

231004

COMBINED COMPETITIVE EXAMINATION (MAIN)

ELECTRICAL ENGINEERING

Paper-I

Time : 3 Hours

Full Marks : 200

- Note : (1) The figures in the right-hand margin indicate full marks for the questions.
(2) Attempt five questions in all.
(3) Question No. 1 is compulsory.

1. Answer any *ten* questions from the following : 4×10=40
- State and prove maximum power transfer theorem.
 - A resistance R is connected in parallel to an inductance L . If a voltage $v = V \cos \omega t$ is applied across this parallel network, find the phasor current of the circuit.
 - At what frequency will the current lead the voltage by 30° in a series circuit with $R = 8 \Omega$ and $C = 30 \mu\text{F}$?
 - Define the Z-parameters of a two-port network.
 - Derive the expression for frequency of a parallel resonant circuit.
 - With reference to electromagnetic theory, write the Laplace and Poisson equations.
 - A 400-V, 3- ϕ voltage is applied to a balanced 3- ϕ Δ -connected load of phase impedance $(15 + j20) \Omega$. Find the phase and line currents.
 - Write the Maxwell's equations in differential form.
 - Describe a laboratory standard of emf.
 - What is a transducer? Name two active and two passive transducers.
 - Describe the working principle of a half-wave rectifier circuit.
 - Show how a NOR gate can be used to realize a NOT gate.

2. Answer any **eight** questions from the following : 5×8=40
- (a) Explain the construction and working principle of a moving iron repulsion type instrument.
 - (b) Explain how an operational amplifier can be used as a subtractor.
 - (c) Describe the mechanism of torque production in rotating machine.
 - (d) Define armature reaction and discuss its effects on the performance of dc machines.
 - (e) What are lap and wave windings? Which among them is used for high current and which for high voltage d.c. generator?
 - (f) List the applications of d.c. shunt and d.c. series motors.
 - (g) Derive an expression for the e.m.f. generated in the armature winding of a synchronous machine.
 - (h) Explain why synchronous motors do not have their own starting torque.
 - (i) In an induction motor, the rotor always runs in the direction of stator field. Explain.
 - (j) Write the names of various types of magnetic material. Give one example of each.
3. Answer any **five** questions from the following : 8×5=40
- (a) A transmission line has characteristic impedance of $(75 + j0.01) \Omega$ and is terminated in a load impedance of $(70 + j50) \Omega$. Find the reflection coefficient.
 - (b) Derive the expression for voltage gain of an NPN transistor amplifier circuit using h -parameters.
 - (c) Compare R - S flip-flop with D flip-flop.
 - (d) Explain how an electro-dynamometer type instrument is able to measure the true r.m.s. value of a voltage or current irrespective of its waveform.
 - (e) Derive the e.m.f. equation of a two-winding transformer. Why is the rating of transformer expressed in kVA instead of kW?
 - (f) Define voltage regulation of a transformer. A 100-kVA, 2200/220-V transformer has leakage reactance drop of 8% and resistance drop of 2%. Find the voltage regulation at full load and at 0.8 p.f. lagging.
 - (g) Based on energy band theory, differentiate among conductors, semiconductors and insulators.

4. Answer any **four** questions from the following :

10×4=40

- (a) The switch in Fig. 1 has been in position 1 for a long time. It is then moved to position 2 at $t = 0$. Obtain the expression for i , for $t > 0$.

