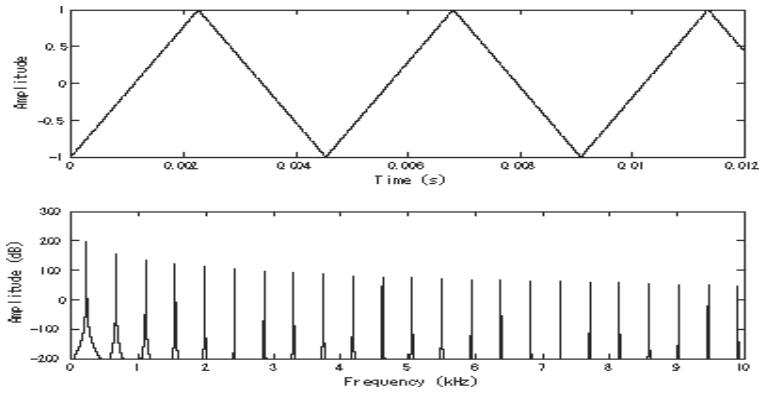
Waveforms:

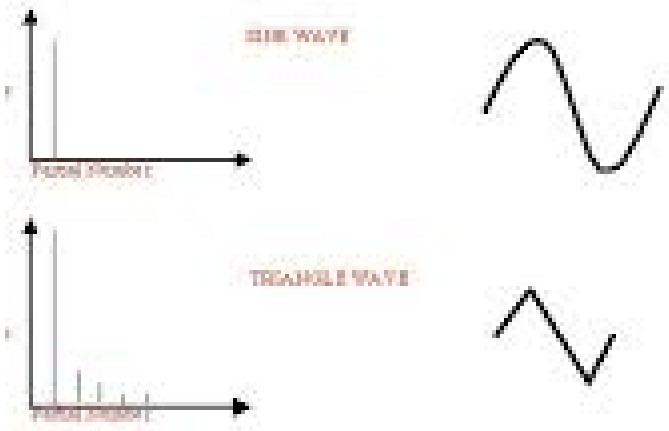


WINTER-19 EXAMINATION

Subject Name: Basic Electrical and Electronics Engineering **Subject Code:** 22310

Model Answer

	(d)	**(i) Draw the time domain and frequency domain representation of sine wave and triangular wave.** **(ii) Define frequency and wavelength.**	**4M**
	Ans:	**(i)Time domain and frequency domain representation of sine wave**  **time domain and frequency domain representation of triangular wave.**  **OR**	**1 Mark each**

		 **ii) Define frequency and wavelength.** Frequency: Number of cycle completed in one second called as frequency Wavelength: Wavelength can be defined as the distance between two successive crests troughs of a wave.	
	e)	**(i) Discuss ideal and practical voltage source** **(ii) Compare CB, CC and CE configuration (two points)**	**4M**
	Ans:	(i) Discuss ideal and practical voltage source Ideal voltage source The ideal voltage source has a constant voltage across its terminal, irrespective of the current drawn from the source. Ideal Voltage Source have zero internal resistance. Practically an ideal voltage source cannot be obtained.	**(i)1 mark each, (ii)1/2 mark each point**

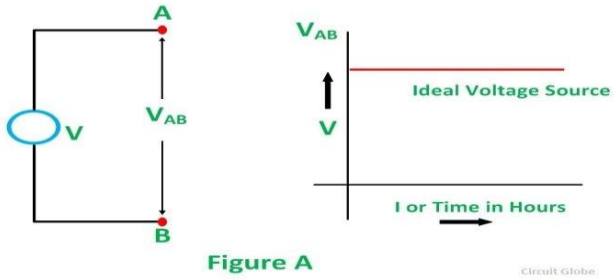


Figure A

practical voltage source

While the practical voltage source can supply only limited amount of current to the load. Also, practical voltage source has series internal resistance. due to this internal resistance; voltage drop takes place, and it causes the terminal voltage to reduce.

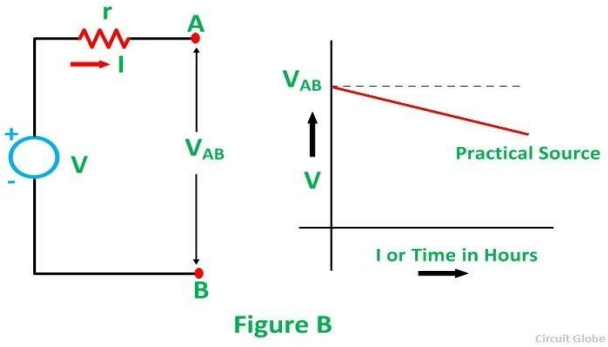


Figure B

(ii) Compare CB, CC and CE configuration (two points)

Parameter	CB	CE	CC
Input impedance	Very Low(less than 100 ohm)	Low(less than 1K)	Very High(750K)
Output impedance	Very High	High	Low
Current gain	Less than 1	High	Very high
Voltage gain	Greater than CC but less than CE	Highest	Lowest(less than 1)

OR

Parameter	**CB**	**CE**	**CC**
Input terminal	**emitter**	**Base**	**base**

Output terminal	**collector**	**collector**	**emitter**
common	**base**	**emitter**	**collector**
Input current	**Ie**	**Ib**	**Ib**
Output current	**Ic**	**Ic**	**Ie**
Current gain	**Alpha=Ic/Ie less than 1**	Beta=Ic/Ib greater than 1	**Gamma=Ie/Ib large**
Input voltage	**Veb**	**Vbe**	**Vbc**
Input Resistance	**Medium**	**High**	**Medium**
Output Resistance	**Very high**	**High**	**low**
Voltage gain	**150**	**500**	**unity**
Power gain	**Medium**	**High**	**medium**
PHASE	**In phase**	**180 phase shift**	**In phase**

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**(i) Compare between analog and digital IC.** **(ii) Find the value of resistor from the given color code.** **(1) Brown, Black, Red, Silver** **(2) Orange, Red, Brown, Gold**	**6M**

Ans: (i) Compare between analog and digital IC.

Items	Analog IC	Digital IC
Signal Characteristics	Continuous, such as light, sound, speed, temperature, etc.	Discrete, 0 and 1.
Technological Complexity	High entry barrier with 10~15 years learning curve	Relying on Computer Aided Design (CAD) tools with 3~5 year learning curve
Product Accreditation	More than 1 year	3~6 months
Substitution	Low	High
Product Portfolio	Low volume, High variety	High volume, Low variety
Applications	Power management, Audio amplification, Signal transformation and monitoring	Logic computation, Control, Digital signal coding/decoding
Price	Stable	Volatile

(i) 1/2 mark each point

(ii) Find the value of resistor from the given color code.

(1) Brown, Black, Red, Silver
(2) Orange, Red, Brown, Gold

1) $10 * 10^2$=10*100=1000 ohm=1kohm,10%

2) $32 * 10^1$= 320 ohm,5%

(ii) 1 mark each calculation

b) Draw the circuit diagram and describe the working principle of full wave bridge rectifier. Draw its waveforms. **6M**

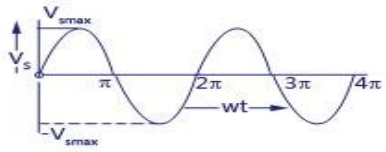
Ans:

During the first half cycle

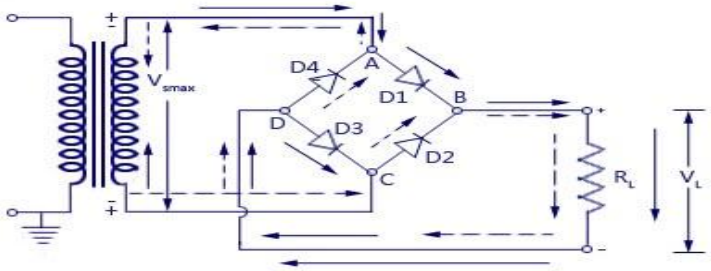
During the first half cycle of the input voltage, the upper end of the transformer secondary winding is positive with respect to the lower end. Thus during the first half cycle diodes D1 and D_3 are forward biased and current flows through arm AB, enters the load resistance R_L, and returns back flowing through arm DC. During this half of each input cycle, the diodes D_2 and D_4 are reverse biased and current is not allowed to flow in arms AD and BC. The flow of current is indicated by solid arrows in the figure above. We have developed another diagram below to help you understand the current flow quickly. See the diagram below – the green arrows indicate the beginning of current flow from the source (transformer secondary) to the load resistance. The red arrows indicate the return path of current from load resistance to the source, thus completing the circuit.

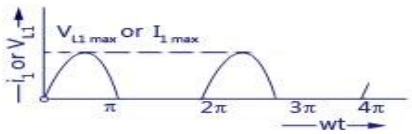
Diagram - 2marks, working - 2marks, waveform- 2marks

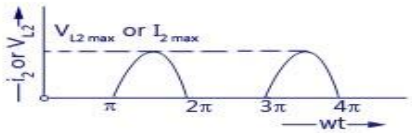
		During the second half cycle During the second half cycle of the input voltage, the lower end of the transformer secondary winding is positive with respect to the upper end. Thus diodes D_2 andD_4 become forward biased and current flows through arm CB, enters the load resistance R_L, and returns back to the source flowing through arm DA. The flow of current has been shown by dotted arrows in the figure. Thus the direction of flow of current through the load resistance R_L remains the same during both half cycles of the input supply voltage. See the diagram below – the green arrows indicate the beginning of current flow from the source (transformer secondary) to the load resistance. The red arrows indicate the return path of current from load resistance to the source, thus completing the circuit.	

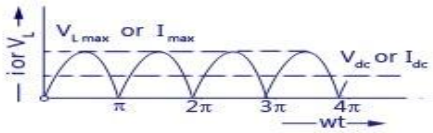


Input Voltage Waveform









Rectified Output Voltage/Current Waveforms

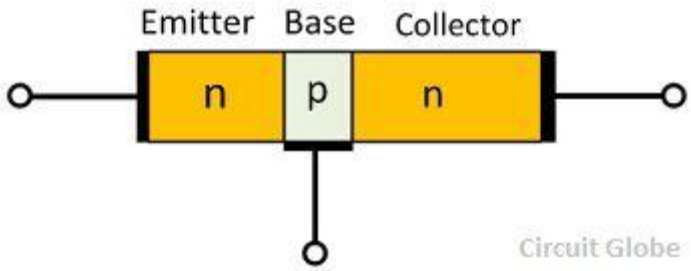
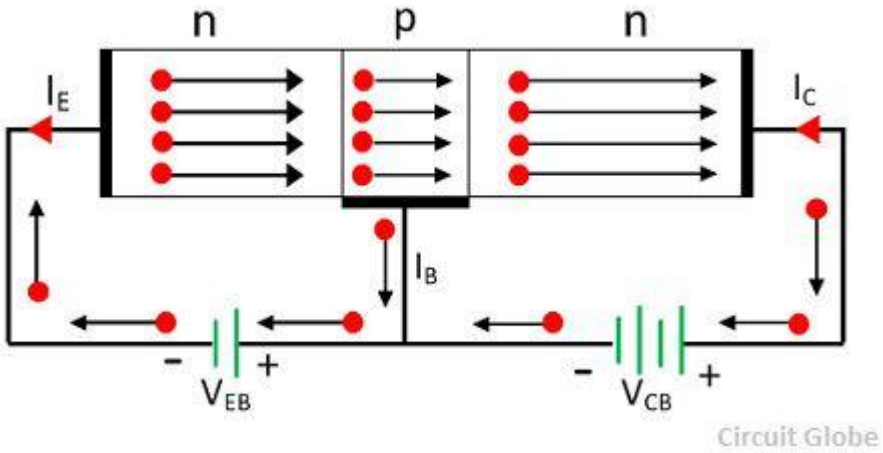
BRIDGE RECTIFIER

www.CircuitsToday.com

OR

Description in simple

At positive half cycle the Diode D1 and D3 will be forward biased and current path will be Terminal A, Diode D1,Terminal B, Resistor RL, terminal D, diode D3, and terminal C back to transformer and output will positive half cycle. At the negative half cycle diode D2 and D4

		will be forward biased current path will be Terminal C, Diode D2,Terminal B, Resistor RL, terminal D, diode D4, and terminal A back to transformer and output will positive half cycle.	
	c)	**Draw the construction of BJT (NPN) and explain its working principle. State and explain different operating regions.**	**6M**
	Ans:	Construction of BJT (NPN):  Working of NPN Transistor The circuit diagram of the NPN transistor is shown in the figure below. The forward biased is applied across the emitter-base junction, and the reversed biased is applied across the collector-base junction. The forward biased voltage V_{EB} is small as compared to the reverse bias voltage V_{CB}.  The emitter of the NPN transistor is heavily doped. When the forward bias is applied across the emitter, the majority charge carriers move towards the base. This causes the emitter	**Construction diag.-1mark,working-2 marks,** **opoerating region explanation-2marks, state region-1 mark**

		current I_E. The electrons enter into the P-type material and combine with the holes. The base of the NPN transistor is lightly doped. Due to which only a few electrons are combined and remaining constitutes the base current I_B. This base current enters into the collector region. The reversed bias potential of the collector region applies the high attractive force on the electrons reaching collector junction. Thus attract or collect the electrons at the collector. The whole of the emitter current is entered into the base. Thus, we can say that the emitter current is the sum of the collector or the base current. Active region. The region between cut off and saturation is known as *active region*. In the active region, collector-base junction remains reverse biased while base-emitter junction remains forward biased. Consequently, the transistor will function normally in this region. Saturation. The point where the load line intersects the *IB* = *IB*(*sat*) curve is called *saturation*. At this point, the base current is maximum and so is the collector current. At saturation, collector-base junction no longer remains reverse biased and normal transistor action is lost. $I_{C\,(sat)} \simeq \frac{V_{CC}}{R_C}$; $V_{CE} = V_{CE(sat)} = V_{knee}$ If base current is greater than *IB*(*sat*), then collector current cannot increase because collector-base junction is no longer reverse-biased. OR Both junction are forward bias and ouput current change with output biasing voltage transistor in saturation region. In this region transistor act as closed switch. Cut off. The point where the load line intersects the *IB* = 0 curve is known as*cut off*. At this point, *IB* = 0 and only small collector current (*i.e*. collector leakage current *ICEO*) exists. At cut off, the base-emitter junction no longer remains forward biased and normal transistor action is lost. The collector-emitter voltage is nearly equal to *VCC i.e. VCE* (*cut off*) = *VCC* OR	

		Both junction are reversed bias and ouput current is Zero with input current is Zero transistor in cut off. In this region transistor act as open switch	

22310

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

SECTION - I

1. Attempt any SIX of the following: **12**

a) Define self induced Emf. Write equation of self induced Emf.

b) State Lenz's Law.

c) Draw sinusoidal waveform showing various quantities associated with it.

d) Define RMS value and Average value of AC waveform.

e) State applications of single phase AC motors.

f) Write the Emf equation of transformer. State the meaning of each term in it.

g) Define -

(i) Current

(ii) Potential difference

h) State Faradays laws of electromagnetic inductions.

Marks

2. Attempt any THREE of the following: **12**

a) Draw and explain B-H curve.

b) Obtain the delta connected equivalent for the star connected circuit (Fig. No. 1)

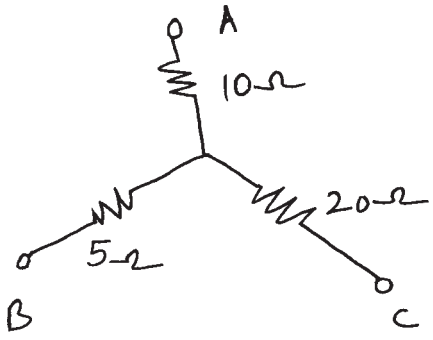


Fig. No. 1

c) Draw and describe power triangle. State its significance.

d) Compare magnetic and electric circuits (four points)

e) Describe the construction and working principle of auto transformer.

3. Attempt any TWO of the following: **12**

a) Describe the operation of inductor with a sinusoidal AC voltage as input. Draw waveform for voltage across and current through the inductor. Draw its phasor representation.

b) Describe the construction and working principle of single phase AC motor.

c) State the different types of transformers. Describe the construction and general principle of transformer.

Marks

SECTION - II

4. Attempt any FIVE of the following: **10**

a) Define active component. Give two examples.

b) State any four specifications of resistor.

c) Draw symbol of -

(i) PN junction diode

(ii) Zener diode

d) State the need for filler circuits in power supply.

e) Define α. Give the relationship between α and β.

f) Define the following with respect to BJT.

(i) Input resistance

(ii) Output resistance

g) Compare between active and passive components.

5. Attempt any THREE of the following: **12**

a) Describe the operation of transistor as a switch with suitable diagram.

b) Draw and explain the operation of zener as a voltage regulator.

c) Define filter. State its types. Draw any one filter with input and output waveform.

d) (i) Draw the time domain and frequency domain representation of sine wave and triangular wave.

(ii) Define frequency and wavelength

e) (i) Discuss ideal and practical voltage source.

(ii) Compare CB, CC and CE configuration (two points)

Marks

6. Attempt any TWO of the following: **12**

a) (i) Compare between analog and digital IC.

(ii) Find the value of resistor from the given color code.

(1) Brown, Black, Red, Silver

(2) Orange, Red, Brown, Gold

b) Draw circuit diagram and describe the working principle of full wave bridge rectifier. Draw it's waveforms.

c) Draw construction of BJT (NPN) and explain its working principle. State and explain the different operating regions.

SUMMER – 2022 EXAMINATION

Subject Name: Thermal Engineering **Model Answer Subject Code: 22337**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	a	The factors that cause a process to be irreversible are called irreversibilities. They include friction, unrestrained expansion, heat transfer across a finite temperature difference, mixing of two fluids, electric resistance, inelastic deformation of solids, chemical reactions, and combustion process.	02 (1/2 mark for each factor)

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	b	Assumptions for ideal gas are : (1) the collisions occurring between molecules are elastic and their motion is frictionless, meaning that the molecules do not lose energy; (2) the total volume of the individual molecules is magnitudes smaller than the volume that the gas occupies; (3) there are no intermolecular forces acting between the molecules or their surroundings; (4) the molecules are constantly in motion, and the distance between two molecules is significantly larger than the size of an individual molecule. As a result of all these assumptions, an ideal gas would not form a liquid at room temperature.	02 (1/2 mark for each assumption)

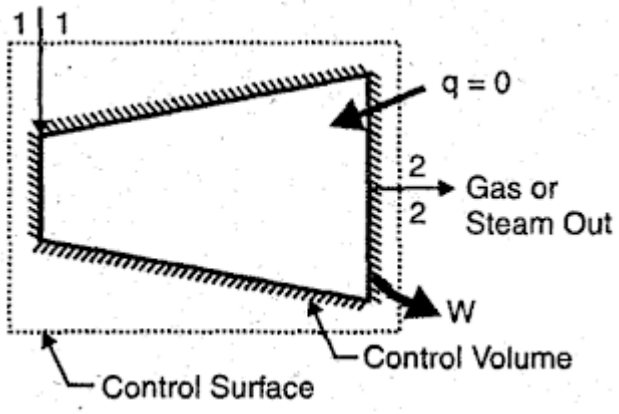
Q. No.	Sub Q. N.	Answer	Marking Scheme
01	c	The function of the superheater is to increase the temperature of steam above its saturation temperature as heat contained in unit mass of superheated steam is more than dry saturated or wet steam; it is extensively used in steam power plants. The function of blow-off cock is to discharge mud and other sediments deposited in the bottom most part of the water space in the boiler, while boiler is in operation. It can also be used to drain-off boiler water.	02 (1 mark for each function)

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	d	The Mach Number is a dimensionless value useful for analyzing fluid flow dynamics problems where compressibility is a significant factor. It is ratio of velocity at a state in flowing fluid to the value of sonic velocity at the same state. The Mach Number can be expressed as M = v / c where M = Mach number ; v = fluid flow speed (m/s) ;c = speed of sound (m/s) significance:-. If the mach number is < 1, the flow speed is lower than the speed of sound - and the speed is subsonic. If the mach number is ~ 1, the flow speed is approximately like the speed of sound - and the speed is transonic. If the mach number is > 1, the flow speed is higher than the speed of sound - and the speed is supersonic. If the mach number is >> 1, the flow speed is much higher than the speed of sound - and the speed is hypersonic	02

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	e	When the back pressure is decreased in case of a nozzle the mass flow rate through the nozzle increases proportionally. But after a fixed value of back pressure is reached , increase in mass flow rate is not observed . This value of back pressure is known as critical pressure. So we can define critical pressure as the back pressure for the maximum mass flow rate through the nozzle.	02

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	f	The main functions of a steam condenser are listed below: 1. The condenser lowers the back pressure at the turbine exhaust. Thus, steam expands through a higher pressure ratio across the turbine. It results into (i) increased work done per cycle, (ii) improved thermal efficiency of the cycle, and (iii) reduced steam consumption. 2. The condenser enables the recovery and recirculation of pure feed water into the plant. Thus, (i) the cost of water softening plant is reduced, and (ii) it also saves the cost of fresh water to be supplied to the boiler. 3. The condenser enables the removal of air and non-condensable gases from steam. Thus the heat-transfer rate is improved and tube corrosion is reduced.	02 (1 mark for each function)

Q. No.	Sub Q. N.	Answer	Marking Scheme
01	g	Thermal conductivity can be defined as the rate at which heat passes through a specified material, expressed as the amount of heat that flows per unit time through a unit area with a temperature gradient of one degree per unit distance. The SI unit of this quantity is watts per meter-Kelvin or $Wm^{-1}K^{-1}$.	02

Q. No.	Sub Q. N.	Answer	Marking Scheme
02	a	For steady flow process, net quantity of energy contained within the system will never change with respect to time. Therefore according to the principle of conservation of energy, we will have following statement and energy equation for a steady flow process. Net quantity of energy entering to the control volume = Net quantity of energy leaving the control volume $$H_1 + \frac{mV_1^2}{2} + mgZ_1 + Q - W = H_2 + \frac{mV_2^2}{2} + mgZ_2$$ Steady flow energy equation for a turbine Turbine is basically defined as one prime mover where thermal energy of the high pressure fluid will be converted in to mechanical energy in terms of rotation of turbine shaft. Mechanical energy developed by turbine will be finally converted in to electrical energy. Turbine is also designated as mechanical device that will provide the work energy through the expansion of fluid. Let us see here the following figure, where high pressure fluid enters at inlet 1-1 and low pressure fluid leaves the turbine at its outlet section i.e. 2-2.  Let turbine is well insulated and hence there will no heat energy interaction between system and surrounding and therefore we can say that Q =0. When fluid flows through a turbine, change in kinetic energy could be assumed as zero as velocity of fluid flow will be small and we can neglect the small change in kinetic energy of the fluid. Therefore, we will have ΔKE =0 We have also assumed here that change in potential energy is zero or we can say that ΔPE =0 Let us implement above data that we have mentioned above in steady flow energy	02 01

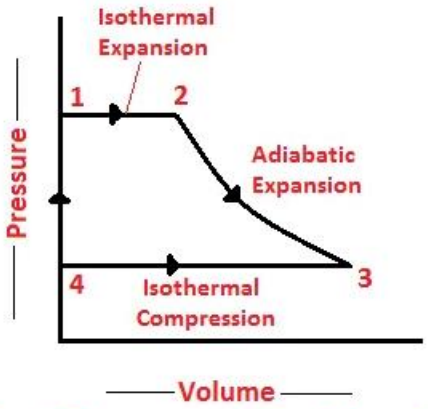
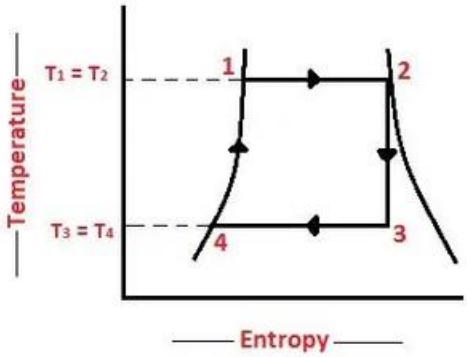
		equation for a steady flow process and we will have following equation $H_1 - W = H_2$ We have taken work energy as positive because turbine is producing the work energy and this work is being done over the surrounding by the system. $W = H_1 – H_2$ We can also say that, work energy produced by the turbine during the process will be the result of drop in enthalpy. Steady flow energy equation for a condenser The condenser is used to condense the steam in case of steam power plant and condense the refrigerant vapour in the refrigeration system using water or air as cooling medium. For this system: ΔPE=0, ΔKE=0 (as their values are very small compared with enthalpies) W=0 (since neither any work developed nor absorbed) Using energy equation to steam flow h1−Q=h2 i.e. Q = h1 − h2 Where Q = Heat lost by 1 Kg of steam passing through the condenser.	01

Q. No.	Sub Q. N.	Answer	Marking Scheme
02	b		04 (01 mark for each parameter)

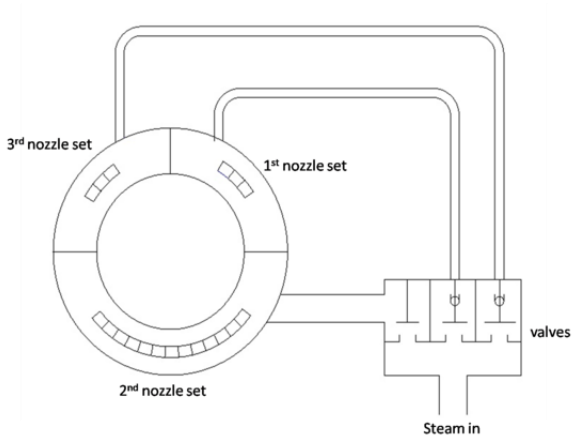
Parameter	Isothermal	Adiabatic
Definition	It is defined as one of the thermodynamic processes which occur at a constant temperature.	It is defined as one of the thermodynamic processes which occur without any heat transfer between the system and the surrounding

Heat transfer	It contains the transfer of heat.	It does not contain the transfer of heat.
Pressure vs volume	The pressure is more in comparison to volume.	The pressure is less in comparison to volume.
Temperature	The temperature remains constant in such a process.	Temperature changes due to variations in the internal system in such a process.
Heat	To maintain the temperature, heat can be added or released to the system.	No need to add or release the heat, constant temperature maintenance is not required here.
Rate of transformation	The transformation is slow in such a process.	The transformation is fast in such a process.

Q.	Sub	Answer	Marking

No.	Q. N.		Scheme
02	c	 **P-v Diagram of Rankine Cycle**  **T-s Diagram of Rankine Cycle**	02
		Process 4–1: The working fluid is pumped from low to high pressure. As the fluid is a liquid at this stage, the pump requires little input energy. Process 4-1 is isentropic compression. Process 1–2: The high-pressure liquid enters a boiler, where it is heated at constant pressure by an external heat source to become a dry saturated vapour. The input energy required can be easily calculated graphically, using an enthalpy–entropy chart (h–s chart, or Mollier diagram), or numerically, using steam tables or software. Process 1-2 is constant pressure heat addition in boiler. Process 2–3: The dry saturated vapour expands through a turbine, generating power. This decreases the temperature and pressure of the vapour, and some condensation may occur. The output in this process can be easily calculated using the chart or tables noted above. Process 2-3 is isentropic expansion. Process 3–4: The wet vapour then enters a condenser, where it is condensed at a constant pressure to become a saturated liquid. Process 3-4 is constant pressure heat rejection in condenser.	02

Q. No.	Sub Q. N.	Answer	Marking Scheme
02	d	Q 2 d] Given :→ $P = 8$ bar $v = 0.28\ m^3/kg$ From steam Tables at $P = 8$ bar $T_{sat} = 170.4°C$, $v_g = 0.2408\ m^3/kg$ $= 170.4 + 273$ $= 443.4\ K$ $\therefore v_g < v$ (ie) $0.2408 < 0.28$ This means that given steam is in superheated region hence given steam is superheated steam. In superheated region, gas laws are applicable hence $\frac{v_1}{T_1} = \frac{v_2}{T_2}$ (i.e) $\frac{v_g}{T_{sat}} = \frac{v_{sup}}{T_{sup}}$ $\therefore \frac{0.2408}{443.4} = \frac{0.28}{T_{sup}}$ $\therefore \boxed{T_{sup} = 515.58\ K}$	02 02

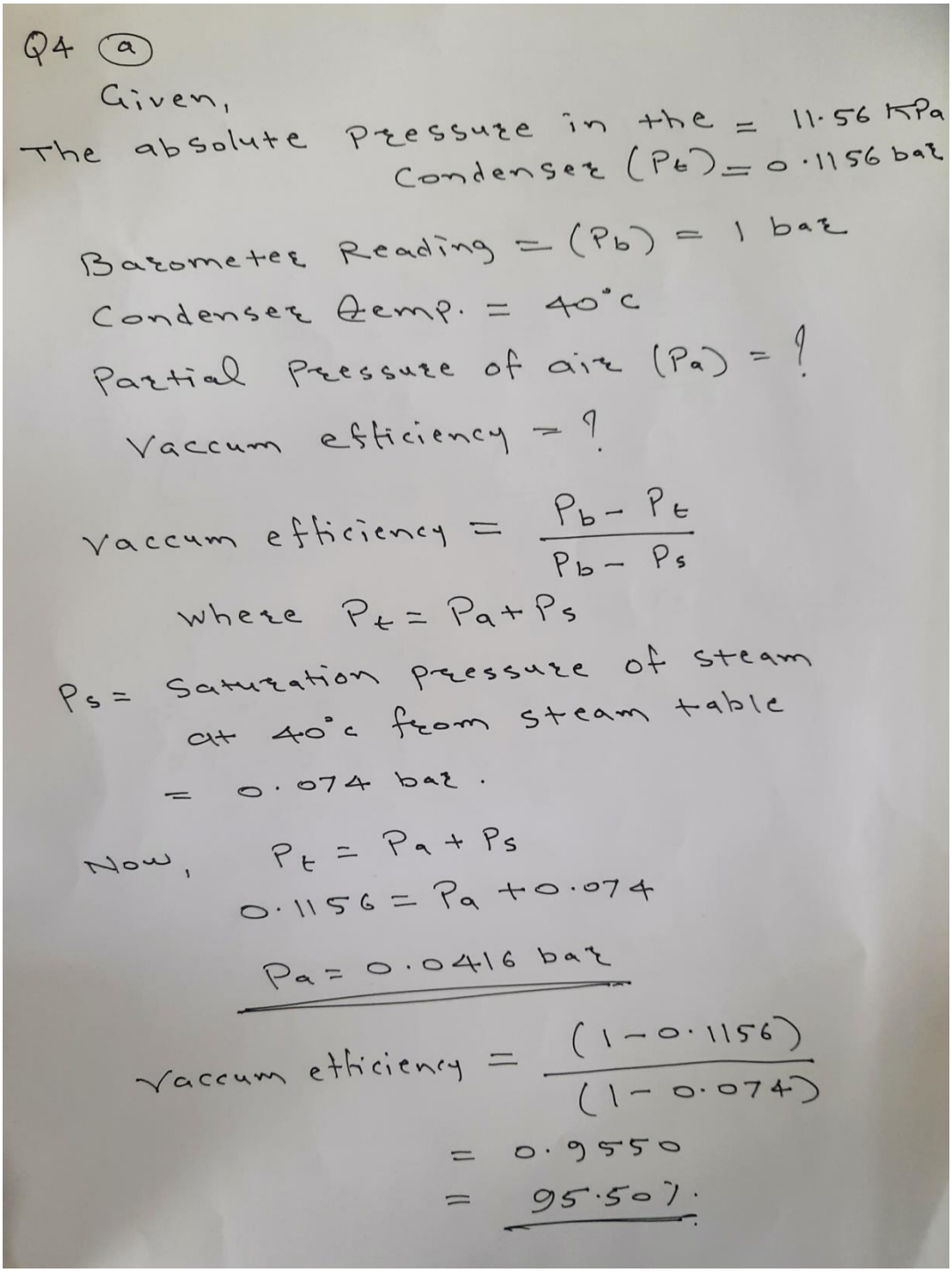
Q. No.	Sub Q. N.	Answer	Marking Scheme
03	a	In nozzle governing the flow rate of steam is regulated by opening and shutting of sets of nozzles rather than regulating its pressure. In this method groups of two, three or more nozzles form a set and each set is controlled by a separate valve. The actuation of individual valve closes the corresponding set of nozzle thereby controlling the flow rate. In actual turbine, nozzle governing is applied only to the first stage whereas the subsequent stages remain unaffected. Since no regulation to the pressure is applied. Figure shows the mechanism of nozzle governing applied to steam turbines. As shown in the figure the three sets of nozzles are controlled by means of three separate valves.  	02 02

