



# SESSION - 3





## GATE 2014: General Instructions during Examination


1. Total duration of the GATE examination is **180** minutes.
2. The clock will be set at the server. The countdown timer at the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You need not terminate the examination or submit your paper.
3. Any useful data required for your paper can be viewed by clicking on the **Useful Common Data** button that appears on the screen.
4. Use the scribble pad provided to you for any rough work. Submit the scribble pad at the end of the examination.
5. You are allowed to use a non-programmable type calculator, however, sharing of calculators is not allowed.
6. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

 You have not visited the question yet.

 You have not answered the question.

 You have answered the question.

 You have NOT answered the question, but have marked the question for review.

 You have answered the question, but marked it for review.

The **Marked for Review** status for a question simply indicates that you would like to look at that question again. *If a question is answered, but marked for review, then the answer will be considered for evaluation unless the status is modified by the candidate.*

### Navigating to a Question :

7. To answer a question, do the following:
  - a. Click on the question number in the Question Palette to go to that question directly.
  - b. Select an answer for a multiple choice type question by clicking on the bubble placed before the 4 choices, namely A, B, C and D. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
  - c. Click on **Save & Next** to save your answer for the current question and then go to the next question.
  - d. Click on **Mark for Review & Next** to save your answer for the current question and also mark it for review, and then go to the next question.

**Caution:** Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on a question number without saving the answer to the previous question.

You can view all the questions by clicking on the **Question Paper** button. This feature is provided, so that if you want you can just see the entire question paper at a glance.

### Answering a Question :

8. Procedure for answering a multiple choice (MCQ) type question:
  - a. Choose one answer from the 4 options (A,B,C,D) given below the question, click on the bubble placed before the chosen option.
  - b. To deselect your chosen answer, click on the bubble of the chosen option again or click on the **Clear Response** button.
  - c. To change your chosen answer, click on the bubble of another option.
  - d. To save your answer, you MUST click on the **Save & Next** button.
9. Procedure for answering a numerical answer type question:
  - a. To enter a number as your answer, use the virtual numerical keypad.
  - b. A fraction (e.g. -0.3 or -.3) can be entered as an answer with or without '0' before the decimal point. As many as four decimal points, e.g. 12.5435 or 0.003 or -932.6711 or 12.82 can be entered.
  - c. To clear your answer, click on the **Clear Response** button.
  - d. To save your answer, you MUST click on the **Save & Next** button
10. To mark a question for review, click on the **Mark for Review & Next** button. *If an answer is selected (for MCQ) or entered (for numerical answer type) for a question that is **Marked for Review**, that answer will be considered in the evaluation unless the status is modified by the candidate.*
11. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.
12. Note that ONLY Questions for which answers are **saved** or **marked for review after answering** will be considered for evaluation.

### Choosing a Section :

13. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing will be highlighted.
14. A checkbox is displayed for every optional Section, if any, in the Question Paper. To select the optional Section for answering, click on the checkbox for that Section.
15. If the checkbox for an optional Section is not selected, the **Save & Next** button and the **Mark for Review & Next** button will NOT be enabled for that Section. You will

only be able to see questions in this Section, but you will not be able to answer questions in the Section.

16. After clicking the **Save & Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.
17. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

### **Changing the Optional Section :**

18. After answering the chosen optional Section, partially or completely, you can change the optional Section by selecting the checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section. If you do not want to reset the Section and want to continue answering the previously chosen optional Section, then click on the **BACK** button.
19. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.
20. You can shuffle between different Sections or change the optional Sections any number of times.

# GATE 2014 Examination

## EE: Electrical Engineering

Duration: 180 minutes

Maximum Marks: 100

**Read the following instructions carefully.**

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen.
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory.  
The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.  
The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.
5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type (MCQ)** and **numerical answer type**.
9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (○) placed before the choice.
10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices. **For these questions, the answer should be entered** by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of  $\frac{1}{3}$  marks for a 1-mark question and  $\frac{2}{3}$  marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.
13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

### **Declaration by the candidate:**

“I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition”.

**Q. 1 – Q. 5 carry one mark each.**

- Q.1 While trying to collect an envelope from under the table, Mr. X fell down and was losing consciousness.
- I II III
- IV

Which one of the above underlined parts of the sentence is NOT appropriate?

- (A) I (B) II (C) III (D) IV
- Q.2 If she \_\_\_\_\_ how to calibrate the instrument, she \_\_\_\_\_ done the experiment.
- (A) knows, will have (B) knew, had  
(C) had known, could have (D) should have known, would have
- Q.3 Choose the word that is opposite in meaning to the word “coherent”.
- (A) sticky (B) well-connected (C) rambling (D) friendly
- Q.4 Which number does not belong in the series below?  
2, 5, 10, 17, 26, 37, 50, 64
- (A) 17 (B) 37 (C) 64 (D) 26
- Q.5 The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

Q No.	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	2	23	18	3

What is the average of the marks obtained by the class in the examination?

- (A) 1.34 (B) 1.74 (C) 3.02 (D) 3.91
- Q. 6 – Q. 10 carry two marks each.**

- Q.6 A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is
- (A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.  
(B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.  
(C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.  
(D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

- Q.7 By the beginning of the 20<sup>th</sup> century, several hypotheses were being proposed, suggesting a paradigm shift in our understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

Which of the following inference(s) may be drawn from the above passage?

- (i) Our understanding of the universe changes based on the positions of stars
- (ii) Paradigm shifts usually occur at the beginning of centuries
- (iii) Stars are important objects in the universe
- (iv) Experimental evidence was important in confirming this paradigm shift

(A) (i), (ii) and (iv)      (B) (iii) only      (C) (i) and (iv)      (D) (iv) only

- Q.8 The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013

- (A) increased by 5 %      (B) decreased by 13%  
(C) decreased by 20%      (D) decreased by 11%

- Q.9 The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?



- (A) 1:1      (B) 2:1      (C) 1.5:1      (D) 2.5:1

- Q.10 Consider the equation:  $(7526)_8 - (Y)_8 = (4364)_8$ , where  $(X)_N$  stands for X to the base N. Find Y.

- (A) 1634      (B) 1737      (C) 3142      (D) 3162

**END OF THE QUESTION PAPER**

**Q. 1 – Q. 25 carry one mark each.**

Q.1 Two matrices  $A$  and  $B$  are given below:

$$A = \begin{bmatrix} p & q \\ r & s \end{bmatrix}; \quad B = \begin{bmatrix} p^2 + q^2 & pr + qs \\ pr + qs & r^2 + s^2 \end{bmatrix}$$

If the rank of matrix  $A$  is  $N$ , then the rank of matrix  $B$  is

- (A)  $N/2$  (B)  $N-1$  (C)  $N$  (D)  $2N$

Q.2 A particle, starting from origin at  $t = 0$  s, is traveling along  $x$ -axis with velocity

$$\mathbf{v} = \frac{\pi}{2} \cos\left(\frac{\pi}{2}t\right) \text{ m/s}$$

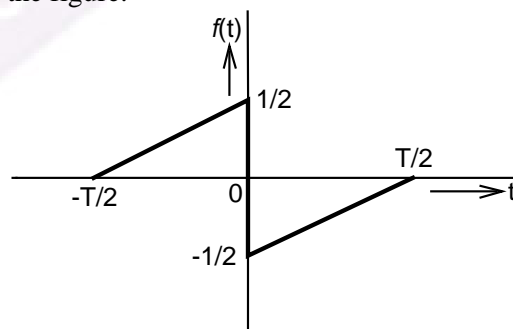
At  $t = 3$  s, the difference between the distance covered by the particle and the magnitude of displacement from the origin is \_\_\_\_\_.