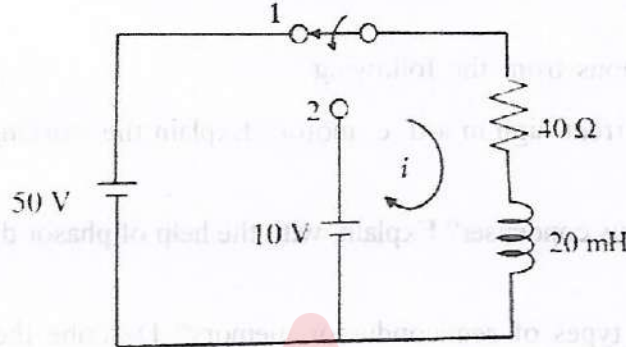
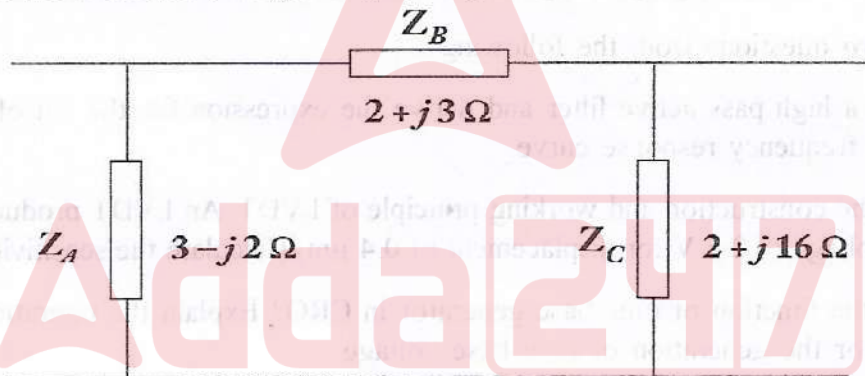


Fig. 1

- (b) Convert the Δ -circuit of Fig. 2 into an equivalent Y-circuit.



- (c) The magnetic field intensity vector of a plane wave is given by $\vec{H}(x, y, z, t) = 10 \sin(5000t + 0.004x + 30\hat{d}_y)$, where \hat{d}_y denotes unit vector in y direction. Find the phase velocity of propagating wave.
- (d) Explain how Wien's bridge can be used for experimental determination of frequency. Derive the expression for frequency at balance condition.
- (e) Describe the working of a crystal oscillator. List its advantages and disadvantages.

5. Answer any **two** questions from the following :

20×2=40

- (a) The four arms of a Wheatstone bridge are as follows :

$$AB = 100 \Omega; BC = 10 \Omega; CD = 4 \Omega; DA = 50 \Omega$$

The galvanometer has a resistance of 20Ω and is connected across BD . A source of 10 V d. c. is connected across AC . Find the current through the galvanometer. What should be the resistance in the arm DA for no current through the galvanometer?

- (b) Explain different methods of speed control of d. c. shunt motor. Give comparative features of each.
- (c) Describe, in detail, the successive approximation method of analog to digital (A/D) conversion.
6. Answer any *four* questions from the following : 10×4=40
- (a) Why is starting current high in a d. c. motor? Explain the working of a 4-point starter for d.c. motor.
- (b) What is synchronous condenser? Explain, with the help of phasor diagrams, its operation and application.
- (c) What are various types of semiconductor memory? Describe them briefly.
- (d) With circuit diagram, explain the principle of operation of *J-K* type flip-flop.
- (e) Write an assembly language program to find the largest number in a data array.
7. Answer any *two* questions from the following : 20×2=40
- (a) Describe a high-pass active filter and derive the expression for the cut-off frequency. Draw its frequency response curve.
- (b) Explain the construction and working principle of LVDT. An LVDT produces an r.m.s. output voltage of 2.6 V for displacement of 0.4 μm . Calculate the sensitivity of LVDT.
- (c) What is the function of time base generator in CRO? Explain the operation of circuit suitable for the generation of time base voltage.
8. Prove the single-phase induction motor is not self-starting. Explain the principle of operation of capacitor-start, capacitor-run, single-phase induction motor. Discuss the torque-speed characteristic of this motor. 40
9. Give the laboratory circuit diagrams to perform open and short circuit tests of single-phase transformer with explanation and then draw the equivalent circuit diagram using data from the experiments. How will you determine the losses from these tests? Why does hysteresis loss in a transformer decrease at higher frequencies with constant voltage? 40
10. Describe, in brief, Scott connection of two single-phase transformers for conversion of a balanced 3-phase to a balanced 2-phase supply. Draw circuit diagram and relevant phasor diagram. 40