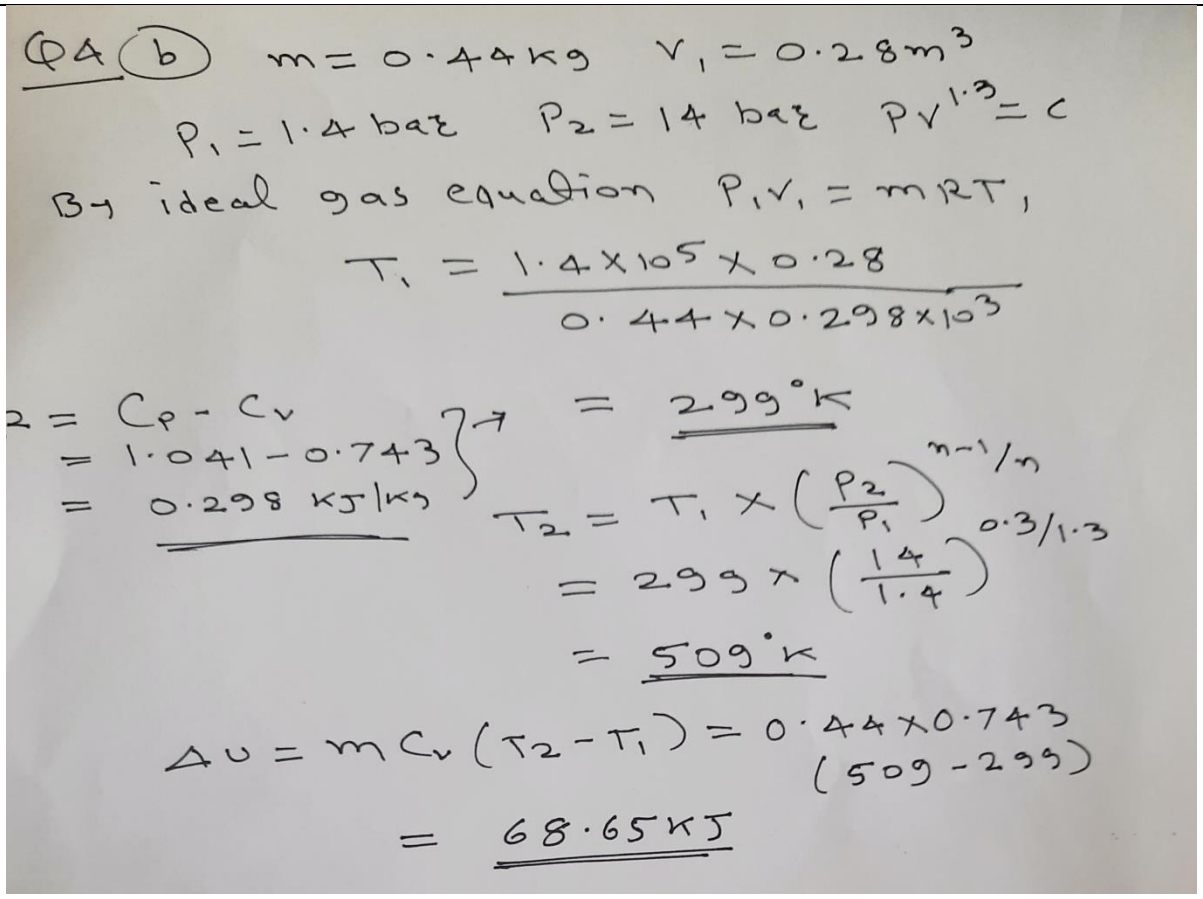
Q. No.	Sub Q. N.	Answer	Marking Scheme
03	b	**Give classification of steam turbine.** Classification of steam turbines: a) With respect to action of steam: i. Impulse turbine ii. Reaction Turbine b) With respect to method of compounding i) Pressure compounding ii) Velocity compounding iii) Pressure-Velocity Compounding c) With respect to expansion stages i) Single stage ii) Multistage	04 Any four criteria

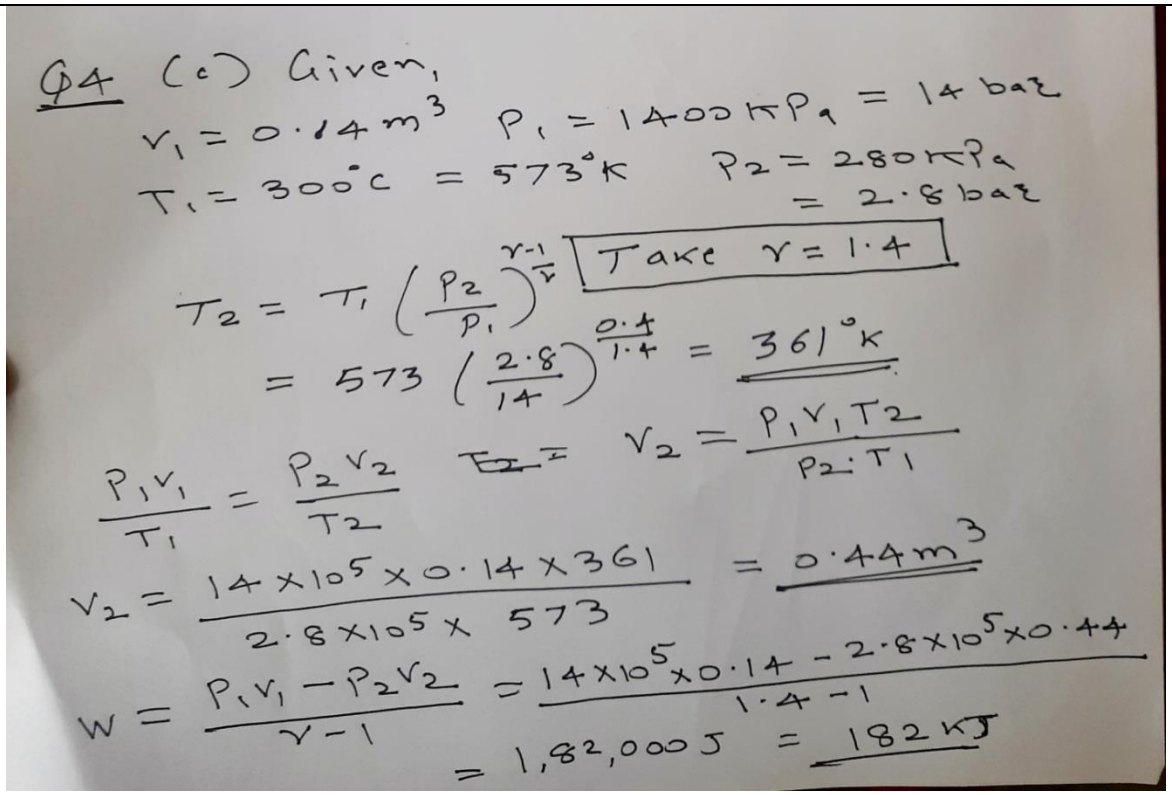
		d) With respect to direction of flow i) Axial flow ii) Radial flow iii) Tangential flow e) With respect to pressure of steam i) Low pressure ii) High pressure iii) Medium pressure f) With respect to shaft position i) Vertical shaft ii) Horizontal shaft g)According to The Nature Of Exhaust Steam. i) Condensing Type Steam Turbine. ii) Non Condensing Type Steam Turbine. h) According to No. Of Passes Of Steam Over Turbine Blades. i) Single Flow Turbine. ii) Double Flow Turbine. i)According to method of the governing. i) Turbine. ii) Turning With Nozzle Governing. With Throttle Governing iii)Turbine With By Pass Governing. j) According to their usage in industry. i) Stationary Turbine With Constant Rotation Speed ii) Stationary Turbine With Variable Speed iii) Non Stationary Turbine With Variation Speed.	

Q. No.	Sub Q. N.	Answer	Marking Scheme
3	c	Q3 (c) Given, $m = 1\,kg \quad P_1 = 1\,bar \quad T_1 = 156^\circ C = 429^\circ K$ $V_2 = 0.28\,m^3$ Isothermal Process By ideal gas eqn $P_1V_1 = mRT_1$ $1 \times 10^5 \times V_1 = 1 \times 287 \times 429$ $\therefore V_1 = 1.23123\,m^3$ $W = P_1V_1 \log_e (V_2/V_1)$ $= 1 \times 10^5 \times 1.23123 \log_e \left(\frac{0.28}{1.23}\right)$ $= -182342.6\,J$ $= -182.34\,kJ$ '−' signs is due to compression process In isothermal process change in internal energy $du = mC_vdT$ $= 0$	02 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
03	d	Energy conservation in Boilers can be accomplished by applying following steps. 1. Stack Temperature 2. Feed Water Preheating using Economiser 3. Combustion Air Preheat 4. Incomplete Combustion 5. Excess Air Control 6. Radiation and Convection Heat Loss 7. Automatic Blowdown Control 8. Reduction of Scaling and Soot Losses 9. Proper Boiler Scheduling 10. Boiler Replacement	04 (01 mark for each step)

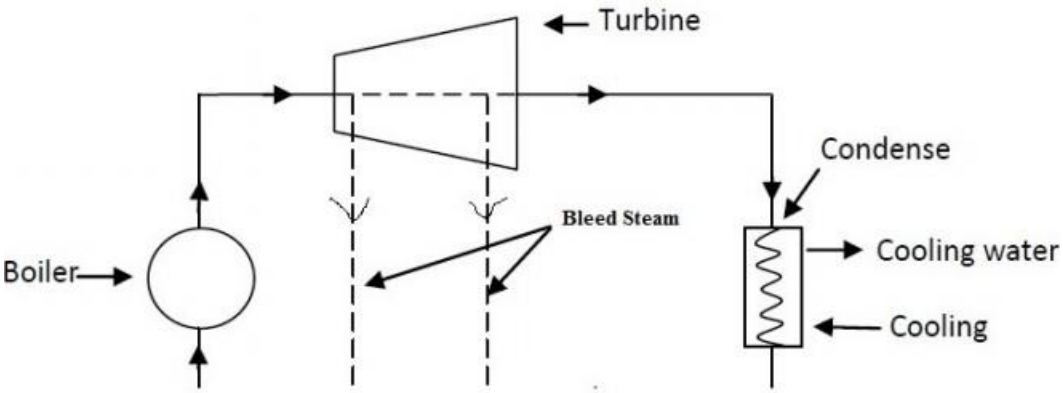
Q. No.	Sub Q. N.	Answer	Marking Scheme
04	a		02 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
04	b		01 01 02

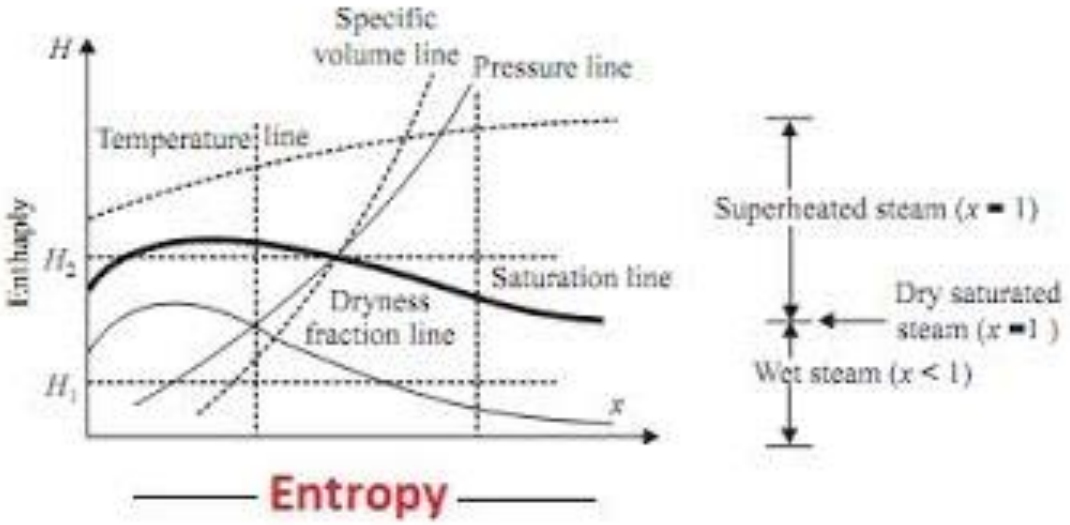
Q. No.	Sub Q. N.	Answer	Marking Scheme
04	c		02 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
04	d	Natural convection is a method of heat transfer in which natural means influence the motion of the fluid. There is no influence from external facts. This movement of molecules in the fluid is due to the differences between densities of different regions of the same fluid. The density of a fluid decreases when it heats and vice versa. That is because of the thermal expansion of the fluid (the speed of molecules increase with the temperature increase, which results in the increase of the volume of the fluid. Although the volume increases, the mass remains constant. Therefore the density decreases). Examples of natural convection include cooling down a boiled egg when kept in the normal air, loss of cool of a cool drink can, etc. Forced convection is a method of heat transfer in which external means influence the motion of the fluid. There, external sources such as pumping, fans, suction devices, etc. are useful in generating the fluid motion. This method is very valuable because it can efficiently transfer heat from a heated object. Some common examples of this mechanism include air conditioning, steam turbines, etc.	02 02

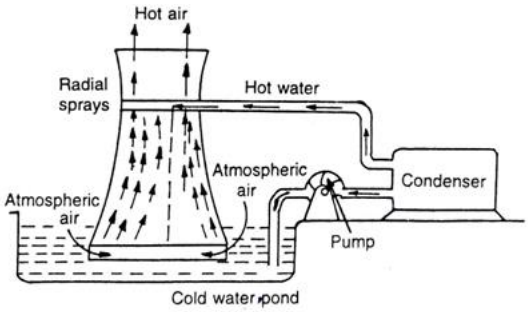
Q. No.	Sub Q. N.	Answer	Marking Scheme
04	e	Classification of steam condensers: A) Jet condenser/contact type condenser a) Parallel flow condenser b) Counter flow condenser c) High level condenser d) Ejector condenser B) Surface condenser/non contact type a) Down flow surface condenser b) Central flow surface condenser c) Regenerative surface condenser d) Evaporative surface condenser e) Double pass surface condenser or shell and tube type	 02 02

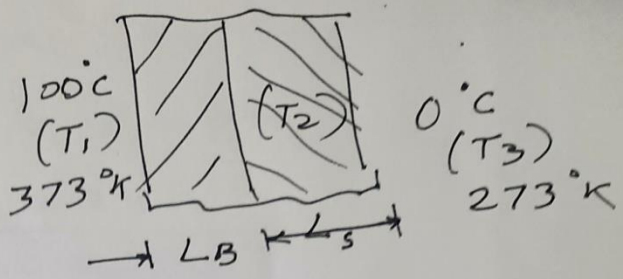
Q. No.	Sub Q. N.	Answer	Marking Scheme
05	a	 **Figure: Bleeding of steam** The process of draining steam from the turbine, at certain points during its expansion, and using this steam for heating the feed water supplied to the boiler, is known as bleeding and this process of feed heating is known as regenerative feed heating. At. certain sections of the turbine, a small quantity of wet steam is drained out from the turbine, as shown in fig. This bled steam is then circulated around the feed water pipe leading from the hot-well to the boiler. The relative cold feed water causes this bled steam to condense, the heat thus lost by steam being transferred to the feed water. The condensed steam then drains into the hot-well. The result of this process is to supply the boiler with hotter feed water whilst a small amount of work is lost by the turbine. This definitely increases efficiency of plant, but there is also a decrease in the work done per kilogram of steam; Advantages – 1. Thermal efficiency of boiler increases. 2. Specific fuel consumption decreases.	02 02 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
05	b	 Most automotive heat exchangers are similar to shell and tube cross flow design, with multiple tube passes. But instead of having a defined shell around the tubes, with another controlled fluid forced across the tubes by means of a pump, there is no limited control volume for the shell. The tubes are open to the air and are dependant upon outside conditions. $Q = h\ A\ \Delta T$ Some types of Automotive Heat Exchangers include but are not limited to radiators, oil coolers and intercoolers. It is possible to use heat exchangers for almost any of the fluids in a vehicle. Air conditioners and heaters are also examples, however they are not restricted to vehicles. A radiator is a cooling device used in the engine in which hot liquid flows through exposed pipes and transfers heat to the air by fans. Fins are used to conduct the heat from the tubes and transfer it to the air. The fluid used is typically a mixture of ethylene glycol, water and a small amount of corrosion reducer. Oil coolers are used mainly in transmissions to keep the oil temperatures within safe limits. Finally intercoolers are air-to-air or air-to-liquid heat exchangers. They are used on turbocharged internal combustion engines to cool down the hot compressed air coming from the turbocharger.	03 03

Q. No.	Sub Q. N.	Answer	Marking Scheme
05	c	Features of Mollier Chart are : Constant Pressure lines Constant Temperature lines Constant Volume lines Constant Enthalpy lines Constant Entropy lines 	02 04

Q. No.	Sub Q. N.	Answer	Marking Scheme
06	a	Q6 (a) Given, $W = 1.25$ kwh $= 1.25 \times 3600 = 4500$ kJ $\Delta U = Q - W$ $4500 = Q - 4500$ $Q = 9000$ kJ	02 04

Q. No.	Sub Q. N.	Answer	Marking Scheme
06	b	The purpose of cooling tower is to remove heat from a building or facility by spraying water down through the tower to exchange heat into the inside of the building. Air comes in from the sides of the tower and passes through the falling water. As the air passes through the water, heat is exchanged and some of the water evaporates. This heat and evaporated water flow out the top of the tower in the form of a fine cloud-like mist. The cooled water is collected at the bottom of the tower and pumped back into the plant or building for reuse. Cooling towers provide large scale air-conditioning where land and (or) water are expensive, or regulations prohibit the return of once-through cooling waters In natural draft cooling tower, hot water is pumped to ring trough's. Trough sprays water in the form of droplets, which is placed at bottom of towers. Most advantage is of no use of fan, for air circulation. An air circulation takes place by the pressure difference of air inside and outside of cooling tower (natural flow).  Natural draught cooling tower.	02 02 02

Q. No.	Sub Q. N.	Answer	Marking Scheme
06	c	Q6 (c) $L_B = L_S = 10$ mm $K_B : K_S = 2:1$  $\frac{Q}{A} = \frac{(T_1 - T_2)}{\frac{L_B}{K_B}} = \frac{(T_2 - T_3)}{\frac{L_S}{K_S}}$ $\frac{(T_1 - T_2)}{\left(\frac{0.01}{2K_S}\right)} = \frac{(T_2 - T_3)}{\left(\frac{0.01}{K_S}\right)}$ $(T_1 - T_2) \times \frac{0.01}{K_S} = (T_2 - T_3) \times \left(\frac{0.01}{2K_S}\right)$ $2(T_1 - T_2) = (T_2 - T_3)$ $2T_1 - 2T_2 = T_2 - T_3$ $2T_1 + T_3 = T_2 + 2T_2$ $3T_2 = 2T_1 + T_3$ $3T_2 = (2 \times 373) + 273$ $T_2 = 1019/3 = \underline{339.67°K}$.	02 02 02

22337

21222

3 Hours / 70 Marks Seat No. | | | | | | | | |

15 minutes extra for each hour

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Use of Steam tables, logarithmic, Mollier's chart is permitted.

(8) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following **10**

a) List the factors making the process irreversible.

b) List any two assumptions for ideal gas.

c) State the function of

i) Superheater

ii) Blow off cock

d) Recite the significance of Mach number.

e) Define critical pressure in nozzle.

f) State the functions of condenser.

g) Define thermal conductivity and State its unit.

P.T.O.

Marks

2. Attempt any THREE of the following **12**

a) Write steady flow energy equation and apply it to turbine and condenser.

b) Differentiate between adiabatic and isothermal process.

(Four points)

c) Draw P-V and T-S diagram of Rankine cycle and list the processes involved in it.

d) Determine if the steam is wet or superheated and calculate the dryness fraction or the superheated steam temperature for P = 8 bar and V = 0.28 m^3/kg.

3. Attempt any THREE of the following **12**

a) Describe with neat sketch nozzle control governing.

b) Classify turbines in details.

c) One Kg of air initially at 1 bar and 156°C is compressed isothermally till the volume is reduced to 0.28 m^3. Determine the work done and change in internal energy.

d) Recite the steps involved in energy conservation of boilers.

4. Attempt any THREE of the following **12**

a) The partial absolute pressure in the condenser is 11.56 KPa when the barometer reads 1 bar. The condenser temperature is 40°C. Calculate partial pressure of air and vacuum efficiency.

b) 0.44 Kg of gas having a volume 0.28 m^3 and a pressure of 1.4 bar is compressed to a pressure of 14 bar according to $pv^{1.3}$ = C. Find the change of internal energy.

C_p = 1.041 KJ/Kg-k

C_v = 0.743 KJ/Kg-k

c) A quantity of gas occupying 0.14 m^3 at a pressure of 1400 KPa and 300°C is expanded isentropically to 280 KPa calculate

i) Final temperature and

ii) Work transfer

Marks

d) Define natural and forced convection and give two examples of each.

e) Classify condensers in details.

5. Attempt any TWO of the following **12**

a) Explain with neat sketch bleeding of steam. State its advantages.

b) Explain with neat sketch automotive heat exchanger.

c) Draw a schematic diagram of Mollier chart and list its features.

6. Attempt any TWO of the following **12**

a) A refrigerator is loaded with fresh food and door is closed. After some period, machine consumes 1.25 KWh of electrical energy and internal energy of food items decreases by 4500 KJ. Calculate the magnitude and direction of heat transfer for the steam.

b) State the purpose of cooling tower and describe with neat sketch natural draught cooling tower.

c) Sheets of brass and steel each 10 mm thick are placed in contact. The outer surface of brass is kept at 100°C and outer surface of steel is kept at 0°C. Estimate the temperature of common interface if thermal conductivities of brass and steel are in the ratio of 2:1.

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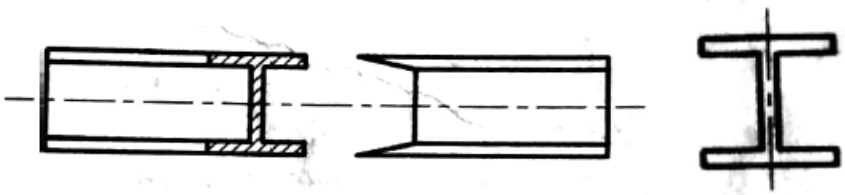
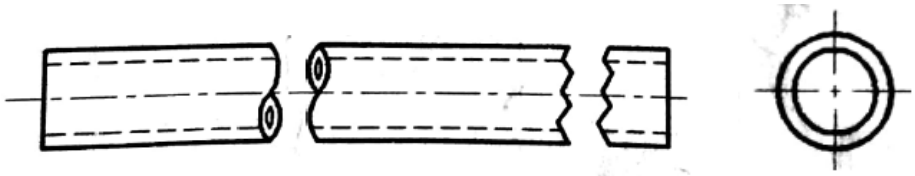
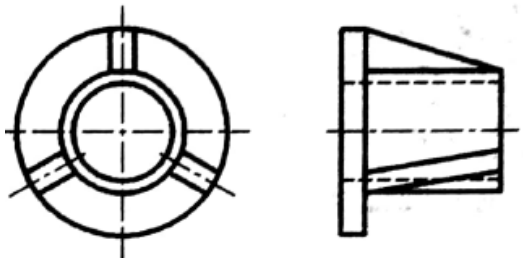
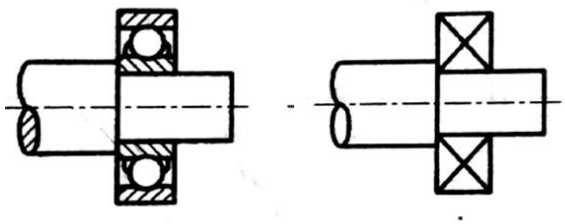
SUMMER – 19 EXAMINATION

Subject Name: Mechanical Working Drawing **Model Answer** Subject Code: 22341

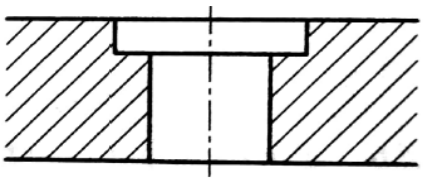
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

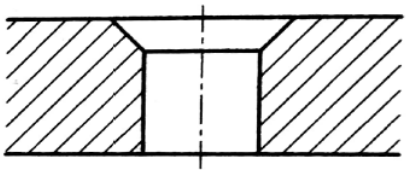
Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a	i) I-section or Rolled section  ii) long brake in pipe 	2 M each
	B	i) Radial ribs  ii)Bearings 	

c

counter bore

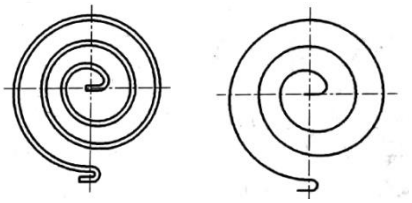


countersunk bore

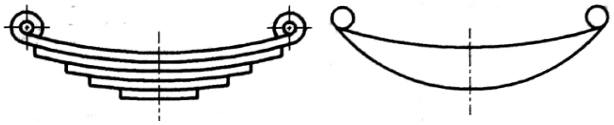


d

i) Spiral spring



ii) Semi elliptic leaf spring with eyelets



e

i) Circularity

ii) Cylindricity

f

GRINDING – MANUFACTURING METHOD

N7 - SURFACE ROUGHNESS VALUE IN MICRON METER

5 - MACHINING ALLOWANCE

C- DIRECTION OF LEY

100 - SAMPLING LENGTH

50 – OTHER ROUGHNESS VALUE

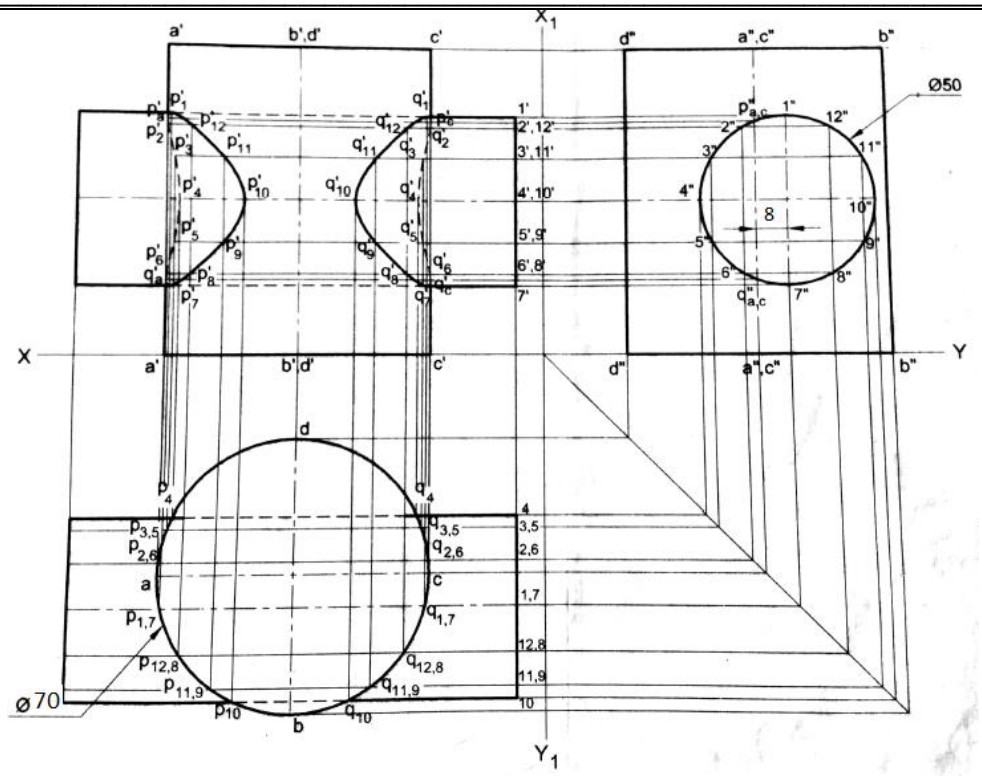
G

The toleranced edge is parallel with in 0.02 mm to the datum line A

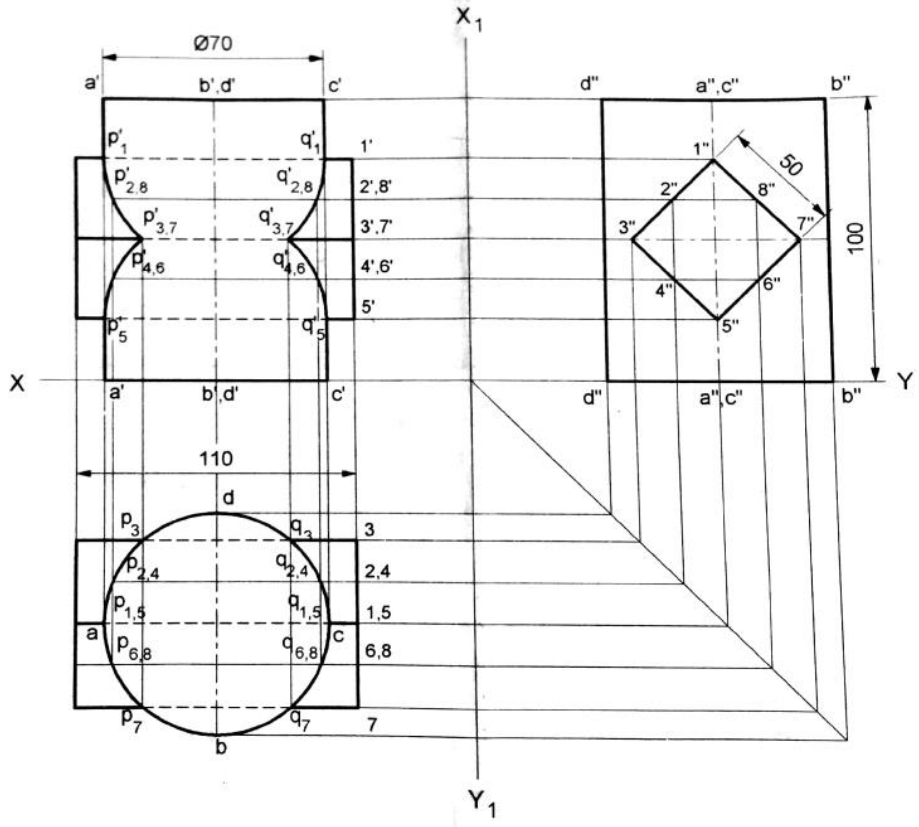
The toleranced edge is perpendicular with in 0.03 mm to the datum line A

2 a

B

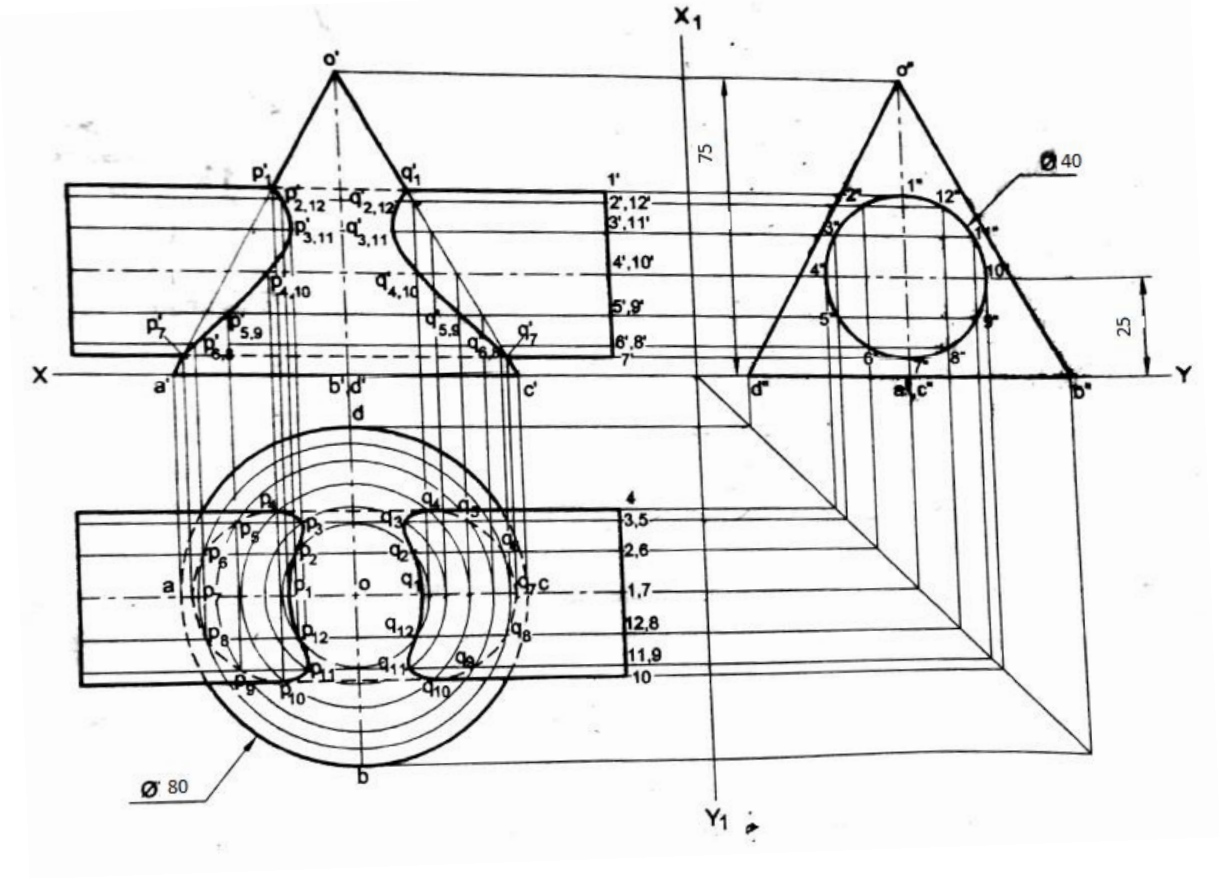


2 M each view



2 M each view

3	A	c	2M each view



a)

4M

For Hole 50 H7 $^{+0.030}_{+0.000}$

Upper limit of hole = 50.000 + 0.030
= 50.03 mm

Lower limit of hole = 50.000 + 0.000
= 50.000 mm

For shaft 50 n6 $^{+0.039}_{+0.020}$

Upper limit of shaft = 50.000 + 0.039
= 50.039 mm

Lower limit of shaft = 50.000 + 0.020
= 50.020 mm

Max. allowance = Upper limit of hole − lower limit of shaft
= 50.030 − 50.020 = 0.01 mm

Min. allowance = Lower limit of hole − Upper limit of shaft
= 50.000 − 50.039 = −0.039 mm

Hence Type of fit is Transition fit.

