

## 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 Choose the most appropriate phrase from the options given below to complete the following sentence.

India is a post-colonial country because

- (A) it was a former British colony
- (B) Indian Information Technology professionals have colonized the world
- (C) India does not follow any colonial practices
- (D) India has helped other countries gain freedom

- Q.2 Who \_\_\_\_\_ was coming to see us this evening?

- (A) you said
- (B) did you say
- (C) did you say that
- (D) had you said

- Q.3 Match the columns.

Column 1

- 1) eradicate
- 2) distort
- 3) saturate
- 4) utilize

Column 2

- P) misrepresent
- Q) soak completely
- R) use
- S) destroy utterly

(A) 1:S, 2:P, 3:Q, 4:R

(B) 1:P, 2:Q, 3:R, 4:S

(C) 1:Q, 2:R, 3:S, 4:P

(D) 1:S, 2:P, 3:R, 4:Q

- Q.4 What is the average of all multiples of 10 from 2 to 198?

- (A) 90
- (B) 100
- (C) 110
- (D) 120

- Q.5 The value of  $\sqrt{12 + \sqrt{12 + \sqrt{12 + \dots}}}$  is

- (A) 3.464
- (B) 3.932
- (C) 4.000
- (D) 4.444

**Q. 6 – Q. 10 carry two marks each.**

- Q.6 The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?

- (A) Kaliningrad was historically Russian in its ethnic make up
- (B) Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia
- (C) Koenigsberg was renamed Kaliningrad, as that was its original Russian name
- (D) Poland and Lithuania are on the route from Kaliningrad to the rest of Russia

- Q.7 The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.

Which one of the following statements, if true, does not contradict this conclusion?

- (A) A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent  
(B) More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency  
(C) Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test  
(D) The number of people with malarial fever (also contracted from mosquito bites) has increased this year
- Q.8 If  $x$  is real and  $|x^2 - 2x + 3| = 11$ , then possible values of  $|-x^3 + x^2 - x|$  include  
(A) 2, 4 (B) 2, 14 (C) 4, 52 (D) 14, 52
- 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 doubled in 2009, by what percent did the number of male students increase in 2009?

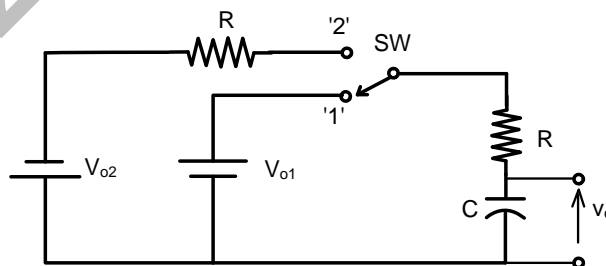


- Q.10 At what time between 6 a.m. and 7 a.m. will the minute hand and hour hand of a clock make an angle closest to  $60^\circ$ ?  
(A) 6: 22 a.m. (B) 6: 27 a.m.  
(C) 6: 38 a.m. (D) 6: 45 a.m.

