QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in Two Sections and printed both in HINDI and in ENGLISH.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, THREE questions are to be attempted choosing at least ONE question from each Section.

The number of marks carried by a question/part is indicated against it.

Answers must be written in the medium authorized in the Admission Certificate which must be stated clearly on the cover of this Question-cum-Answer (QCA) Booklet in the space provided. No marks will be given for answers written in a medium other than the authorized one.

Assume suitable data, if considered necessary, and indicate the same clearly.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.
Q. 1(a) For the circuit shown in Figure, evaluate the current through and the voltage across each element.

\[ E = 4 \sin (2\pi \times 10^7 t - 0.8x) \, \text{V/m}. \]

Find:

(a) \( E \theta \eta \)

(b) The time-average power carried by the wave.

Q. 1(c) Derive the expressions for instantaneous and average power in a single-phase ac circuit.
Q. 1(d) What are the function and determine its value when

\[ V_0 = -3V_1 - 2V_2. \]

In the Figure shown what is the function of \( R_0 \) and determine its value when

\[ V_0 = -3V_1 - 2V_2. \]

Find the efficiency of a class A amplifier shown in Figure. Given that the voltage drop across \( R_E \) is 1 V, the signal current swings from -0.5 A to +0.5 A and the DC current is 1 A.
Q. 2(a) A 8-pole, 240 V lap-wound, series motor has armature and series field resistances of 0.2 ohm and 0.02 ohm respectively. There are 660 armature conductors. If the flux per pole is 0.03 Wb and the torque developed in the armature is 320 N-m, find the current taken by the motor and its speed.

Q. 2(b) A single-phase full converter is connected to RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10 A is constant over the working range. For \( R = 0.4 \, \Omega \) and \( L = 2 \, \text{mH} \), compute:
(a) firing angle delay for \( E = 120 \, \text{V} \) and input power factor.
(b) firing angle delay for \( E = -120 \, \text{V} \) and input power factor.

Q. 2(c) Find the z transform of:
\[ f(t) = \sin \omega t \quad t \geq 0 \]

Q. 3(a) Find the Laplace transform of the function:
\[ f(t) = 2e^{-t} \cos(10t) - t^4 + 6e^{-t} - 10 \quad t > 0 \]

Q. 3(b) A distortionless line has \( z_0 = 60 \, \Omega \), \( \alpha = 20 \, \text{mNp/m} \), \( u = 0.6 \, c \) where \( c \) is the velocity of the wave in vacuum. Find \( R \), \( L \), \( G \), \( C \) and \( \lambda \) at 100 MHz.
Q. 3(c) A two-port network has \( z_{11} = z_{12} = z_{21} = z_{22} = 200 \, \Omega \). Two such networks are connected in cascade. What are the overall \( z \)-parameters of the composite network?

Q. 4(a) Explain the speed enhancement gained in MOS device by using silicon-on-sapphire or spinel (SOS). What are the other good features of the process? Mention the drawbacks.

Q. 4(b) In the network shown in Figure, determine the value of current through 1 \( \Omega \) resistance connected between terminals A and B. Verify the answer using superposition theorem also.

Q. 4(c) The transfer function of a system is given as:

\[
\frac{C(s)}{R(s)} = \frac{s + 3}{s(s + 1)(s + 2)}
\]

Find out the impulse response of the system.
SECTION—B

Q. 5(a) A single-phase full converter is supplied from 230 V, 50 Hz source as shown in Figure. The load consists of R = 10 Ω and a large inductance so as to render the load current constant. For firing delay angle of 30°, determine:

(a) average output voltage
(b) average output current
(c) average and rms values of thyristor current
(d) input power factor.

![Figure](image)

Q. 5(b) A battery is charged through a resistor R as shown in Fig. For an ac source voltage of 230 V, 50 Hz find the value of average charging current for R = 8 Ω and E = 150 V.

