Code: 9A02405

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ANALOG ELECTRONIC CIRCUITS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) Compare the small signal model of BJT and FET.

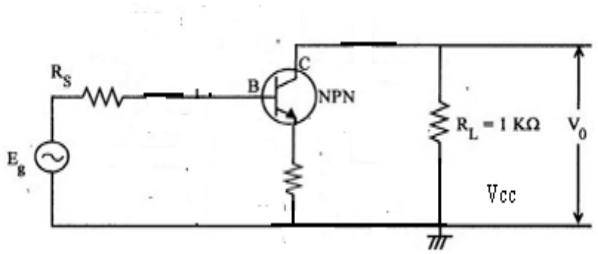
(b) For a CB transistor amplifier driven by a voltage source of internal resistance R_s = 600 Ω, the load impedance is a resistor R_L = 1200 Ω. The h-parameters are h_{ib} = 22 Ω, h_{rb} = 4 × 10^{-4}, h_{fb} = -0.98 and h_{ob} = 0.25 μA/V. Compute the current gain A_I, the input impedance R_i, voltage gain A_V, overall voltage gain A_{VS}, overall current gain A_{IS}, output impedance Z_o and power gain A_p.

2 (a) Sketch the frequency response of R-C coupled amplifier and explain the effect of emitter capacitance

(b) In an R-C coupled amplifier, AVM = 60, f_L = 50 Hz and f_H = 100 KHz. Find the values of frequencies at which the gain reduces to 50 on either side of midband region.

3 (a) Effect of feedback in the amplifiers frequency response and stability by its poles.

(b) The current series feedback type of transistor amplifier of figure shown has the following data of circuit constants: R_L= 1 kΩ, R_e = 100 kΩ, R_2 = 20 kΩ, R_1 = 30 kΩ, and h_{fe} = 100. Calculate A_v, R_i, R_{if}, A_{vf} and loop gain in dB. h_{ie}= 1 kΩ.



4 (a) What is meant by Barkhausen criterion and derive open loop and closed loop gains of an BJT amplifier.

(b) In a transistorized Hartley oscillator, the two inductances are 2 mH and 20 μH while the frequency is to be changed from 950 KHz to 2050 KHz. Calculate the range over which the capacitor is to be varied.

5 (a) Explain about power amplifiers and its features.

(b) Derive an expression for efficiency of class-A amplifier.

6 (a) Explain the response of the clamping circuit when a square wave input is applied under steady state conditions.

(b) Explain the effect of diode characteristics on clamping voltage.

7 Derive the expression for collector to emitter voltage with R_B in base in series with V_{BB}.

8 Explain the method of unsymmetrical triggering of the binary with relevant circuit diagram.

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Code: 9A02405

2

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ANALOG ELECTRONIC CIRCUITS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

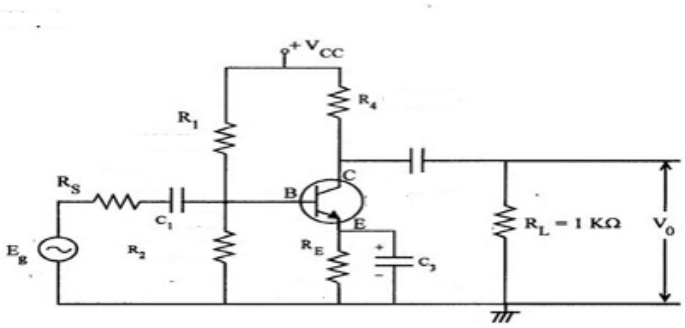
*****

1 (a) Compare the performances of BJT and FET.

(b) Draw the AC equivalent circuit of a CE amplifier with un-bypassed emitter resistor using h-parameter model and derive the equations for input impedance, output impedance, voltage gain and current gain.

2 (a) Draw the high frequency π model of a transistor and explain it.

(b) For the CE amplifier in figure. Calculate the mid frequency voltage gain and lower 3-dB point. The transistor has h-parameters of h_{fe} = 400 and h_{ie} = 10 kΩ. The circuit details are R_S = 600 Ω, R_L = 5 kΩ, R_E = 1 kΩ, V_{CC} = 12 V, R_1 = 15 kΩ, R_2 = 2.2 kΩ and C_E = 50 μF.