**END OF THE QUESTION PAPER**

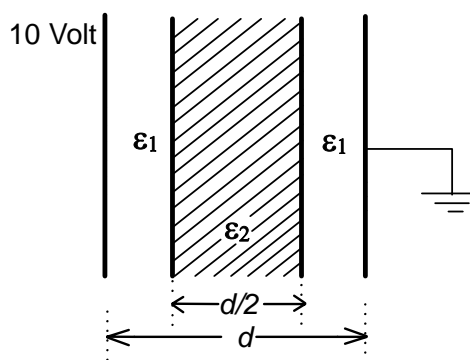
**Q. 1 – Q. 25 carry one mark each.**

- Q.1 Which one of the following statements is true for all real symmetric matrices?  
 (A) All the eigenvalues are real.  
 (B) All the eigenvalues are positive.  
 (C) All the eigenvalues are distinct.  
 (D) Sum of all the eigenvalues is zero.
- Q.2 Consider a dice with the property that the probability of a face with  $n$  dots showing up is proportional to  $n$ . The probability of the face with three dots showing up is \_\_\_\_\_.
- Q.3 Minimum of the real valued function  $f(x) = (x - 1)^{2/3}$  occurs at  $x$  equal to  
 (A)  $-\infty$  (B) 0 (C) 1 (D)  $\infty$
- Q.4 All the values of the multi-valued complex function  $1^i$ , where  $i = \sqrt{-1}$ , are  
 (A) purely imaginary. (B) real and non-negative.  
 (C) on the unit circle. (D) equal in real and imaginary parts.
- Q.5 Consider the differential equation  $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} - y = 0$ . Which of the following is a solution to this differential equation for  $x > 0$ ?  
 (A)  $e^x$  (B)  $x^2$  (C)  $1/x$  (D)  $\ln x$
- Q.6 Two identical coupled inductors are connected in series. The measured inductances for the two possible series connections are  $380 \mu\text{H}$  and  $240 \mu\text{H}$ . Their mutual inductance in  $\mu\text{H}$  is \_\_\_\_\_
- Q.7 The switch SW shown in the circuit is kept at position '1' for a long duration. At  $t = 0+$ , the switch is moved to position '2'. Assuming  $|V_{o2}| > |V_{o1}|$ , the voltage  $v_c(t)$  across the capacitor is



- (A)  $v_c(t) = -V_{o2}(1 - e^{-t/2RC}) - V_{o1}$   
 (B)  $v_c(t) = V_{o2}(1 - e^{-t/2RC}) + V_{o1}$   
 (C)  $v_c(t) = -(V_{o2} + V_{o1})(1 - e^{-t/2RC}) - V_{o1}$   
 (D)  $v_c(t) = (V_{o2} - V_{o1})(1 - e^{-t/2RC}) + V_{o1}$

- Q.8 A parallel plate capacitor consisting two dielectric materials is shown in the figure. The middle dielectric slab is placed symmetrically with respect to the plates.



If the potential difference between one of the plates and the nearest surface of dielectric interface is 2 Volts, then the ratio  $\epsilon_1 : \epsilon_2$  is

- (A) 1:4 (B) 2:3 (C) 3:2 (D) 4:1

- Q.9 Consider an LTI system with transfer function

$$H(s) = \frac{1}{s(s+4)}$$

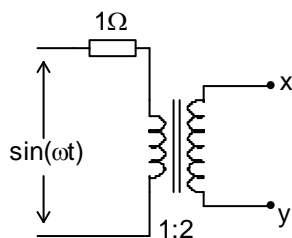
If the input to the system is  $\cos(3t)$  and the steady state output is  $A \sin(3t + \alpha)$ , then the value of  $A$  is

- (A) 1/30 (B) 1/15 (C) 3/4 (D) 4/3

- Q.10 Consider an LTI system with impulse response  $h(t) = e^{-5t} u(t)$ . If the output of the system is  $y(t) = e^{-3t} u(t) - e^{-5t} u(t)$  then the input,  $x(t)$ , is given by

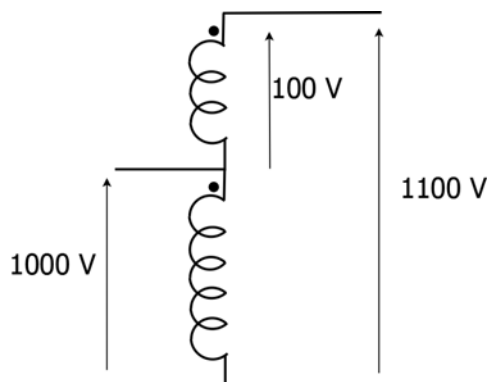
- (A)  $e^{-3t} u(t)$  (B)  $2 e^{-3t} u(t)$   
(C)  $e^{-5t} u(t)$  (D)  $2 e^{-5t} u(t)$

- Q.11 Assuming an ideal transformer, the Thevenin's equivalent voltage and impedance as seen from the terminals x and y for the circuit in figure are



- (A)  $2 \sin(\omega t)$ ,  $4\Omega$  (B)  $1 \sin(\omega t)$ ,  $1\Omega$   
(C)  $1 \sin(\omega t)$ ,  $2\Omega$  (D)  $2 \sin(\omega t)$ ,  $0.5\Omega$

- Q.12 A single phase, 50 kVA, 1000V/100 V two winding transformer is connected as an autotransformer as shown in the figure.