B

b) define:

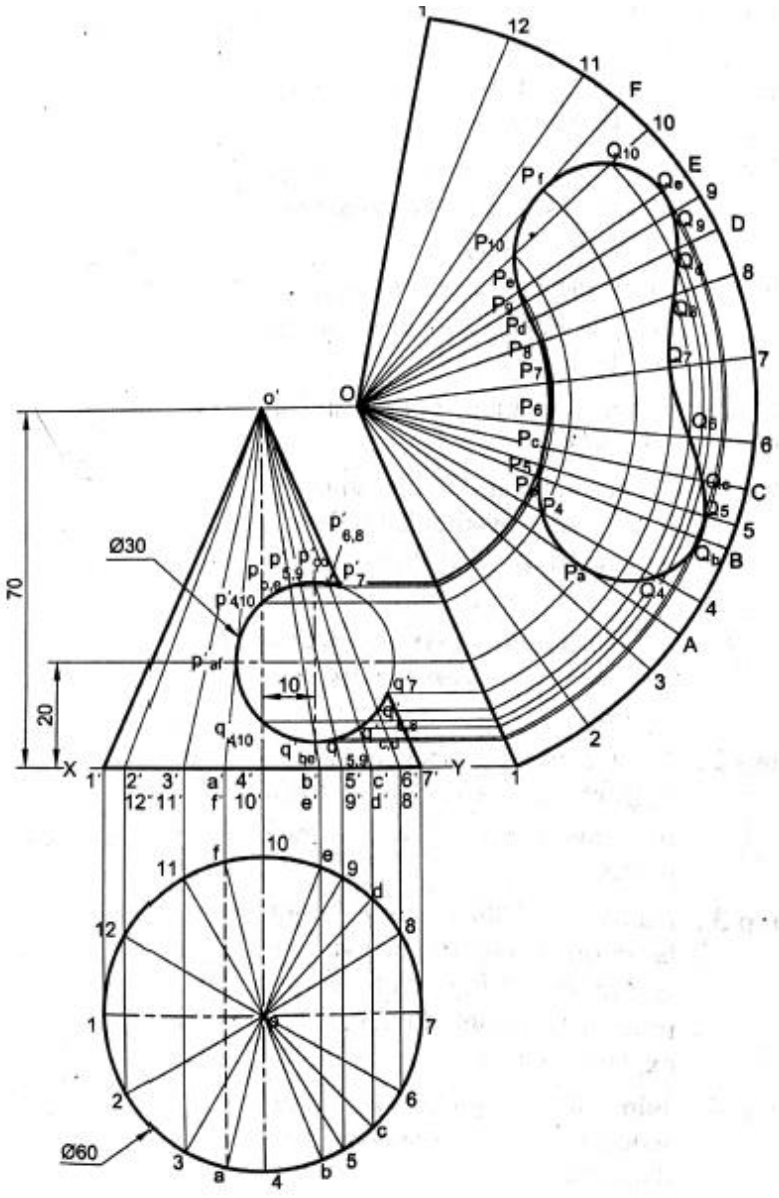
i) Allowance: is the difference between the male part dimension & female part dimension. Or Difference between the hole dimensions and shaft dimensions for any type of fit. Or maximum iterferences betweentwo parts. — 1M each

ii) Clearance: is the difference in the shaft diameter & hole diameter.

iii) Interferance: The upper limit size of the hole is smaller or at least equal to the lower limit size of shaft

iv) Deviation: The difference between basic size and actual size is known as deviation

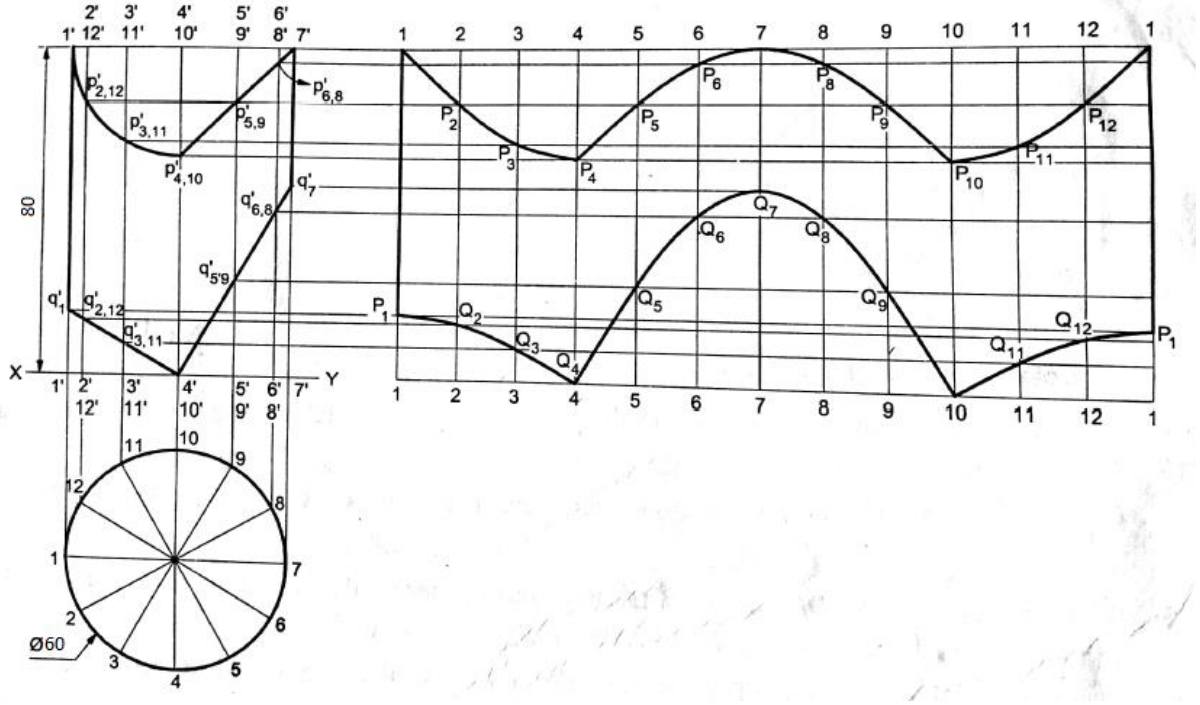
i)



FV & TV 3M

Dev 3M

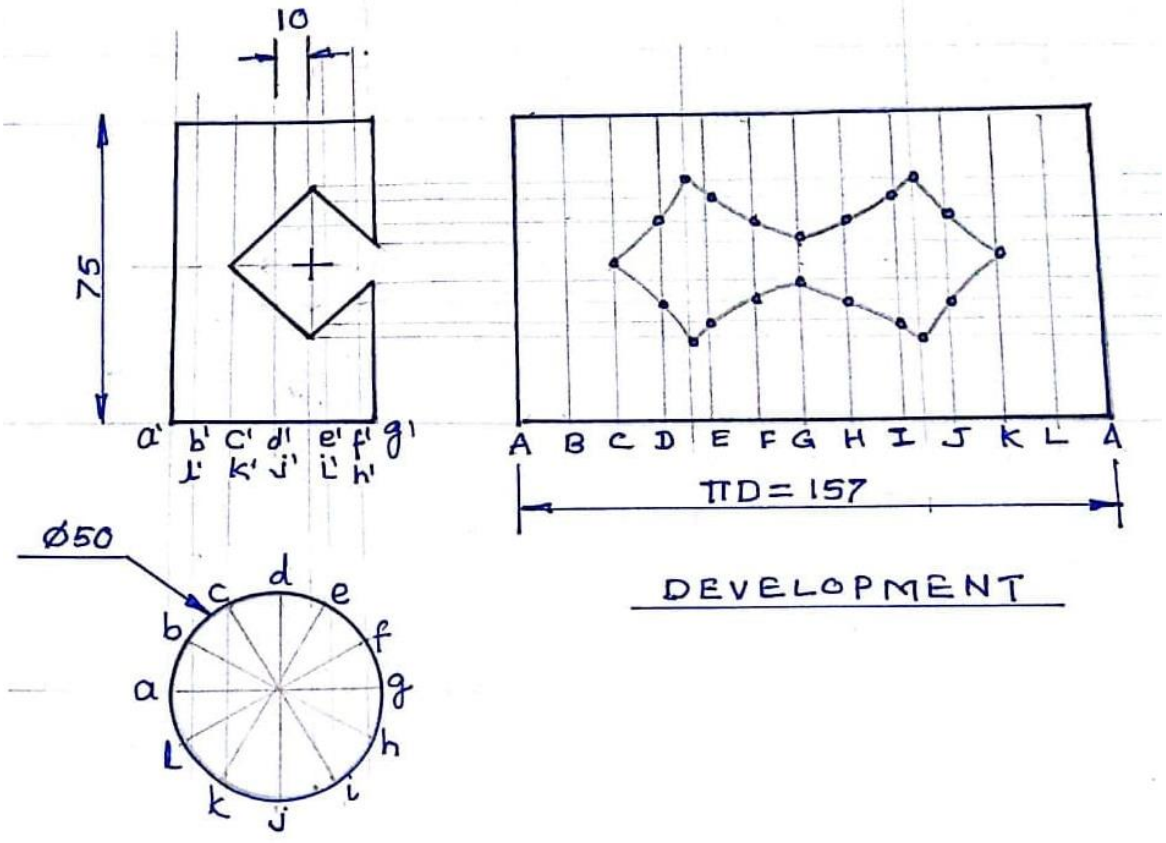
ii)



FV & TV 3M

Dev 3M

iii)

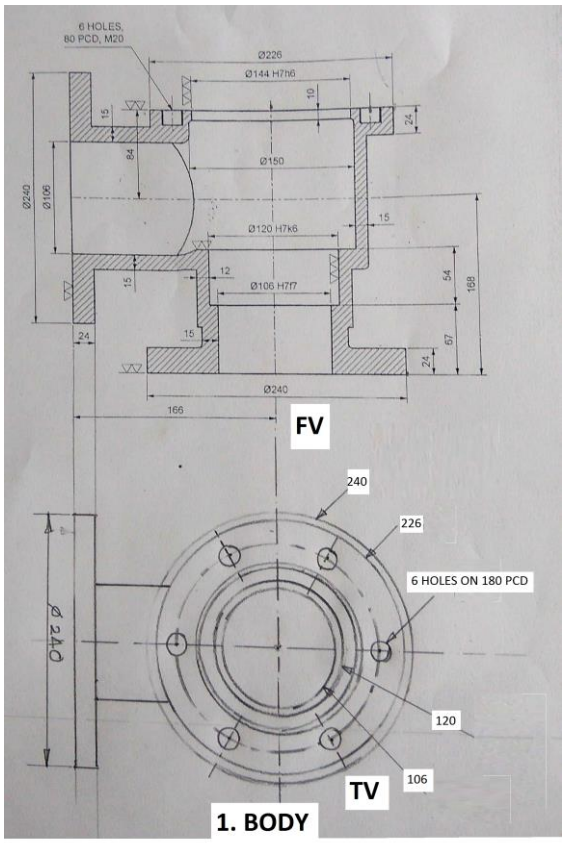


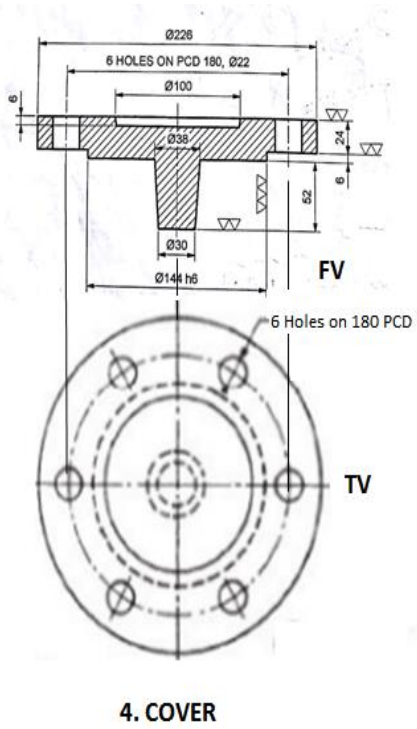
FV & TV 3M

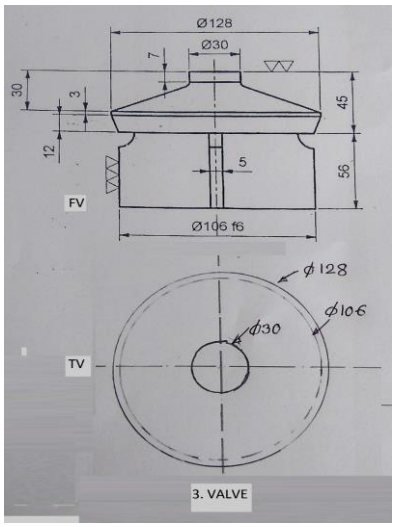
Dev 3M

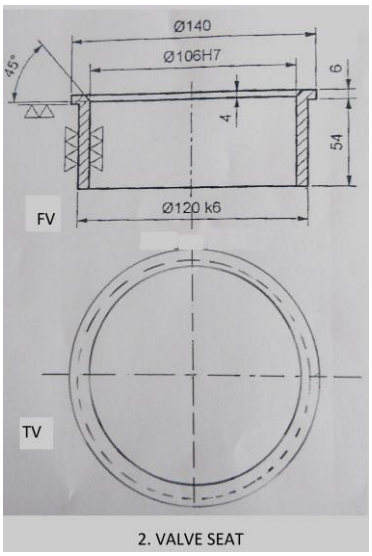
4

(BODY SECT. FV & HALF TV -08 M , COVER SECT. FV & T.V 4 M, VALVE SEAT SECT.FV & TV - 02 M & VALVE FV AND TV 02 Marks)



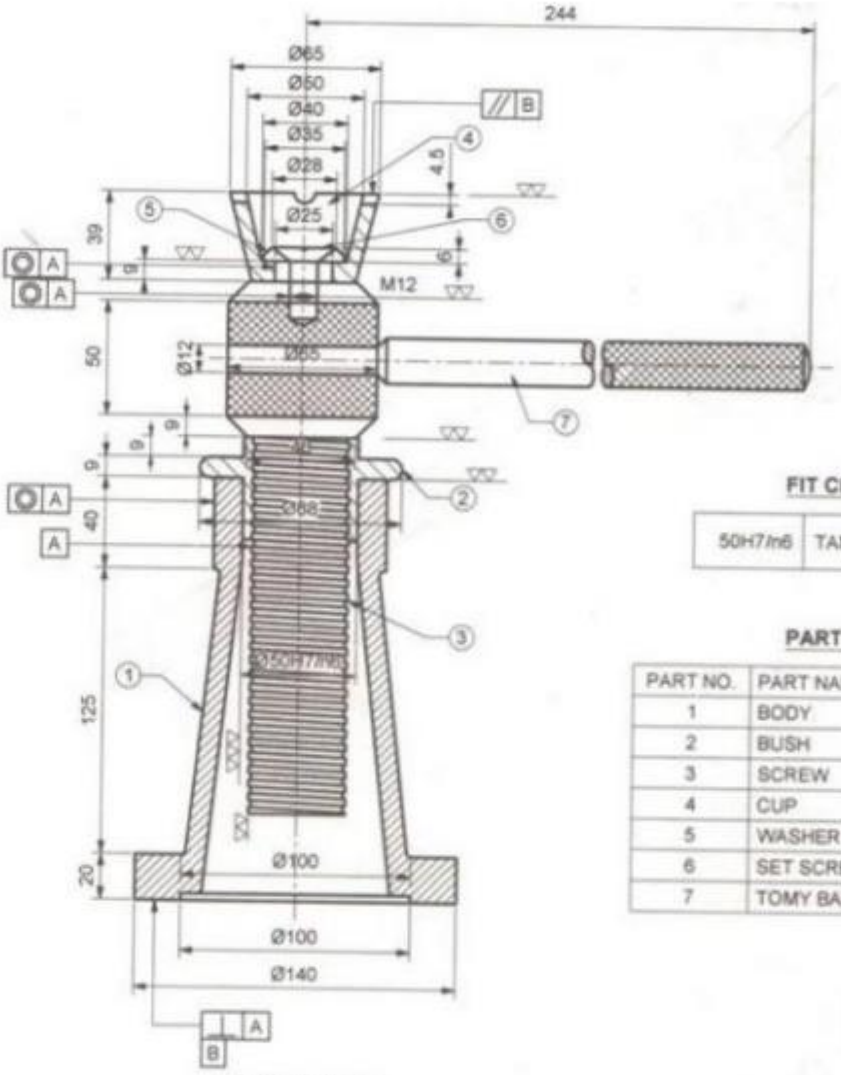






5 a

(SECTIONAL FV-10 M, TV-4M, BILL OF MATERIALS -2 MARKS)

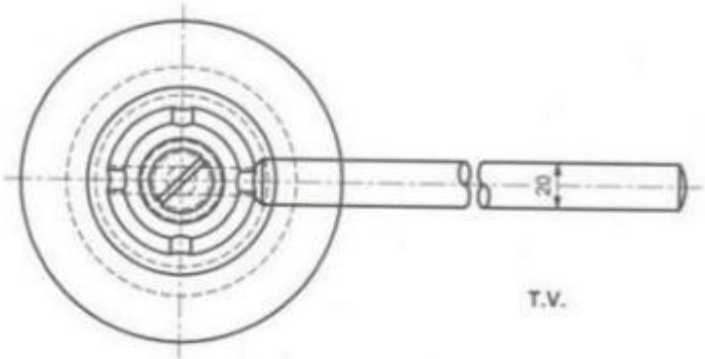


FIT CHART

50H7/m6	TANSINTION FIT

PART LIST

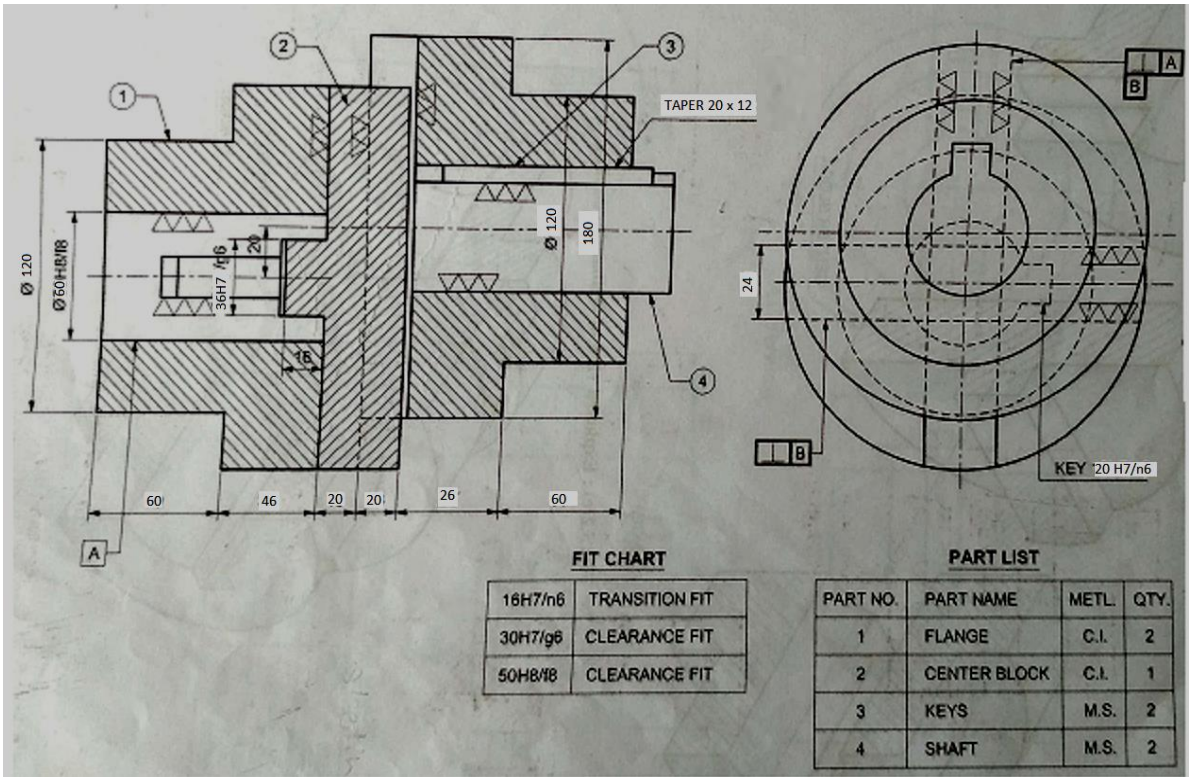
PART NO.	PART NAME	MATL.	QTY
1	BODY	C.I.	1
2	BUSH	M.S.	1
3	SCREW	M.S.	1
4	CUP	C.I.	1
5	WASHER	M.S.	1
6	SET SCREW	M.S.	1
7	TOMY BAR	M.S.	1



T.V.

b

(SECTIONAL FV-9 M, LHSV- 05 M, BILL OF MATERIALS -2 MARKS)



22341

21819

4 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) Answer each next main Question on a new page.

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **10**

(a) Draw the conventional representation of the following :

(i) I-section or rolled section

(ii) Long Break in pipe

(b) Draw the conventional representation for common feature.

(i) Radial Ribs

(ii) Bearings

(c) Draw the actual sketch of Counter Bore and Counter Sunk hole.

(d) Draw the actual sketch and conventional representation :

(i) Spiral Spring

(ii) Semi-elliptic leaf spring with eyelets.

(e) Draw the symbols representing the characteristics to be toleranced.

(i) Circularity

(ii) Cylindricity

(f) State the meaning of symbols shown in the Fig. No. 1.

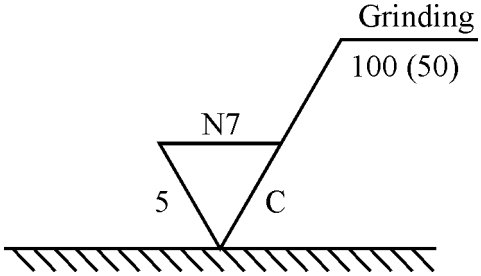


Fig. No. 1

(g) Refer the Fig. No. 2 and state the meaning of symbol X and Y.

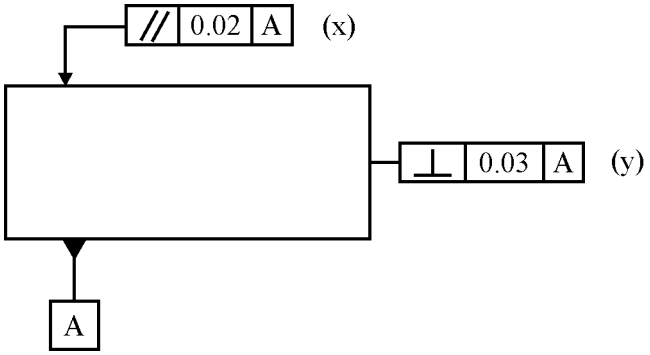


Fig. No. 2

2. Attempt any TWO of the following : **12**

(a) A vertical cylinder of 70 mm diameter is penetrated by another cylinder of 50 mm diameter. The axis of the penetrating cylinder is parallel to both H.P. and V.P. and is 8 mm away from the axis of the vertical cylinder. Draw its projections showing curves of intersection.

(b) A vertical cylinder of diameter of 70 mm and height 100 mm is completely penetrated by a horizontal square prism of side 50 mm and length 110 mm. The axis of the prism bisects the axis of the cylinder. All the rectangular faces of the prism are equally inclined to H.P. Draw Front View, Top View and Side View showing the curves of intersection.

(c) A cone with base diameter 80 mm and axis height 75 mm is kept on the H.P. on its base. It is penetrated by a horizontal cylinder of diameter 40 mm with its axis parallel to V.P. and intersecting the axis of the cone at a distance of 25 mm above the base of the cone. Draw the projections solid showing curves of intersection.

3. (A) Attempt any ONE of the following : **4**

(a) Calculate the upper and lower limit of size 50 H7/n6 fit. State the type of fit. Refer Fig. No. 5 for tolerance values.

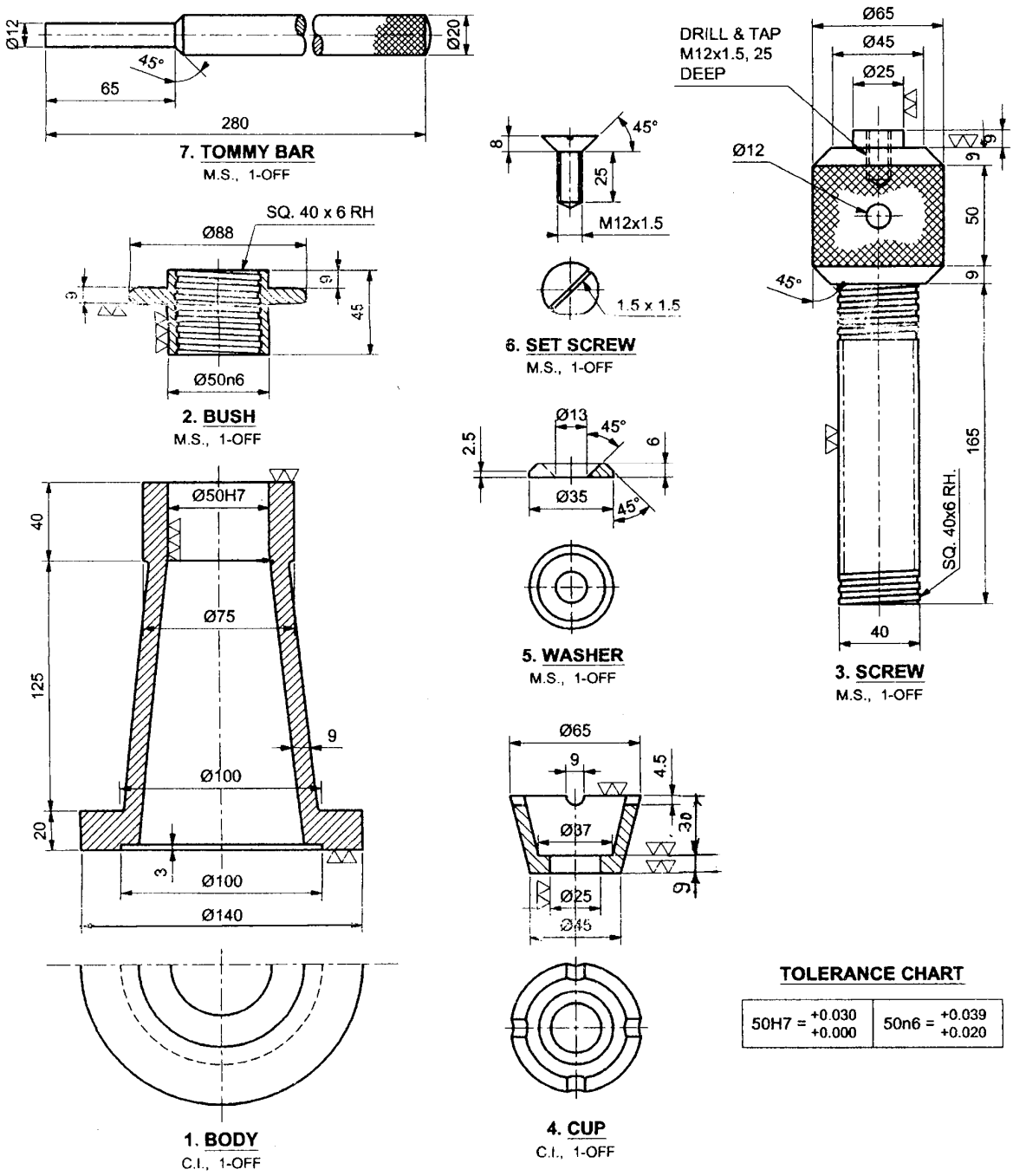


Fig. No. 5

P.T.O.

(b) Define :

(i) Allowance

(ii) Clearance

(iii) Interference

(iv) Deviation

(B) Attempt any **TWO** of the following : **12**

(i) A cone with base diameter 60 mm and axis length 70 mm rests on its base on H.P. A circular hole of 30 mm diameter is drilled through the cone such that its axis is perpendicular to V.P., parallel to H.P. and 20 mm above the base of cone. Draw the development of the surface showing the effect of the hole if axis of hole is 10 mm to the right of axis of the cone.

(ii) Draw the development of the lateral surface of the cylinder shown in Fig. No. 3.

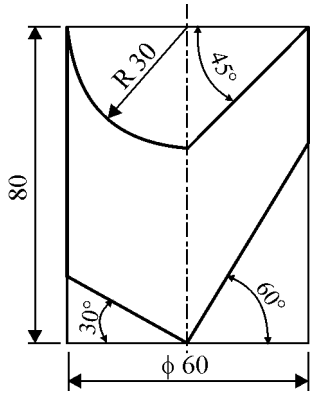
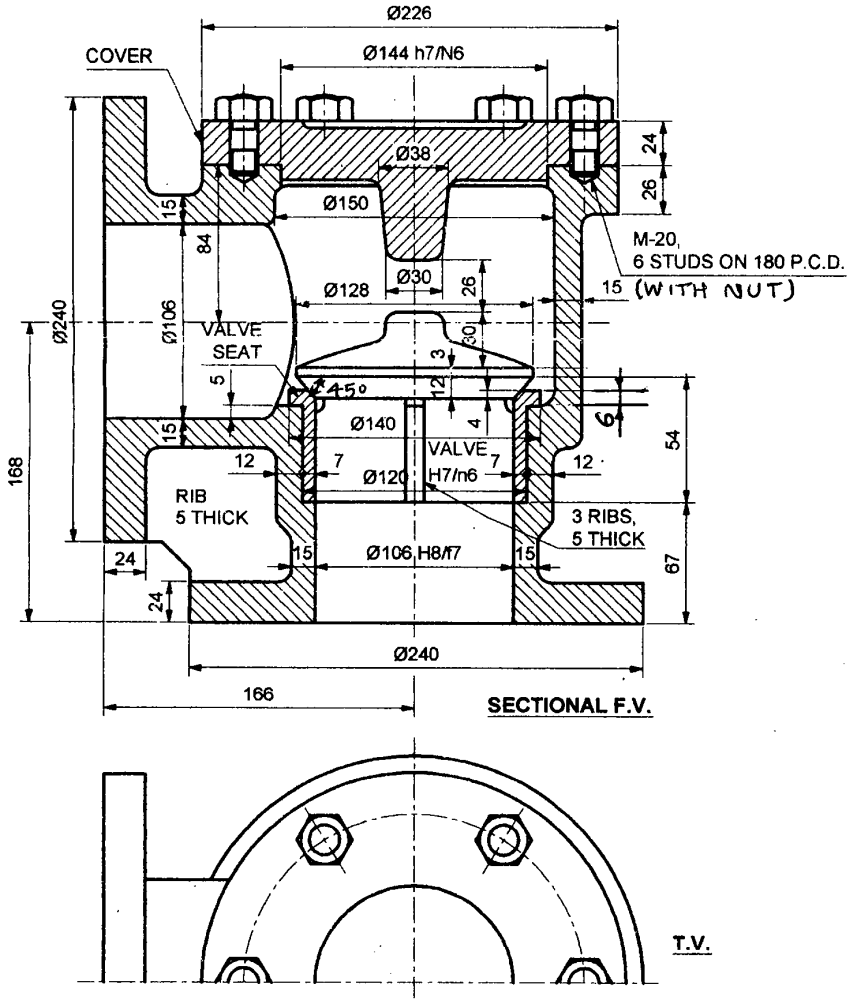


Fig. No. 3

(iii) A cylinder of base diameter 50 mm and height 75 mm is kept on H.P. A square hole of side 30 mm is drilled through it, the axis of which is perpendicular to V.P., parallel the H.P. and 10 mm to the right of the axis of the cylinder. Axis of the hole is at centre height and all the faces of the hole are equally inclined to H.P. Draw the development of lateral surface of the cylinder in such a way that square hole appears centrally in the development.

4. Attempt the following : **16**

Fig. No. 4 shows the assembly of Non-Return Valve, Attempt any two of the following :



PART LIST

PART NO.	PART NAME	MATERIAL	QTY.
1	BODY	C.I.	1
2	VALVE SEAT	G.M.	1
3	VALVE	G.M.	1
4	COVER	C.I.	1
5	STUD WITH NUT	M.S.	6

Fig. No. 4

(1) Draw the Sectional Front View and Top View of body.

(2) Draw the Front View and Top View of Valve.

(3) Draw the Sectional Front View and Top View of Cover.

P.T.O.