Q.3 Let  $\nabla \cdot (f \mathbf{v}) = x^2y + y^2z + z^2x$ , where  $f$  and  $\mathbf{v}$  are scalar and vector fields respectively. If  $\mathbf{v} = y\mathbf{i} + z\mathbf{j} + x\mathbf{k}$ , then  $\mathbf{v} \cdot \nabla f$  is

- (A)  $x^2y + y^2z + z^2x$  (B)  $2xy + 2yz + 2zx$   
(C)  $x + y + z$  (D) 0

Q.4 Lifetime of an electric bulb is a random variable with density  $f(x) = kx^2$ , where  $x$  is measured in years. If the minimum and maximum lifetimes of bulb are 1 and 2 years respectively, then the value of  $k$  is \_\_\_\_\_.

Q.5 A function  $f(t)$  is shown in the figure.



The Fourier transform  $F(\omega)$  of  $f(t)$  is

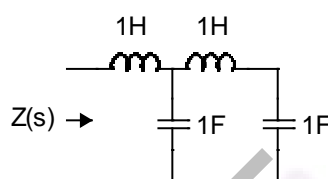
- (A) real and even function of  $\omega$ . (B) real and odd function of  $\omega$ .  
(C) imaginary and odd function of  $\omega$ . (D) imaginary and even function of  $\omega$ .



- Q.6 The line A to neutral voltage is  $10\angle 15^\circ$  V for a balanced three phase star-connected load with phase sequence ABC. The voltage of line B with respect to line C is given by
- (A)  $10\sqrt{3}\angle 105^\circ$  V (B)  $10\angle 105^\circ$  V  
 (C)  $10\sqrt{3}\angle -75^\circ$  V (D)  $-10\sqrt{3}\angle 90^\circ$  V

- Q.7 A hollow metallic sphere of radius  $r$  is kept at potential of 1 Volt. The total electric flux coming out of the concentric spherical surface of radius  $R$  ( $> r$ ) is
- (A)  $4\pi\epsilon_0 r$  (B)  $4\pi\epsilon_0 r^2$  (C)  $4\pi\epsilon_0 R$  (D)  $4\pi\epsilon_0 R^2$

- Q.8 The driving point impedance  $Z(s)$  for the circuit shown below is



- (A)  $\frac{s^4 + 3s^2 + 1}{s^3 + 2s}$  (B)  $\frac{s^4 + 2s^2 + 4}{s^2 + 2}$   
 (C)  $\frac{s^2 + 1}{s^4 + s^2 + 1}$  (D)  $\frac{s^3 + 1}{s^4 + s^2 + 1}$

- Q.9 A signal is represented by

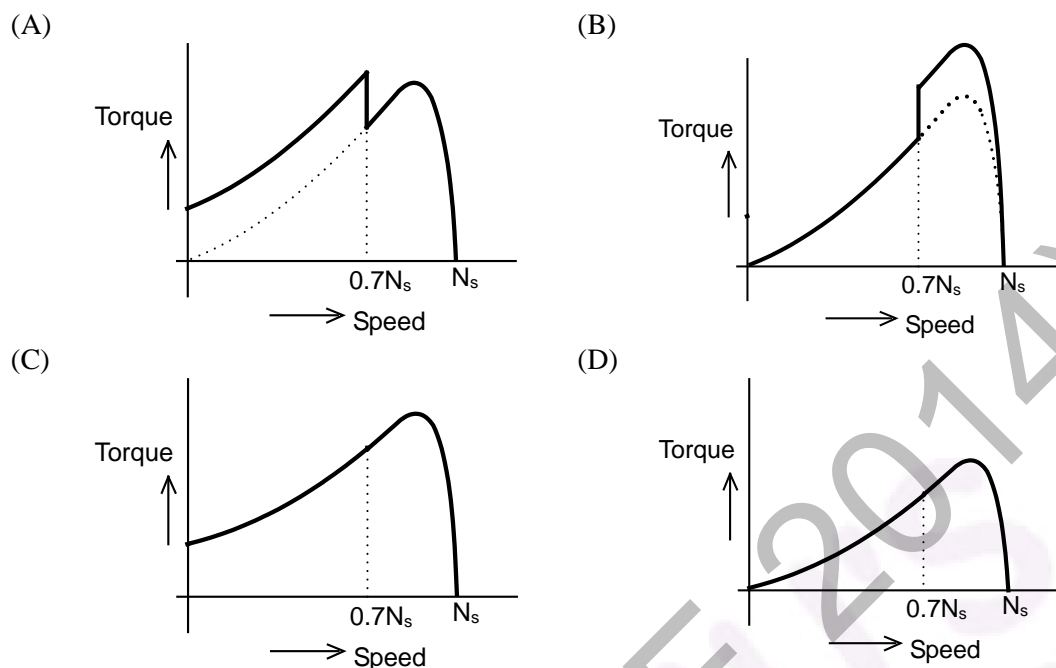
$$x(t) = \begin{cases} 1 & |t| < 1 \\ 0 & |t| > 1 \end{cases}$$

The Fourier transform of the convolved signal  $y(t) = x(2t) * x(t/2)$  is

- (A)  $\frac{4}{\omega^2} \sin\left(\frac{\omega}{2}\right) \sin(2\omega)$  (B)  $\frac{4}{\omega^2} \sin\left(\frac{\omega}{2}\right)$   
 (C)  $\frac{4}{\omega^2} \sin(2\omega)$  (D)  $\frac{4}{\omega^2} \sin^2 \omega$
- Q.10 For the signal  $f(t) = 3 \sin 8\pi t + 6 \sin 12\pi t + \sin 14\pi t$ , the minimum sampling frequency (in Hz) satisfying the Nyquist criterion is \_\_\_\_\_.