The kVA rating of the autotransformer is \_\_\_\_\_.

- Q.13 A three-phase, 4-pole, self excited induction generator is feeding power to a load at a frequency  $f_1$ . If the load is partially removed, the frequency becomes  $f_2$ . If the speed of the generator is maintained at 1500 rpm in both the cases, then

- (A)  $f_1, f_2 > 50$  Hz and  $f_1 > f_2$  (B)  $f_1 < 50$  Hz and  $f_2 > 50$  Hz  
(C)  $f_1, f_2 < 50$  Hz and  $f_2 > f_1$  (D)  $f_1 > 50$  Hz and  $f_2 < 50$  Hz

- Q.14 A single phase induction motor draws 12 MW power at 0.6 lagging power. A capacitor is connected in parallel to the motor to improve the power factor of the combination of motor and capacitor to 0.8 lagging. Assuming that the real and reactive power drawn by the motor remains same as before, the reactive power delivered by the capacitor in MVAR is \_\_\_\_\_.

- Q.15 A three phase star-connected load is drawing power at a voltage of 0.9 pu and 0.8 power factor lagging. The three phase base power and base current are 100 MVA and 437.38 A respectively. The line-to-line load voltage in kV is \_\_\_\_\_.

- Q.16 Shunt reactors are sometimes used in high voltage transmission systems to
- (A) limit the short circuit current through the line.  
(B) compensate for the series reactance of the line under heavily loaded condition.  
(C) limit over-voltages at the load side under lightly loaded condition.  
(D) compensate for the voltage drop in the line under heavily loaded condition.

- Q.17 The closed-loop transfer function of a system is  $T(s) = \frac{4}{(s^2 + 0.4s + 4)}$ . The steady state error due to unit step input is \_\_\_\_\_.

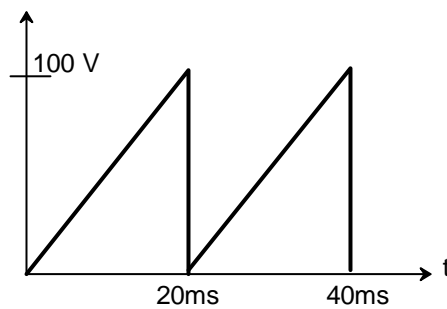
- Q.18 The state transition matrix for the system

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

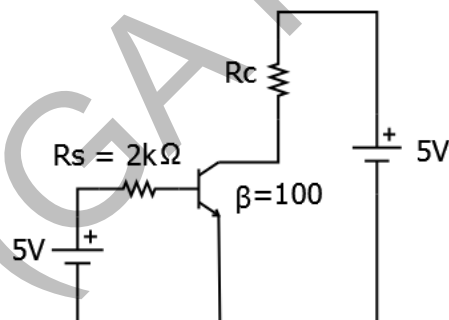
is

- (A)  $\begin{bmatrix} e^t & 0 \\ e^t & e^t \end{bmatrix}$  (B)  $\begin{bmatrix} e^t & 0 \\ t^2 e^t & e^t \end{bmatrix}$   
(C)  $\begin{bmatrix} e^t & 0 \\ t e^t & e^t \end{bmatrix}$  (D)  $\begin{bmatrix} e^t & t e^t \\ 0 & e^t \end{bmatrix}$

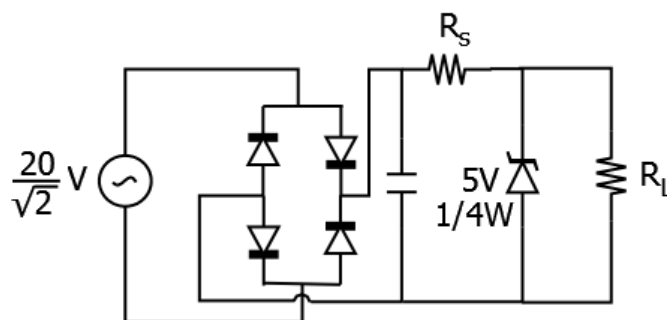
- Q.19 The saw-tooth voltage waveform shown in the figure is fed to a moving iron voltmeter. Its reading would be close to \_\_\_\_\_