5. Attempt any ONE of the following : **16**

(a) Fig. No. 5 shows the details of screw jack. Draw the

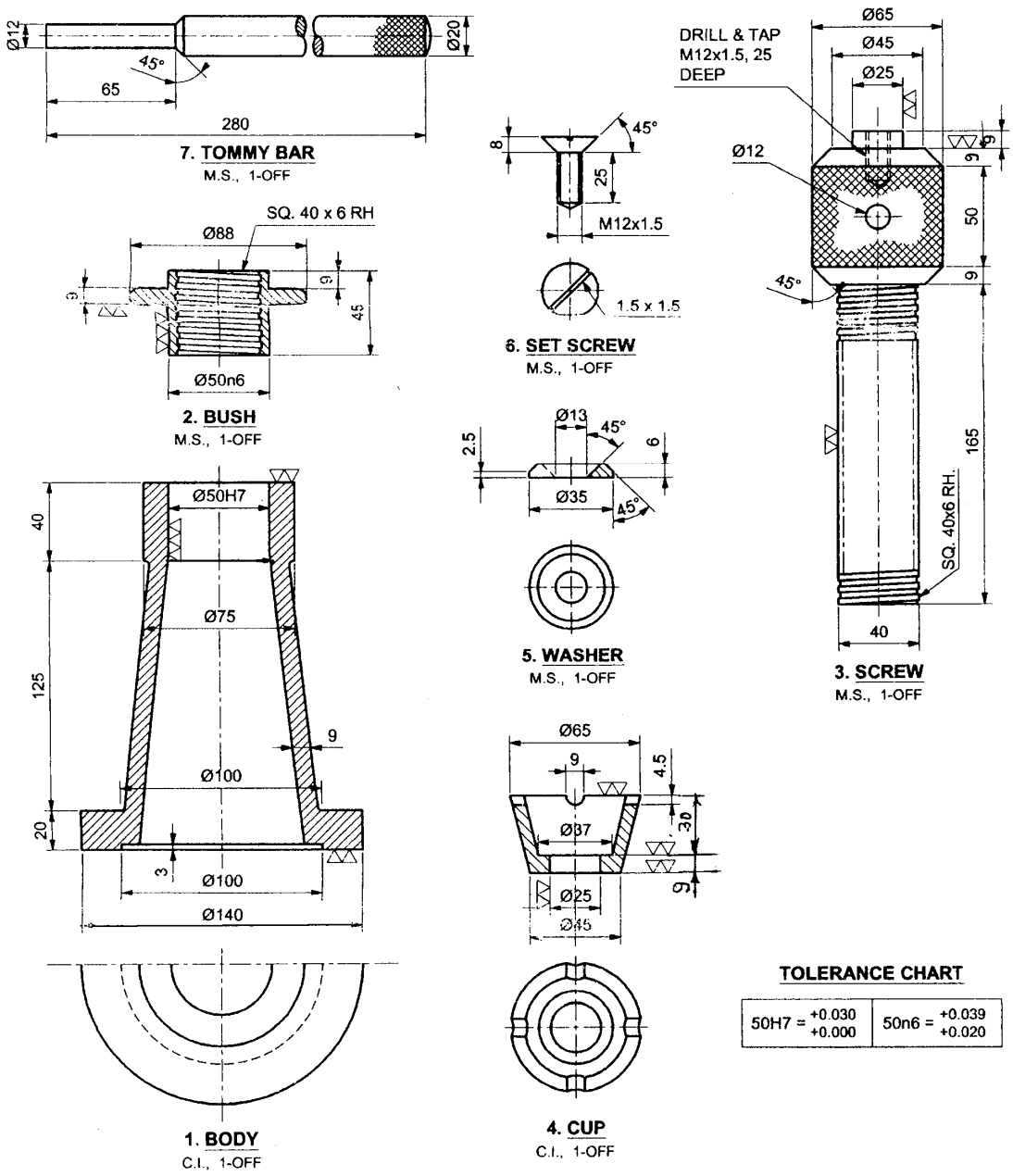


Fig. No. 5

(i) Sectional Front View

(ii) Top view

(iii) Part List and Dimensions

(b) Fig. No. 6 shows the details of Oldham's coupling. Draw the following views of the assembly :

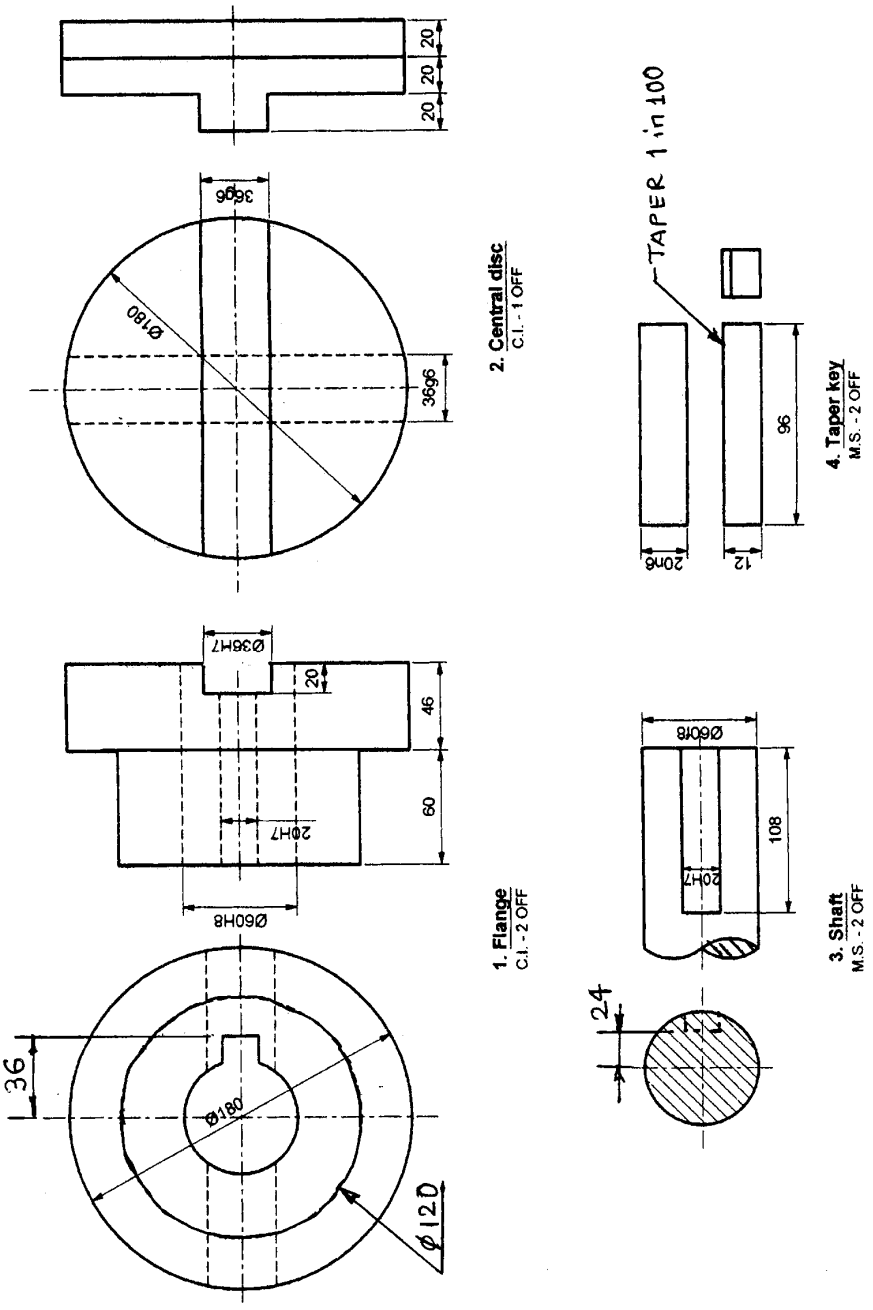


Fig. No. 6

(i) Sectional Front View

(ii) Left hand Side View

P.T.O.

(iii) Give overall dimensions. Indicate the parts on assembly. Prepare bill of material. Indicate assembly fits on the drawing. The axes of shafts are parallel to each other and 24 mm apart.

———————

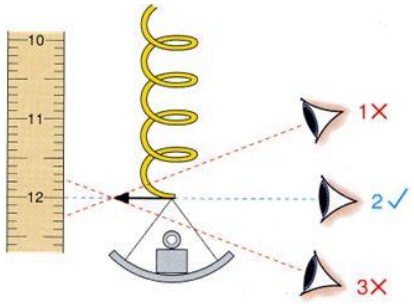
SUMMER– 19 EXAMINATION

Subject Name – Engineering Metrology **Model Answer** Subject Code: 22342

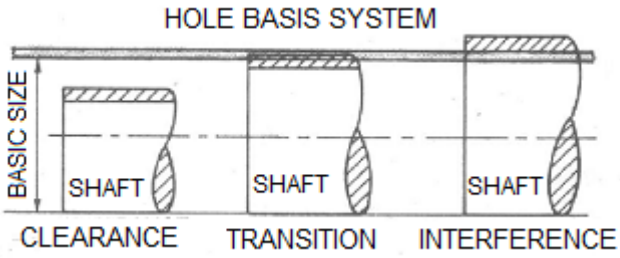
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	SubQN.	Answer	Marking Scheme
1	a	**Accuracy: -** The closeness to the measured value with true value is called accuracy. **Precision: -** Repeatability of measuring process is called precision.	**01 marks for each definition**
	b	1) **Line Standard** 2) **End Standard 3) Wave length standard**	**01 mark each any two**
	c	**Advantages of Interchangeability:-** i) Assembly time is reduced, as the operator is not required to waste his/her skill in fitting the mating components by trial and error. ii) There is an increased output with reduced production cost. iii) Improve quality and reduce the time for operation. iv) The replacement and worn-out or defective parts and repairs becomes very easy. v) The cost of maintenance and shutdown period is also reduced to minimum.	**01 mark each any two**
	d	**Run out error:** It is the total range of the readings of a fixed indicator with contact point applied to a surface rotated, without axial movement about a fixed axis. Run out error is related to concentricity of gear outer diameter with mounting hole.	**02 marks for definition**
	e	**Uses of combination set:-** 1)used to check squareness of the work pieces, 2)use to measure an angle of 45 degree.	**01 mark each any two use**

		3)used to find centres of cylindrical objects. 4)square head with steel rule to measure the height of the work pieces	
	f	**Causes of surface roughness:-** Vibrations, material of the work piece, type of machining, rigidity of the system consisting of machine tool, fixtures, cutting tool and work, type form material and sharpness of the cutting tool, cutting conditions (speed, feed and depth of cut), type of coolant used	**Any four causes ½ mark each**
	g	**RMS value in surface finish:-** R.M.S. value is defined as the square root of the arithmetic means of the values of the squares of the ordinates of the surface measured from a mean line. $RMS = \sqrt{\frac{h1^2+h2^2+h3^2+\cdots+hn^2}{n}}$ **Note:- formula not essential if written give advantage**	**02 marks for definition**
2	a	Parallax error:- This occurs when the pointer in a scale is not observed along a line normal to the scale. Now this can understand with help of this diagram, we have the scale here, and we have pointer here, and the observer is observing the pointer from 3 different positions. This is position number 1, position number 2 and we have position number 3. When the observer observes the scale and pointer from the location 2 is observing the scale normally, then we get the correct real. When we observes from the location 1 now you may get the reading at this place which is incorrect real. Similarly when the observer observes from location 3 again there will be an error. So this parallax error can be eliminated by reducing the distance between the scale and pointer.  	**02 marks for explanation, 02 marks for figure**
	b		**01 mark each any four points**

Mechanical Comparator	Pneumatic Comparator
1) Mechanical comparators are robust and compact in design	Pneumatic Comparators are not portable and compact in design
2) Usually the Mechanical comparators have linear scale.	The scale is generally not linear
3) Due to more moving parts the friction is more	It has few number of moving parts

		which reduces the accuracy	and in some cases none. Thus the accuracy obtained is more due to absence of friction and inertia.	
		4) Less degree of magnification as compare to pneumatic comparators.	It is possible to obtain high degree of magnification	
		5) Less costlier as compared to other comparators	Cost is high as compared to mechanical comparators	
	c	**Hole Basis system** In hole basis system the hole is kept as the constant and the shaft upper and lower deviation values determine the type of fit. In hole basis system the Lower deviation of the hole will be Zero. - In this system lower deviation of the hole is Zero i.e the lower limit of hole is the same as basic size. - The higher limit of hole and the two limits of size for the shaft are then varied to give the desired type of fit. - - The system is denoted by symbol 'H'.  **HOLE BASED SYSTEM** **Size of the Hole is kept constant, Shaft size is varied to get different fits** Hole basis system is preferred over the shaft basis system because holes are machined by standard drills or reamers having fixed dimensions, while the shafts can be turned or ground to any given dimension. Hence it is convenient to produce various sizes of shafts than holes of various sizes	**02 mark for explanation , 02 marks for sketch**
	d	-Work piece is mounted on a glass plate placed on the table. -Light from lamp at the extreme right is collimated in the tube connecting the lamp to the center of instrument and is reflected as a parallel beam by the prism at the end of the tube. - On its way up, this beam collects the image of the object to be inspected and this enters the microscope. -Before the rays reach the eyepiece, it is turned by another prism. This is shown in Figure . - For the most effective manipulation, the magnified image of the work is viewed through the eyepiece (or is projected). -superimposed on a prepared background engraved on glass disk in the eyepiece.	**02 marks for explanation, 02 marks for sketch**

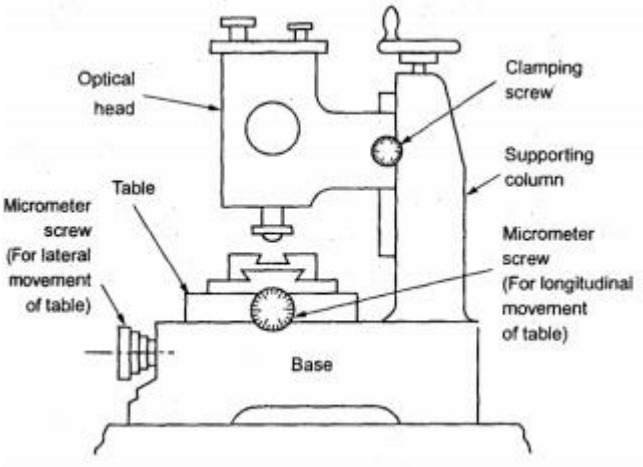


Fig Tool Maker's Microscope

3 a

Explain i) Environmental error ii) Calibration error

02 marks for each explanation

Environmental errors:

The measuring instruments are assembled and calibrated in certain environmental conditions and are designed to be used in within certain restricted conditions, but when they are used in different conditions, there are errors in measurement, which are considered to be the environmental errors. Most of the instruments are designed to be used within certain limits of temperature, pressure, humidity, altitude etc and when the limits are extended there are errors in the measuring instruments.

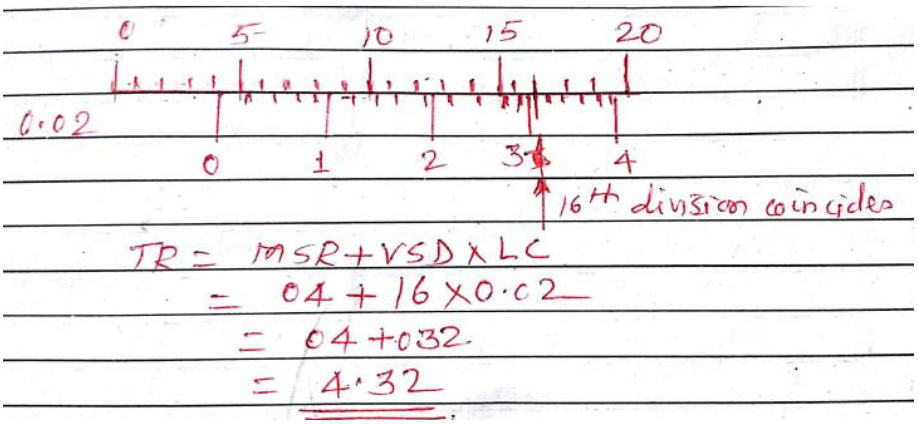
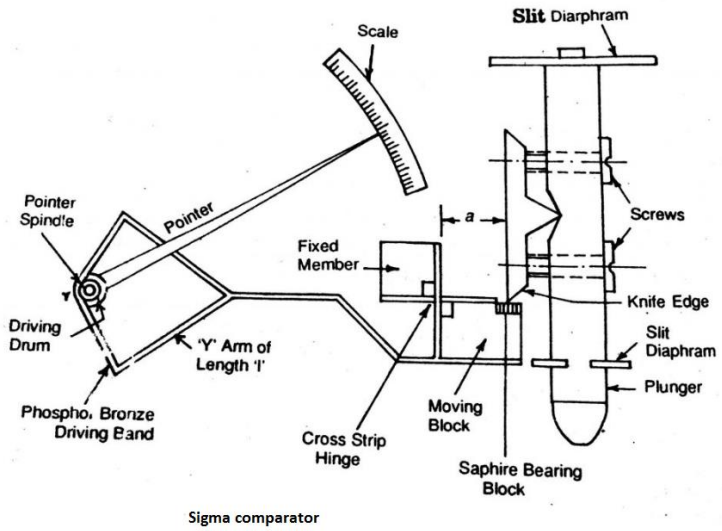
Here are some precautions to be taken to reduce the environmental errors in the instruments:

- Use in the instruments within the specified limits of temperature, pressure and humidity for which the instrument has been designed. These limits are mentioned in the instruments instructions manual.
- If you have to use the instrument beyond the specified limits of environmental conditions, then apply suitable corrections to the recorded measurement.
- One can also calibrate the instrument newly in the new conditions.
- There are some devices that enable applying the compensation automatically.

Calibration error:
The difference between values indicated by an instrument and those that are actual. Normally, a corr ection card is
placed next to the instrument indicating the instrument error. Also called calibration error.

Calibration in measurement technology and metrology is the comparison of measurement values delivered by a device under test with those of a calibration standard of known accuracy. Such a standard could be another measurement device of known accuracy, a device generating the quantity to be measured such as a voltage, sound tone, or a meter ruler.

Any deviation from standard, engraving scales, is considered as calibration error.

	b	**Draw the diagram indicates 4.32 mm on vernier scale.** vernier scale reading  	**04 marks**
	c	**Explain in brief construction and working of sigma comparator.** Construction and working of Sigma comparator: • The Plunger will hold the contact with the work piece, and it is positioned in place with the help of slit diaphragms. • the plunger will have a notch at its centre as shown in the figure. • A knife Edge is attached to the plunger to magnify the linear movement of the plunger. which is connected to the Cross strip with the help of moving the block. • The Y-shaped metallic arm is connected to the cross strip to Driving drum. This arm rotated and makes the drum to rotate and hence the pointer will move on the scale. • The first step of magnification take place at the knife edge and cross strip and the second step of magnification is done at the drum diameter and the pointer length.  Sigma comparator	**02 marks for explanation, 02 marks for sketch**

d **Differentiate between hole basis system and shaft basis system.** — **01 mark each any four points**

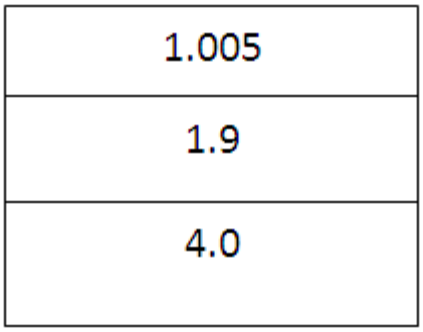
Hole basis system	Shaft basis system
• Size of hole whose lower deviation is zero is assumed as the basis size.	• Size of the shaft whose upper deviation is zero, is assumed as the basis size.
• Limits on the hole kept constant and those of shaft desired type at fit.	• Limits on the shaft kept constant and those on the hot varied to have necessary fit.
• The Hole basis system is referred to in mass production because it is convenient and less costing to make a hole of correct size due to availability by stand grills.	• This system is not suitable for mass production because it is inconvenient and time-consuming and costly to have a shaft of the correct size.
• It is more easily to vary a shaft size according to the fit required.	• It is some difficult to find the hole size according to the fit required.
• It requires less amount of capital and storage space.	• It required large capital, storage space. for a large number of tools required to produce holes of different size.
• Gauging of the shaft can be easily and conveniently done.	• Being internal measurement gauging of the hole cannot be easily conveniently done.

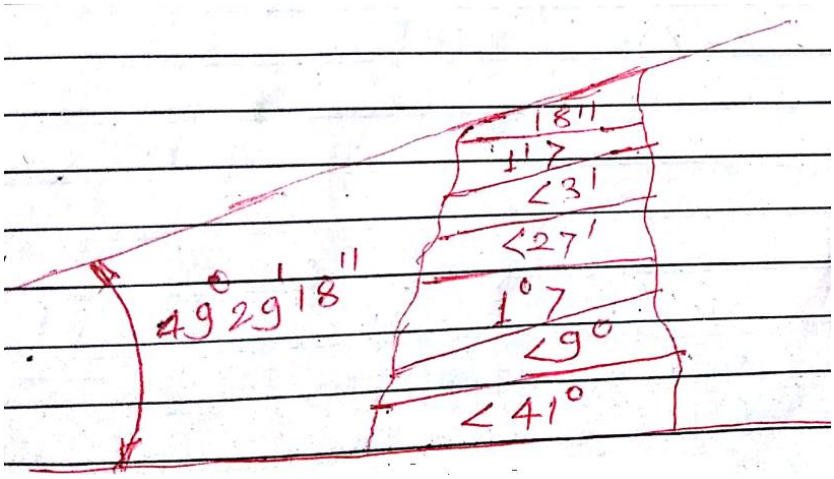
4 a **Measure a distance of 6.905 mm with the help of slip gauge using 112 set. Show the arrangement with sketch.** — **03 marks for no. of gauges, 01 mark for arrangement**

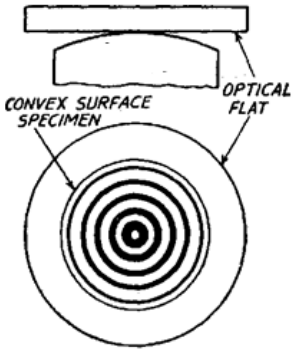
M122/1

step	range	quantity
--	1.0005	01
0.001	1.001-1.009	09
0.01	1.01-1.49	49
0.1	1.6-1.9	04
0.5	0.5-24.5	49
10	30-100	08
--	25. 75	02
	Total	122

Gauges required to build 6.905 mm are- 4.0 + 1.9 + 1.005 = 6.905

		 Slip gauge arrangement By using M112 table we use 1.005, 1.9 and 4.	
	b	**A shaft of 25 +- 0.004mm is to be checked by means of GO and NOGO gauge. Design the dimension of gauge required.** Maximum size = 25+0.004 = 25.004 Minimum size = 25-0.004 = 24.996 GO gauge allows max. shaft dia. Of 25.004 NOGO gauge designed to min. size of 24.996	**04 marks (02 mark for each dimension)**
	c	**Write the examples of use of following types of fits.** **i) Push fit** Requires a moderate pressure. e.g. gear slip bushing, PVC pipe push fit with solvent **ii) Press fit** Interference required to maintain this fit e.g. bushing, bearing pins, gears, pulleys, shaft collar **iii) Running fit** Permits free rotation or movement e.g. nut bolt assembly, running shaft in bearing. **iv) Wringing fit** Provides either zero interference or clearance e.g. gears of machine tools	**01 mark each**

	d	**An angle of 49 degrees 29' 18" is to be developed by using std. angle gauge set of 13 pieces. Calculate the gauges required and sketch the arrangement.** Angle gauge set of 13 pieces **[1^0 3^0 9^0 27^0 41^0] [1' 3' 9' 27'][3" 6" 18" 30"]** **$49^0 = 41^0 + 9^0 - 1^0$;** **29' = 27' + 3' - 1' ;** **18" = 18" total 7 pieces required to build the given dimension.**  **Arrangement of angle gauges**	**03 marks for no of angle gauges, 01 mark for arrangement**
	e	**Explain procedure to determine whether the given surface is concave or convex by using optical flat.** **Concave surface:** If the optical flat is placed on some spherically concave surface. And the contact is made at the central high point and in centre a bright circle will be visible. Around it, there will be concentric dark and bright circular fringes. As the distance from the centre increases, the separation between optical flat and surface keeps on increasing and the fringes become narrow and more closely spaced as shown in fig.	**02 marks each (01 mark for explanation 01 mark for sketch)**

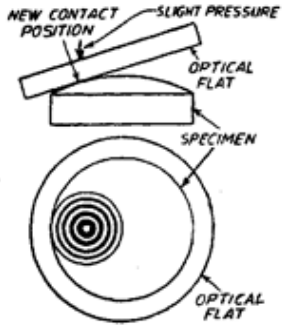


Fringe pattern as observed through optical flat.

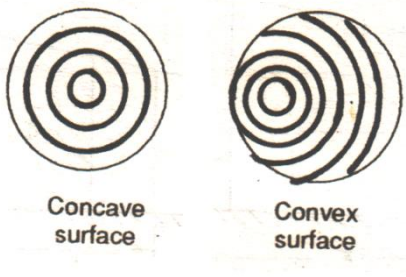
Convex surface:

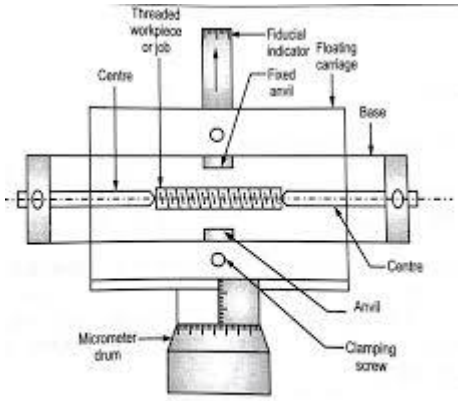
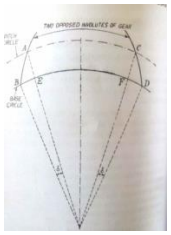
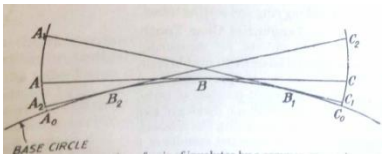
To distinguish between the two conditions of convex and concave surfaces one edge of the optical flat is lightly pressed. In case of convex surface, by light pressure the optical flat will rock on a new high spot and the centre of the fringe pattern will move as shown in Fig. Also the outer fringes will move closer together. In case of spherically concave surface, the flat is resting on a line passing around the surface and on lightly pressing the edge of the optical flat, the edge line does not move as the pressure is varied. Rather, light pressure at the centre will cause the optical flat to be deflected and will become more nearly parallel to the concave surface, thus reducing the number of fringes observed.

Thus if by light pressure, the centre of fringes is displaced and the fringes are brought closer, it is convex surface and the level at that place must be lowered down to form a flat surface. If by light pressure the number of fringes is reduced and the fringes move apart, it is concave surface.



Test for convex surface.



5	a	**Floating Carriage Micrometer:** -The floating carriage micrometer consists of a three units a) A casting base carries a pair of centers, on which the treaded work piece is mounted. b) Another carriage mounted at exactly 900 to the above, which is capable to move parallel to thread axis. c) Another carriage mounted on the above, which is capable to move at 900 to the thread axis. - on one end of the upper carriage, there is a fixed anvil and a fiducial indicator which ensures that all the measurements are made at same pressure. Floating Carriage Micrometer is supplied with the set of master cylinders and wires, which are used to measure effective diameter of threads. Limitation of floating carriage micrometer is , it can be used for measurement of external threads only. Least count of this instrument is 0.002 mm  Floating carriage diameter measuring machine	**Principle and working - 04, Sketch – 02**
	b	**Base tangent method** In this method, the span of a convenient number of teeth is measured with the help of the tangent comparator. Consider a straight edge ABC being rolled back and forth along a base circle as shown in fig. Its ends thus sweep out opposed involutes A_2AA_1 and C_2CC_1 respectively. Thus the measurements made across these opposite involutes by span gauging will be constant Length of arc BD = distance between two opposite involutes = Nm cosϕ[tanϕ – ϕ – π/2N + πS/N]   	**Base tangent method - 03,** **Sketch – 03**

	c			**CLA -03, RMS – 03**

h1	45	$(h_1)^2=2025$
h2	42	$(h_2)^2=1764$
h3	40	$(h_3)^2=1600$
h4	30	$(h_4)^2=900$
h5	35	$(h_5)^2=1225$
h6	30	$(h_6)^2=900$
h7	25	$(h_7)^2=625$
h8	25	$(h_8)^2=625$
h9	24	$(h_9)^2=576$
h10	18	$(h_{10})^2=324$
	CLA=31.4	1056.4
		RMS= 32.50231

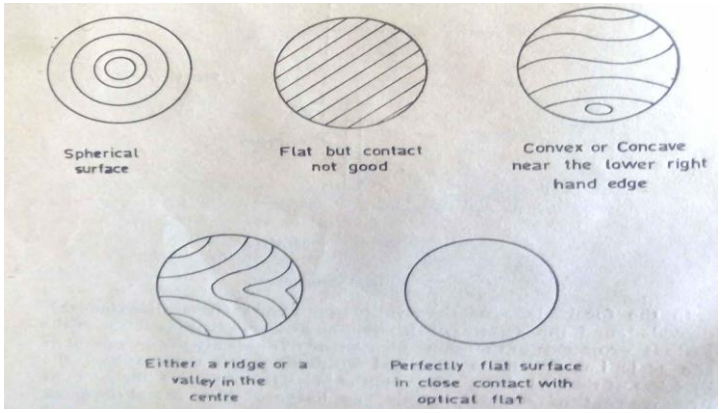
1) CLA = $|h_1+h_2+h_3+.....+h_n| / n$

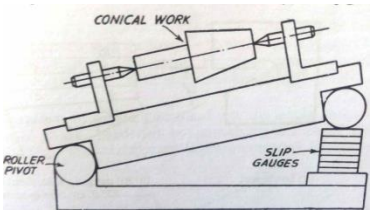
= 314/10

= 31.4

2)RMS=$\sqrt{(h_1)^2+(h_2)^2+(h_3)^2+...(h_{10})^2/10}$

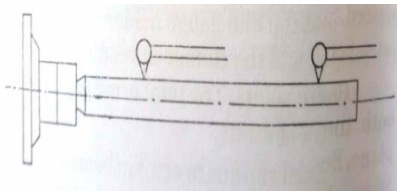
=32.50

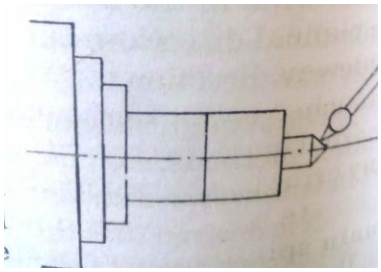
6	a	**Sketches of fringe patterns and their meanings** 	**any four interference patterns with meaning 1.5 each**
	b	**Taper angle of plug gauge** Taper Plug gauge is mounted between sine centers. One roller of sine bar is rested on surface plate, while slip gauges are added below other roller till the tapered edge of gauge becomes parallel to the surface plate. This can be checked using dial indicator and height gauge. Then using sine principle the taper angle can be find out $\sin\theta = h / L$, Where θ = taper angle, h= Height of slip gauges, L = center distance between the two rollers of sine bar.	**Procedure -03,** **Sketch – 03**



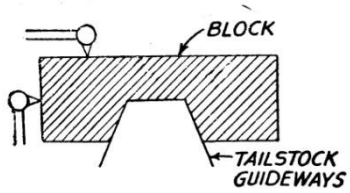
c **Alignment test on lathe** — **any of these fig - 03 marks**

(i) Run out of spindle





(ii) Parallelism of tail stock



21819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **10**

(a) Define accuracy & precision.

(b) List different measuring standards.

(c) State the advantages of interchangeability. (atleast two)

(d) Define – Run out w.r.t. gear.

(e) State the use of "combination set".

(f) List the causes of surface roughness.

(g) Define – RMS value.

2. Attempt any THREE of the following : **12**

(a) Explain parallax error with neat sketch.

(b) Differentiate between mechanical and pneumatic comparator. (atleast four points)

(c) Explain Hole basis system. State its significance in production.

(d) Explain working principle of 'Tool Maker's' microscope.

3. Attempt any THREE of the following : **12**

(a) Explain

(i) Environmental error

(ii) Calibration error

(b) Draw the diagram indicates a reading of 4.32 mm on vernier scale.

(c) Explain brief construction & working of "sigma comparator".

(d) Differentiate between Hole basis system and Shaft basis system. (atleast four points)

4. Attempt any THREE of the following : **12**

(a) Measure a distance of 6.905 mm with the help of slip gauges using 112 set of slip gauges. Show the arrangement with neat sketch.

(b) A shaft of 25 ± 0.004 mm is to be checked by meance of GO and NOGO gauge. Design the dimensions of a gauge required.

(c) Write the examples of use of following types of fits :

(i) Push fit

(ii) Press fit

(iii) Running fit

(iv) Wringing fit

(d) An angle of 49° 29′ 18″ is to be developed by using standard angle gauge set of 13 pieces. Calculate the gauges required and sketch the arrangement.

(e) Explain procedure to determine whether the given surface is concave or convex by using optical flat.

5. Attempt any TWO of the following : **12**

(a) Explain the working principle of "Floating carriage micrometer" with neat sketch.

(b) Describe the procedure of measurement of tooth thickness using 'Base Tangent Method' with neat sketch.

(c) In the measurement of surface roughness, height of 10 successive peaks and valleys were measured from a datum as

Peaks – 45, 42, 40, 30, 35 microns.

Valleys – 30, 25, 25, 24, 18 microns.

Determine the Ra value of the surface.

If these values are obtained over length of 20 mm, find CLA & RMS values.

6. Attempt any TWO of the following : **12**

(a) Sketch and interpret the meaning of various interference fringes patterns observed using optical flat.

(b) The angle of taper plug gauge is to be checked using sine centre and slip gauges. Sketch the set-up and describe the procedure.