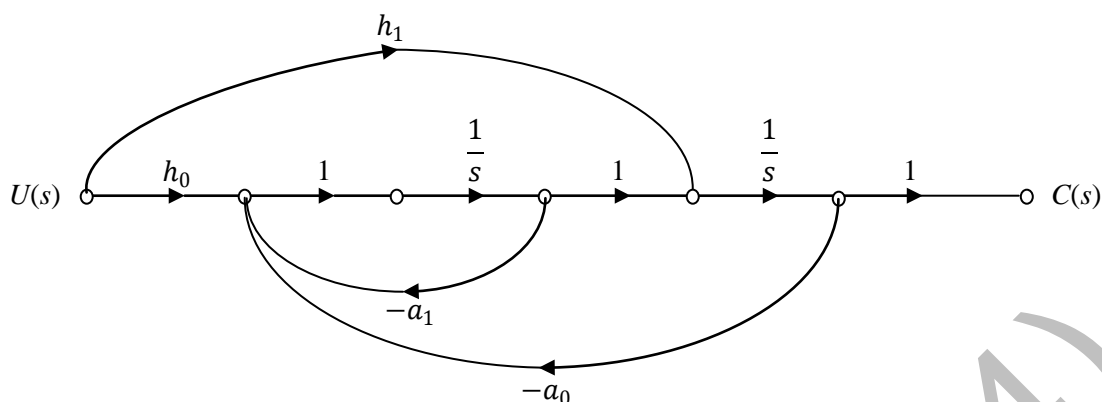
- Q.11 In a synchronous machine, hunting is predominantly damped by
- (A) mechanical losses in the rotor  
 (B) iron losses in the rotor  
 (C) copper losses in the stator  
 (D) copper losses in the rotor

- Q.12 A single phase induction motor is provided with capacitor and centrifugal switch in series with auxiliary winding. The switch is expected to operate at a speed of  $0.7 N_s$ , but due to malfunctioning the switch fails to operate. The torque-speed characteristic of the motor is represented by



- Q.13 The no-load speed of a 230 V separately excited dc motor is 1400 rpm. The armature resistance drop and the brush drop are neglected. The field current is kept constant at rated value. The torque of the motor in Nm for an armature current of 8 A is \_\_\_\_\_.
- Q.14 In a long transmission line with  $r, l, g$  and  $c$  are the resistance, inductance, shunt conductance and capacitance per unit length, respectively, the condition for distortionless transmission is
- (A)  $rc = lg$  (B)  $r = \sqrt{l/c}$   
 (C)  $rg = lc$  (D)  $g = \sqrt{c/l}$
- Q.15 For a fully transposed transmission line
- (A) positive, negative and zero sequence impedances are equal  
 (B) positive and negative sequence impedances are equal  
 (C) zero and positive sequence impedances are equal  
 (D) negative and zero sequence impedances are equal
- Q.16 A 183-bus power system has 150 PQ buses and 32 PV buses. In the general case, to obtain the load flow solution using Newton-Raphson method in polar coordinates, the minimum number of simultaneous equations to be solved is \_\_\_\_\_.

Q.17 The signal flow graph of a system is shown below.  $U(s)$  is the input and  $C(s)$  is the output.



Assuming,  $h_1 = b_1$  and  $h_0 = b_0 - b_1 a_1$ , the input-output transfer function,  $G(s) = \frac{C(s)}{U(s)}$  of the system is given by

(A)  $G(s) = \frac{b_0 s + b_1}{s^2 + a_0 s + a_1}$

(B)  $G(s) = \frac{a_1 s + a_0}{s^2 + b_1 s + b_0}$

(C)  $G(s) = \frac{b_1 s + b_0}{s^2 + a_1 s + a_0}$

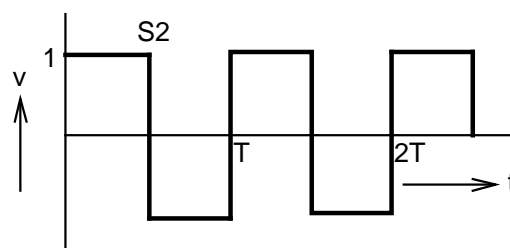
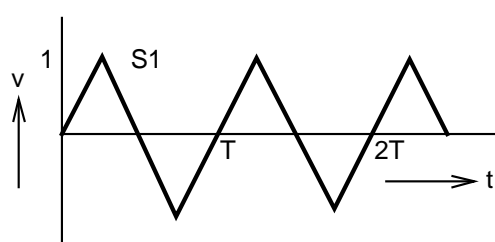
(D)  $G(s) = \frac{a_0 s + a_1}{s^2 + b_0 s + b_1}$

Q.18 A single-input single-output feedback system has forward transfer function  $G(s)$  and feedback transfer function  $H(s)$ . It is given that  $|G(s)H(s)| < 1$ . Which of the following is true about the stability of the system?

- (A) The system is always stable
- (B) The system is stable if all zeros of  $G(s)H(s)$  are in left half of the  $s$ -plane
- (C) The system is stable if all poles of  $G(s)H(s)$  are in left half of the  $s$ -plane
- (D) It is not possible to say whether or not the system is stable from the information given

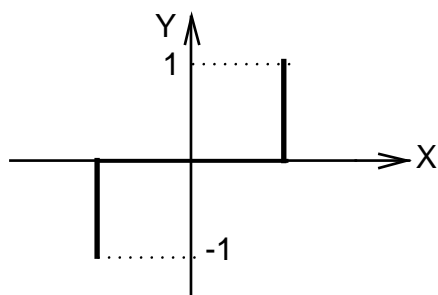
Q.19 An LPF wattmeter of power factor 0.2 is having three voltage settings 300 V, 150 V and 75 V, and two current settings 5 A and 10 A. The full scale reading is 150. If the wattmeter is used with 150 V voltage setting and 10 A current setting, the multiplying factor of the wattmeter is \_\_\_\_\_.

- Q.20 The two signals S1 and S2, shown in figure, are applied to Y and X deflection plates of an oscilloscope.

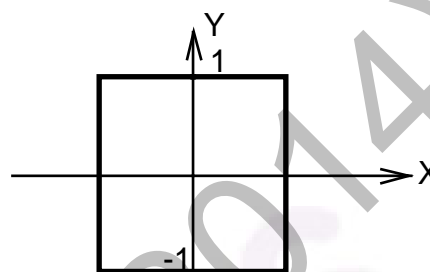


The waveform displayed on the screen is

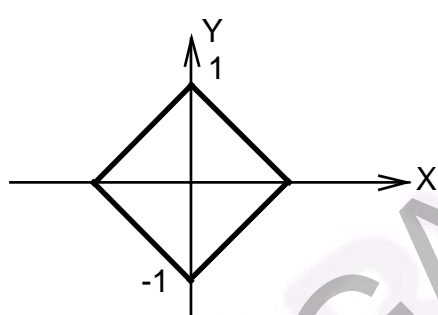
(A)



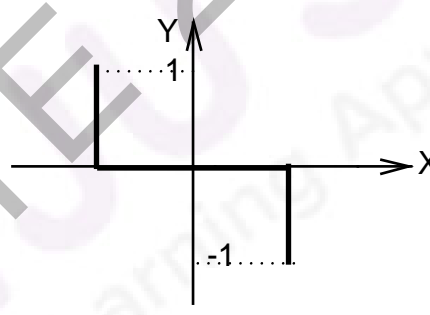
(B)



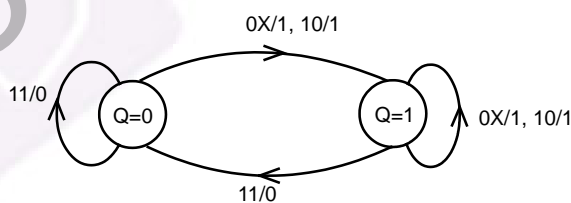
(C)



(D)



- Q.21 A state diagram of a logic gate which exhibits a delay in the output is shown in the figure, where X is the don't care condition, and Q is the output representing the state.