3 Draw and explain voltage-shunt amplifier using h-parameter model, derive voltage gain, input resistance, output resistance and current gain closed loop and open loop.

4 Consider RC network in the FET phase shift oscillator. If R_o is the output impedance of the amplifier, derive that the frequency of oscillation f and the minimum gain A.

5 (a) Show that in the case of transformer coupled class A power amplifier, maximum theoretical efficiency is 50%.

(b) Compare series fed and transformer coupled class-A amplifiers.

6 (a) Explain double divide clipper using circuit and necessary waveforms.

(b) Give the applications of voltage comparators.

7 (a) Explain the variation in V_{BE} with temperature with the help of suitable waveform.

(b) Explain the temperature dependence of h_{FE}.

8 A collector coupled one shot using n-p-n silicon transistors has the following parameters: V_{CC} = 3 V, V_{BB} = 9 V, R = 2.7 kΩ, R_C = 270 Ω, R_1 = 1 kΩ, R_2 = 15 kΩ, C = 0.01 μF, h_{FE} = 25 and r'_{bb} = 100 Ω. Neglect saturation voltages. Calculate and plot the waveforms at each base and collector.

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Code: 9A02405

3

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ANALOG ELECTRONIC CIRCUITS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Classify the amplifier and discuss the distortion in BJT and FET amplifiers.

(b) Design a single stage dc coupled CE amplifier for the given specification: V_{CC} = 24 V, I_C = 1 mA and R_L = 120 kΩ.

2 (a) Explain the miller theorem and derive miller capacitance.

(b) Draw and explain the miller's high frequency equivalent circuit with resistive load for a NPN transistor.

3 (a) Define the amount of feedback in decibels and state the three fundamental assumptions which are made in order that the expression A_I / (1 + Aβ).

(b) An amplifier has a midband gain of 125 and a bandwidth of 250 Hz. (i) If 4% negative feedback is introduced, find the new bandwidth and gain. (ii) If the bandwidth is to be restricted to 1 MHz, find the feedback ratio.

4 A crystal has the following parameters: L = 20 mH, C_1 = 65 μF, C_h = 1.0 pF and R = 4.5 kΩ. Find the series resonant frequency and Q-factor of the crystal. (i) Find the series resonant frequency. (ii) By what percent does the parallel resonant frequency exceed the series resonant frequency? (iii) Find the Q of the crystal.

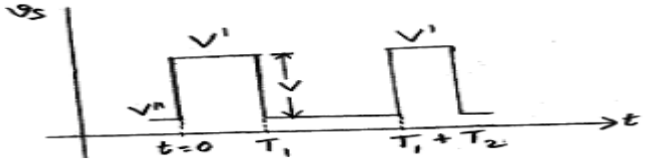
5 (a) Explain the reasons for harmonic distortion in push-pull power amplifiers.

(b) Derive the expression for the power of output signal having distortion.

(c) Calculate the transformer turns ratio required to match a 8 Ω speaker load to an amplifier so that the effective load resistance is 3.2 kΩ.

6 (a) State and prove clamping-circuit theorem.

(b) A square wave input as shown in figure below is applied to the clamping circuit. Sketch the steady-state output waveform and derive the necessary expressions.



7 (a) How transistor can be used as a switch in the circuit.

(b) A germanium transistor is operated at room temperature in the CE configuration. The supply voltage is 12 V, the collector-circuit resistance is 400 and the base current is 40 percent higher than the minimum value required to drive the transistor into saturation. Assume the following transistor parameters: I_{CO} = -10 μA, I_{EO} = -4 μA, h_{FE} = 200, and r_{bb0} = 500. Find V_{BE}(Sat) and V_{CE}(Sat).

8 Calculate the stable state currents and voltages for the self biased bistable multivibrator which uses n-p-n silicon transistors. The various parameters for the circuit are: V_{CC} = 12 V, R_1 = 30 kΩ, R_C = 4 kΩ, R_2 = 10 kΩ and R_E = 500 Ω.