(c) Draw the following alignment test of Lathe Machine :

(i) Parallelism of tail stock

(ii) Run out of spindle

WINTER – 19 EXAMINATION

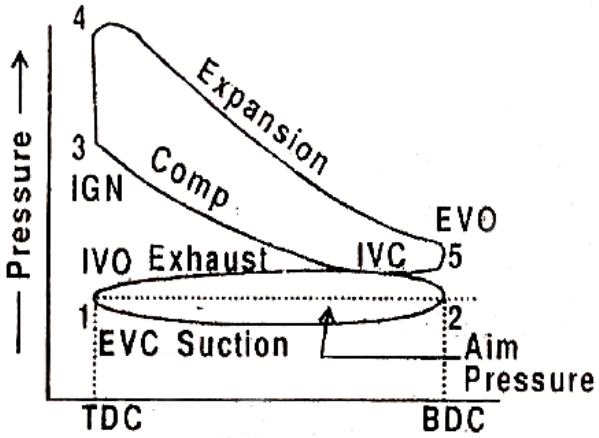
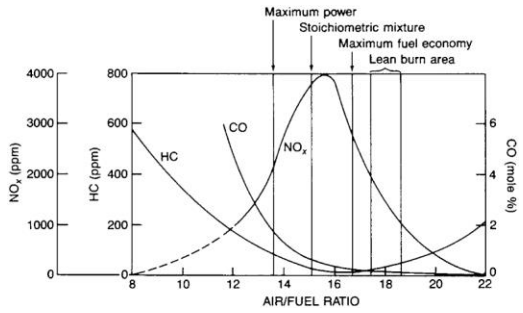
Subject Name: Power Engg. & Refrigeration **Model Answer** Subject Code: 22562

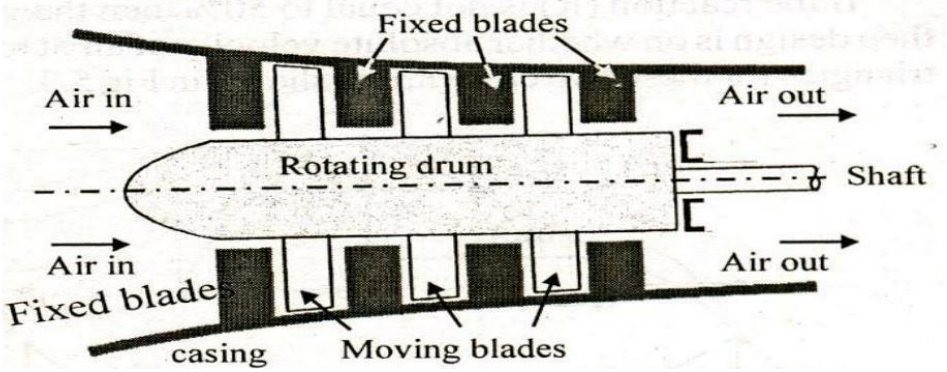
Important Instructions to examiners:

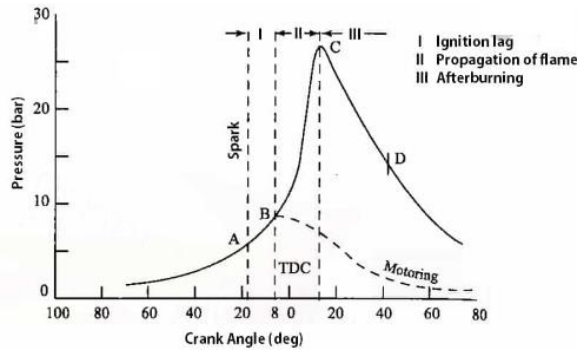
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Q.1 (A)	a)	Following are the diagnostic tools used in fault finding of MPFI engines 1. Engine Code Readers 2. Compression Testers 3. Spark Plug Testers 4. Mechanic's Stethoscope 5. Scan Tool 6. Battery Tester 7. Power Probe III	**Any 4** **2M**
	b)	SEER: Seasonal Energy Efficiency Ratio (**SEER**), is most commonly used to measure the efficiency of a central air conditioner. The higher the SEER, the more efficient the system OR It is the ratio of cooling Capacity to energy consumed in watts-hours. EER: Energy Efficiency Ratio (**EER**) is a measure of how efficiently a cooling system will operate when the outdoor temperature is at a specific level (95 degrees F). The higher the EER, the more efficient the system. In technical terms,(Correction) OR It is the ratio of total capacity to the total KW energy usage at specific humidity and temperature condition.	1M each
	c)	Purpose of Selective Catalytic Reduction (SCR) : 1. It reduces Nox 75% to 90% 2. Converts it in to molecular nitrogen and water vapor 3. It reduces HC emission up to 80% 4. It reduces PM emission 20 to 25%.	**2M** **Any 2 Point**
	d)	Compressor pressure ratio (CPR), is the ratio of the air total pressure exiting the compressor to	2M

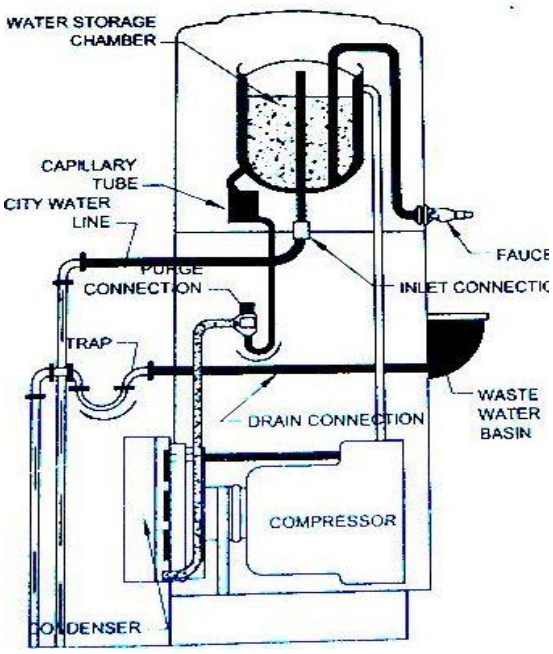
		the air pressure entering the compressor. This number is always greater than 1.0.	
	e)	Following are the components of jet engine: 1. Air intakes 2. Compressors 3. Combustors 4. Turbines 5. Afterburners (reheat) **6.** Nozzle 7. Bypass duct **8.** Shaft	Any Six For 2M
	f)	Following are the different liquid propellants used in rocket engines 1. kerosene, Liquid oxygen and Liquid Hydrogen similar to kerosene 2. Alcohol and its derivatives (Ethyl Alcohol) 3. hydrazine and its derivatives 4. Hydrogen peroxide 5. liquid hydrogen	2m ½ M Each Any 4 Point
	g)	Following are the objectives of supercharging 1. To compensate for loss of power due to high altitudes for air craft engines 2. To obtain better performance from the existing engine 3. For a given weight and bulk of the engine, super charging increase power output. This is important in air craft, marine and automotive engines where weight and space are considered 4. Super charging is done to induct more amount of air into cylinder per unit times and hence to burn more amount of fuel to increase power output	**2m** **½ M** **Each** **Any 2 Points**

Q.2	a)	 Indicator Diagram For A Four Stroke Cycle Petrol Engine. Actual Indicator diagram for 4 stroke petrol engine	4M
	b)	Graph indicating changes in pollutants level w.r.t air fuel ratio 	4M
	c)	Axial flow compressor : Working Principle: As the fluid enters and leaves in the axial direction, the centrifugal component in the energy equation does not come into play. Here the compression is fully based on diffusing action of the passages. The diffusing action in stator converts absolute kinetic head of the fluid into rise in pressure. The relative kinetic head in the energy equation is a term that exists only because of the rotation of the rotor. The rotor reduces the kinetic head of the fluid and adds it to the absolute kinetic head of the fluid i.e. the impact of the rotor on the fluid particles increases its velocity (absolute) and thereby reduces the relative velocity between the fluid and the rotor. In short increases the absolute velocity of the fluid and the stator converts this into pressure rise.	2M

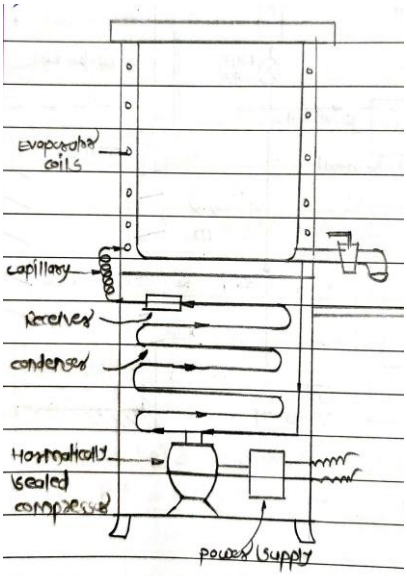
			2M
	d)	Heavy frame industrial gas turbines compared to aero derivative gas turbines are usually slower in speed, narrower in operating speed range, heavier, larger, have higher air flow, slower in start-up and need more time and spare parts for maintenance. Heavy frame industrial gas turbines use hydrodynamic bearing. Aero derivative gas turbines use anti-friction bearing. Advanced aircraft engine and space technologies have been used to provide maintainable, flexible, light weight and compact aero derivative gas turbines. The key to maintainability is the modular concept which provides for removal of components and replacement without removing the gas turbine from its support mounts. The heavy frame industrial units, by contrast, require more amount of effort to remove and replace components (especially combustor parts) and more effort to inspect or repair the sections. The user should weigh needs and requirements against the variety of gas turbines offered. Applications- Traditionally, preference has been to place the aero derivative units in remotely located applications (including offshore) and to place heavy frame industrial units in easily accessible base-load applications. The heavy frame industrial gas turbines consume more fuel and more air than the aero derivative units. They are exposed to a greater quantity of the contaminants in air that cause corrosion.	2M 2M
Q.3	a)	Following are Changes in automobile manufacturers in achieving BS6 norms of diesel engines 1. Reduction in HC emission by 45% 2. Reduction in NO_X emission by 70% 3. Reduction in PM emission by 80% 4. Use of Lean NO_X traps 5. Use selective catalytic reduction (SCR) 6. Use of Diesel particulate filter 7. Five times reduction in Sulpher %	**Any Four Changes 1M each**

		8. OBD for all diesel vehicles 9. Real Driving Emission introduced in vehicles 10. Fumigation 11. Catalytic converter monitoring 12. Misfire detection	
	b)	Combustion In S I Engine  According to Ricardo, There are three stages of combustion in SI Engine as shown in figure above 1. Ignition lag stage 2. Flame propagation stage 3. After burning stage 1. Ignition lag stage: There is a certain time interval between instant of spark and instant where there is a noticeable rise in pressure due to combustion. This time lag is called IGNITION LAG. 2. Flame propagation stage: Once the flame is formed at "b", it should be self sustained and must be able to propagate through the mixture. This is possible when the rate of heat generation by burning is greater than heat lost by flame to surrounding. After the point "b", the flame propagation is abnormally low at the beginning as heat lost is more than heat generated. 3.After burning: Combustion will not stop at point "c" but continue after attaining peak pressure and this combustion is known as after burning. This generally happens when the rich mixture is supplied to engine.	Fig. 2M Stages 2M

c)



OR



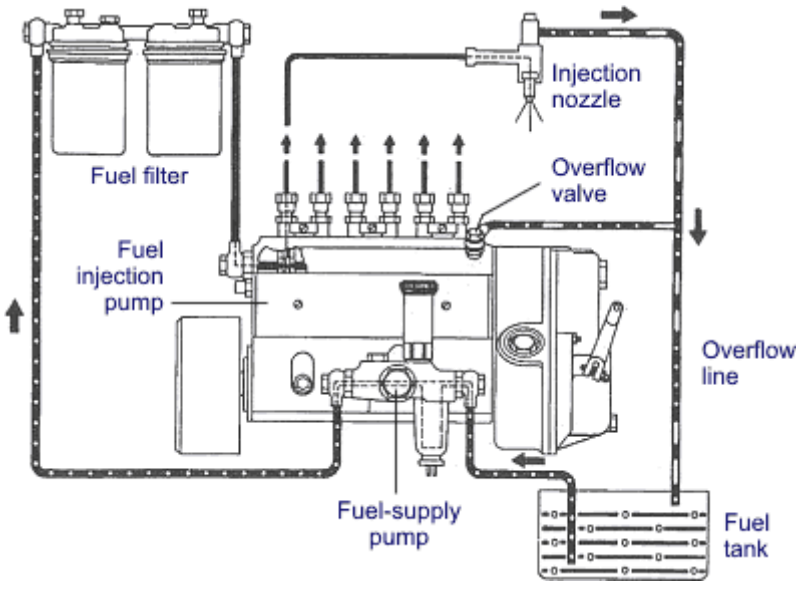
Storage type Water Cooler

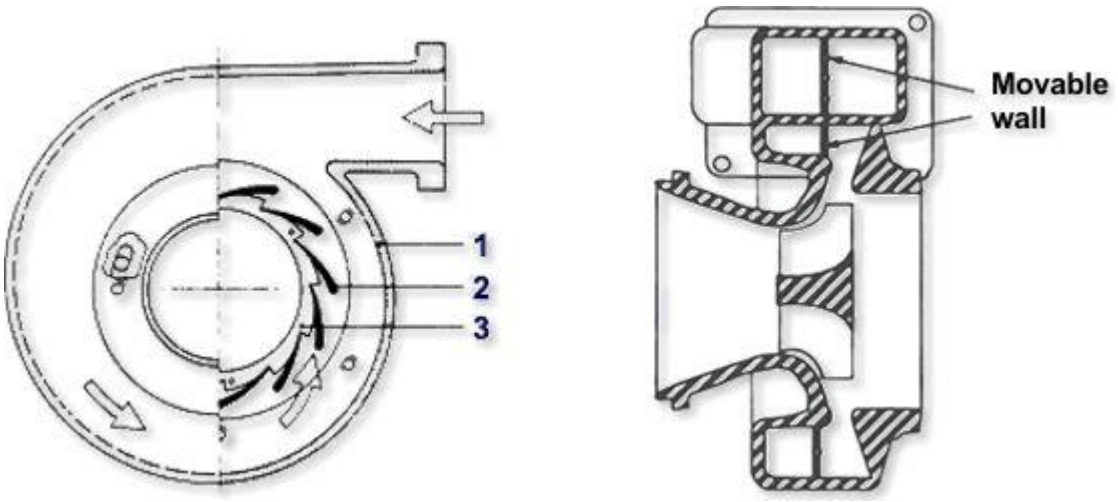
Fig. 2M

The storage type cooler has the evaporator coil soldered on to the walls of the storage tank of the cooler, generally on to the outside surface of the walls. The tank could be of the galvanized steel or stainless steel sheets. Water level is maintained in the tank by a float wall.

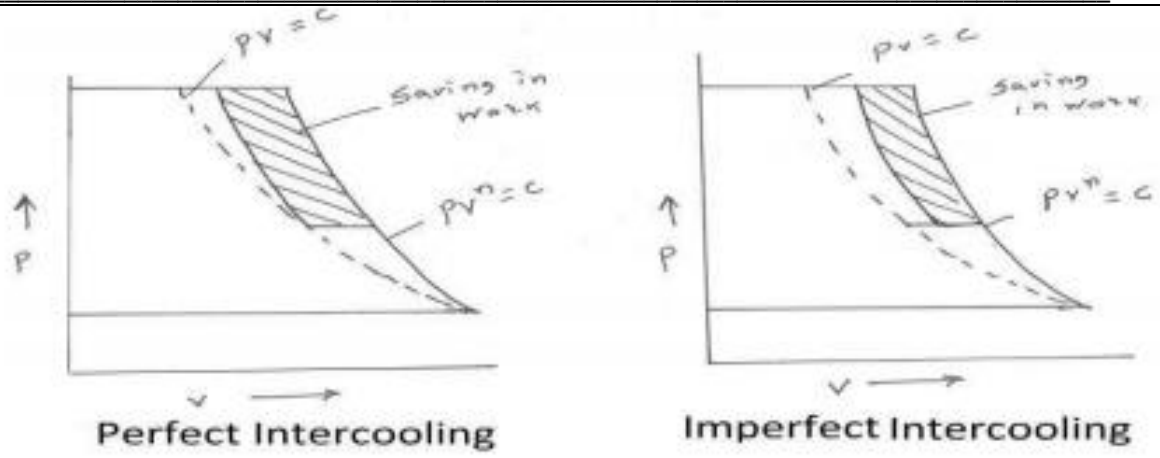
Push type water taps are generally provided for drawing cold water in both the types, to minimize the wastage of refrigerated water. Thermostat controls the operation of the compressor to maintain the water temperature at the desired level. The feeler bulb of the thermostat is clamped on to the water coil just at its outlet end in the instantaneous cooler. In the storage type, the bulb is kept immeresed in water in the tank or clamped to the wall of the storage tank on the outside at a lower level, much below the lower most evaporator refrigerant tube soildered on to the tank.

2M

	d)	Q3 (d) Compression ratio = 8 $\eta_{air\ std.} = 1 - \frac{1}{r_c^{\gamma-1}}$ $= 1 - \frac{1}{8^{1.4-1}}$ $= 0.5647$ $= 56.47\%$	2M
		No, the Otto cycle efficiency 56.47% will always be lower than Carnot cycle efficiency.	1M
		Justification: Carnot theorem states that keeping operating conditions same, Carnot engine is more efficient than any other engine. So, Otto cycle efficiency is lower than Carnot cycle efficiency.	1M
Q.4	a)	 **Inline Fuel Injection Pump**	Fig. 3M Naming 1M

	b)	 **Variable Geometry Turbocharger** Variable Turbine Geometry technology is the next generation in turbocharger technology where the turbo uses variable vanes to control exhaust flow against the turbine blades. The problem with the fixed geometry turbocharger that big turbochargers do not work well at slow engine speeds, while small turbochargers are fast to spool but run out of steam pretty quick. A turbocharger equipped with Variable Turbine Geometry has little movable vanes which can direct exhaust flow onto the turbine blades. The vane angles are adjusted via an actuator. The angles of the vanes vary throughout the engine RPM range to optimize turbine behaviour.	Sketch 2M Justification 2M
	c)	**TEWI (Total equivalent warming impact)** TEWI = GWP· L · n + GWP·m·(1−α) + n · E · β (1) where, GWP - Refrigerant Global Warming Potential (equivalent to CO2) [kg CO2/kg refrigerant] L - Annual leakage rate [kg/year] n - System operating life time [years] m - Refrigerant charge [kg] α - Recycling factor [%] E - Annual energy consumption [kWh/year] β - CO2 emissions on energy generation [kg CO2/kWh] **LCCP (Life-cycle climate performance)** LCCP = TEWI + GWP (Indirect) [energy consumption expressed as CO_2- eq emissions from chemical production & transport, manufacturing components & vehicle assembly and end-of-life] + GWP (direct) [chemical refrigerant emissions including atmospheric reaction products, manufacturing leakage, and end-of- -life]	2M 2M

d)



2 M each

e)

Turbojet Engine	Turboprop Engine
• Power produced by the turbine is used to drive the compressor • Low Takeoff thrust • Low Propulsive efficiency • Less space is needed compared to turboprop engine. • Reduction gear is not needed	• Power produced by the turbine is used to drive the compressor and propeller. • High Takeoff thrust • Propulsive efficiency is good. • More space is needed • Reduction gear needed
- Engine is noisy - Engine consist of Diffuser, Compressor, Combustion Chamber, Turbine, Nozzle.	- Engine is less noisy - Engine consist of Diffuser, Compressor, Combustion Chamber, Turbine, Nozzle with Propeller

Any four points 1M each

Q.5	a)		

Q5 (a)

Indicated Power $= P_m \cdot L \cdot A \cdot N$

$= 5.8 \times 10^5 \times 0.13 \times \frac{\pi}{4} \times (0.12)^2 \times \frac{940}{60}$

$= 13365.2 \text{ W}$

$= \underline{13.365 \text{ kW}}$ — (4) m

Piston speed $= 2LN$

$= 2 \times 0.13 \times \frac{940}{60}$

$= \underline{4.073 \text{ m/sec.}}$ — (2) m

Speed in terms of m/min Piston speed = 244.38 m/min

b)

Q5 (b) $V_1 = V_s \times N$

$= \frac{\pi}{4} d^2 l \times N$

$= \frac{\pi}{4} \times (0.301)^2 \times 0.301 \times \frac{101}{60}$

$= 0.0161 \ m^3/sec.$ — (2) M

$P_1 V_1 = m R T_1$

$m = \frac{P_1 V_1}{R T_1} = \frac{1 \times 10^5 \times 0.0161}{287 \times 300}$

$= 0.0187 \ kg/sec.$ — (2) M

$W = \frac{n}{n-1} m R T_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$

$= \frac{1.25}{1.25-1} \times 0.0187 \times 287 \times 300 \left[\left(\frac{8}{1} \right)^{\frac{1.25-1}{1.25}} - 1 \right]$

$= 4151.69 \ W$

$= 4.152 \ kW$ — (2) M

c)

Q5 (c) $C.O.P. = \dfrac{h_1 - h_4}{h_2 - h_1}$

$= \dfrac{185 - 70}{206 - 185} = \underline{5.476}$ — (2) m

Ref. effect = 9.5 Tons

$= 9.5 \times 210$

$= \underline{1995 \text{ kJ/min}}$

Ref. effect = $m(h_1 - h_4)$ — (2) m

$m = \dfrac{1995}{185 - 70}$

$= 17.35 \text{ kg/min}$

$= \underline{0.289 \text{ kg/sec.}}$ — (2) m

Q.6 a)

Q6 (a)

B.P. with all cylinder working = 16.25 kw

$I.P_1 = (B.P.)_{\text{all cylinder working}} - (B.P.)_{2,3,4}$

$= 16.25 - 11.55 = 4.7$ kw

$I.P_2 = 16.25 - 11.65 = 4.6$ kw

$I.P_3 = 16.25 - 11.70 = 4.55$ kw

$I.P_4 = 16.25 - 11.50 = 4.75$ kw

(2) marks

Total $I.P. = I.P._1 + I.P._2 + I.P_3 + I.P_4$

$= 4.7 + 4.6 + 4.55 + 4.75$

$= 18.6$ kw — (2) marks

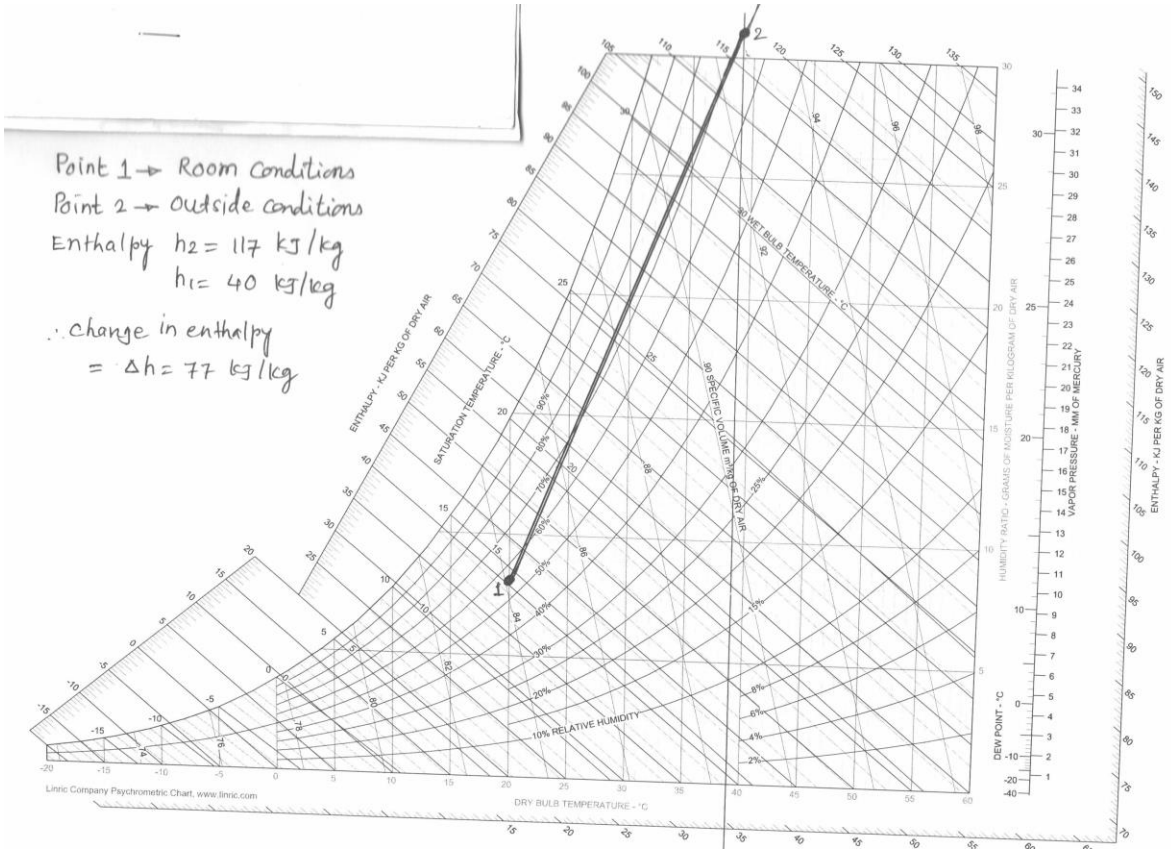
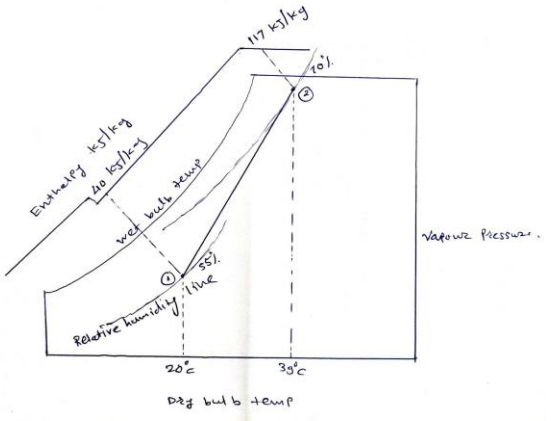
$\eta_{mech.} = \frac{B.P.}{I.P.} = \frac{16.25}{18.6} =$

$= 87.36\%$ — (2) marks

b)

Reciprocating compressor	Rotary compressor
1. Compression of air takes place with help of piston and cylinder arrangement with reciprocating motion of piston.	1. Compression of air takes place due to rotary motion of blades.
2. Delivery of air intermittent.	2. Delivery of air is continuous.
3. Delivery pressure is high i.e. pressure ratio is high.	3. Delivery pressure is low, i.e. pressure ratio is low.
4. Flow rate of air is low.	4. Flow rate of air is high.
5. Speed of compressor is low because of unbalanced forces.	5. Speed of compressor is high because of perfect balancing.
6. Reciprocating air compressor has more number of moving parts.	6. Rotary air compressor has less number of moving part.
7. It needs proper lubrication and more maintenance.	7. It required less lubrication and maintenance.

Any Six points 1M each

		8. Due to low speed of ration it can't be directly coupled to prime mover but it requires reduction of speed.	8. Rotary air compressor can be directly coupled to prime mover.	
		9. It is used when small quantity of air at high pressure is required. 10. Receiver Compulsory 11. Mechanical Efficiency Low 12. More Starting torque required	9. It is used where large quantity of air at lower pressure is required. 10. Receiver not compulsory 11. Mechanical Efficiency High 12. Less Starting torque required	
	c)	 Skelton diagram - 	3 Marks for calculation 3 Marks for dig.

WINTER – 19 EXAMINATION

Subject Name: Advanced manufacturing process **Model Answer** Subject Code: **22563**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following**	10
	a)	**Enlist any four process parameters in EDM** Ans: Process parameters in EDM are: 1. Peak current 2. Peak Voltage 3. Spark gap 4. Pulse duration 5. Dielectric pressure 6. Material removal rate (MRR) 7. Polarity	1 process parameter = 1/2 marks
	b)	**State the equation of cutting speed for milling operation** Ans: The equation for cutting speed for milling calculation is $Cutting\ Speed = \frac{\pi\, dn}{100}\ m/min$ Where d= diameter of cutter(m) ,N= Cutter speed (RPM)	Correct equation with meaning= 2 marks
	c)	**List the various gear finishing methods** Ans: Gear finishing methods: 1. Gear shaving 2. Gear grinding 3.Gear Honing 4. Gear lapping 5. Gear burnishing	2 methods= 1 mark
	d)	**Name the basic components of CNC machine** Ans: Basic components of CNC machine are 1) Input device 2. Control unit 3. Drives for spindle/table slides 4. Machine tool 5. Feedback system	4 basic components =2 marks

Q. No.	Sub Q. N.	Answer	Marking Scheme
	e)	**Write only classification of CNC machines.** Ans: Classification of CNC machines 1. As per feedback system : a) Open loop Type b) Closed loop type 2. As per motion control : a) Point to point path motion b) Continuous path motion 3. As per application: a) CNC milling b) CNC Turning c) CNC drilling	Classification on any one basis = 2 marks
	f)	**Write meaning of following G and M codes** Ans: 1. G02 : Circular interpolation clockwise 2. M30: Program end , reset to start	1 meaning= 1 mark
	g)	**State any two examples of fixed automation** Ans: Examples of fixed automation are a. Transfer lines used in automotive industry b. Automatic assembly machines or systems installed for assembly without need of human being c. Industrial robots installed or fixed for performing repetitive operations	Two examples=2 mark
Q.2		**Attempt any THREE of the following**	12
	a)	**Explain the purpose of electrolyte in ECM.** Ans: Purpose of electrolyte in ECM process 1. It is conductive medium without which ECM process cannot be performed. 2. It carries the current between the tool and the work piece. 3. It removes the particles of ECM process from the cutting region It helps to remove heat produced by the current flow in the operation	4 points= 4 marks

b) **Compare between Vertical and horizontal milling machine**

Ans

Parameter	Vertical milling	Horizontal milling
1. Position of arbor	It is mounted vertically	It is mounted horizontally
2. Spindle and worktable	Spindle is vertical and perpendicular to the work table	Spindle is horizontal and parallel to the work table
3.Cutter movement	It can be moved up and down.	It can be moved up and down.
4.spindle tilting	It can be tilted for angular milling operations	It cannot be tilted
5.Opertions	Angular milling, slot milling, T- slot milling, flat milling, etc	Plain milling, gear cutting, form milling, gang milling, etc

4 points= 4 marks

C) **Describe Automatic tool changer (ATC) of CNC machine**

Ans:

Concept of Automatic tool changer (ATC):

1. Tool changing in CNC machines is carried out automatically by using Automatic tool changer according to the sequence of operations given in the part program
2. Tool magazine is provided with various tools mounted sequentially and identified by specific tool number which helps for tool changing using ATC

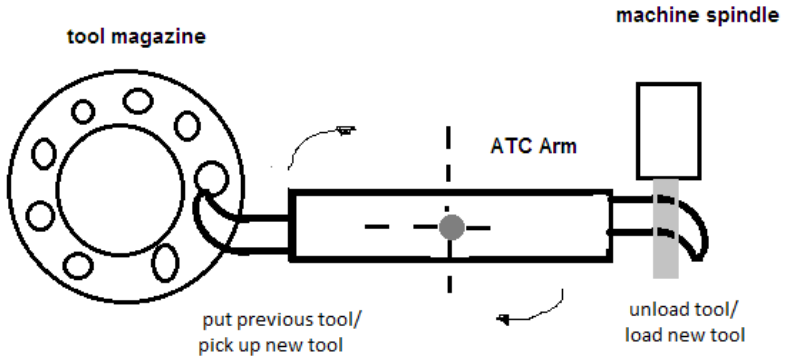


Fig. Automatic tool changer

concept -2 Marks

Function : 2 marks

Function of automatic tool changer:

1. It will improve the production rate and tool carrying capacity of the machine.
2. It will help to save time required for changing tools as per number of operations to be performed on the work piece.
3. It will automatically unload the tool from the spindle of machine and load the new cutting tool from tool magazine using tool changing arm.
4. The arm of ATC can be rotated through 180 degree to unload the tool from

spindle and put this tool in the tool magazine.
5. In the next rotation it will hold the tool from tool magazine and load it in the machine spindle.

d) **Justify the need of tool length compensation of CNC machine**

Ans:

1. Tool used in CNC machines may have difference in their lengths and during programming it will be difficult to specify coordinates as per tool length of individual tools, hence tool length compensation is required.
2. During programming when tools are changed , any variation in tool length will throw the origin out of zero, to prevent this tool length compensation is required

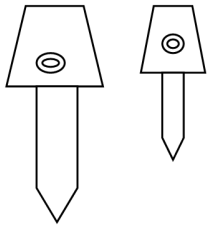


Fig. tools of different lengths

3. It is the procedure to mention the difference in length of tool assumed during programming and actual tool used for machining for error free programming of CNC.
4. The standard tool length is used as a reference during programming and length of various tools was measured in advance to specify difference in length of standard tool and actual tool in the form of tool length compensation.
5. It will help easy programming without making changes in the program even if tool is changed.

4 points : 4 marks

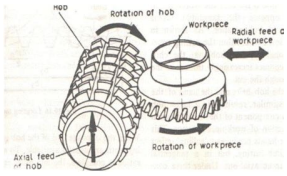
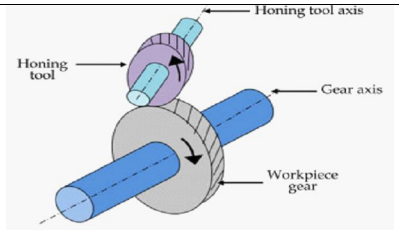
3 **Attempt any THREE of the following** 12

a) **Differentiate between gear hobbing and gear honing**

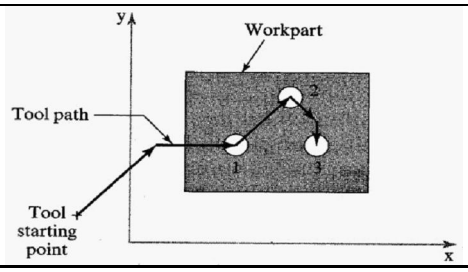
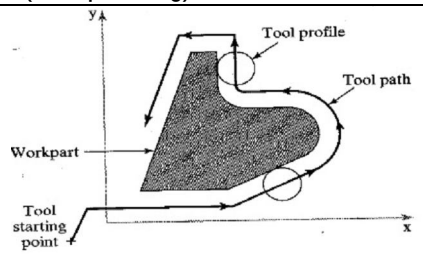
Ans

S. N.	Gear Hobbing	Gear Honing
1	It is gear manufacturing method	It is gear finishing method.
2	Cutting tool known as hob is used	Honing stones are used as cutter.
3	The direction of feed of the hob can be achieved in three ways.	The honing tool traverses back and forth in parallel path to the work gear axis.
4	Hob and workpiece gear are indexed independently.	The honing tool drives the work gear.
5	Material removal rate is high.	Material removal rate is low.
6	It is carried out before hardening of gear.	It is carried out after hardening of gear.
7	It is used for manufacturing of gear teeth.	It is used for superfinishing of gear teeth.
8	Higher depth of cut.	Lower depth of cut.
9	Poor surface finish.	Good surface finish.
10	Poor dimensional accuracy.	High dimensional accuracy.
11	Poor Tolerance	Close tolerance,

Any For Points = 01 Mark Each

		12	Higher load on cutter(Hob)	Lower load on Cutter (Honing Tool)
		13	Higher feed rate.	Lower feed rate.
		14		

b) Ans **Compare "Point to Point" and continuous path CNC machine**

S. N.	Point to Point	Continuous Path
1	The primary function of point to point path control system, is to move a cutting tool form one point location to another predefined point on the worktable	Contouring system generates a continuously controlled tool path by the capability of computing the points of the path
2	It is the cheapest tool control system	It is the most expensive.
3	It is generally used for hole operations such as drilling, boring, reaming, tapping and punching.	Contouring system had the ability to perform linear and circular or parabolic interpolation.
4	It is the lowest level of motion control between the tool and workpiece.	It is the highest level of control between the tool and workpiece.
5	Point-to-point (PTP) is also sometimes called a positioning system.	Continuous Path is also called Contouring path system.
6	It is simple and easy.	Contouring is the most complex
7	Only two axis movement can complete PTP operation.	Simultaneous movement of more than one axis movement can take place to complete the operation.
8	It is not capable to perform Contouring operations.	It is capable of performing both PTP and straight-cut operations.
9	No cutting is performed between holes, there is no need for controlling the relative motion of the tool and workpiece between hole locations	Contouring system generates a continuously controlled tool path by the capability of computing the points of the path (interpolating).
10		

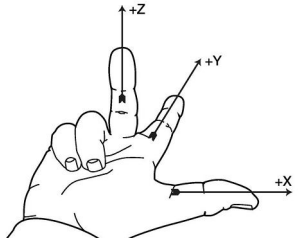
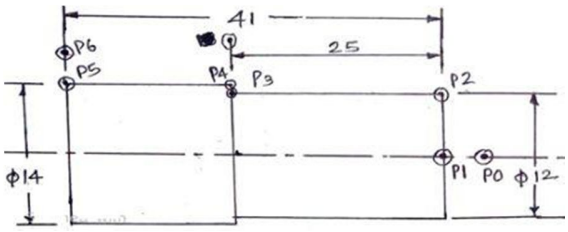
Any Four = 01 Mark Each.

c) Ans **Explain the meaning of following block format of CNC.**
N020 G03 X12 Y14 Z-0.5 I0 J12 EOB

N0020 – Block Number.
G03 – Circular interpolation (Counter- Clockwise).
X12 – X coordinate of the arc end point = 12.
Y14 – Y coordinate of the arc end point = 14.
Z-0.5 – Depth of Cut in Z - Direction= 0.5.
I0 – Distance along X – axis from the arc start point to the arc center point = 0.
J12 – Distance along Y – axis from the arc start point to the arc center point = 12.