The logic gate represented by the state diagram is

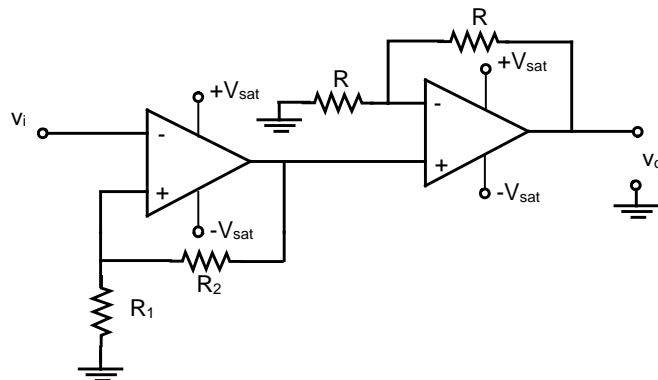
(A) XOR

(B) OR

(C) AND

(D) NAND

Q.22 An operational-amplifier circuit is shown in the figure.



The output of the circuit for a given input  $v_i$  is

- (A)  $-\left(\frac{R_2}{R_1}\right)v_i$  (B)  $-\left(1 + \frac{R_2}{R_1}\right)v_i$   
 (C)  $\left(1 + \frac{R_2}{R_1}\right)v_i$  (D)  $+V_{sat}$  or  $-V_{sat}$

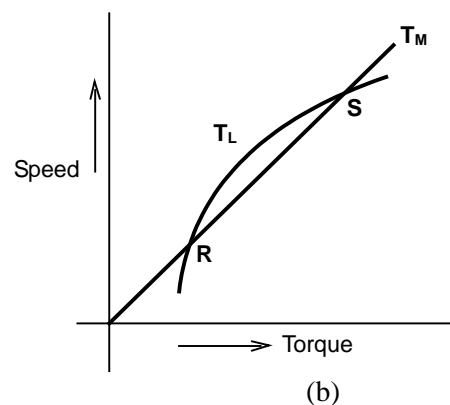
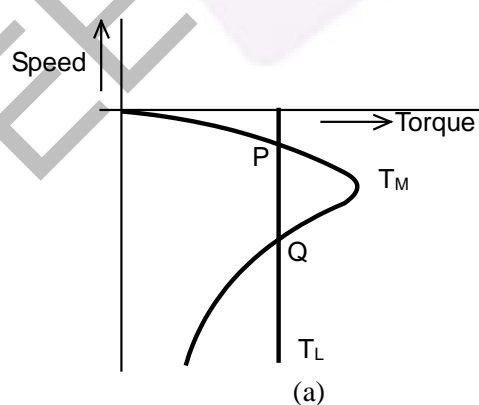
Q.23 In 8085A microprocessor, the operation performed by the instruction LHL D 2100<sub>H</sub> is

- (A)  $(H) \leftarrow 21_H$ ,  $(L) \leftarrow 00_H$   
 (B)  $(H) \leftarrow M(2100_H)$ ,  $(L) \leftarrow M(2101_H)$   
 (C)  $(H) \leftarrow M(2101_H)$ ,  $(L) \leftarrow M(2100_H)$   
 (D)  $(H) \leftarrow 00_H$ ,  $(L) \leftarrow 21_H$

Q.24 A non-ideal voltage source  $V_s$  has an internal impedance of  $Z_s$ . If a purely resistive load is to be chosen that maximizes the power transferred to the load, its value must be

- (A) 0  
 (B) real part of  $Z_s$   
 (C) magnitude of  $Z_s$   
 (D) complex conjugate of  $Z_s$

Q.25 The torque-speed characteristics of motor ( $T_M$ ) and load ( $T_L$ ) for two cases are shown in the figures (a) and (b). The load torque is equal to motor torque at points P, Q, R and S



The stable operating points are

- (A) P and R (B) P and S (C) Q and R (D) Q and S

**Q. 26 – Q. 55 carry two marks each.**

Q.26

Integration of the complex function  $f(z) = \frac{z^2}{z^2 - 1}$ , in the counterclockwise direction, around  $|z-1| = 1$ , is

- (A)  $-\pi i$  (B) 0 (C)  $\pi i$  (D)  $2\pi i$

Q.27

The mean thickness and variance of silicon steel laminations are 0.2 mm and 0.02 respectively. The varnish insulation is applied on both the sides of the laminations. The mean thickness of one side insulation and its variance are 0.1 mm and 0.01 respectively. If the transformer core is made using 100 such varnish coated laminations, the mean thickness and variance of the core respectively are

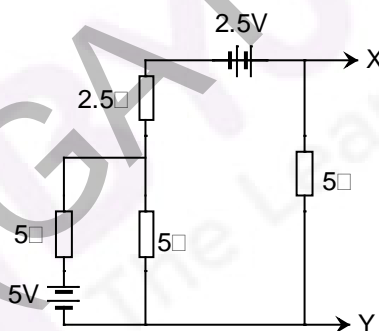
- (A) 30 mm and 0.22 (B) 30 mm and 2.44 (C) 40 mm and 2.44 (D) 40 mm and 0.24

Q.28

The function  $f(x) = e^x - 1$  is to be solved using Newton-Raphson method. If the initial value of  $x_0$  is taken as 1.0, then the absolute error observed at 2<sup>nd</sup> iteration is \_\_\_\_\_.

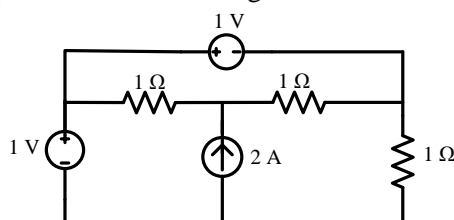
Q.29

The Norton's equivalent source in amperes as seen into the terminals X and Y is \_\_\_\_\_.