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Code: 9A02405

4

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ANALOG ELECTRONIC CIRCUITS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Derive the voltage gain and input resistance of CG amplifier.

(b) Design a single stage DC coupled CE amplifier for the given specification: V_{CC} = 20 V, I_C = 1 mA and R_L = 100 kΩ.

2 Derive the voltage gain, input admittance and input miller capacitance of CD amplifier using its high frequency equivalent circuit.

3 (a) Explain with circuit diagram a negative feedback amplifier and obtain expression for its closed loop gain.

(b) An amplifier with stage gain 200 is provided with negative feedback of feedback ratio 0.05. Find the new gain.

4 Using Barkhausen criterion to the tuned drain oscillator and verify the following equation, and derive $g_m.w^2 = \frac{1}{LC}\left(1 + \frac{r}{r_d}\right)$.

5 (a) Define the conversion efficiency of a power amplifier A class? A power amplifier with a direct coupled load has a collector efficiency of 15% and delivers a power output of 5 Watts. Find:
(i) The DC power input. (ii) Power dissipation at maximum output.

(b) Draw the push-pull power amplifier circuit. Derive the expression for the output current in push pull amplifier with base current as $i_b = I_{bn}$ sin wt.

6 Explain the response of a low pass RC circuit to an exponential input and ramp input. Derive the required equations.

7 (a) Describe the switching times of BJT by considering the charge distribution across the base region. Explain this for cut off, active and saturation regions.

(b) Define the following terms:
(i) Storage time. (ii) Delay time. (iii) Rise time. (iv) Fall time.

8 Design and explain the fixed bias bistable multivibrator

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Code: 9A02406

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

NETWORK THEORY

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

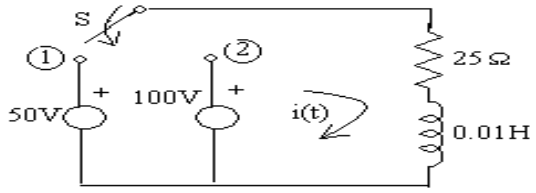
1 (a) Write down the advantages of a poly phase system? What is phase sequence? Explain the significance of phase sequence.

(b) A delta connected 3-phase load has a resistance of 10 Ω and inductive reactance of 15 Ω in each phase. It is fed by 3-phase, 440 V, 50 Hz supply. Find
(i) Apparent power. (ii) Active power. (iii) Reactive power.

2 Show that in the two-wattmeter method of 3-Φ power measurement, the sum of the readings of the two wattmeters gives the total power consumed in 3-Φ circuit. Hence prove: $\Phi = \tan^{-1}(\sqrt{3}(w_1-w_2)/ (w_1+w_2))$.
Where Φ is the phase angle of the load and w_1 & w_2 are the readings of the wattmeters.

3 (a) Derive the expression for current when a dc voltage V is applied suddenly (i.e. at time = 0) by closing a switch in a series R-L circuit.

(b) In the circuit shown in fig below, the switch is in position (1) to establish steady state condition and at t = 0, it is switched to position (2). Find the resulting current.



4 A series RC circuit with R = 100 Ω and C = 25 μF has a sinusoidal voltage V = 250 sin (500 t). Find the total current assuming that the capacitor is initially uncharged.

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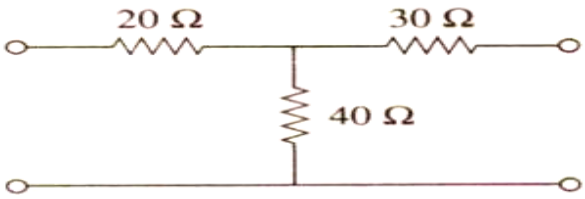
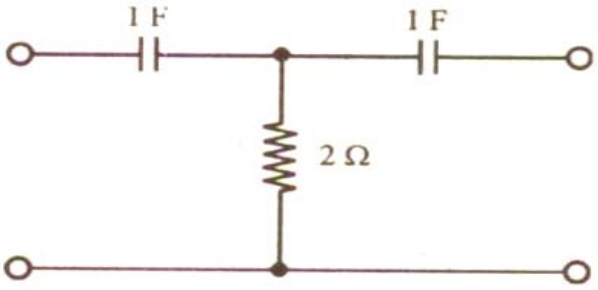
5 Determine z and y parameters of the network shown below:



6 Find the transmission parameters for the network shown below:



7 Sketch the diagram of a rectangular pulse train. Derive its Fourier series.

8 Discuss the time shifting and frequency shifting properties of Fourier transform.

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Code: 9A02406

2

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

NETWORK THEORY

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

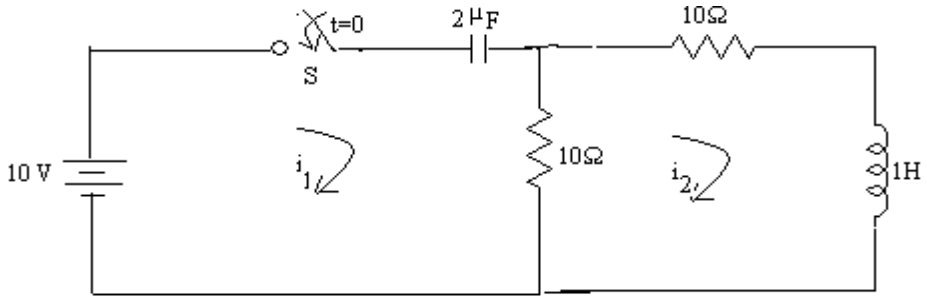
1 (a) Derive the relation between phase voltage and line voltage, phase current and line current of a three phase delta connected balanced system.

(b) Three choke coils each having a resistance of 10 Ω and inductance 0.019 H are connected in star across a 3-phase, 415 V, 50 Hz ac supply.
Find (i) Line current (ii) Power factor and (iii) Power input.

2 Two wattmeters are used to measure the power input in a 3-Φ circuit indicate 1000 W and 500 W respectively. Find the power factor of the circuit:
(i) When both wattmeter readings are positive.
(ii) When the latter is obtained by reversing the current coil connections. Derive the expression for power factor.

3 (a) Derive the expression for current when a dc voltage V is applied suddenly (i.e. at time = 0) by closing a switch in a series R-L circuit.

(b) In the circuit shown in the below fig. the switch is closed at t = 0. Find the values of i_1, i_2, di_1/dt, di_2/dt, d^2i_1/dt^2 and d^2i_2/dt^2 at $t = 0^+$.



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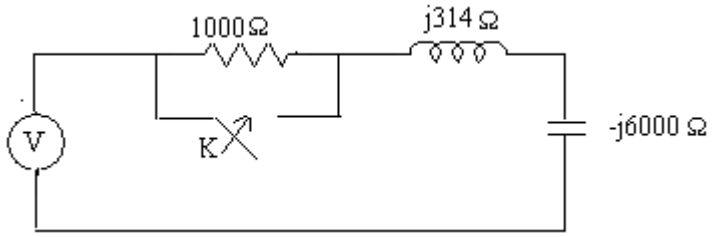
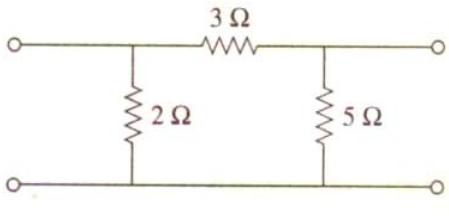
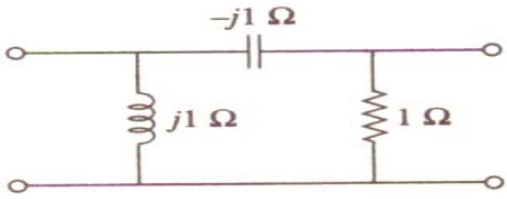
4 In fig shown below with switch open, steady state is reached with V = 100 sin (314 t) volts. The switch is closed at t = 0. The circuit is allowed to come to steady state again. Determine the steady state current and complete solution of transient current.



5 Determine the h-parameters for the circuit shown below:



6 Determine the Z-parameters of the two-ports shown below:



7 Sketch the diagram of a saw-tooth wave form. Derive its Fourier series.

8 (a) Derive the Fourier transform of the double-sided exponential $e^{-a(t)}$.