Correct Ans. = ½ Mark Each

		EOB – End of Block.	
	d) Ans	**Describe fixed and programmable automation0** **Fixed Automation (Hard automation):** Fixed automation refers to the use of special purpose equipment to automate a fixed sequence of processing or assembly operations. Each of the operation in the sequence is usually simple, involving perhaps a plain linear or rotational motion or an uncomplicated combination of two. It is relatively difficult to accommodate changes in the product design. **Advantages:** 1. Low unit cost 2. Automated material handling 3. High production rate. **Disadvantages:** 1. High initial Investment 2. Relatively inflexible in accommodating product changes**.** **Examples:** Transfer Lines, Assembly lines etc. **Programmable Automation:** In programmable automation, the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations. The operation sequence is controlled by a program, which is a set of instructions coded. So that they can be read and interpreted by the system. New programs can be prepared and entered into the equipment to produce new products. **Example:** Numerical controlled machine tools, industrial robots and programmable logic controller **Advantages:** 1. Flexible to deal with design variations. 2. Suitable for batch production. **Disadvantages:** 1. High investment in general purpos equipment 2. Lower production rate than fixe automation.	**02 Marks** **02 Marks**
4		**Attempt any THREE of the following:**	**12**
	a) Ans	**Classify the different methods of gear manufacturing.** **Classification of Gear Manufacturing Methods:** **A) Cutter Method** 1) By formed disc cutter in milling machine 2) By formed end mill 3) By formed single point cutting tool 4) By formed cutter in a shear speed gear shaper 5) By formed cutter in a broaching machine **B) Template method in gear cutting machine** **C) Generating method** 1) By rack tooth cutter in gear cutting machine 2) By a pinion cutter in gear cutting machine 3) By a hob cutter 4) By Bevel gear genarator **D) Casting** 1) Sandcasting 2) Die casting 3) Investment casting **E) Stamping** **F) Powder metallurgy**	**Correct Answer = 04 Marks**

		G) Plastic molding **H) Extruding**	
	b) Ans	**Apply right hand rule for axes identification of CNC vertical milling with neat diagram** **Right Hand Rule for Axes Identification of CNC Vertical Milling :**  The main axis of movement and the direction of movement along this axis is identified as follows: **Z- Axis:** The Z- axis motion is always the axis of the main spindle of the machine. It does not matter whether the spindle carries the work piece or the cutting tool. On vertical machines the Z-axis is vertical. Positive Z movement is in the direction is towards the tip of middle finger. **X-Axis:** The X-axis is always horizontal and parallel to the work holding surface. If the Z-axis is vertical in vertical milling machine, positive X-axis movement is identified as being to the tip of thumb. **Y-Axis:** The Y-axis is always at right angle to both the X-axis and Z-axis. Positive Y-axis movement is identified as being to the tip of Fore finger. **A- Axis:** Direction of curled finger about X – axis is rotary motion along X-axis is consider as positive. **B- Axis:** Direction of curled finger about Y – axis is rotary motion along Y-axis is consider as positive. **C- Axis:** Direction of curled finger about Z– axis is rotary motion along Z-axis is consider as positive.	**Sketch 01 Mark** **&** **Explanation = 03 Marks**
	c) Ans	**Calculate the cutting parameters and prepare process sheet for the component shown in Fig. No. 1 with neat diagram. All the dimensions are in mm.** **Given: Raw material - Aluminium, Stock Size – Dia.14 X 42 length, Feed (*f*) = 0.2 mm/rev., Cutting Speed (V) = 90 m/min., Consider work zero (W) as per Fig. No. 1.**  Figure No. 1 Given Data: V = 90 m/min., *f* = 0.2 mm/rev., D = 14 mm, Depth of cut, d_c = 1 mm, Length of Cut, *l*= 25 mm Cutting Parameters: Spindle Speed: V = πDN/1000 N = 2043 rpm. Feed: *f* = 0.2 mm/rev. Depth of Cut: d_c = 1 mm	**01 Mark for Calculation and 03 Marks for Process Sheet**

Part Name:- *Question No. 4 (c)*			**Name of Operator:-**			
Part Material:- *Aluminium*			**Name of Machine :-** *Centre Lathe*			
Part No.:- *Figure No. 1*			**Part Size:-** *Dia. 14 X 42 Length.*			
Operation No.	**Description**	**Machine Tool**	**Tools / Fixture**	**Spindle Speed in rpm.**	**Feed in mm/rev.**	**Depth of Cut in mm**
1	Clamp the blank in chuck	Cetre Lathe	3 jaw chuck,			
2	Facing Operation	Cetre Lathe	Single point cutting tool. (Facing Tool)	2043	0.2	1
3	Turning	Cetre Lathe	Single point cutting tool. (Turning tool)	2043	0.2	1
4	Unloading Job		Chuck Key			

d) **Develop full G and M code manual part program of CNC lathe for the component shown in Fig. No. 1 using word address format (WAF).**

Ans

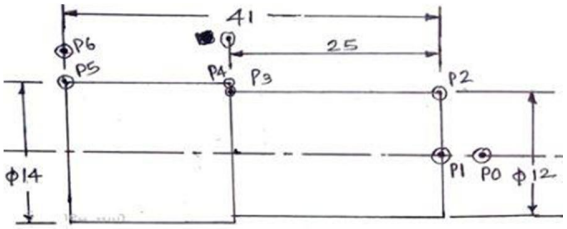


Figure No. 1

Point	X	Z
P0	0.0	2.0
P1	0.0	0.0
P2	12.0	0.0
P3	12.0	-25.0
P4	14.0	-25.0
P5	14.0	-41.0
P6	20.0	-41.0

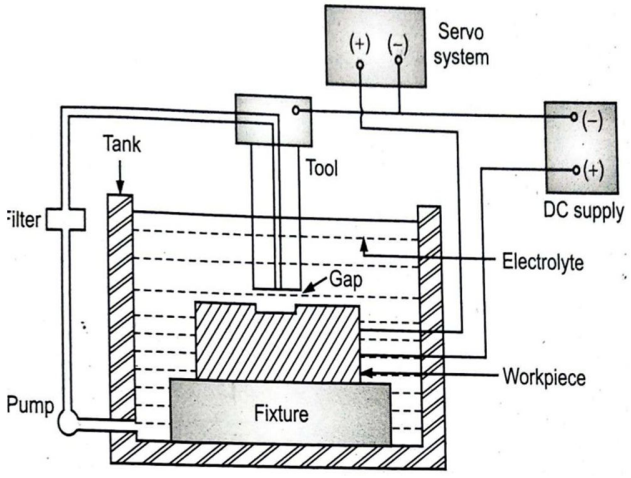
O1234;
N001 G28 U0.0 W0.0;
N002 G90 G21 G95;
N003 M03 S2043 M08;
N004 G00 X0.0 Z2.0;
N005 G01 X0.0 Z0.0 F0.2;
N006 G01 X12.0 Z0.0;
N007 G01 X12.0 Z -25.0;
N008 G01 X14.0 Z -25.0;
N009 G01 X14.0 Z -41.0;
N010 G01 X20.0 Z -41.0;
N011 G28 U0.0 W0.0;
N012 M05;
N013 M09;
N014 M30;

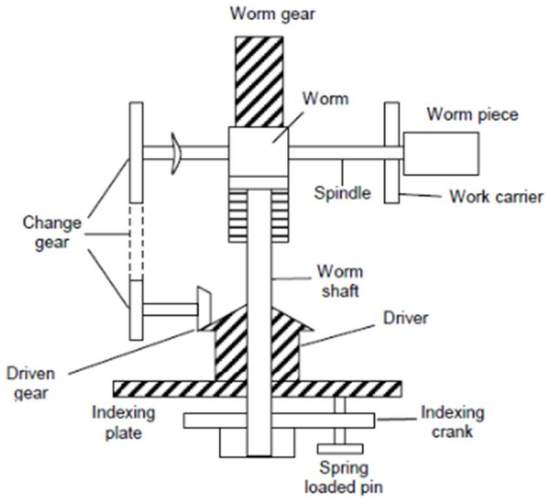
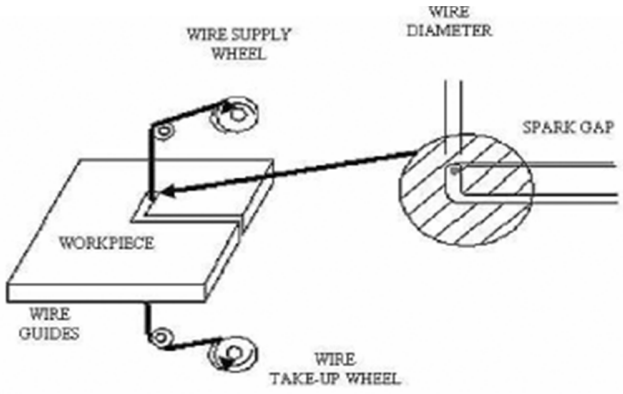
Correct Answer = 04 Marks

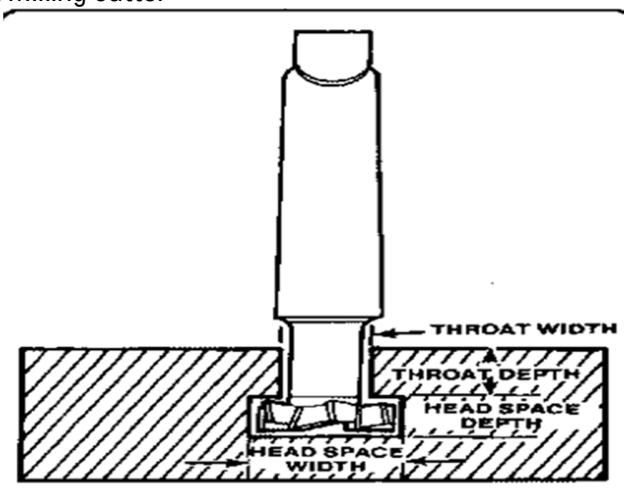
e) **Justify the need of Group Technology in today's manufacturing situation**

Ans

Group technology is an approach to organizing manufacture which can be applied in any industry (machining, welding, foundry, press work, forging, plastic molding, etc.) where small-

		batch variety production is used. The basic approach enables all aspects of manufacturing, from design, through estimating and planning, to production, to be rationalized. It forms the basis for the development of computer-aided procedures and flexible automation. Group technology is a manufacturing philosophy or principle whose basic concept is to identify and bring together related or similar parts and processes, to take advantage of the similarities which exist, during all stages of design and manufacture. **Advantages of Group Technology:** The following are the advantages of introducing GT in manufacturing: 1. Work in progress and finished stock levels are re-duced. 2. Simplified estimating, accounting and work man-agement. 3. Improved plant replacement decisions, and. 4. Improved job satisfaction, morale, and communica-tion. 5. Short throughput times because machines are closed together. 6. Better quality because the group complete parts and the machines are closed together under one foreman. 7. Lower material handling costs because machines are closed together under one foreman. 8. Better accountability because of machines complete parts. 9. The foreman can be made responsible for costs, quality, and completion by the due date. 10. Training for promotion since GT provides a line of succession because a group is a mini-department. 11. Automation GT is the first evolutionary step in automation. 12. Reduced set up time since similar parts brought together on the same. 13. Morale and job satisfaction since most workers prefer to work in groups. The output is improved due to improved resource utilization.	**Any Four Advantages = 01 Mark Each.**
5		**Attempt any <u>TWO</u> of the following**	**12**
	a) Ans	**Draw set up diagram of ECM processes showing all the elements. State the function of each element**  **Functions of each element:-** [1] Fixture :- To hold the work piece rigidly and securely [2] DC Supply :- To supply current to cathode and anode [3] Tank :- To store the electrolyte [4] Tool (Cathode) :- To remove the material by controlled dissolution of anode	2 Marks for diagram And 1 mark each for any 4 correct function of elements

		[5] Servo system :- To circulate the electrolyte	
	b) Ans	**Draw internal mechanism of universal dividing head and label the parts**  **Figure:- Internal Mechanism of Universal Dividing Head**	4 Marks for neat diagram And 2 Marks for labeling
	c) Ans	**Explain need of virtual CNC machine simulators** **Need of Virtual CNC Machine Simulator:-** [1] Manufacturing process can be defined and verified in early stage [2] allows designers to conduct machining process planning, generating tool path [3] easy to visualize the process and simulate operations [4] Automatically calculate machining time [5] The tool path generated can be converted into CNC codes [6] Editing in the program is easy sue to prior information [7] Errors can be found out easily [8] Provides analysis features	1 Mark each for any 6 correct points
6		**Attempt any TWO of the following**	12
	a) Ans	**Draw a set up diagram of wire cut EDM and label the parts, also suggest the approximate range of following process parameters with its measuring units** **(i)** Discharge current **OR** Pulse frequency **(ii)** Wire speed **OR** Wire tension  **Figure 1. Details of WEDM Cutting Gap.** **(i) Discharge current OR Pulse frequency** Discharge current is limited to 30 A Pulse frequency is about 1 MHz **(ii) Wire speed OR Wire tension** Wire speed is about 2.5 to 150 mm/s	3 Marks for neat diagram and 1 mark for labeling 1 mark for any 1 correct point 1 mark for any 1 correct point

		Wire tension is about 50 – 60 % of tensile strength of wire	
	b) Ans	**Apply compound indexing method to divide 51 divisions on circular blank** Index crank movement (T) = 40 /N Where , N = No of divisions required T = 40 / 51 Let's try circle17 and 18 holes Factors of divisions required **x** factors of difference of hole circles Factors of 40 **x** Factors of first circle **x** Factors of second circle = 3 x 17 x 1 10 x 4 x 17 x 3 x 6 = 1 / 240 As all the factors from numerator can be cancelled we can select the 17 and 18 hole circle plate 240 / 17 – 240 / 18 **OR** 240 / 18 – 240 / 17 14 x 2 / 17 – 13 x 6 / 18 **OR** 13 x 6 / 18 – 14 x 2 / 17 **The above equation can be written as = 2 / 17 + 12 / 18 OR -12 / 18 – 2 / 17** Similar signs show that both the movements will be in the same direction. By adopting the first result we get the required movement.	2 Marks for formula 4 Marks for correct stepwise answer
	c) Ans	**Use the different milling cutter to cut T Slot on rectangular block with neat diagram also mention the sequence of operations and types of milling cutter used** **[1] T Slot cutter** Different milling cutter used for the T slot Milling [1] End milling cutter / Plain milling cutter [2] Special type T Slot Milling Cutter  **Figure :- T Slot Milling Operation** **Sequence of Operation** [1]]Using plain / end milling cutter plain slots are produced [2] The T slot cutter is used to enlarge and face the bottom of the slots	2 Marks for neat diagram 2 Marks for Sequence of operation

22563

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

Marks

1. Attempt any FIVE of the following: **10**

a) Enlist any four process parameters in EDM.

b) State the equation of cutting speed for milling operation.

c) List the various gear finishing methods.

d) Name the basic components of an CNC machine.

e) Write only classification of CNC machine.

f) Write meaning of following G and M-codes.

(i) G02

(ii) M30

g) State any two examples of fixed automation.

Marks

2. Attempt any THREE of the following: **12**

a) Explain the purpose of electrolyte in ECM.

b) Compare between vertical and horizontal milling machine.

c) Describe automatic tool changer (ATC) of CNC machine.

d) Justify need of tool length compensation of CNC machine.

3. Attempt any THREE of the following: **12**

a) Differentiate between gear hobbing and gear honing.

b) Compare "Point to Point" and continuous path CNC machine.

c) Explain the meaning of following block format of CNC.

N020 G03 X12 Y14 Z-0.5 I0 J12 F90 E0B

d) Describe fixed and programmable automation.

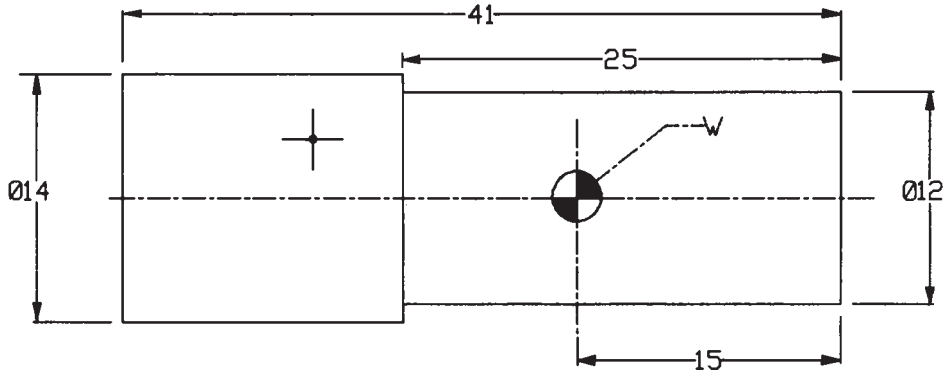
4. Attempt any THREE of the following: **12**

a) Classify the different methods of gear manufacturing.

b) Apply right hand rule of axes identification to CNC vertical milling with neat diagram.

c) Calculate the cutting parameters and prepare process sheet for the component shown in Fig. No.1. with neat diagram. All dimensions are in mm.

Given: Raw material - Aluminium, stock size ϕ14 X42 length, feed (*f*) = 0.2 mm/rev, cutting speed (V) = 90 m/min. Consider work zero (W) as per the Fig. No.1.



Q. No. 4c & 4d Fig. No. 1

Marks

d) Develop full G and M code manual part program of CNC lathe for component shown in Fig. No.1. using word address format (WAF).

e) Justify the need of Group Technology in today's manufacturing situation.

5. Attempt any TWO of the following: **12**

a) Draw set-up diagram of ECM processes showing all the elements. State the function of each elements.

b) Draw internal mechanism of universal dividing head and label the parts.

c) Explain need of virtual CNC machine simulators.

6. Attempt any TWO of the following: **12**

a) Draw set-up diagram of wire cut EDM and label the parts, also suggest approximate range of following process parameters with it's measuring unit.

(i) Discharge current **OR** Pulse frequency.

(ii) Wire speed **OR** Wire tension.

b) Apply compound indexing method to divide 51 divisions on circular blank.

c) Use the different milling cutter to cut 'T' slot on rectangular block with neat diagram, also mention the sequence of operations and types of milling cutter used.

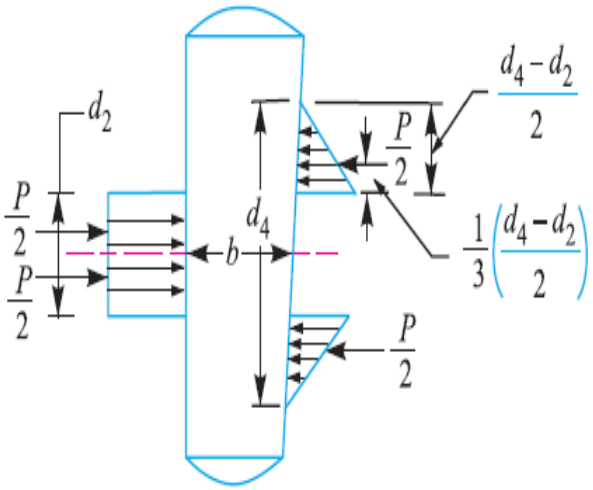
WINTER – 19EXAMINATION

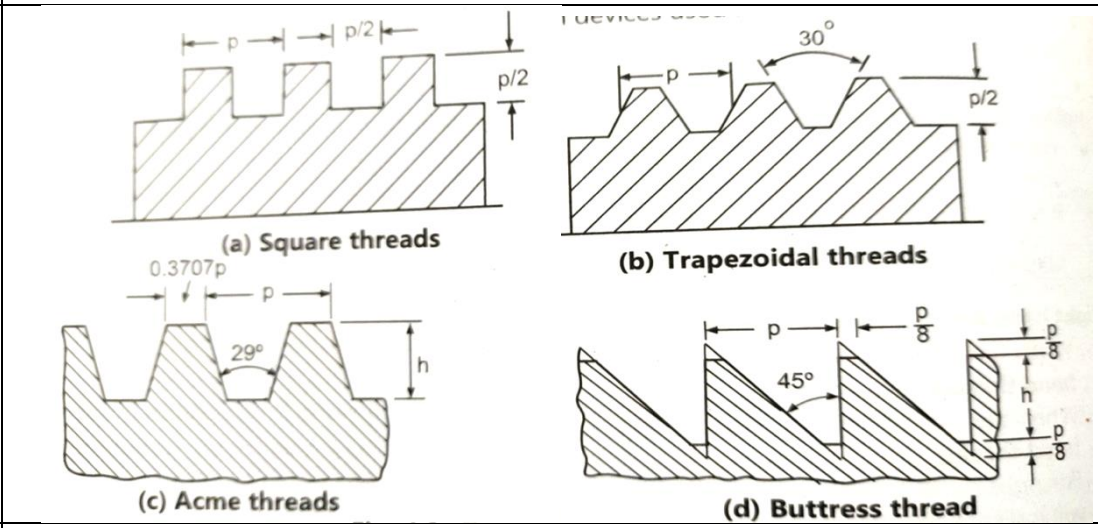
Subject Name: Elements of Machine Design **Model Answer** **Subject Code:** 22564

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N		Marking Scheme
1.		**Attempt anyFIVE of the following**	**10 Marks**
	a)	**Define factor of safety for ductile and brittle material.**	
	Ans	**Factor of safety for ductile material:** It is defined as ratio of yield stress to the working stress or For Ductile Material, $\text{Factor of safety} = \frac{Yield\ stress}{working\ stress\ /\ Designstress}$ **Factor of safety for Brittle material :** It is defined as ratio of ultimate stress to the working stress /permissible /design stress or For Brittle material, $\text{Factor of safety} = \frac{Ultimate\ stress}{working\ stress\ /\ Designstress}$----------	01 M 01 M
	b)	**List four properties desirable for spring material(Any Four)**	
	Ans	1)High Resilience 2) High ductile 3)High static strength 4) High fatigue strength 5) Non corrosive	1/2 M each
	c)	**List four applications of knuckle joints (Any Four)**	
	Ans	1) Link of bicycle chain, 2) Tie bar of roof truss, 3) Link of suspension bridge 4)Valve mechanism, 5) Fulcrum of lever, 6) Joint for rail shifting mechanism	1/2 M each
	d)	**Name four types of keys(Any Four)**	
		1) Sunk keys 2) Gibb-head key 3)Feather key 4)Woodruff key 5)Saddle keys 6)Tangent keys 7)Round keys 8) Splines Key	1/2 M each
	e)	**List any four application of power screw.**	
	Ans	1) Machine Vice 2) power press 3) Universal testing machine 4) C clamps etc. OR 1)To raise the load 2) To clamp the work-piece 3) to load specimen 4)to obtain accurate motion	1/2 M each
	f)	**Classify springs**	

	Ans	1) Helical springs: Compression helical spring, Tension helical spring 2) Conical and volute springs 3) Torsion springs 4) Laminated or leaf springs 5)Disc or Belleville springs 6) Special purpose springs	1/2 M each
	g)	**Give four applications of gear drive. (Any Four)**	
	Ans	1) Gear box of vehicle 2)Machine tool 3)Gear mechanism of wrist watch 4) Dial Indicator 5) Cement mixing unit 4) Diff. Mechanism of automobiles	1/2 M each
2.		**Attempt anyTHREE of the following**	**12 Marks**
	a)	**Write the meaning of following material designation.**	
	Ans	1)40C8 : Plain carbon steel carbon 0.4% of average, manganese 0.8% 2)SG 700/2 : spheroidal Graphite cast iron with Min UTS 700N/mm2 and elongation 0.2 % 3)Fe E200 : Steel with yield strength of 200N/mm2 4)X10Cr18Ni9 : high alloy steel carbon 0.10% of average, chromium 18%, Nickel 9%,	1 Mark each
	b)	**Explain the failure of cotter in bending with suitable sketch and strength equation**	
	Ans	**Bending failure of cotter:** Theoretically .It is assumed that the load is uniformly distributed over the various cross-sections of the joint. But in actual practice, this does not happen and the cotter is subjected to bending. In order to find out the bending stress induced, it is assumed that the load on the cotter in the rod end is uniformly distributed while in the socket end it varies from zero at the outer diameter ($d4$) and maximum at the inner diameter ($d2$), as shown in Fig.  	2 Marks fig.

		The maximum bending moment occurs at the centre of the cotter and is given by $M_{max} = \frac{P}{2}\left(\frac{1}{3} \times \frac{d_4 - d_2}{2} + \frac{d_2}{2}\right) - \frac{P}{2} \times \frac{d_2}{4}$ $= \frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{2} - \frac{d_2}{4}\right) = \frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{4}\right)$ We know that section modulus of the cotter, $Z = t \times b^2 / 6$ $\therefore$ Bending stress induced in the cotter, $\sigma_b = \frac{M_{max}}{Z} = \frac{\frac{P}{2}\left(\frac{d_4 - d_2}{6} + \frac{d_2}{4}\right)}{t \times b^2 / 6} = \frac{P\,(d_4 + 0.5\,d_2)}{2\,t \times b^2}$ This bending stress induced in the cotter should be less than the allowable bending stress of the cotter.	2 Marks
	c)	**Write Lewis equation for strength of gear tooth give meaning of each term**	
	Ans	Lewis equation for strength of gear tooth : **W_T = 6w.b. Pc. Y = 6w.b.πm. y** **Where,** W_T = Tangential load acting at the term , 6w = Beam strength of the tooth , b = Width of the gear face Pc = Circular pitch m = Module Y = Lewis form factor or tooth form factor.	2 Marks for equation & 2 Marks for notations
	d)	**Draw freehand sketches of thread profiles (any four) with full details**	
	Ans		1 Marks for each type
3.		**Attempt any <u>THREE</u> of the following:**	**12marks**
	a)	Explain maximum principal stress theory and maximum shear stress theory with their uses.	
	Ans	**1. <u>Maximum Principal (Normal) Stress Theory (Rankine's Theory):</u>** According to this theory, the failure or yielding occurs at a point in a member when the maximum principal (Normal) stress in a bi-axial stress system reaches the limiting strength of the material in a simple tension test.	

Since, for ductile material the limiting strength is the stress at yield point & for brittle material the limiting strength is the ultimate stress.

∴ According to the above theory, taking FOS into consideration,

The maximum principal (Normal) stress (σ_{t1}) in a bi-axial stress system is given by,

$$\sigma_{t1} = \frac{\sigma_{yt}}{FOS} \quad \ldots for\ ductile\ material$$

$$\sigma_{t1} = \frac{\sigma_{ut}}{FOS} \quad \ldots for\ brittle\ material$$

2 marks

Application:
Designing of machine components of brittle material.
Examples:
Spindle of screw jack, machine bed, C-frame, Overhang crank.

2. <u>Maximum Shear Stress Theory (Guest's or Tresca's Theory):</u>

According to this theory, the failure or yielding occurs at a point in a member when the maximum Shear Stress in a bi-axial stress system reaches a value equal to shear stress at yield point in a simple tension test.

∴ According to the above theory, taking FOS into consideration,

The maximum principal (Normal) stress (σ_{t1}) in a bi-axial stress system is given by,

$$\tau_{max} = \frac{\tau_{yt}}{FOS}$$

Since, the shear stress at yield point in a simple tension test is equal to one-half the yield stress in tension.

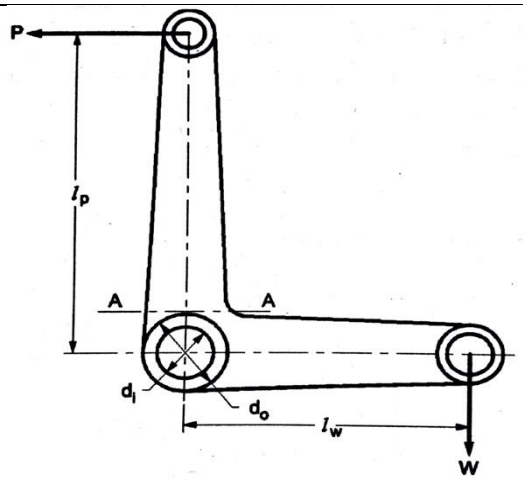
$$\tau_{max} = \frac{\sigma_{yt}}{2 \times FOS}$$

2 marks

Application:
Designing of machine components of ductile material.
Examples:
Spring, key, crank shaft, propeller shaft.

b) Write general design procedure of the bell crank lever. (any four steps)

Ans



1. Find the effort (P) required to raise the load (W),

Taking moment about the fulcrum F, we have,

$$W \times l_w = (P) \times l_p$$

2. Find reaction at fulcrum pin at F,

$$R_F = \sqrt{W^2 + P^2}$$

Find:

3. Design of fulcrum pin:

i. Fulcrum pin is designed by considering under bearing pressure,

$$P_b = \frac{R_F}{l_f . d_f}$$

where, l_p = length of fulcrum pin.

d_p= diameter of fulcrum pin.

Find :l_p, d_p.

ii. Fulcrum pin is subjected to double shear,

$$\tau = \frac{R_F}{2A} = \frac{R_F}{2.\frac{\pi}{4} {d_p}^2}$$

Find: τ Check the shear stress induced in the fulcrum pin.

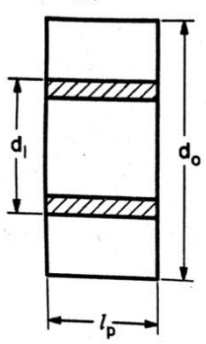
4. Diameter of boss of lever:

The boss of the lever is subjected to bending stress due to bending moment of lever.

Let,

d_i = inner diameter of the boss of the lever/ diameter of hole in lever.

d_o = outer diameter of the boss of the lever/ diameter of boss at fulcrum.



A brass bush of 3 mm thickness is pressed into the boss of the fulcrum as a bearing so that renewal become simple when wear occurs.

1 marks for any four steps each

$d_i = d_p + 2 \times 3$

$d_i = d_p \ldots (if\ bush\ is\ not\ used)$

$d_i = 2 \times d_p$

$B.M. = M = W \times l_w = P \times l_p$

$$Z = \frac{I}{y} = \frac{l_p({d_o}^3 - {d_i}^3)/12}{d_o/2}$$

$$\therefore \sigma_b = \frac{M}{Z}$$

Check the σ_b induced in the lever arm at the fulcrum.