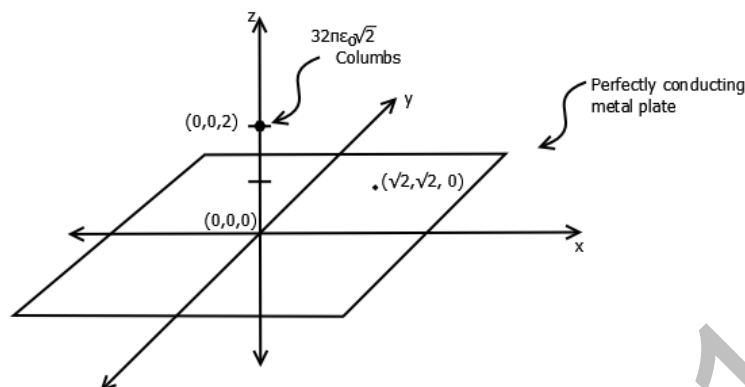


Q.30

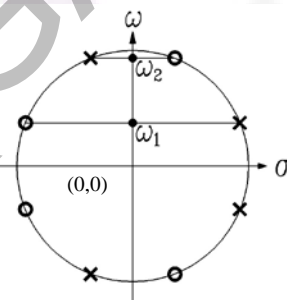
The power delivered by the current source, in the figure, is \_\_\_\_\_.



- Q.31 A perfectly conducting metal plate is placed in x-y plane in a right handed coordinate system. A charge of  $+32\pi\epsilon_0\sqrt{2}$  coulombs is placed at coordinate  $(0, 0, 2)$ .  $\epsilon_0$  is the permittivity of free space. Assume  $\hat{i}$ ,  $\hat{j}$ ,  $\hat{k}$  to be unit vectors along x, y and z axes respectively. At the coordinate  $(\sqrt{2}, \sqrt{2}, 0)$ , the electric field vector  $\vec{E}$  (Newtons/Columb) will be

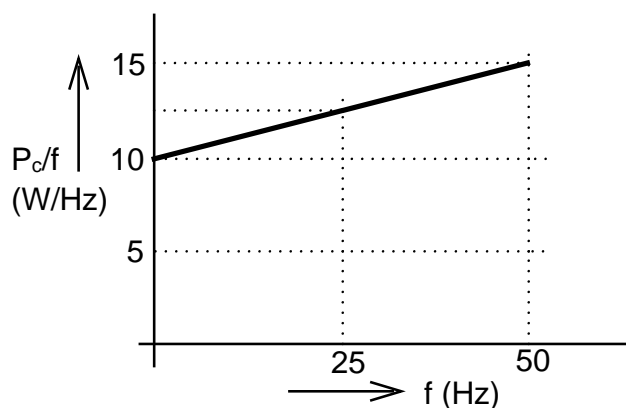


- (A)  $2\sqrt{2} \hat{k}$  (B)  $-2 \hat{k}$  (C)  $2 \hat{k}$  (D)  $-2\sqrt{2} \hat{k}$
- Q.32 A series  $RLC$  circuit is observed at two frequencies. At  $\omega_1 = 1$  krad/s, we note that source voltage  $V_1 = 100\angle 0^\circ$  V results in a current  $I_1 = 0.03\angle 31^\circ$  A. At  $\omega_2 = 2$  krad/s, the source voltage  $V_2 = 100\angle 0^\circ$  V results in a current  $I_2 = 2\angle 0^\circ$  A. The closest values for  $R, L, C$  out of the following options are
- (A)  $R = 50 \Omega; L = 25$  mH;  $C = 10 \mu\text{F}$ ; (B)  $R = 50 \Omega; L = 10$  mH;  $C = 25 \mu\text{F}$ ;  
 (C)  $R = 50 \Omega; L = 50$  mH;  $C = 5 \mu\text{F}$ ; (D)  $R = 50 \Omega; L = 5$  mH;  $C = 50 \mu\text{F}$ ;
- Q.33 A continuous-time LTI system with system function  $H(\omega)$  has the following pole-zero plot. For this system, which of the alternatives is TRUE?



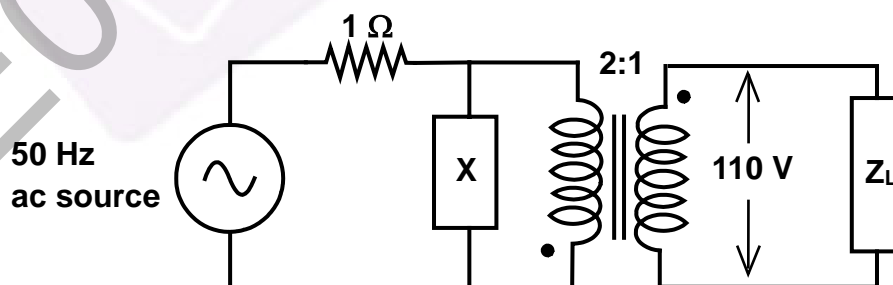
- (A)  $|H(0)| > |H(\omega)|; |\omega| > 0$  (B)  $|H(\omega)|$  has multiple maxima, at  $\omega_1$  and  $\omega_2$   
 (C)  $|H(0)| < |H(\omega)|; |\omega| > 0$  (D)  $|H(\omega)| = \text{constant}; -\infty < \omega < \infty$
- Q.34 A sinusoid  $x(t)$  of unknown frequency is sampled by an impulse train of period 20 ms. The resulting sample train is next applied to an ideal lowpass filter with a cutoff at 25 Hz. The filter output is seen to be a sinusoid of frequency 20 Hz. This means that  $x(t)$  has a frequency of
- (A) 10 Hz (B) 60 Hz (C) 30 Hz (D) 90 Hz
- Q.35 A differentiable non constant even function  $x(t)$  has a derivative  $y(t)$ , and their respective Fourier Transforms are  $X(\omega)$  and  $Y(\omega)$ . Which of the following statements is TRUE?
- (A)  $X(\omega)$  and  $Y(\omega)$  are both real. (B)  $X(\omega)$  is real and  $Y(\omega)$  is imaginary.  
 (C)  $X(\omega)$  and  $Y(\omega)$  are both imaginary. (D)  $X(\omega)$  is imaginary and  $Y(\omega)$  is real.

- Q.36 An open circuit test is performed on 50 Hz transformer, using variable frequency source and keeping  $V/f$  ratio constant, to separate its eddy current and hysteresis losses. The variation of core loss/frequency as function of frequency is shown in the figure



The hysteresis and eddy current losses of the transformer at 25 Hz respectively are

- (A) 250 W and 2.5 W (B) 250 W and 62.5 W  
(C) 312.5 W and 62.5 W (D) 312.5 W and 250 W
- Q.37 A non-salient pole synchronous generator having synchronous reactance of 0.8 pu is supplying 1 pu power to a unity power factor load at a terminal voltage of 1.1 pu. Neglecting the armature resistance, the angle of the voltage behind the synchronous reactance with respect to the angle of the terminal voltage in degrees is \_\_\_\_\_.
- Q.38 A separately excited 300 V DC shunt motor under no load runs at 900 rpm drawing an armature current of 2 A. The armature resistance is  $0.5 \Omega$  and leakage inductance is 0.01 H. When loaded, the armature current is 15 A. Then the speed in rpm is \_\_\_\_\_
- Q.39 The load shown in the figure absorbs 4 kW at a power factor of 0.89 lagging.