(b) Derive the Fourier transform of saw-tooth pulse, $p(t) = 10 + [u(t) - u(t-2)]$

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Code: 9A02406

3

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

NETWORK THEORY

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

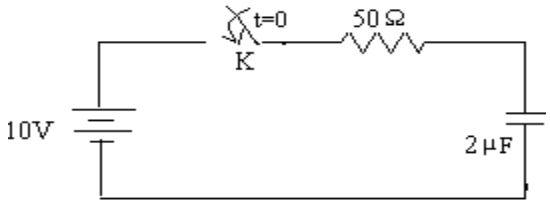
1 (a) Explain the three watt meter method measurement of power with a neat diagram.

(b) Three coils each having a resistance of 20 Ω and an inductive reactance of 15 Ω are connected in delta and fed by a 3-phase, 400 V, 50 Hz system. Find (i) Line current (ii) Power and (iii) Power factor

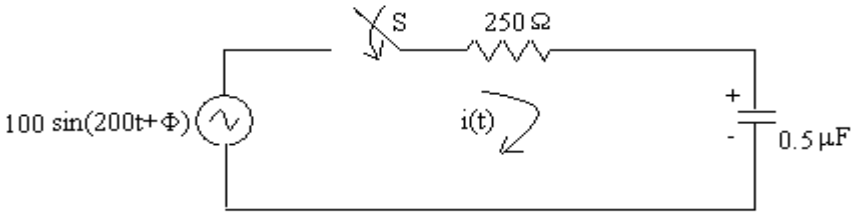
2 A symmetrical 3-phase, 100 V, three wire supply feeds an unbalanced star connected load, with impedances of the load as, $Z_R = 5\angle 0^0$, $Z_Y = 2\angle 90^0$ and $Z_B = 4\angle -90^0$ ohms. Find the (i) Line currents. (ii) Voltage across the impedances. (iii) The displacement neutral voltage by using star-delta conversion method.

3 (a) Obtain the expression for i(t) in a series R-C circuit is exited with a dc voltage source V, when the switch is closed at time t = 0.

(b) In the circuit shown in fig below, switch 'K' is closed at t = 0. Find the values of i, di/dt and d^2i/dt^2 at $t = 0^+$.



4 In the RC circuit shown in the fig below, the capacitor has an initial charge $Q_0 = 25 \times 10^{-6}$ C with polarity as shown. A sinusoidal voltage V = 100 sin (200t + Φ) is applied to the circuit at a time corresponding to $\Phi = 30^0$. Determine the expression for the current i(t).



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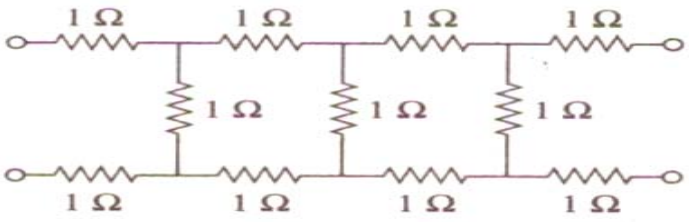
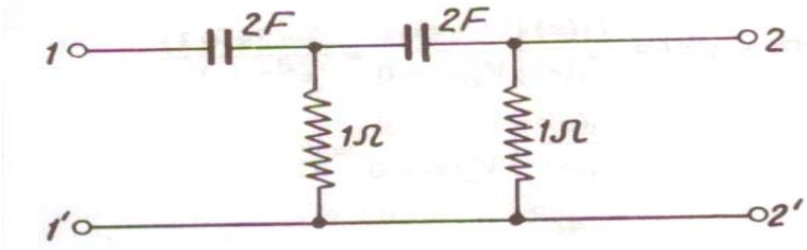
5 Find the impedance parameters of the network shown below:



6 Find the y-parameters for the following network.



7 Determine the Fourier series for the half-wave rectified cosine function.

8 Discuss the time integration and Frequency differentiation properties of Fourier transform.

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Code: 9A02406

4

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

NETWORK THEORY

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

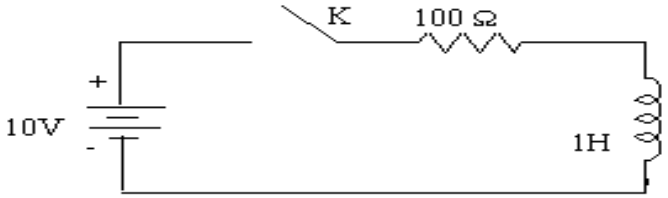
1 (a) Derive the relation between phase and line values of a three phase delta connected balanced system.