![Figure](image)
Q. 5(c) सिद्ध कीजिए कि किसी स्थिति: उल्लेखित डीसी शॉट एमोटर के द्वारा विकसित यांत्रिक ऊर्जा तब अधिकतम होगी जब पर्याप्त इ.एम.एफ. अनुप्रयुक्त बोल्टेज के आधे के बराबर हो, यदि क्षेत्र ऊर्जा को नजरअंदाज कर दिया जाय।

Prove that mechanical power developed by a self excited DC shunt motor is maximum when back e.m.f. is equal to half the applied voltage, if the field loss is neglected. 10

Q. 5(d) विचारिए, बैंड वैद्युत 10 kHz का एक प्रवेश संकेत-बैंड संकेत, और मध्य आवृत्ति जो 0.535 से 1.605 MHz के परामान में स्थित हो। इसकी है कि इस संकेत को एक ऐसे नियत आवृत्ति बैंड में परिवर्तित किया जाय, जिसका केंद्र 0.455 MHz पर हो। 0.455 MHz पर केंद्रित आवृत्ति बैंड को प्राप्त करने के लिए स्थानीय दोलक (ऑसिलेटर) में आवश्यक रूप से प्रदान किए जाने वाली ट्रूनिंग के परामाण का निर्धारण कीजिए।

Consider an incoming narrow-band signal of bandwidth 10 kHz, and mid frequency that may lie in the range of 0.535 to 1.605 MHz. It is desired to translate this signal to a fixed frequency band centered at 0.455 MHz. Determine the range of tuning that must be provided in the local oscillator to obtain the frequency band centered at 0.455 MHz.

Q. 5(e) $F = \Sigma(0, 2, 3, 4, 5, 7)$ के लिए सभी संभव अन्तर्गत फलन प्राप्त कीजिए।

Obtain all the possible minimal functions for:

$$F = \Sigma(0, 2, 3, 4, 5, 7).$$

Q. 6(a) एक 440 V डीसी शॉट मोटर की 2000 आर.पी.एम. की भार शून्य स्पीड है। वह पूर्ण भार बलआपूर्ण (टीफ), न्यूरीक्त आर्मेचर बोल्टेज के और पूर्ण क्षेत्र करेंट पर 1000 आर.पी.एम. पर चल रही है। यदि भार बलआपूर्ण को कम करने की निर्देशित मान का 50% कर दिया जाय, और आर्मेचर बोल्टेज को पूर्ण मान पर अपरिवर्तनीय बनाए रखा जाय तो, स्पीड बढ़कर 1050 आर.पी.एम. हो जाती है। पूर्ण भार पर आर्मेचर बोल्टेज पात माधुर्म कीजिए। आर्मेचर प्रतिरोध के प्रभाव को नजरअंदाज कीजिए।

A 440 V dc shunt motor has a no-load speed of 2000 rpm. It is running at 1000 rpm at full load torque, reduced armature voltage and full field current. If load torque is reduced to 50% of rated value with armature voltage and field voltage held constant at previous values, the speed increases to 1050 rpm. Find the armature voltage drop at full load. Neglect the effect of armature reaction.
Q. 6(b) Divide by N counter is shown in the figure below. If initially $Q_0 = 0$, $Q_1 = 1$, $Q_2 = 0$, what is the value of N?

![CLOCK diagram](attachment:image.png)

**Figure**

Q. 6(c) Draw the circuit for the speed control of a separately-excited dc motor from a single-phase source and explain it.

Q. 7(a) A 20 kVA, 2500/250 V, single-phase transformer at unity power factor is 98% both at rated load and half rated load. Determine:

(i) the core loss and ohmic losses and
(ii) the p.u. value of the equivalent resistance of the transformer.

Q. 7(b) Discuss phase and frequency modulation. Explain, why in practice phase modulation is not favoured.

Q. 7(c) Discuss the circuit shown in the figure. If initially $Q_0 = 0$, $Q_1 = 1$, $Q_2 = 0$, what is the value of N?
An RLE load is operating in chopper circuit from a 500 V dc source as shown in Figure.
For \( R = 0 \), \( L = 0.064 \) and constant \( E \), the duty cycle is 0.2. Find the chopping frequency
to limit the amplitude of load current excursion to 10 A.

\[
Q. 8(a)
\]

A 3-phase, 12 pole alternator is coupled to an engine running at 500 r.p.m. The alternator
supplies power to an induction motor which has a full-load speed of 1455 r.p.m. Find the
slip and number of poles of the motor.

\[
Q. 8(b)
\]

Evaluate the maximum and minimum values of \( V(t) \) of the amplitude-modulated voltage
signal defined as :
\[
V(t) = 10(1 + 0.5 \cos \omega t + 0.2 \cos 2 \omega t) \cos \omega_o t.
\]

\[
Q. 8(c)
\]

A separately excited dc motor, operating from a single-phase half controlled bridge (semi-
converter) at a speed of 1440 rpm, has an input voltage of 330 sin 314 t and back emf
80 V. The SCRs are fired symmetrically at \( \alpha = 30^\circ \) in every half cycle and the armature
has a resistance of 4 \( \Omega \). Calculate the average armature current and the motor torque.