- Q.20 While measuring power of a three-phase balanced load by the two-wattmeter method, the readings are 100 W and 250 W. The power factor of the load is \_\_\_\_\_.
- Q.21 Which of the following is an invalid state in an 8-4-2-1 Binary Coded Decimal counter  
 (A) 1 0 0 0                      (B) 1 0 0 1                      (C) 0 0 1 1                      (D) 1 1 0 0
- Q.22 The transistor in the given circuit should always be in active region. Take  $V_{CE(sat)} = 0.2$  V,  $V_{BE} = 0.7$  V. The maximum value of  $R_C$  in  $\Omega$  which can be used, is \_\_\_\_\_.



- Q.23 The sinusoidal ac source in the figure has an rms value of  $\frac{20}{\sqrt{2}}$  V. Considering all possible values of  $R_L$ , the minimum value of  $R_S$  in  $\Omega$  to avoid burnout of the Zener diode is \_\_\_\_\_.



- Q.24 A step-up chopper is used to feed a load at 400 V dc from a 250 V dc source. The inductor current is continuous. If the 'off' time of the switch is 20  $\mu$ s, the switching frequency of the chopper in kHz is \_\_\_\_\_.

- Q.25 In a constant  $V/f$  control of induction motor, the ratio  $V/f$  is maintained constant from 0 to base frequency, where  $V$  is the voltage applied to the motor at fundamental frequency  $f$ . Which of the following statements relating to low frequency operation of the motor is TRUE?
- (A) At low frequency, the stator flux increases from its rated value.  
 (B) At low frequency, the stator flux decreases from its rated value.  
 (C) At low frequency, the motor saturates.  
 (D) At low frequency, the stator flux remains unchanged at its rated value.

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

- Q.26 To evaluate the double integral  $\int_0^8 \left( \int_{y/2}^{(y/2)+1} \left( \frac{2x-y}{2} \right) dx \right) dy$ , we make the substitution  $u = \left( \frac{2x-y}{2} \right)$  and  $v = \frac{y}{2}$ . The integral will reduce to

- (A)  $\int_0^4 \left( \int_0^2 2u \, du \right) dv$  (B)  $\int_0^4 \left( \int_0^1 2u \, du \right) dv$   
 (C)  $\int_0^4 \left( \int_0^1 u \, du \right) dv$  (D)  $\int_0^4 \left( \int_0^2 u \, du \right) dv$

- Q.27 Let  $X$  be a random variable with probability density function

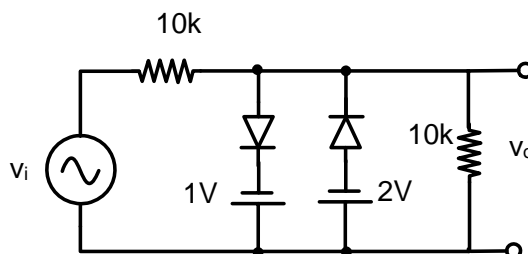
$$f(x) = \begin{cases} 0.2, & \text{for } |x| \leq 1 \\ 0.1, & \text{for } 1 < |x| \leq 4 \\ 0, & \text{otherwise.} \end{cases}$$

The probability  $P(0.5 < X < 5)$  is \_\_\_\_\_.