5. Design of lever to find dimensions:

The lever is subjected to B.M. ,

The maximum B.M. acts near the boss,

$$M = P \times \left[l_p - \frac{d_o}{2}\right] or = W \times \left[l_w - \frac{d_o}{2}\right]$$

$$\therefore \sigma_b = \frac{M}{Z}$$

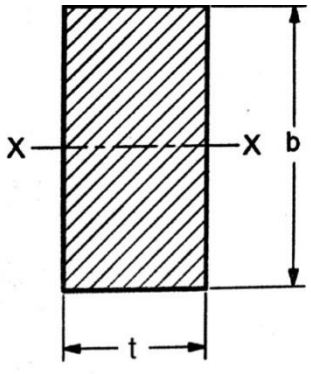
i. Consider rectangular cross-section of the lever,

$$Z = \frac{I}{y} = \frac{\frac{tb^3}{12}}{\frac{b}{2}} = \frac{tb^2}{6} \qquad (b = 3t)$$

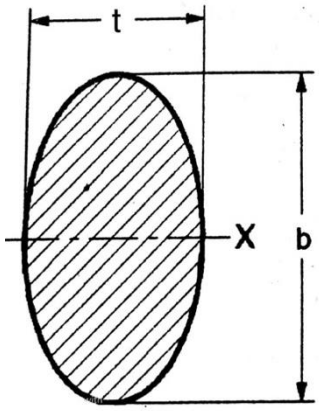
where,

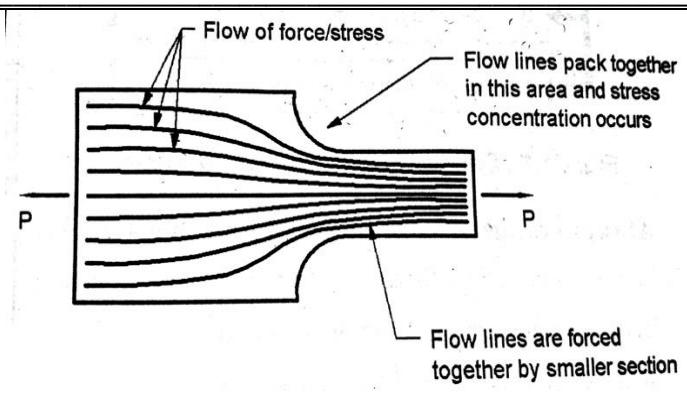
b = depth of the lever.

t = thickness of the lever.



ii. For elliptical section,

		$Z = \frac{I}{y} = \frac{\frac{\pi t b^3}{64}}{\frac{b}{2}} = \frac{\pi t b^2}{32}$ where, t = minor axis of ellipse. b = major axis of ellipse.  	
	c)	State any four applications of spring.	
	Ans	**Applications of spring: (Any Four)** 1. In automobile suspension. 2. In railway suspension. 3. In shot blasting machine. 4. In clocks and toys to store energy. 5. In spring balance and engine indicator to measure force. 6. In clutch, brakes, spring loaded valves, etc.	1 mark for one applica- tion any four each
	d)	Define stress concentration. Explain any four methods to reduce it with neat sketch.	
	Ans	**Stress Concentration:** Whenever the machine component changes the shape of its cross section the stress distribution pattern no longer holds good and the neighborhood of the discontinuity is different. The stresses induced in the neighborhood are much higher than the stress induced in the other part of the component. This abrupt change in cross section or the discontinuity form is called stress concentration. It is for all kinds of stresses caused due to keyways, grooves, notches, roughness or scratches.	Fordefinition 2 marks for stress concen- -tration

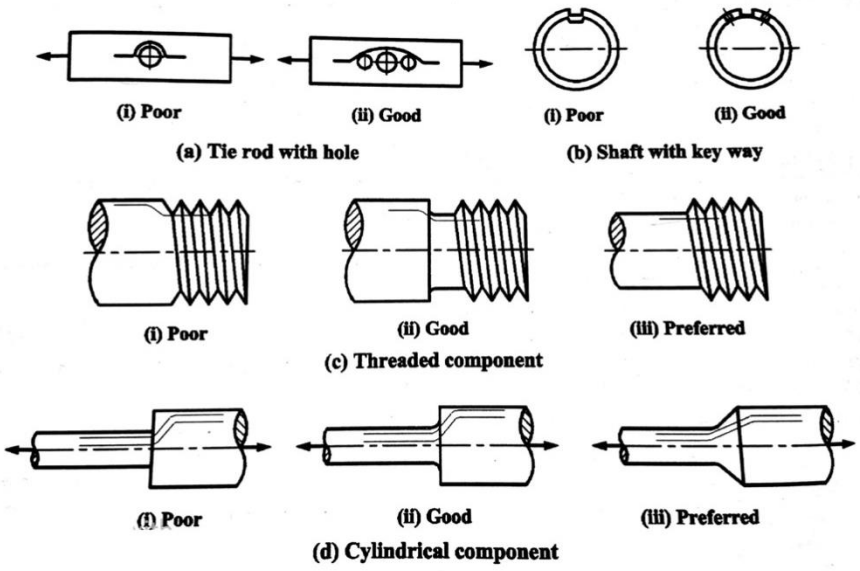


The effect of stress concentration cannot be completely eliminated but its effect can be reduced by altering the geometry of the component.

So the following methods are adopted to reduce the effect of stress concentration:

2 marks for methods to reduce them

1. Providing additional holes and notches.
   a. Use of multiple notches.
   b. Drilling additional holes.
   c. Removing roughness.
2. By providing fillet radius to the corners of the members and under and notches for the members in bending.
3. Reduction in stress concentration of the threaded component.
4. By drilling small holes near the large holes or providing additional holes in the shafts.
5. By providing taper cross sections to the members having sharp corners.



e) Define the following terms with respect to spring:

Ans

i) Free length:

It is the length of the spring in free or unloaded condition.

It is denoted by 'L_f'.

Free length = Solid Length + Maximum Compression + clearance between adjacent coils.

Free length = $L_f = n'd + \delta_{max} + 0.15 \times \delta_{max}$

$= n'd + \delta_{max} + (n'-1) \times 1mm.$

The clearance between two adjacent coils is taken as 1mm sometimes it is taken as 15% of the maximum deflection.

ii) Solid length:

When the compression spring is compressed until the coil comes in contact or touches each other, then the spring is said to be in solid condition. This length of spring is known as solid length.

1 Mark for each term

It is denoted by 'L_s'.

Solid length = $L_s = n'd$

where n' = total number of coils or turns.

d = diameter of wire in mm.

iii) Spring index:

It is defined as the ratio of mean diameter of coil to the diameter of wire.

It is denoted by 'C'.

Spring index = $C = \frac{D_m}{d}$

Where, D_m = Mean diameter of coil in mm.

d = wire diameter in mm.

iv) Spring rate:

The spring rate/ spring stiffness is defined the load required per unit deflection of the wire.

It is denoted by 'K'.

Spring rate/ Spring Stiffness = $K = \frac{W}{\delta} = \frac{W}{s}$ (N/mm)

where W = axial load in N.

δ = maximum deflection in mm

Q.4		**Attempt any <u>TWO</u> of the following:**	12 marks

	a)	Explain importance of shape and size in aesthetic design.	
	Ans	The aesthetic characteristics is a very important for all design elements. The aesthetics is the property to have good performance along with the better appearance for the satisfaction of the customer. In the buyer's market, have a number of products with same identical parameters, but the appearance of the of the product plays a major role in attracting the customers. The aesthetic has a produce with the extent which contributes varies from product to product. This is important for the designer to have develop the shape of a product so that customer get attracted towards it and the appearance should be pleasing. For example the cars are designed in the form of aerodynamic shape, this aesthetic forms helps in the performance by getting less resistance of air as well as the appearance which extent in contribution. The shape is also the important aesthetic criteria that the products develops and designed should not be bulky in size which will affect the performance as well as the appearance of the product. The designer thus have the choice to minimize the shape and can form smaller size product designs rather than bulky designs. Thus, aesthetics helps to get the better appearance and performance which extent its contributions from product to product.	6 marks
	b)	The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively.	6 marks
	Ans	**Let,** d_c = core diameter of tie rod. d = do = nominal (maximum) diameter of tie rod D = Outside diameter of coupler nut. l = Length of coupler nut. D_1 = Inside diameter of coupler. D_2 = Outside diameter of coupler. L = Total length of coupler = 0.6 d	

Given, $P = 44 \times 10^3$ N

$\sigma_t = 75$ N/mm^2

$\tau = 37.5$ N/mm^2

$\sigma_c = 90$ N/mm^2 ..... (Assumed)

We know that, for threaded component

$P_d = 1.3 \times P = 1.3 \times 44 \times 10^3 = 57.2 \times 10^3$ N

Here we use turnbuckle as a adjustable screw joint.

i] Diameter of Rod :-

$$\sigma_t = \frac{P_d}{A} = \frac{P_d}{\frac{\pi}{4} d_c^2}$$

$$\therefore 75 = \frac{57.5 \times 10^3}{\frac{\pi}{4} d_c^2}$$

$\therefore d_c = 31.16$ mm ≈ 32 mm

$\frac{d_c}{d_o} = 0.84$ $\therefore d_o = 38.095$ mm ≈ 40 mm

ii] Length of Coupler Nut (l) :-

$$\tau = \frac{P_d}{A} = \frac{1.3 \times P}{\pi d_o \cdot l}$$

$\therefore l = 12.138$ mm

But $l = 1.25\, d = 50$ mm

iii] Outside diameter of coupler nut (D) :-

$$\sigma_t = \frac{P}{\frac{\pi}{4}(D^2 - d^2)}$$

$\therefore D = 50.705 = 52$ mm

But $D = 1.25 \times d = 50$ mm $\therefore$ Design is safe

iv] Outside diameter of coupler (D_2) :-

$$\sigma_t = \frac{P}{A} = \frac{P}{\frac{\pi}{4}(D_2^2 - D_1^2)}$$

But, $D_1 = d + 6 = 40 + 6 = 46$ mm

$$\therefore 75 = \frac{44 \times 10^3}{\frac{\pi}{4}(D_2^2 - 46^2)}$$

$$\therefore D_2 = 53.5 \text{ mm} = 54 \text{ mm}$$

But, $D_2 = 1.5\,d = 1.5 \times 40 = 60$ mm

v] Length of coupler Nut = $L = 6 \cdot d = 240$ mm

vi] Thickness of coupler = $t = 0.75\,d = 30$ mm

vii] Thickness of coupler nut = $t_1 = 0.5\,d = 20$ mm

	c)	A Lathe receives power from an overhung shaft situated exactly above the lathe pulley by means of the belt drive. A pulley weighing 400 N and of diameter 270 mm is fixed on the shaft. The centre to centre distance between the two shaft supporting bearing is 900 mm. the maximum power required by machine is 5 kW at 200 rpm. The belt tension ratio is 2.5. Determine the diameter of the shaft. Allowable shear stress for shaft material is 40 N/mm^2.	6 marks

$P = 5 \times 10^3$ Watt

$N = 200$ rpm

$W_p = 400$ N

$D = 270$ mm

$\frac{T_1}{T_2} = 2.5$

$\tau = 40$ N/mm^2

$$\text{Power} = \frac{2\pi NT}{60}$$

$$5 \times 10^3 = \frac{2\pi \times 200 \times T}{60}$$

$\therefore T = 238.732$ N.m

$T = 238.732 \times 10^3$ N.mm

$$\frac{T_1}{T_2} = 2.5 \quad \therefore \quad T_1 = 2.5 \times T_2$$

$$T = (T_1 - T_2) \times R$$

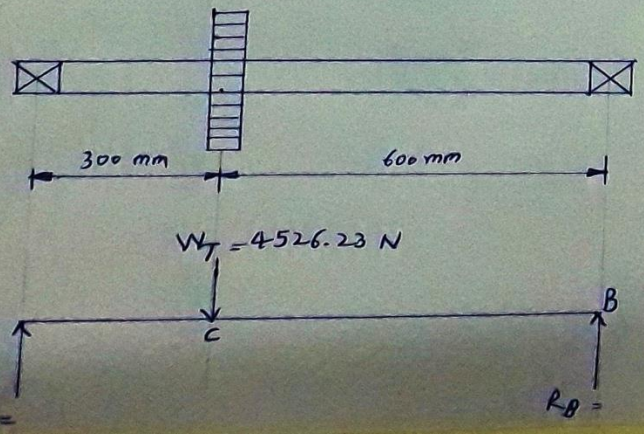
$$238.732 \times 10^3 = (2.5\,T_2 - T_2) \times \frac{270}{2}$$

$\therefore T_2 = 1178.92$ N & $T_1 = 2947.31$ N

Now, Total weight $= W_T = W_p + T_1 + T_2$

$= 400 + 1178.92 + 2947.31$

$\therefore W_T = 4526.23$ N



$\Sigma F_y = 0 \quad \therefore R_A + R_B = 4526.233 \text{ N}$

$\Sigma M_A = 0 \quad -(W_T \times 300) + R_B \times 900 = 0$

$\therefore R_B = 1508.744 \text{ N} \quad \& \quad R_A = 3017.48 \text{ N}$

Now, find Moments at A, B & C

$M_A = 0$

$M_C = R_B \times 600 = 905.24 \times 10^3 \text{ N.mm}$

$M_B = 0$

$\therefore M = 905.24 \times 10^3 \text{ N.mm}$

Now, $T_{eq} = \frac{\pi}{16} \tau d^3 = \sqrt{M^2 + T^2}$

$\therefore \frac{\pi}{16} \times 40 \times d^3 = \sqrt{(905.24 \times 10^3)^2 + (238.73 \times 10^3)^2}$

$\therefore d = 49.21 \text{ mm}$

$\therefore d = 50 \text{ mm} \quad \ldots$ diameter of shaft

5.		**Attempt any<u>TWO</u> of the following**	**12 Marks**
	a)	A flanged protective type coupling is required to transmit 7.5 KW at 720 rpm. Assume the following stresses for the coupling components. Permissible shear stress for shaft, bolt & key material = 33 N/mm^2. Permissible crushing stress for bolt & key material = 60 N/mm^2. Find: (i) Diameter of shaft (ii) Diameter of key (iii) Diameter of bolt	
	Ans	P = 7.5 KW N= 720rpm τ = 33 N/mm^2 σ = 60 N/mm^2 **Step 1)Find Torque** $P = \frac{2\pi NT}{60}$	

$T = \frac{7.5\times10^3 \times60}{2\times\pi\times720}$

T= 99.47N.m= 99.47× 10^3N.mm

Step 2) We also know that

$T= \frac{\pi}{16} \times \tau \times d^3$

99.47× 10^3N.mm= $\frac{\pi}{16} \times 33 \times d^3$

d^3 = 15351.41**d = 24.85 mm=25mm**

Step 3)Design of hub

Outer diameter of hub

D= 2d = 2×25 = 50 mm

Length of hub, L= 1.5d =1.5 ×25= 37.5mm

Let, now check induced shear stress

$$T= \frac{\pi}{16} \times \tau c \times \frac{[D^4 - d^4]}{D}$$

$99.47\times 10^3= \frac{\pi}{16} \times \tau c \times \frac{[50^4 - 25^4]}{50}$

$\tau c = 4.32\ N/mm2$

Since induced shear stress is less than permissible value 33N/mm2 the design is safe

Step 4)Design of key, here Rectangle key is used

from table W=10mm

t= 8mm

Length of key is taken as length of the hub = L = 37.5mm

Let us now check induced stresses

$$\mathbf{T = l \times w \times \tau \times \frac{d}{2}}$$

$99.47\times 10^3= 37.5\times 10 \times \tau \times \frac{25}{2}$

τ =21.22≤ 33N/mm^2

$99.47\times 10^3 = l \times \frac{t}{2} \times \sigma_{ck} \times \frac{25}{2}$

$99.47\times 10^3 = 37.5 \times \frac{8}{2} \times \sigma_{ck} \times \frac{25}{2}$

σ_{ck} = 53.05≤ 60N/mm^2

Design is safe.

Step 5) Design for flange

		t_f = 0.5 d = 0.5 ×25= 12.5mm Now, check induced shear stress in flange T = $\frac{\pi D^2}{2} \times \tau \times tf$ $99.47 \times 10^3 = = \frac{\pi 25^2}{2} \times \tau \times 12.5$ τ= 8.10 N/mm^2 Flange is safe. **Step 6) Design for bolts** Number of bolts is n = 3 D_1= 3d= 3 × 25=75mm Bolts are subjected to shear stress T = $\frac{\pi}{4} \times d1^2 \times tb \times n \times \frac{D1}{2}$ $99.47 \times 10^3 = \frac{\pi}{4} \times d1^2 \times 33 \times 3 \times \frac{75}{2}$ d 1^2= $\frac{99.47 \times 103}{2915.79}$ d 1^2= 34.11 d1=5.84mm Assume coarse thread nearest to standard diameter M6 **step 7)** Outer diameter of the flange,D_2= 4d= 4×25 = 100mm **Step 8)** Thickness of protective circumferential flange, tp= 0.25d = 0.25×25 = 6.25mm	
	b)	The lead screw of lathe has ACME thread of 60 mm outside diameter & 8 mm pitch. It supplies drive to a tool carriage which need an axial force of 2000 N. A collar bearing with inner & outer radius as 30 mm & 60 mm respectively is provided. The coefficient of friction for the screw thread is 0.12 & collar is 0.10. Find the torque required to drive the screw & the efficiency of the screw.	
	Ans	d_0= 60mm W= 2000N D_2= 30mm D_1= 60mm p = 8mm μ =0.12 μ_2 = 0.10 **To Find**	

T=?

η =?

Step 1) Mean diameter of screw

$d = d_0 - \frac{p}{2} = 60 - \frac{8}{2} = 56mm$

$\tan\alpha = \frac{p}{\pi d} = \frac{8}{\pi \times 56}$

$\tan\alpha = 0.045$

angle for ACME thread $2\beta = 29^0 \beta = 14.5^0$

$\mu_1 = \tan\emptyset_1 = \frac{\mu}{\cos\beta}$

$\mu_1 = \tan\emptyset_1 = \frac{\mu 0.12}{\cos 14.5}$

$\mu_1 = \tan\emptyset_1 = 0.1239$

Step 2) Torque required to overcome friction of screw

$T_1 = W \frac{\tan\alpha + \tan\emptyset_1}{1 - \tan\alpha . \tan\emptyset_1} \times d/2$

$T1 = 2000 \times \frac{0.045 + 0.1239}{1 - 0.045.0.1239} \times 56/2$

T1= 9576N.mm

Step 3) Assuming uniform wear to overcome collar friction

$R = \frac{R1+R2}{2} =$

$R = \frac{30+60}{2} = 45mm$

$T_2 = \mu \times W \times R = 0.10 \times 2000 \times 45 = 9000N.mm$

T = T1 +T2 = 9576 + 9000 = 18576 N.mm

Step 4)

$\eta = \frac{T0}{T} = \frac{W tan\alpha \times \frac{d}{2}}{T}$

$\eta = \frac{T0}{T} = \frac{2000 \times tan\alpha \times \frac{56}{2}}{18576}$

$\eta = 0.1371 = 13.71\%$

c) State the steps involved in selection of proper ball bearing from manufacturer's catalogue.

Ans

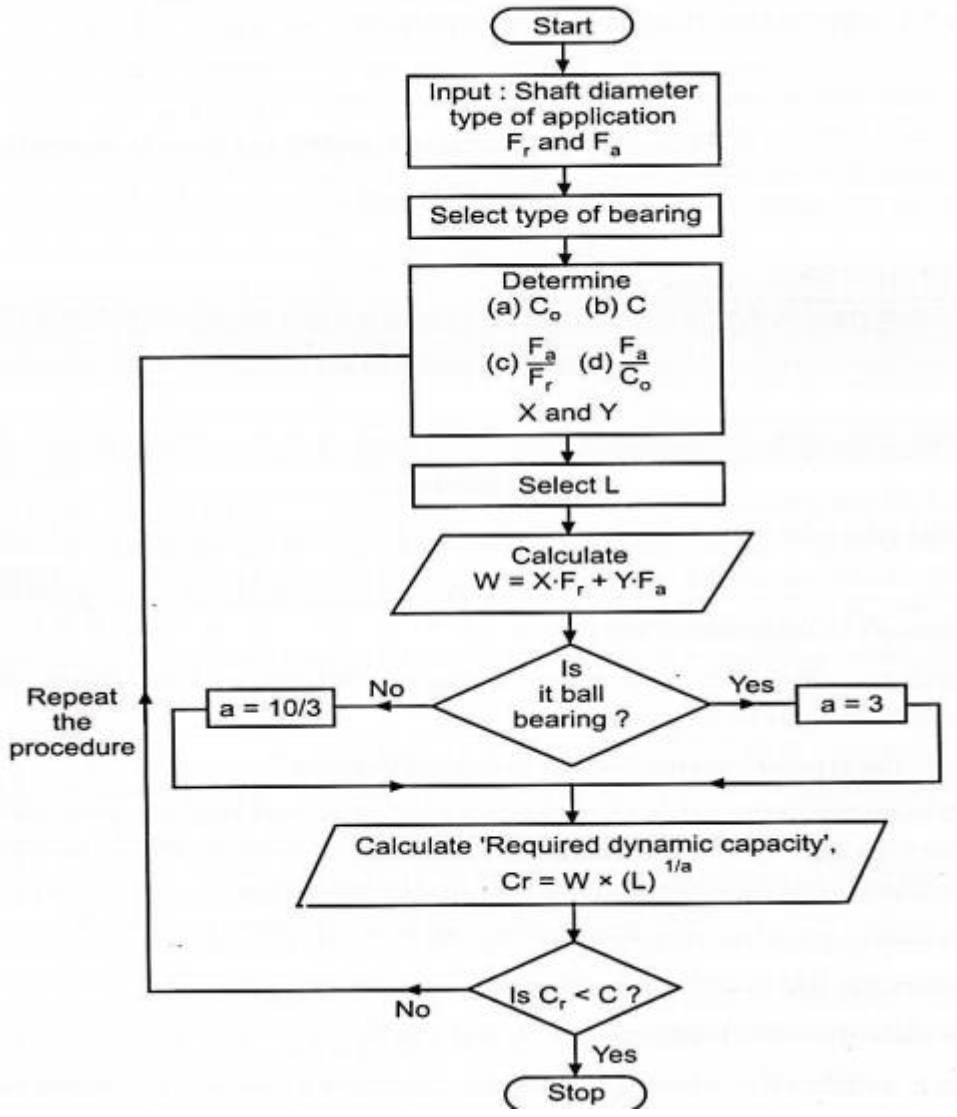
1) Calculate radial and axial forces and determine dia. of shaft.

2) Select proper type of bearing.

3) Start with extra light series for given diagram go by trial of error method

4) Find value of basic static capacity (co) of selected bearing from catalogue.

5) Calculate ratios Fa/VFr and Fa/Co.

		6) Calculate values of radial and thrust factors.(X & Y) from catalogue. 7) For given application find value of load factor Ka from catalogue. 8) Calculate equivalent dynamic load using relation. Pe = (XVFr + YFA) Ka. 9) Decide expected life of bearing considering application. Express life in million revolutions L10 10) Calculate required basic dynamic capacity for bearing by relation. 11) Check whether selected bearing has req. dynamic capacity, IF it not select the bearing of next series and repeat procedure from step-4 **OR**	
		OR (flowchart) 	
6.		**Attempt anyTWO of the following**	**12 Marks**
	a)	A plate 75 mm wide & 12.5 mm thick is to be joined with another plate by single transverse & parallel fillet weld. Maximum tensile & shear stresses are 70 N/mm^2& 56 N/mm^2 respectively. Find the length of each parallel fillet weld if joint is subjected to 90 KN.	
	Ans	Given data	

		W= 75KN t = 12.5mm τ= 56 N/mm^2 σ t =70 N/mm^2 P= 90×10^{3}N/mm^2 **Step 1) Load carried by single transverse** P_1= 0.707× s × l_1× σ t P_1= 0.707 × 12.5 × 62.5×70 ……(l_1 =75-12.5 =62.5) P_1= 38664.06 N **Step 2) Double parallel fillet weld** P_2= 1.414 × S × l_2× τ P_2= 1.414 × 12.5 × l_2× 56 P_2= 989.8 × l_2 **Step 3) P= P_1 + P_2** 90 × 10^3 = 38664.06 + 989.8 × l_2 l_2= 51.86mm l_2= 51.86+ 12.5 l_2 = 64.36 mm	**2 Marks** **2 Marks** **2 Marks**
	b)		
	Ans	W= 1000N δ = 25mm C = $\frac{D}{d}$ = 0.6 $\tau = 420$ mm G=84 × 10^3 N/mm^2 **Step 1)** Mean diameter of spring coil K= $\frac{4C-1}{4C-4}+\frac{0.615}{4C-4}$ K= $\frac{4\times5-1}{4\times5-4}+\frac{0.615}{4\times5-4}$ K= 1.31 **Step 2)** Maximum shear stress 420 =K $\frac{(8\times W\times C)}{\pi d^2}$= 1.31 × $\frac{(8\times1000\times5)}{\pi d^2}$ d = 6.3mm	

From table take d = 6.401 or same value also considered

D = C × d = 5 × 6.401= 32.005

Outer diameter of spring

D_0= D+d=32.005 + 6.401= 38.406 mm

Step 3) number of turns of the coil

$$\delta = \frac{8WC^3n}{G.d}$$

$$25 = \frac{8\times1000\times5^3n}{84\times10^3\times6.401}$$

$$n = \frac{25}{1.86}$$

n= 13.44=14

Step 4) for square and ground ends

n'= n+2 = 14+2 =16

Step 5) Free length

L_f= n'd + δ + 0.15× δ = 16× 6.401 + 25 + 0.15× 25 = 131.2 mm

Step 6) Pitch of the coil

$$= \frac{free\ length}{n'-1} = \frac{131.2}{16-1} = 8.76 \text{ mm}$$

c) A hollow transmission shaft having inside diameter 0.6 times outside diameter, is made up of plain carbon steel 40C8 & having permissible shear stress equal to 65 MPa. A belt pulley, 1000 mm in diameter is mounted on a shaft, which overhangs the left hand bearing by 250 mm. The belt are vertical power transmit to the machine shaft below the pulley. The tension on tight & slack side of belt are 3 kN& 1 kN respectively, while weight of pulley is 500 N. The angle of rap of the belt on pulley is 180°. Calculate outside & inside diameter of shaft.

Ans

Given data

d = 0.6 D

T_1= 3 × 10^3 N

T_2= 1× 10^3 N

W_t =500N

$\tau = 65MPa$

$\theta = 180^0$

Diameter of the pulley, D=1000mm

K= d/D =0.6

Step 1) Find torque

		T= (T1-T2)R = (3000-1000) × 500 = 1× 10^6N.mm Total weight on the pulley W_t = T1 + T2 + W= 3000+1000+500= 4500 N **Step 2) Bending moment** M= W_t× 250 = 4500 × 250= 1.125 × 10^6 N.mm **Step 3) Find equivalent twisting moment** $T_{eq} = \sqrt{M^2 + T^2} = \sqrt{(1.125 \times 10^6)^2 + (1 \times 10^6)^2}$ = 1.50× 10^6 N.mm $T_{eq} = \frac{\pi}{16} \times \tau \times d_0^3 \times (1 - K^4)$ 1.56 × $10^6 = \frac{\pi}{16} \times 65 \times d_0^3 \times (1-0.6^4)$ d_0= 51.97 =55mm di = 0.6× 55 =33 mm	**02 Marks** **02 Marks** **02 Marks**

22564

11920

4 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define factor of safety for ductile and brittle material.

b) List four properties desirable for spring material.

c) List four applications of knuckle joint.

d) Name four types of keys.

e) List any four applications of power screw.

f) Classify springs.

g) Give four applications of gear drive.

Marks

2. Attempt any THREE of the following: **12**

a) Write the meaning of following material designation.

(i) 40C8

(ii) SG 700/2

(iii) Fe E200

(iv) X10Cr18Ni9

b) Explain failure of cotter in bending with suitable sketch and strength equation.

c) Write Lewis equation for strength of gear tooth. Give meaning of each term.

d) Draw freehand sketches of thread profiles (any four) with full details.

3. Attempt any THREE of the following: **12**

a) Explain maximum principal stress theory and maximum shear stress theory with their uses.

b) Write general design procedure of the bell crank lever. (any four steps)

c) State any four applications of spring.

d) Define stress concentration. Explain any four methods to reduce it with neat sketch.

e) Define the following terms with respect to spring:

(i) Free length

(ii) Solid length

(iii) Spring index

(iv) Spring rate

Marks

4 Attempt any TWO of the following : **12**

a) Explain importance of shape and size in aesthetic design.

b) The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively.

c) A lathe receives power from an overhung shaft situated exactly above the lathe pulley by meance of the belt drive. A pulley weighing 400 N and of diameter 270 mm is fixed on the shaft at a distance of 300 mm to the right of the left hand bearing. The centre to centre distance between the two shaft supporting bearing is 900 mm. The maximum power required by machine is 5 kW at 200 rpm. The belt tension ratio is 2.5. Determine the diameter of shaft.

Allowable shear stress for shaft material is 40 N/mm^2.

5. Attempt any TWO of the following : **12**

a) A flanged protective type coupling is required to transmit 7.5 KW at 720 r.p.m. Assume the following stresses for the coupling components.

Permissible shear stress for shaft, bolt and key material = 33 N/mm^2

Permissible crushing stress for bolt and key material = 60 N/mm^2

Find:

(i) Diameter of shaft

(ii) Dimensions of key

(iii) Diameter of bolt

b) The lead screw of lathe has Acme thread of 60 mm outside diameter and 8 mm pitch. It supplies drive to a tool carriage which need an axial force of 2000 N. A collar bearing with inner and outer radius as 30 mm and 60 mm respectively is provided. The coefficient of friction for the screw thread is 0.12 and for collar it is 0.10. Find the torque required to drive the screw and the efficiency of the screw.

c) State the steps involved in selection of proper ball bearing from manufacturer's catalogue.

Marks

6. Attempt any TWO of the following : **12**

a) A plate 75 mm wide and 12.5 mm thick is to be joined with another plate by single transverse and parallel fillet weld, Maximum tensile and shear stresses are 70 N/mm^2 and 56 N/mm^2 respectively. Find the length of each parallel fillet weld if joint is subjected to 90 kN.

b) Design helical compression spring for - maximum load of 1000 N for deflection of 25 mm using value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm^2

Take Wahl's factor, $K = \frac{4c-1}{4c-4} + \frac{0.615}{c}$

Where c = spring index.

c) A hollow transmission shaft having inside diameter 0.6 times the outside diameter, is made of plain carbon steel 40C8 and having permissible shear stress equal to 65 MPa. A belt pulley, 1000 mm in diameter is mounted on the shaft, which overhangs the left hand bearing by 250 mm. The belts are vertical transmit power to the machine shaft below the pulley. The tension on tight and slack side of the belt are 3 kN and 1 kN respectively, while the weight of the pulley is 500 N. The angle of wrap of the belt on pulley is 180°. Calculate outside and inside diameter of the shaft.

WINTER – 19 EXAMINATION

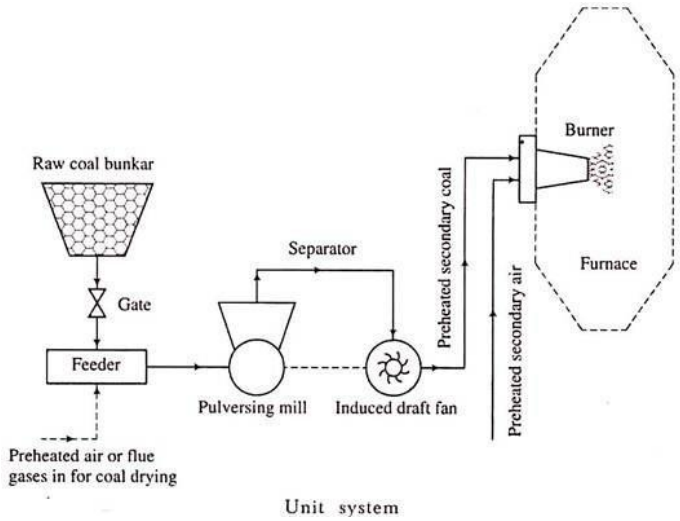
Subject Name: Power Plant Engineering **Model Answer** **Subject Code:** 22566