Assuming the transformer to be ideal, the value of the reactance  $X$  to improve the input power factor to unity is \_\_\_\_\_.



Q.40 The parameters measured for a 220V/110V, 50 Hz, single-phase transformer are:

Self inductance of primary winding = 45 mH

Self inductance of secondary winding = 30 mH

Mutual inductance between primary and secondary windings = 20 mH

Using the above parameters, the leakage ( $L_{l1}$ ,  $L_{l2}$ ) and magnetizing ( $L_m$ ) inductances as referred to primary side in the equivalent circuit respectively, are

(A) 5mH, 20mH and 40mH

(B) 5mH, 80mH and 40mH

(C) 25mH, 10mH and 20mH

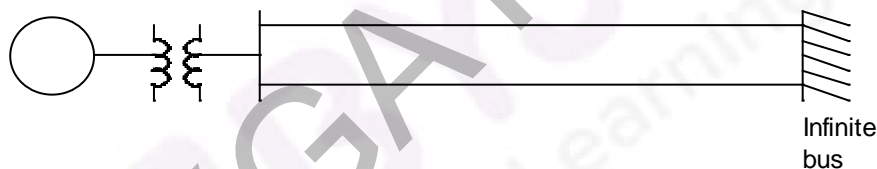
(D) 45mH, 30mH and 20mH

Q.41 For a 400 km long transmission line, the series impedance is  $(0.0 + j0.5) \Omega/\text{km}$  and the shunt admittance is  $(0.0 + j5.0) \mu\text{mho}/\text{km}$ . The magnitude of the series impedance (in  $\Omega$ ) of the equivalent  $\pi$  circuit of the transmission line is \_\_\_\_\_.

Q.42 The complex power consumed by a constant-voltage load is given by  $(P_1 + jQ_1)$ , where,  $1 \text{ kW} \leq P_1 \leq 1.5 \text{ kW}$  and  $0.5 \text{ kVAR} \leq Q_1 \leq 1 \text{ kVAR}$ .

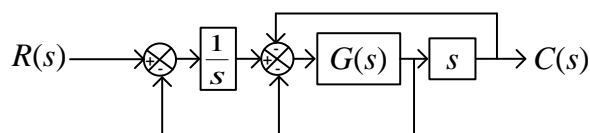
A compensating shunt capacitor is chosen such that  $|Q| \leq 0.25 \text{ kVAR}$ , where  $Q$  is the net reactive power consumed by the capacitor-load combination. The reactive power (in kVAR) supplied by the capacitor is \_\_\_\_\_.

Q.43 The figure shows the single line diagram of a single machine infinite bus system.



The inertia constant of the synchronous generator  $H = 5 \text{ MW-s/MVA}$ . Frequency is 50 Hz. Mechanical power is 1 pu. The system is operating at the stable equilibrium point with rotor angle  $\delta$  equal to  $30^\circ$ . A three phase short circuit fault occurs at a certain location on one of the circuits of the double circuit transmission line. During fault, electrical power in pu is  $P_{\max} \sin \delta$ . If the values of  $\delta$  and  $d\delta/dt$  at the instant of fault clearing are  $45^\circ$  and 3.762 radian/s respectively, then  $P_{\max}$  (in pu) is \_\_\_\_\_.

Q.44 The block diagram of a system is shown in the figure



If the desired transfer function of the system is

$$\frac{C(s)}{R(s)} = \frac{s}{s^2 + s + 1}$$

then  $G(s)$  is

(A) 1

(B)  $s$

(C)  $1/s$

(D)  $\frac{-s}{s^3 + s^2 - s - 2}$

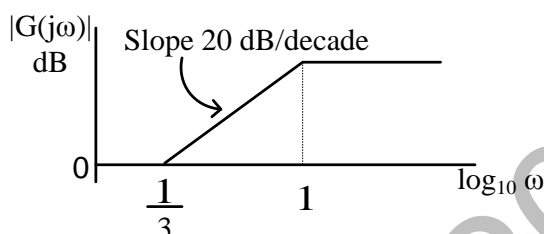
Q.45 Consider the system described by following state space equations

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u ; \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

If  $u$  is unit step input, then the steady state error of the system is

- (A) 0 (B) 1/2 (C) 2/3 (D) 1

Q.46 The magnitude Bode plot of a network is shown in the figure



The maximum phase angle  $\phi_m$  and the corresponding gain  $G_m$  respectively, are

- (A)  $-30^\circ$  and 1.73dB (B)  $-30^\circ$  and 4.77dB  
(C)  $+30^\circ$  and 4.77dB (D)  $+30^\circ$  and 1.73dB

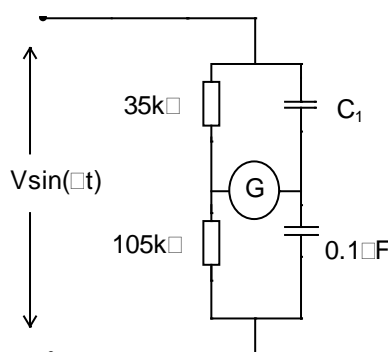
Q.47 A periodic waveform observed across a load is represented by

$$V(t) = \begin{cases} 1 + \sin \omega t & 0 \leq \omega t < 6\pi \\ -1 + \sin \omega t & 6\pi \leq \omega t < 12\pi \end{cases}$$

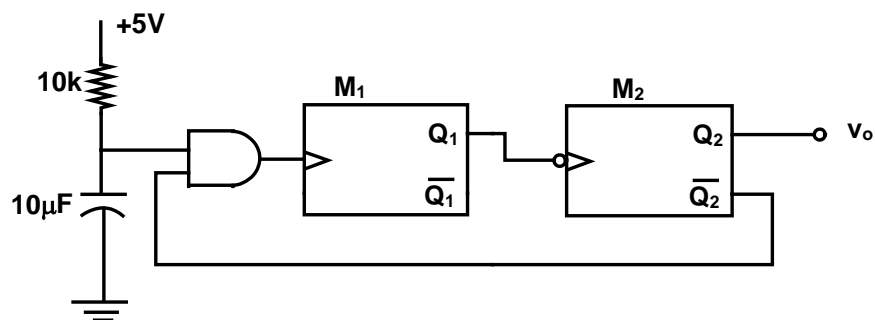
The measured value, using moving iron voltmeter connected across the load, is

- (A)  $\sqrt{\frac{3}{2}}$  (B)  $\sqrt{\frac{2}{3}}$  (C)  $\frac{3}{2}$  (D)  $\frac{2}{3}$