- Q.28 The minimum value of the function  $f(x) = x^3 - 3x^2 - 24x + 100$  in the interval  $[-3, 3]$  is

- (A) 20 (B) 28  
 (C) 16 (D) 32

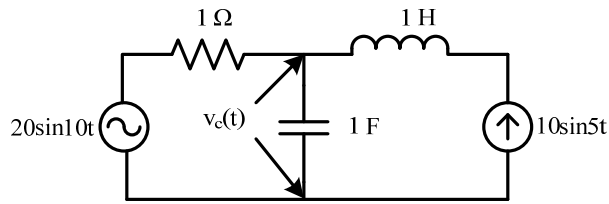
- Q.29 Assuming the diodes to be ideal in the figure, for the output to be clipped, the input voltage  $v_i$  must be outside the range



- (A) -1 V to -2 V (B) -2 V to -4 V  
 (C) +1 V to -2 V (D) +2 V to -4 V

Q.30 The voltage across the capacitor, as shown in the figure, is expressed as

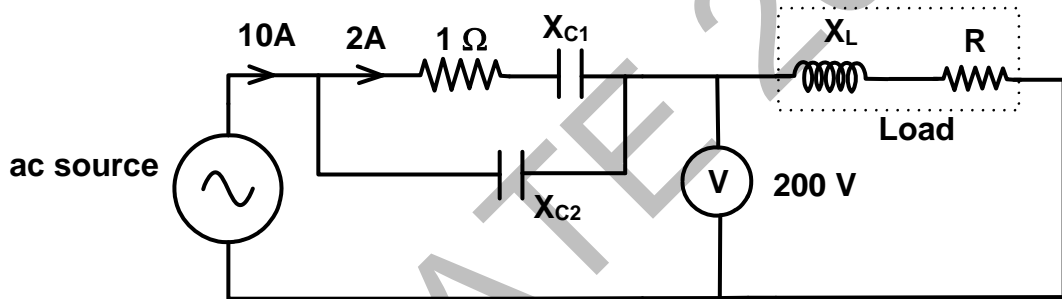
$$v_c(t) = A_1 \sin(\omega_1 t - \theta_1) + A_2 \sin(\omega_2 t - \theta_2)$$



The values of  $A_1$  and  $A_2$  respectively, are

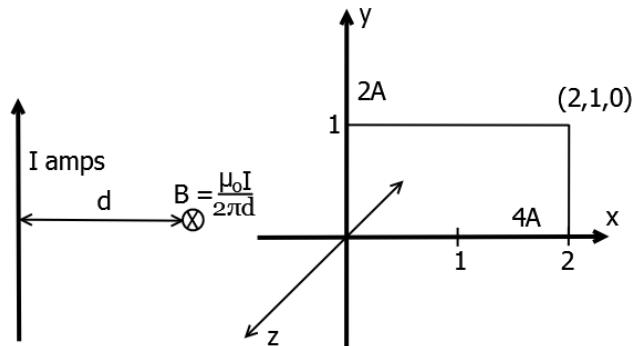
- (A) 2.0 and 1.98      (B) 2.0 and 4.20      (C) 2.5 and 3.50      (D) 5.0 and 6.40

Q.31 The total power dissipated in the circuit, shown in the figure, is 1 kW.



The voltmeter, across the load, reads 200 V. The value of  $X_L$  is \_\_\_\_\_.

Q.32 The magnitude of magnetic flux density ( $\vec{B}$ ) at a point having normal distance  $d$  meters from an infinitely extended wire carrying current of  $I$  A is  $\frac{\mu_0 I}{2\pi d}$  (in SI units). An infinitely extended wire is laid along the x-axis and is carrying current of 4 A in the +ve x direction. Another infinitely extended wire is laid along the y-axis and is carrying 2 A current in the +ve y direction.  $\mu_0$  is permeability of free space. Assume  $\hat{i}$ ,  $\hat{j}$ ,  $\hat{k}$  to be unit vectors along x, y and z axes respectively.