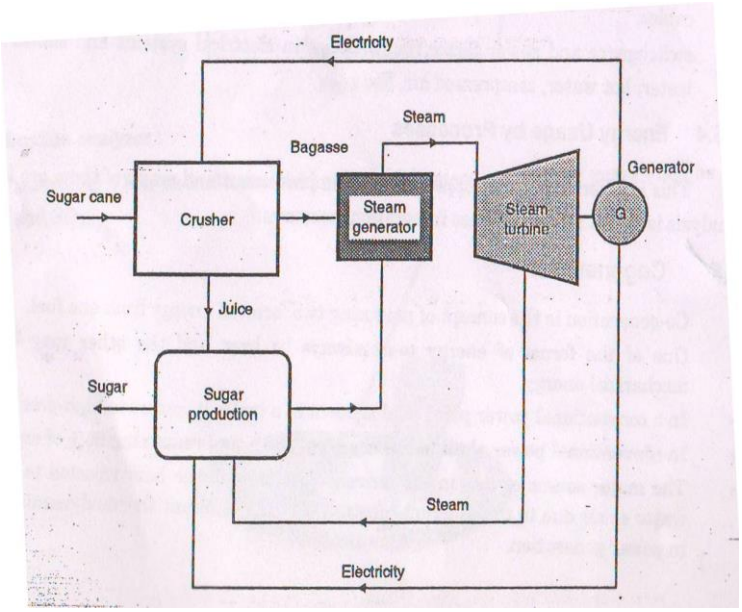
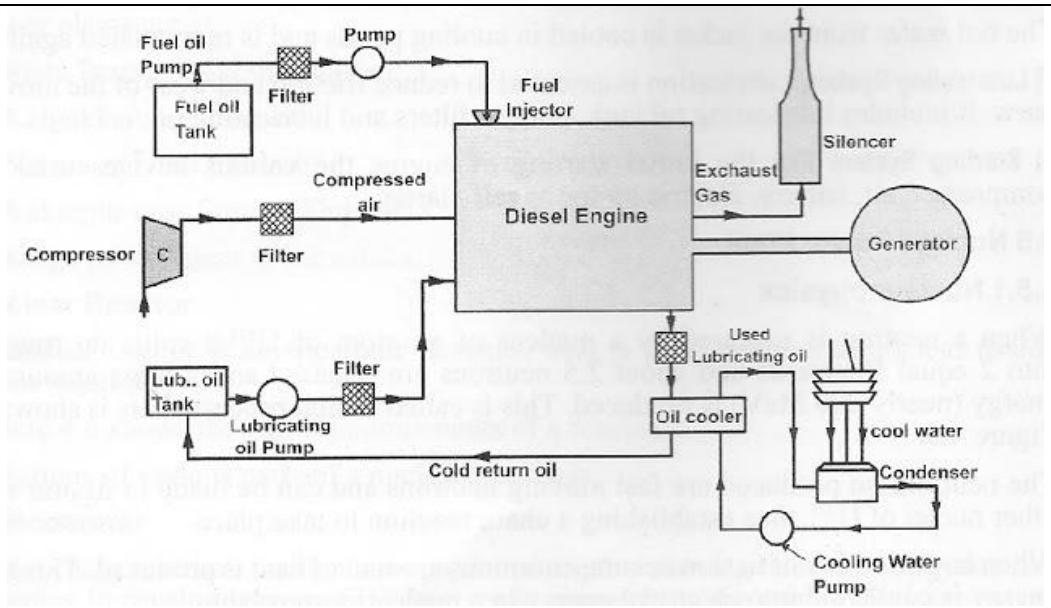
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1 (A)	a)	Types of Power Plant 1. Nuclear power plant 2. Thermal power plant 3. Wind power plant 4. Geothermal power plant 5. Diesel power plant 6. Hydroelectric power plant 7. Tidal power plant	Any four 2M
	b)	Following are the two types of FBC boiler 1) Bubbling Fluidized Bed Combustion (BFBC) 2) Circulating Fluidized Bed Combustion (CFBC).	1M each
	c)	**Advantages of Steam Power Plant – (four points – 2 marks)** 1) The fuel used is quite cheap. 2) It can be installed at any place irrespective of the existence of coal. The coal can be transported to the site of the plant by rail or road. 3) Economical in initial cost compared to hydro plants 4) Running costs are less compared to gas plants or diesel plants 5) Steam plants can withstand for overload for certain extent	2M
	d)	Waste heat is the heat which is not used and exhausted out as a waste product. In thermal power plant large quantity of heat at lower thermal potential (70^0c) is discharged to the atmosphere. If we recover this heat, there will be reduction in fuel consumption, lower harmful emissions and improvement in production efficiency.	2M

	e)	List of nuclear fuel 1. Uranium-235 2. Plutonium-239 3. Uranium – 233 4. Thorium	½ M EACH
	f)	i. Fixed Cost – It is the capital invested in the installation of complete plant. It includes the cost of land, building, equipments, transmission and distribution lines, cost of planning and designing the plant sub-stations and many others. ii. Depreciation cost – It is the amount to get aside per year from the income of the plant to meet the depreciation caused due to wear and tear of the equipments	1M each
	g)	Limitations of Diesel Power Plant 1. The plant has high running charges as the fuel used is costly. 2. The [plant can only generate small power. 3. The maintenance charges are generally high. 4. The cost of lubrication is generally high. 5. The plant does not work satisfactorily under overload conditions for a longer period. 6. Noisier in operation.	Any four 2M
Q.2	a)	Classification of hydroelectric power plants- 1. According to the availability of head • High head power plants • Medium head power plants • Low head power plants 2. According to the nature of load • Base load plants • Peak load plants 3. According to quantity of water available • *Run-off river power plants without pondage.* • *Run-off river power plants with pondage* • *Reservoir power plants.* • *Pump storage plants* • *Mini and micro Hydel plants*	4M

	b)	Following procedure is adopted to do maintenance of major components of high pressure boiler **General Maintenance** Even though the boiler has electrical and mechanical devices that make it automatic or semi-automatic in operation, these devices require systematic and periodic maintenance. Any "automatic" features do not relieve the operator from responsibility, but rather free him from certain repetitive chores, providing him with time to devote to upkeep and maintenance. **Shift Maintenance** Shift maintenance should include checking the boiler water level in the gauge glass and the boiler steam pressure on the gauge. Operate the intermittent blow down valve to remove any accumulated solids in the mud drum. The valves on the water column and gauge glass should be operated to make sure these connections are clear. Monitor water chemistry to adjust the chemical feed treatment and continuous blow down as required, to remain within water treatment guidelines established by the Owner's water treatment consultant. **Daily Maintenance** Daily Maintenance should include a check of the burner operation, including fuel pressure, atomizing air or steam pressure, visual appearance, etc. Clean the observation ports during periods of low fire or shutdown. Test the boiler level alarms and low water cutoff. Maintain a daily schedule of soot blowing. **Monthly Maintenance** Follow the recommendations of you authorized inspector pertaining to safety valve inspection and testing. The frequency of testing, either by the use of the lifting lever or by raising the steam pressure, should be based on the recommendation of your authorized inspector. Test the boiler safety valves in accordance with the manufacturer's instructions to be absolutely sure that the valves have not corroded shut. **Annual Maintenance** Clean both the heating and heated sides of the boiler. Remove all man way and hand hole covers. Open all bottom blow down and drain valves. Hose the inside of the boiler with clean water under high pressure. Use a hand scraper to remove accumulated sludge and scale. Start near the top and work toward the bottom. After cleaning tube exteriors, inspect the tube surfaces for signs of overheating, such as bulging, blackened surfaces in the tubes, etc.	4M
	c)	Layout of solid fuel handling system used in steam power plant -  Unit system	4M

	d)	Co-generation is procedure for generating electric power and useful heat in a single installation. The useful heat may be in the form of steam, hot water, or hot air. In the cogeneration system, a mechanical work is converted into electrical energy in an electric generator and the discharged heat, which would otherwise be dispersed to the environment, is utilized in an industrial process or in other ways. The net result is an overall increase in the efficiency of fuel utilization. In sugar factory juice is extracted from cane and bagasse is burned to generate steam. The steam is sent to steam turbine to generate electricity. Extracted steam and low pressure steam from turbine is used in the process of sugar manufacturing  	2M 2M
Q.3	a)	 Diesel Engine Power Plant	4M

	b)	**Advantages of Gas Power Plant**- 1) Less vibrations hence perfect balancing is possible 2) Mechanical efficiency is high up to 90% 3) Continues power developing hence torque characteristics are better 4) Work developed per kg of air is more 5) Less weight per HP 6) Lubrication and ignition is simple 7) Specific fuel consumption is constant 8) Installation and maintenance costs are less	ANY FOUR 4M
	c)	**Trigeneration Concept:** Trigeneration is the simultaneous process of cooling, heating and power generation from only one fuel input. Trigeneration is the process by which some of heat produced by co-generation plant is used to generate chilled water for air conditioning or refrigeration. Thermal power plants are used to produce electricity. The byproduct is waste heat, which is then directed to absorption chillers and boilers for space cooling, hot water and related purposes. Because of trigeneration we have, • High efficiency production of electricity and heat • Reduced fuel and energy costs • Lower electrical usage during peak summer demand • Engine heat can be used to produce steam of hot water for onsite use • Significant reductions in greenhouse gas emissions No harmful chemical pollutants since water is used as the refrigerant Opportunities in thermal power plants: In thermal power plants the high pressure vapour produced by a boiler is expanded in the turbine generates electricity and the heat is then available as low pressure steam. This steam is then utilized for heating and cooling. Also exhaust gases (flue gas) from boiler after producing steam is utilized in trigeneration.	3M 1M
	d)	Nuclear power plant A nuclear reactor is a special apparatus used to perform nuclear fission. Since the nuclear fission is radioactive, the reactor is covered by a protective shield. Splitting up of nuclei of heavy atoms is called as nuclear fission, during which huge amount of energy is released. Nuclear fission is done by bombarding slow moving neutrons on the nuclei of heavy element. As the nuclei break up, it releases energy as well as more neutrons which further cause fission of neighboring atoms. Hence, it is a chain reaction and it must be controlled, otherwise it may result in explosion. The heat energy released then passed through heat exchanger, the primary coolant transfers heat t**o the secondary coolant (water)and** water from the secondary loop is converted into steam. The primary system and secondary system are closed loop, and they are never allowed to mix up with each other. Thus, heat exchanger helps in keeping secondary system free from radioactive stuff. This generated steam is passed through a steam turbine, which runs due to pressure of the steam. As the steam is passed through the turbine blades, the pressure of steam gradually decreases and it expands in volume. The steam turbine is coupled to an alternator through a rotating shaft thus generating electrical energy.	2M

Thus in Nuclear power plant energy transforms in the following way

Nuclear energy of fuel –- Heat energy of steam --- Kinetic energy of Turbine --- Kinetic energy in alternator to Electrical energy.

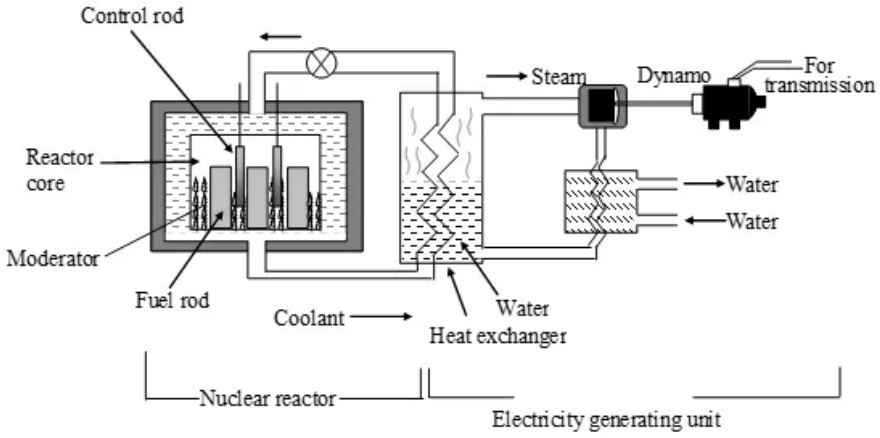


Fig : Nuclear Power Plant

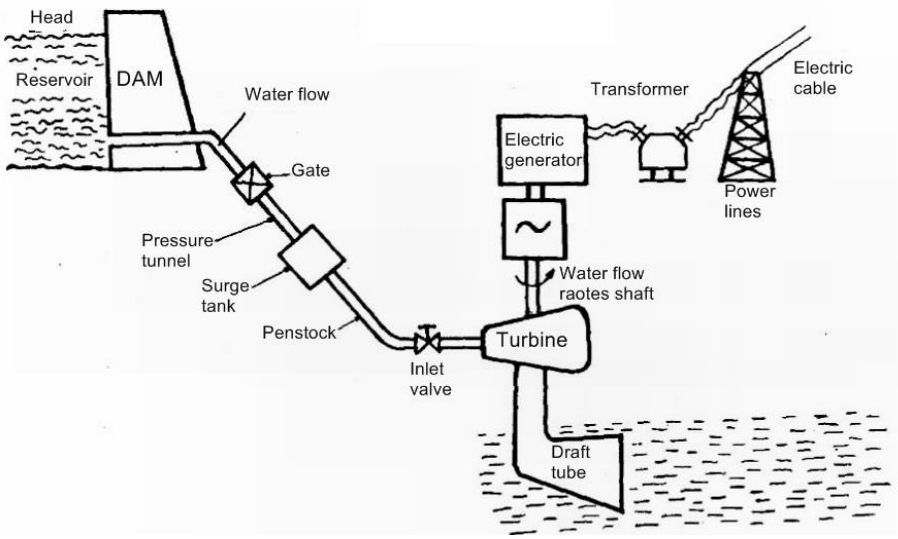
2M FOR SKETCH

Q.4 a)

A hydro electric power plant consists of the following:

1. Reservoir: used to store water during rainy season. This water is used to run the hydraulic turbine
2. Dam: It is a structure of considerable height built across the river. It provides working head of water for power plant
3. Gate: It is provided for controlling of flow of water from reservoir to turbine
4. Waterway and penstock: Waterway carries water from the dm to the power house. It includes canal and penstock or tunnel
5. Hydraulic turbine: These are used to convert the kinetic energy of water into mechanical energy
6. Electric Generator: The mechanical energy from turbine is converted to electrical energy.

2M



Hydroelectric Power Plant

2M FOR SKETCH

	b)	Advantages of Nuclear power plant: 1) Low greenhouse gas emission, 2) Powerful and Efficient 3) Reliable and clean electricity 4) Cheap Electricity 5) Low Fuel Cost 6) Easy Transportation Limitations of Nuclear power plant 1) Radioactive Waste 2) Nuclear Accidents 3) Initial cost of the project, 4) Major Impact on Human Life	ANY FOUR 2M ANY FOUR 2M
	c)	Factors considered for selection of type of power plant 1. Cost of Transmission of Energy: 2. Cost of Fuel: 3. Cost of Land and Taxes: 4. Requirement of Space: 5. Availability of Site for Water Power: 6. Storage Space for Fuel: 7. Transportation Facilities: 8. Availability of Cooling Water: 9. Disposal of Ash: 10. Pollution and Noise: 11. Nature of Load: 12. Reliability of Supply:	ANY EIGHT 4M
	d)	World and National scenario of demand and supply of energy: World energy consumption is the total energy produced and used by the entire human civilization. Typically measured per year, it involves all energy harnessed from every energy source applied towards humanity's endeavors across every single industrial and technological sector, across every country. It does not include energy from food, and the extent to which direct biomass burning has been accounted for is poorly documented. Being the power source metric of civilization, world energy consumption has deep implications for humanity's socio-economic-political sphere. World total primary energy consumption by fuel in 2018 Coal (27%) Natural Gas (24%)	4M

Hydro (renewables) (7%)
Nuclear (4%)
Oil (34%)
Others (renewables) (4%)

Demand of energy in India

During the fiscal year 2017-18, the utility energy availability was 1,205 billion KWh, a short fall relative to requirements of 8 billion KWh (-0.7%). Peak load met was 160,752 MW, 3,314 MW (-2%) below requirements. In the 2018 Load Generation Balance report, India's Central Electricity Authority anticipated energy surplus and peak surplus to be 4.6% and 2.5%, respectively, for the 2018–19 fiscal year It stated that power would be made available to the few states expected to face shortages from regions with a surplus, through regional transmission links From calendar year 2015 onwards, power generation in India has been less of a problem than power distribution.

Supply

India has recorded rapid growth in electricity generation since 1985, increasing from 179 TW-hr in 1985 to 1,057 TW-hr in 2012.The majority of the increase came from coal-fired plants and non-conventional renewable energy sources (RES), with the contribution from natural gas, oil, and hydro plants decreasing in 2012-2017. The gross utility electricity generation (excluding imports from Bhutan) was 1,372 billion kWh in 2018-19, representing 5.53% annual growth compared to 2017-2018.The contribution from renewable energy sources was nearly 17% of the total. In the year 2018-19, more than 50% is contributed by the renewable energy sources to the total incremental electricity generation.

	e)	Q4 (e) Plant Capacity = 60×2 + 30 = 150 mw Avg. Load = Energy Produced / year / 8760 = 700×10^6 / 8760 = 79.90 mw — (1) Plant Load factor = 79.90 / 150 = 0.5326 = 53.26% — (1) Plant use factor = Actual Energy Produced / max. possible energy that can be produced max. possible energy that can be Produced = (60×2×7000) + (30×1500) = 840,000 + 45000 = 8,85,000 mwh = 885×10^6 kwh — (1) ∴ Plant use factor = 700×10^6 / 885×10^6 = 0.79 — (1)	04 M
Q.5	a)	***Lamont Boiler:*** **Principle:** This boiler works on basic principle of forced convection. If the water is circulate by a pump inside the tube, the heat transfer rate from gas to the water is increases. It is the basic principle of it. **Construction:** This boiler is the first force circulation boiler. This boiler consist various part which are as follow. Economizer: Economizer use to preheat the water by using remaining heat of the combustion gases. It	2M

increases the boiler efficiency. The feed water first supplied to the economizer before entering to the boiler.

Centrifugal pump:

The Lamont boiler is a force convection boiler. So a centrifugal pump is used to circulate water inside the boiler. This pump is driven by a steam turbine. The steam for the turbine is taken by the boiler.

Evaporator tube:

The evaporator tube or can say water tubes are situated at furnace wall which increase the heating surface of boiler. This is also at the up side and down side of the furnace and other equipment. The main function of these tubes to evaporate water into steam. This also cools down the furnace wall.

Grate:

The space in the furnace where the fuel is burn is called grate. It is bottom side of furnace.

Furnace:

In the Lamont boiler vertical furnace is used. The main function of Furnace is to burn the fuel.

Super heater:

The steam generated by the evaporator tube is saturated steam. If it directly used in steam turbine can cause the corrosion. So the saturated steam sends to the super heater where it can increase the temperature of steam.

Water steam separator drum:

The steam separator is situated outside from the boiler. The mixture of water and steam from the evaporator tube send to the steam separator where it separate the steam and send it to super heater. The remaining water again sends to the economizer.

Air preheater:

It's main function to preheat air before entering into furnace.

2M

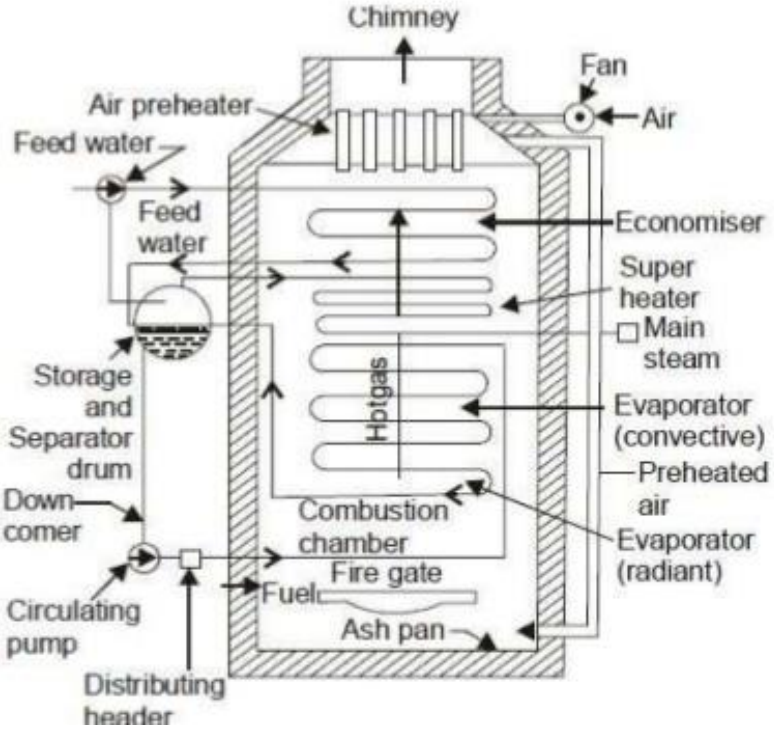
Working:

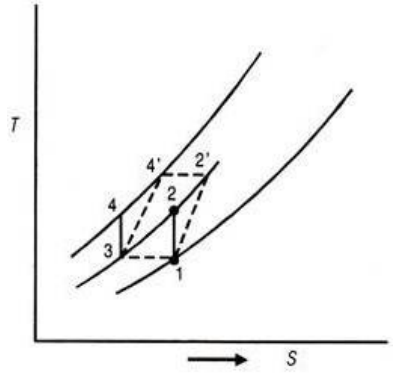
Lamont boiler is a forced circulation, internally fired water tube boiler. The fuel is burn inside the boiler and the water is circulating by a centrifugal pump through evaporator tubes. The working of this boiler is as follow.

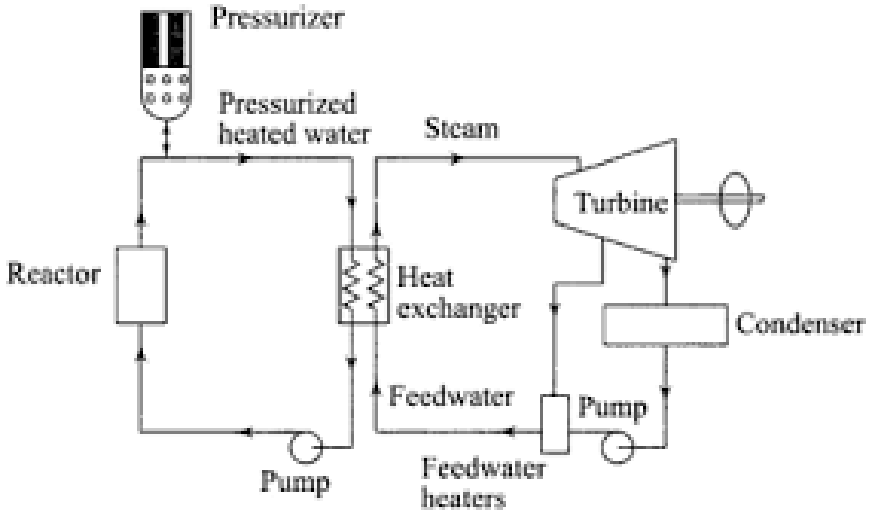
A feed pump forces the water into the economizer where the temperature of water increases. This water forced into the evaporator tube by using a centrifugal pump driven by steam turbine. Water passes 10 – 15 times into the evaporator tube. The mixture of saturated steam and water is formed inside the tube.

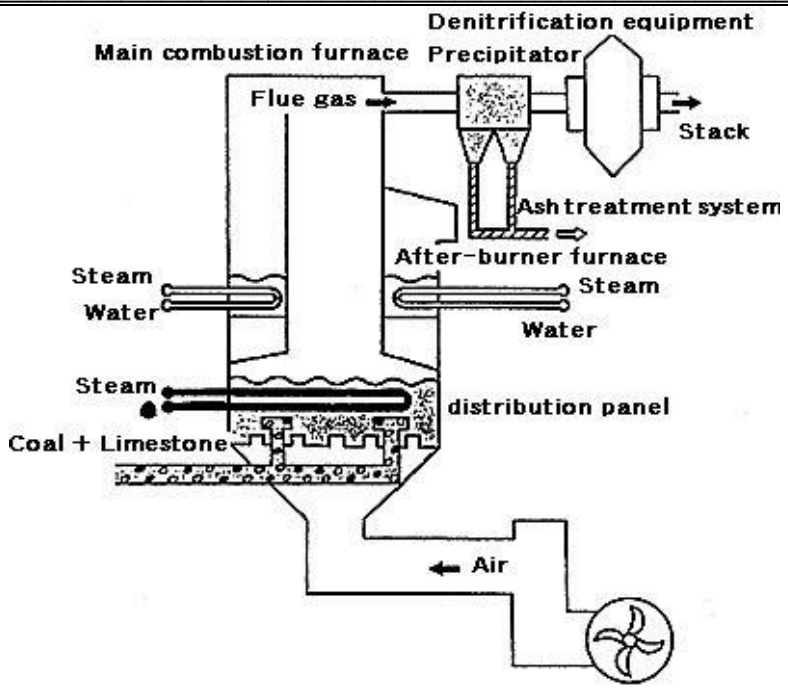
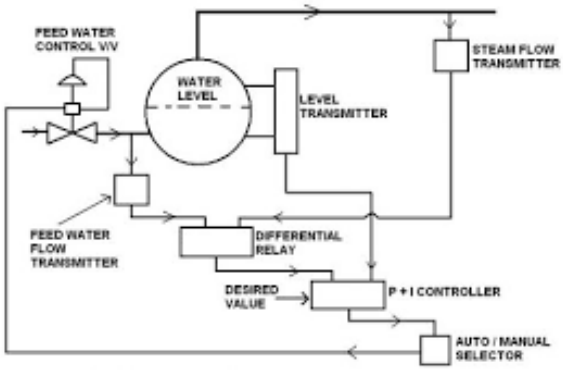
This mixture sends to the steam separator drum which is outside the boiler. Steam from the separator sends to the super heater, where the saturated steam converts into superheated steam. The water again sends to the economizer where it again passes by the evaporator tubes.

The air from the air preheater enter into the furnace where fuel burn. The flue gases first

		heat the evaporator tube then passes by the super heater. These gases from the super heater again use to preheat the air into air preheater before exhaust into atmosphere. This working pressure of this boiler is above 170 bar and have the steam generation capacity of about 50000 kg/hour at temperature 773 ^{0}K .  Lamont Boiler	2M
	b)	**Intercooling Method to improve the thermal efficiency of gas turbine plant:** Net work of the gas turbine cycle can be increased either by reducing the compressor work or increasing the turbine work.. If the compression is achieved in two or more stages, the air delivered by the 1st stage of the compressor, is cooled, on its way to the next stage. This cooling of air in between the two stages is called intercooling. When the air is cooled to the temperature of air entering any stage, intercooling is called perfect intercooling. 1- 2 Isentropic compression in first stage 2- 3 Intercooling between the stages 3-4 Isentropic compression in the second stage 1-5 Isentropic compression without intercooling Vertical distance between 3-4 is less than the vertical distance 2-5 and therefore, [(1-2) + (3-4)] < (1-5) ∴ The compression work is reduced while the turbine work remains same when other data remains same. ∴ Network = $W_t - W_{ci}$ = Constant – reduces W_c	4M

		> $W_t - W_c$ Where $W_c = h_5 - h_1$ W_{ci} = Compression work with intercooling. When the intercooling is perfect and when the intermediate pressure is the geometric mean ($P_2 = \sqrt{p_1 \times p_3}$) then the compression work is minimum.  	2M
	c)	In a Pressurised Water Reactor (PWR), ordinary (light) water is utilized to remove the heat produced inside the reactor core by nuclear fission. This water also slows down (or moderates) neutrons (constituents of atom nuclei that are released in the nuclear fission process). Slowing down neutrons is necessary to sustain the nuclear chain reaction (neutrons have to be moderated to be able to break down the fissile atom nuclei). The heat produced inside the reactor core is transferred to the turbine through the steam generators. Only heat is exchanged between the reactor cooling circuit (primary circuit) and the steam circuit used to feed the turbine (secondary circuit). No exchange of cooling water takes place. The primary water is pumped through the reactor core and the primary side of the steam generators, in four parallel closed loops, by coolant pumps powered by electric motors. Each loop is equipped with a steam generator and a coolant pump. The reactor operating pressure and temperature are such that the cooling water does not evaporate and remains in the liquid state, which increases its cooling effectiveness. A pressuriser connected to one of the coolant loops is used to control the pressure in the primary circuit. Feed water entering the secondary side of the steam generators absorbs the heat transferred from the primary side and evaporates to produce saturated steam. The steam is dried in the steam generators then delivered to the turbine. After exiting the turbine, the steam is condensed and returns as feed water to the steam generators. The generator, driven by the turbine, generates electricity.	4M

		 Pressurised Water Reactor (PWR)	2M
Q.6	a)	In Fluidized Bed Combustion Boiler technology When air or gas is passed through an inert bed of solid particles such as sand supported on a fine mesh or grid, the air initially will seek a path of least resistance and pass upward through the sand. With further increase in the velocity, the air bubbles through the bed and the particles attain a state of high turbulence. Under such conditions, the bed assumes the appearance of a fluid and exhibits the properties associated with a fluid and hence the name "Fluidized Bed combustion". **MECHANISM OF FLUIDISED BED COMBUSTION** If the sand, in a fluidized state, is heated to the ignition temperature of the fuel and the fuel is injected continuously into the bed, the fuel will burn rapidly and the bed attains a uniform temperature due to effective mixing. This, in short is fluidized bed combustion. While it is essential that temperature of bed should be at least equal to ignition temperature of fuel and it should never be allowed to approach ash fusion temperature (1050°C TO 1150°C) to avoid melting of ash. This is achieved by extracting heat from the bed by conductive and convective heat transfer through tubes immersed in the bed. If velocity is too low, fluidization will not occur and if the gas velocity becomes too high, the particles will be entrained in the gas stream and lost. Hence to sustain stable operation of the bed, it must be ensured that gas velocity is maintained between minimum fluidization velocity and particle entrainment velocity. Combustion temperature Excess air level and Superficial gas residence time are the principal factors that influence combustion efficiency of a FBC boiler. Combustion efficiency of Fluidized Bed Combustion (FBC) Boiler is 90% or greater.	4M

		 Fluidized Bed Combustion (FBC) boiler	2M
	b)	 Boiler Feed Water Control System The mass of the water flow and the steam flow must be regulated so mass water flow equals the mass steam flow to maintain drum level. The feed water control regulates the mass water flow to the boiler. The effects of the input control actions interact, since firing rate also affects steam temperature and feed water flow affects the steam pressure, which is the final arbiter of firing rate demand. Economic feasibility of a power plant requires smooth and uninterrupted plant operation in spite of varying electrical power demand. It has been observed from operation experiences of a power plant that one of frequent causes of shutdowns is by violation of safety limits on the water level. The Steam Drum level control is also an influencing factor of overall safety of the power plant as it is closely related to Main Heat Transport coolant inventory and sustained heat removal through natural circulation. Steam drum level control at multiple loop configurations has been	2M 4M

proposed to enhance the safety margin. For proper control of drum level single parameter control is not sufficient, and three element Steam Drum Level Controller has been conventionally used for most of the boilers where controlling parameters are Drum level, steam flow and feed water flow. In this paper we will discuss on some the critical issues on drum level measurement and control, design aspects and installation requirements for safe and trouble-free operation.

c)

Q5 (e)

$$\text{Load factor} = \frac{\text{Avg. Load}}{\text{Peak Load}}$$

$$0.45 = \frac{\text{Avg. Load}}{50}$$

$$\text{Avg. load} = 50 \times 0.45 = 22.5 \text{ MW} \quad (2)$$

$$\text{Demand factor} = \frac{\text{Maximum demand}}{\text{Connected load}}$$

$$= \frac{50}{(20+17+10+9)}$$

$$= \frac{50}{56} = 0.892 \quad (2)$$

$$\text{Diversity factor} = \frac{\text{Sum of Individual max. demands}}{\text{Simultaneous max. demand}}$$

$$= \frac{56}{50} = 1.12 \quad (2)$$

22566

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **10**

(a) Name any four types of power plant.

(b) State the two types of FBC boiler.

(c) State any four advantages of steam power plant.

(d) State the necessity of waste heat recovery in thermal power plant.

(e) Enlist any four nuclear fuel.

(f) Define : (i) Fixed Cost

(ii) Depreciation Cost

(g) State any four limitations of diesel power plant.

2. Attempt any THREE of the following : **12**

(a) Classify hydroelectric power plant.

(b) Explain the maintenance procedure of major components of high pressure boiler.

(c) Draw a layout of solid fuel (coal) handling system used in steam power plant.

(d) Explain working principle of co-generation with neat sketch.

3. Attempt any THREE of the following : **12**

(a) Draw typical layout of diesel engine power plant showing all system.

(b) State any four advantages of gas turbine power plant over steam power plant.

(c) Explain the concept of Trigeneration and enlist the opportunities in thermal power plant.

(d) Explain with neat sketch operating principle of Nuclear power plant.

4. Attempt any THREE of the following : **12**

(a) Explain with neat sketch operating principle of hydroelectric power plant.

(b) State any four advantages and limitations of nuclear power plant.

(c) List the factors to be considered while choosing the type of power plant.

(d) Explain world and national scenario of demand and supply of energy.

(e) A power station has two 60 MW units each running for 7000 hours a year and one 30 MW unit running for 1500 hours a year. The energy produced per year is 700×10^6 kWh.

Calculate : (i) Plant load factor

(ii) Plant use factor

5. Attempt any TWO of the following : **12**

(a) Explain with neat sketch construction and working of Lamont boiler.

(b) Explain with neat sketch intercooling method used to improve the thermal efficiency of a open cycle gas turbine plant.

(c) Explain with neat sketch Pressurised Water Reactor (PWR).

6. Attempt any TWO of the following : **12**

(a) Explain with neat sketch working principle of Fluidized Bed Combustion (FBC) boiler.

(b) Draw schematic diagram of boiler feed water control system. State its importance in thermal power plant.

(c) A 60 MW power station has an annual peak load of 50 MW. The power station supplies loads having maximum demands of 20 MW, 17 MW, 10 MW and 9 MW. The annual load factor is 0.45.

Find : (i) Average load

(ii) Demand factor

(iii) Diversity factor

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*
(2) Illustrate your answers with neat sketches wherever necessary.
(3) Figures to the right indicate full marks.
(4) Assume suitable data, if necessary.
(5) Use of Non-programmable Electronic Pocket Calculator is permissible.
(6) Use of psychrometric chart is allowed.

Marks

1. Attempt any FIVE of the following : **10**

(a) List diagnostic tools used in fault finding of MPFI engines.
(b) Define SEER & EER.
(c) State purpose of Selective Catalytic Reduction (SCR).
(d) Define Pressure Ratio in air compressors.
(e) List at least six components of a jet engine.
(f) List different liquid propellants used in rocket engines.
(g) State four objectives of supercharging.

2. Attempt any THREE of the following : **12**

(a) Draw actual indicator diagram for 4 stroke petrol engine.
(b) Draw a typical graph indicating changes in pollutants level (HC, CO_2 & CO) with respect to changes in air fuel ratio.
(c) Describe in brief working of axial flow compressor with sketch.
(d) Explain in brief aero derivative & heavy frame engine. State their applications separately.

3. Attempt any THREE of the following : **12**

(a) List changes made by automobile manufactures in achieving BS VI norms in diesel engines.
(b) Discuss in brief process of combustion in SI engines with a sketch.
(c) Explain working of a storage type water cooler with a sketch.
(d) In otto cycle compression ratio is 8. Calculate air standard efficiency. Will it be grater than Carnot Cycle ? Justify your answer.

4. Attempt any THREE of the following : **12**

(a) Draw inline fuel injection pump. Name different components.

(b) With sketch, justify use of Variable Geometry Turbocharger as compared to fixed geometry turbocharger.

(c) State formulae to calculate TEWI & LCCP.

(d) Draw PV diagram for working of two stage reciprocating air compressor when inter-cooling in perfect and imperfect.

(e) Compare turbojet & turboprop engines (at least four parameters).

5. Attempt any TWO of the following : **12**

(a) A two stroke cycle internal combustion engine has a mean effective pressure of 5.8 bar. The speed of the engine is 940 rpm. If the diameter of piston and stroke are 120 mm and 130 mm respectively, find the indicated power developed and piston speed.

(b) A single acting reciprocating air compressor has cylinder diameter and stroke of 201 mm & 301 mm respectively. The compressor sucks air at 1 bar and 27 °C and delivers at 8 bar while running at 101 rpm. Find indicate power of compressor, mass of air delivered by compressor per minute. Compression follows law $PV^{1.25} = C$ Take R = 287 J/kg K.

(c) In a typical refrigeration system refrigerating effect of 9.5 Tons of refrigeration is expected. Enthalpy values of refrigerant per kg at various locations are 185 kJ (compressor inlet), 206 kJ (compressor outlet), 70 kJ (condenser exit). Assuming no under cooling & superheating find mass of refrigerant per second required to be circulated. Also find COP of the system.

6. Attempt any TWO of the following : **12**

(a) A 4 cylinder, 4 stroke petrol engine has 5 cm bore and 8 cm stroke. It was tested at constant speed. Fuel consumption was 0.13 kg/min. Spark plugs for four cylinders were cut one after other. Brake Power was measured and was found as follows :

When all cylinders working = 16.25 kW, first cylinder cutoff = 11.55 kW, second cylinder cutoff = 11.65 kW, third cylinder cutoff = 11.70 kW, fourth cylinder cutoff = 11.50 kW. Find IP & Mechanical Efficiency.

(b) Compare reciprocating and rotary air compressor (at least six points).

(c) Expected room conditions are 20 °C & 55% RH. Outdoor conditions are 39 °C and RH 70%. Locate both points on psychrometric chart and find how much enthalpy per kg of air and moisture content per kg of dry air need to be changed to achieve room conditions. Draw skeleton of psychrometric chart and show both points.

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