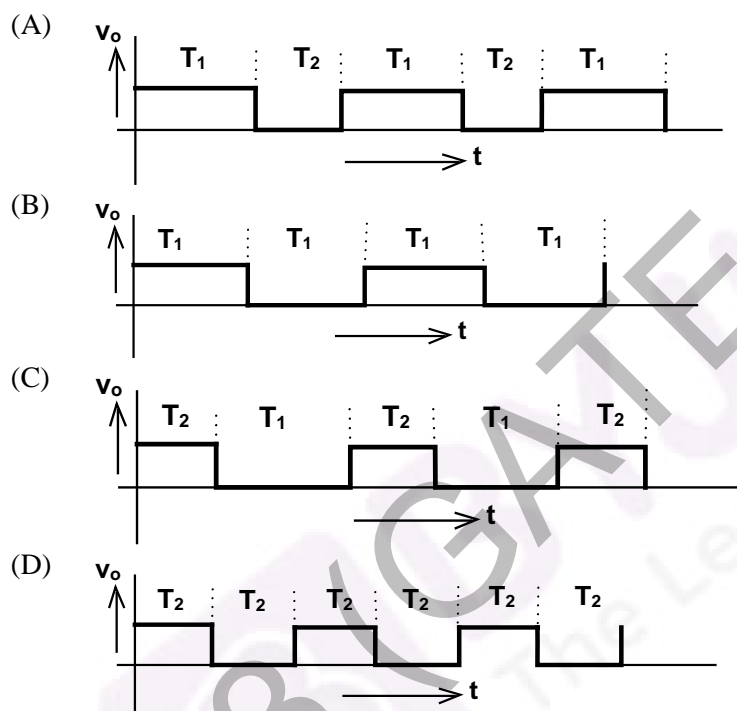
Q.48 In the bridge circuit shown, the capacitors are loss free. At balance, the value of capacitance  $C_1$  in microfarad is \_\_\_\_\_.



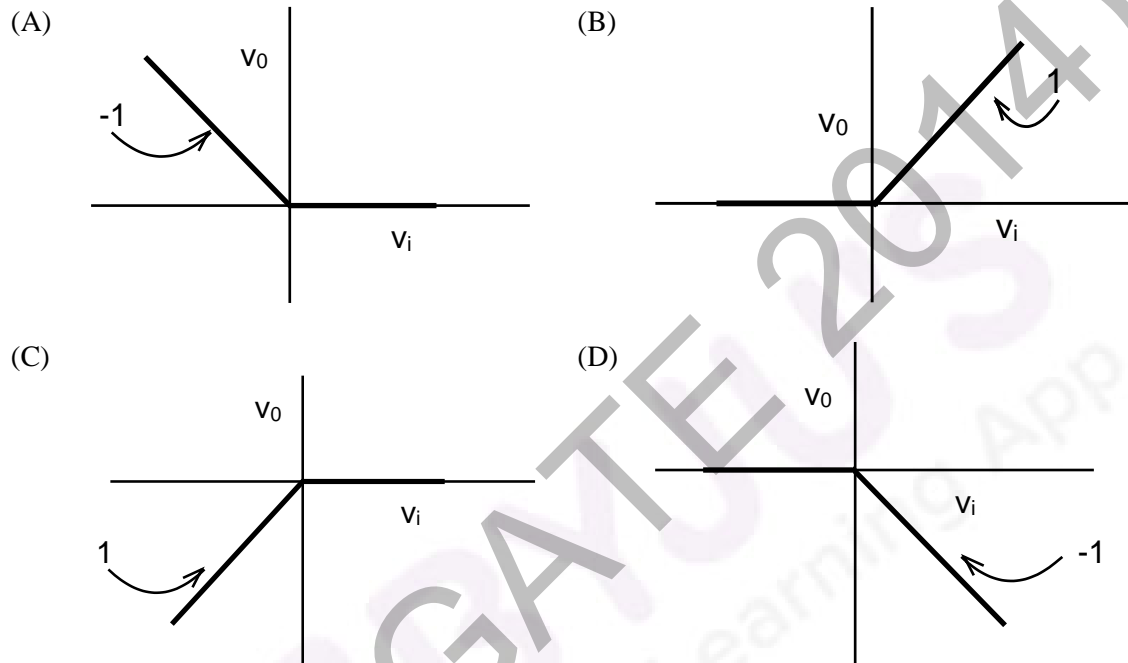
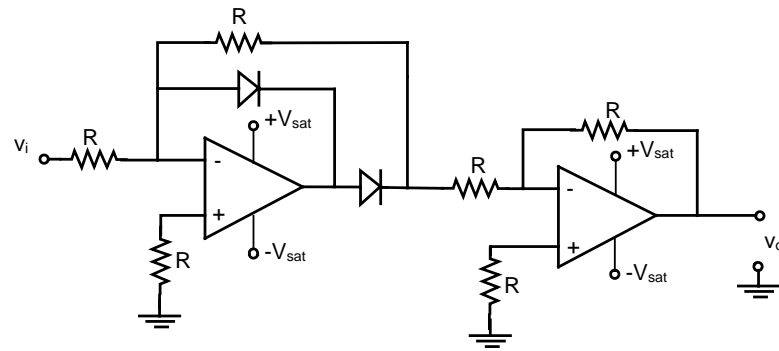
- Q.49 Two monoshot multivibrators, one positive edge triggered ( $M_1$ ) and another negative edge triggered ( $M_2$ ), are connected as shown in figure



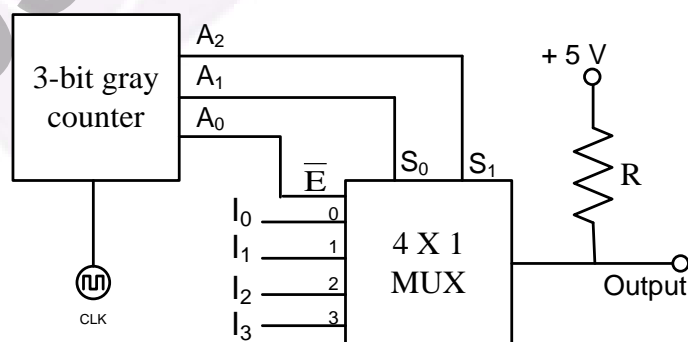
The monoshots  $M_1$  and  $M_2$  when triggered produce pulses of width  $T_1$  and  $T_2$  respectively, where  $T_1 > T_2$ . The steady state output voltage  $v_o$  of the circuit is



Q.50 The transfer characteristic of the Op-amp circuit shown in figure is



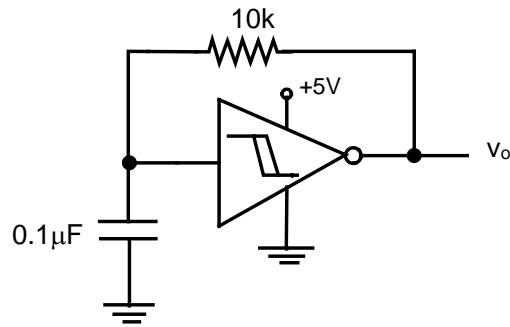
Q.51 A 3-bit gray counter is used to control the output of the multiplexer as shown in the figure. The initial state of the counter is  $000_2$ . The output is pulled high. The output of the circuit follows the sequence