Assuming right handed coordinate system, magnetic field intensity,  $\vec{H}$  at coordinate (2,1,0) will be

- (A)  $\frac{3}{2\pi} \hat{k}$  weber/m<sup>2</sup>      (B)  $\frac{4}{3\pi} \hat{i}$  A/m      (C)  $\frac{3}{2\pi} \hat{k}$  A/m      (D) 0 A/m

Q.33 A discrete system is represented by the difference equation

$$\begin{bmatrix} X_1(k+1) \\ X_2(k+1) \end{bmatrix} = \begin{bmatrix} a & a-1 \\ a+1 & a \end{bmatrix} \begin{bmatrix} X_1(k) \\ X_2(k) \end{bmatrix}$$

It has initial conditions  $X_1(0) = 1$ ;  $X_2(0) = 0$ . The pole locations of the system for  $a = 1$ , are

- (A)  $1 \pm j0$  (B)  $-1 \pm j0$  (C)  $\pm 1 + j0$  (D)  $0 \pm j1$

Q.34 An input signal  $x(t) = 2 + 5\sin(100\pi t)$  is sampled with a sampling frequency of 400 Hz and applied to the system whose transfer function is represented by

$$\frac{Y(z)}{X(z)} = \frac{1}{N} \left( \frac{1 - z^{-N}}{1 - z^{-1}} \right)$$

where,  $N$  represents the number of samples per cycle. The output  $y(n)$  of the system under steady state is

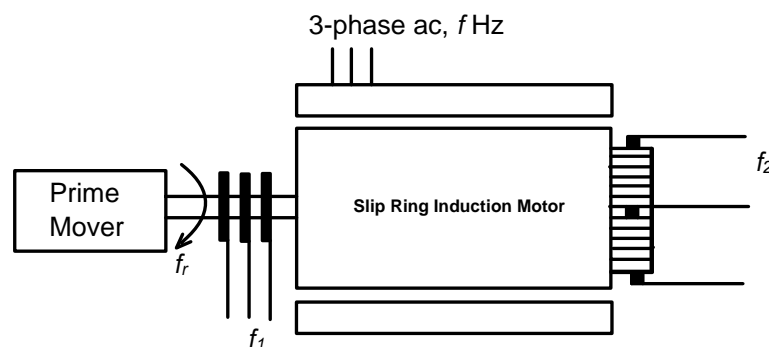
- (A) 0 (B) 1 (C) 2 (D) 5

Q.35 A 10 kHz even-symmetric square wave is passed through a bandpass filter with centre frequency at 30 kHz and 3 dB passband of 6 kHz. The filter output is

- (A) a highly attenuated square wave at 10 kHz.  
(B) nearly zero.  
(C) a nearly perfect cosine wave at 30 kHz.  
(D) a nearly perfect sine wave at 30 kHz.

Q.36 A 250 V dc shunt machine has armature circuit resistance of  $0.6 \Omega$  and field circuit resistance of  $125 \Omega$ . The machine is connected to 250 V supply mains. The motor is operated as a generator and then as a motor separately. The line current of the machine in both the cases is 50 A. The ratio of the speed as a generator to the speed as a motor is \_\_\_\_\_.

Q.37 A three-phase slip-ring induction motor, provided with a commutator winding, is shown in the figure. The motor rotates in clockwise direction when the rotor windings are closed.



If the rotor winding is open circuited and the system is made to run at rotational speed  $f_r$  with the help of prime-mover in anti-clockwise direction, then the frequency of voltage across slip rings is  $f_1$  and frequency of voltage across commutator brushes is  $f_2$ . The values of  $f_1$  and  $f_2$  respectively are

- (A)  $f + f_r$  and  $f$  (B)  $f - f_r$  and  $f$   
(C)  $f - f_r$  and  $f + f_r$  (D)  $f + f_r$  and  $f - f_r$

- Q.38 A 20-pole alternator is having 180 identical stator slots with 6 conductors in each slot. All the coils of a phase are in series. If the coils are connected to realize single-phase winding, the generated voltage is  $V_1$ . If the coils are reconnected to realize three-phase star-connected winding, the generated phase voltage is  $V_2$ . Assuming full pitch, single-layer winding, the ratio  $V_1/V_2$  is
- (A)  $\frac{1}{\sqrt{3}}$  (B)  $\frac{1}{2}$  (C)  $\sqrt{3}$  (D) 2
- Q.39 For a single phase, two winding transformer, the supply frequency and voltage are both increased by 10%. The percentage changes in the hysteresis loss and eddy current loss, respectively, are
- (A) 10 and 21 (B) -10 and 21 (C) 21 and 10 (D) -21 and 10
- Q.40 A synchronous generator is connected to an infinite bus with excitation voltage  $E_f = 1.3$  pu. The generator has a synchronous reactance of 1.1 pu and is delivering real power ( $P$ ) of 0.6 pu to the bus. Assume the infinite bus voltage to be 1.0 pu. Neglect stator resistance. The reactive power ( $Q$ ) in pu supplied by the generator to the bus under this condition is \_\_\_\_\_.
- Q.41 There are two generators in a power system. No-load frequencies of the generators are 51.5 Hz and 51 Hz, respectively, and both are having droop constant of 1 Hz/MW. Total load in the system is 2.5 MW. Assuming that the generators are operating under their respective droop characteristics, the frequency of the power system in Hz in the steady state is \_\_\_\_\_.
- Q.42 The horizontally placed conductors of a single phase line operating at 50 Hz are having outside diameter of 1.6 cm, and the spacing between centers of the conductors is 6 m. The permittivity of free space is  $8.854 \times 10^{-12}$  F/m. The capacitance to ground per kilometer of each line is
- (A)  $4.2 \times 10^{-9}$  F  
(B)  $8.4 \times 10^{-9}$  F  
(C)  $4.2 \times 10^{-12}$  F  
(D)  $8.4 \times 10^{-12}$  F
- Q.43 A three phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive, negative, and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu, and 0.05 pu, respectively, at the machine base quantities. If a bolted single phase to ground fault occurs at the terminal of the unloaded generator, the fault current in amperes immediately after the fault is \_\_\_\_\_.
- Q.44 A system with the open loop transfer function

$$G(s) = \frac{K}{s(s+2)(s^2+2s+2)}$$

is connected in a negative feedback configuration with a feedback gain of unity. For the closed loop system to be marginally stable, the value of  $K$  is \_\_\_\_\_

Q.45 For the transfer function

$$G(s) = \frac{5(s + 4)}{s(s + 0.25)(s^2 + 4s + 25)}$$

The values of the constant gain term and the highest corner frequency of the Bode plot respectively are

- (A) 3.2, 5.0      (B) 16.0, 4.0      (C) 3.2, 4.0      (D) 16.0, 5.0

Q.46 The second order dynamic system

$$\begin{aligned} \frac{dX}{dt} &= PX + Qu \\ y &= RX \end{aligned}$$

has the matrices P, Q and R as follows:

$$P = \begin{bmatrix} -1 & 1 \\ 0 & -3 \end{bmatrix} \quad Q = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad R = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

The system has the following controllability and observability properties:

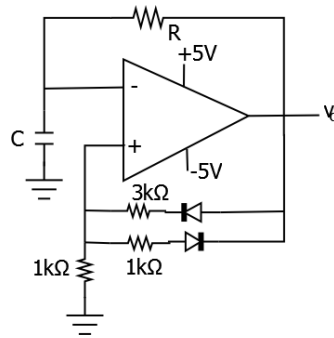
- (A) Controllable and observable  
(B) Not controllable but observable  
(C) Controllable but not observable  
(D) Not controllable and not observable

Q.47 Suppose that resistors  $R_1$  and  $R_2$  are connected in parallel to give an equivalent resistor  $R$ . If resistors  $R_1$  and  $R_2$  have tolerance of 1% each, the equivalent resistor  $R$  for resistors  $R_1 = 300 \, \Omega$  and  $R_2 = 200 \, \Omega$  will have tolerance of

- (A) 0.5%      (B) 1%      (C) 1.2%      (D) 2%

Q.48 Two ammeters X and Y have resistances of  $1.2 \, \Omega$  and  $1.5 \, \Omega$  respectively and they give full-scale deflection with 150 mA and 250 mA respectively. The ranges have been extended by connecting shunts so as to give full scale deflection with 15 A. The ammeters along with shunts are connected in parallel and then placed in a circuit in which the total current flowing is 15A. The current in amperes indicated in ammeter X is \_\_\_\_\_.

Q.49 An oscillator circuit using ideal op-amp and diodes is shown in the figure.