- (A)  $I_0, 1, 1, I_1, I_3, 1, 1, I_2$   
 (C)  $1, I_0, 1, I_1, I_2, 1, I_3, 1$

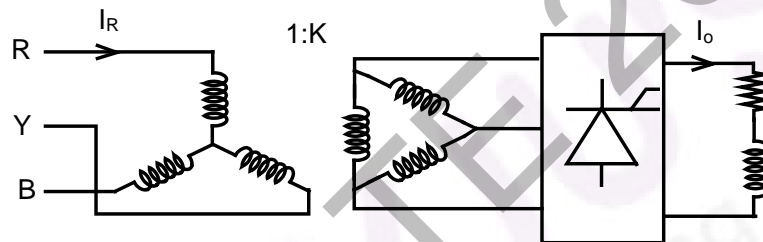
- (B)  $I_0, 1, I_1, 1, I_2, 1, I_3, 1$   
 (D)  $I_0, I_1, I_2, I_3, I_0, I_1, I_2, I_3$

Q.52 A hysteresis type TTL inverter is used to realize an oscillator in the circuit shown in the figure.

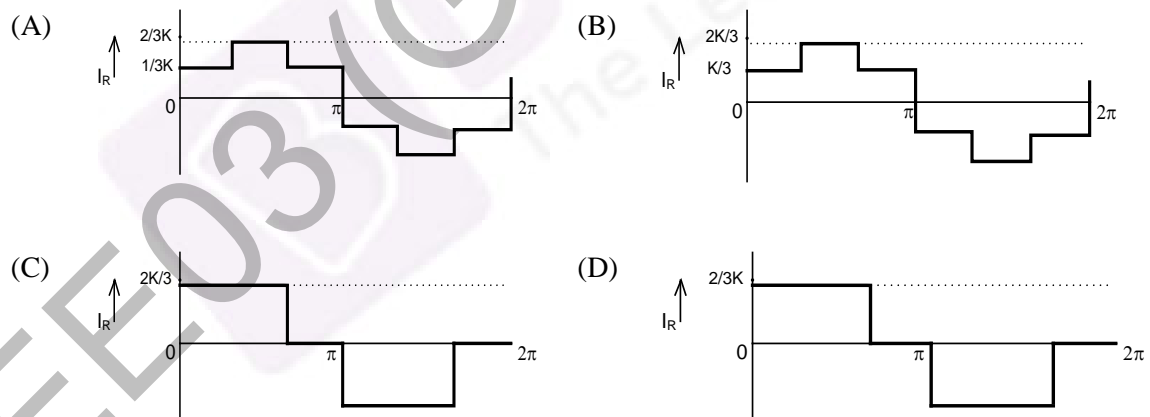


If the lower and upper trigger level voltages are 0.9 V and 1.7 V, the period (in ms), for which output is LOW, is \_\_\_\_\_.

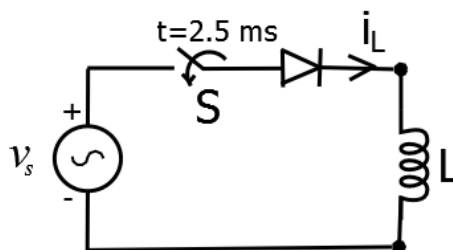
Q.53 A three-phase fully controlled bridge converter is fed through star-delta transformer as shown in the figure.



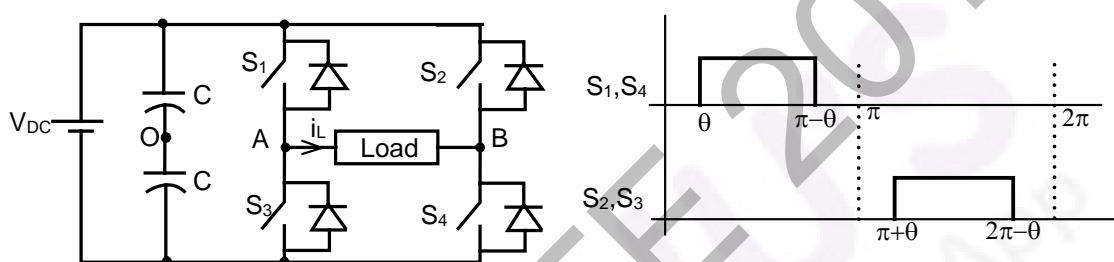
The converter is operated at a firing angle of  $30^\circ$ . Assuming the load current ( $I_o$ ) to be virtually constant at 1 p.u. and transformer to be an ideal one, the input phase current waveform is



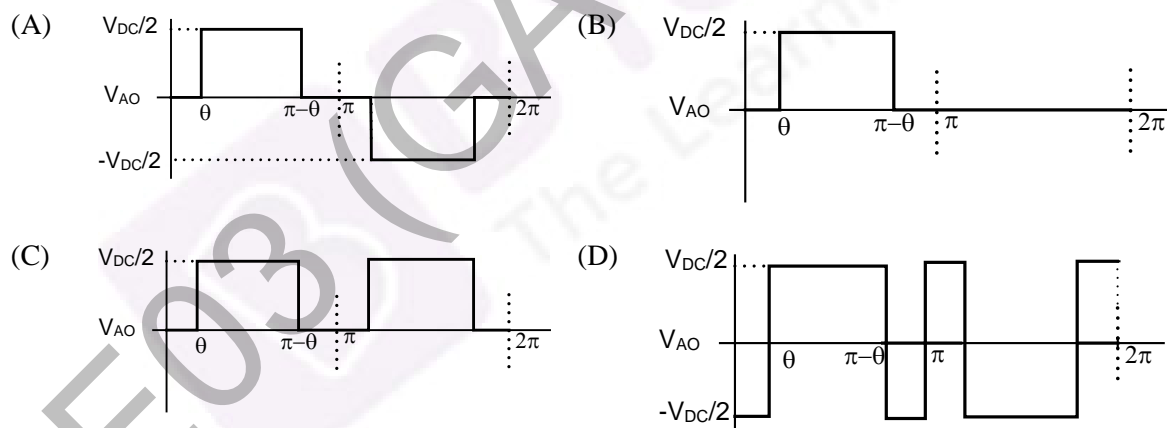
- Q.54 A diode circuit feeds an ideal inductor as shown in the figure. Given  $v_s = 100 \sin(\omega t)$  V, where  $\omega = 100\pi$  rad/s, and  $L = 31.83$  mH. The initial value of inductor current is zero. Switch S is closed at  $t = 2.5$  ms. The peak value of inductor current  $i_L$  (in A) in the first cycle is \_\_\_\_\_.



- Q.55 A single-phase voltage source inverter shown in figure is feeding power to a load. The triggering pulses of the devices are also shown in the figure.



If the load current is sinusoidal and is zero at  $0, \pi, 2\pi, \dots$ , the node voltage  $V_{AO}$  has the waveform



**END OF THE QUESTION PAPER**