The time duration for +ve part of the cycle is  $\Delta t_1$  and for -ve part is  $\Delta t_2$ . The value of  $e^{\frac{\Delta t_1 - \Delta t_2}{RC}}$  will be \_\_\_\_\_.

Q.50 The SOP (sum of products) form of a Boolean function is  $\Sigma(0,1,3,7,11)$ , where inputs are  $A, B, C, D$  ( $A$  is MSB, and  $D$  is LSB). The equivalent minimized expression of the function is

- (A)  $(\bar{B} + C)(\bar{A} + C)(\bar{A} + \bar{B})(\bar{C} + D)$
- (B)  $(\bar{B} + C)(\bar{A} + C)(\bar{A} + \bar{C})(\bar{C} + D)$
- (C)  $(\bar{B} + C)(\bar{A} + C)(\bar{A} + \bar{C})(\bar{C} + \bar{D})$
- (D)  $(\bar{B} + C)(A + \bar{B})(\bar{A} + \bar{B})(\bar{C} + D)$

Q.51 A JK flip flop can be implemented by T flip-flops. Identify the correct implementation.

- (A)
- (B)
- (C)
- (D)

Q.52 In an 8085 microprocessor, the following program is executed

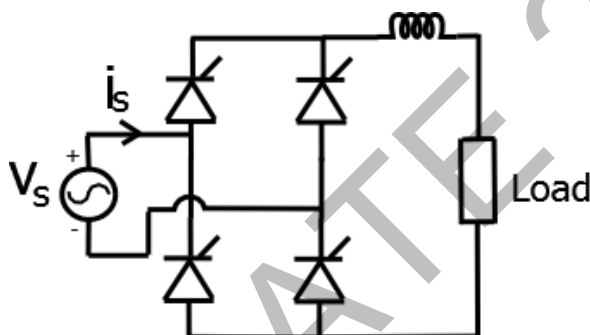
Address location – Instruction

2000H	XRA A
2001H	MVI B,04H
2003H	MVI A, 03H
2005H	RAR
2006H	DCR B
2007H	JNZ 2005
200AH	HLT

At the end of program, register A contains

- (A) 60H                      (B) 30H                      (C) 06H                      (D) 03H

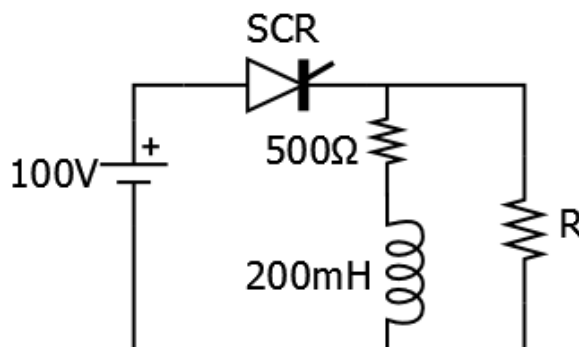
Q.53 A fully controlled converter bridge feeds a highly inductive load with ripple free load current. The input supply ( $v_s$ ) to the bridge is a sinusoidal source. Triggering angle of the bridge converter is  $\alpha = 30^\circ$ . The input power factor of the bridge is \_\_\_\_\_.



Q.54 A single-phase SCR based ac regulator is feeding power to a load consisting of  $5\ \Omega$  resistance and  $16\text{ mH}$  inductance. The input supply is  $230\text{ V}$ ,  $50\text{ Hz}$  ac. The maximum firing angle at which the voltage across the device becomes zero all throughout and the rms value of current through SCR, under this operating condition, are

- (A)  $30^\circ$  and  $46\text{ A}$                       (B)  $30^\circ$  and  $23\text{ A}$   
 (C)  $45^\circ$  and  $23\text{ A}$                       (D)  $45^\circ$  and  $32\text{ A}$

Q.55 The SCR in the circuit shown has a latching current of  $40\text{ mA}$ . A gate pulse of  $50\ \mu\text{s}$  is applied to the SCR. The maximum value of  $R$  in  $\Omega$  to ensure successful firing of the SCR is \_\_\_\_\_.



**END OF THE QUESTION PAPER**