(b) Three inductive coils, each with a resistance of 15 Ω and an inductance of 0.03 H are connected in star to three phase, 400 V, 50 Hz supply. Calculate (i) phase current and line current. (ii) total power absorbed.

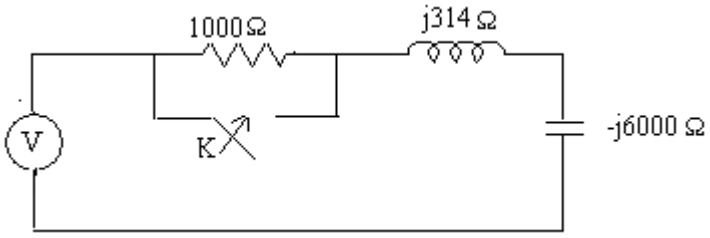
2 Three impedances of (7 + j4) Ω; (3 + j2) Ω and (9 + j2) Ω are connected between neutral and the red, yellow and blue phases, respectively of a 3-phase, four wire system. The line voltage is 440 V. Calculate (i) The current in each line and (ii) The current in the neutral wire.

3 (a) Derive the expression for i(t) in a series R-C circuit is exited with a dc voltage source V, when the switch is closed at time t = 0.

(b) In the circuit shown in fig below, switch 'K' is closed at t = 0. Find the values of i, di/dt and d^2i/dt^2 at $t = 0^+$.



4 In fig shown below with switch open, steady state is reached with V = 100 sin (314t) volts. The switch is closed at t = 0. The circuit is allowed to come to steady state again. Determine the steady state current and complete solution of transient current by using Laplace transform method.



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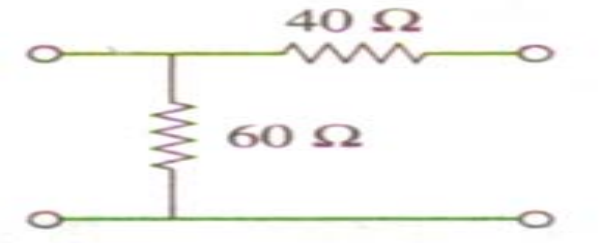
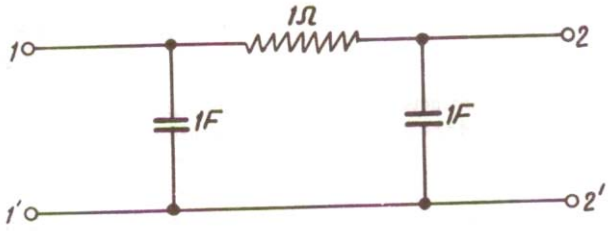
5 Find the h parameters for the network shown below:



6 Find ABCD parameters for the following network:



7 Derive the Fourier series of a half-wave rectified sine wave.

8 Determine the inverse Fourier transform of:

(a) $F(w) = 4\delta(w+3) + \delta(w) + 4\delta(w-3)$

(b) $H(w) = 6\cos 2w$

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Code: 9A02407

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTRICAL MACHINES - II

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Discuss the constructional features of transformers. Draw neat diagrams.

(b) Calculate the flux in the core of a single-phase transformer having a primary voltage of 460 V, at 50 Hz and 100 turns. If the flux density in the core is 2 tesla, calculate the net cross-sectional area of the core.

2 (a) With neat circuit diagrams, explain the procedure for conducting OC and SC tests on a given single-phase transformer to predetermine its regulation and efficiency.

(b) A 100 KVA, 1000 V/10000 V, 50 Hz, single-phase transformer has an iron loss of 1200 W. Find the maximum efficiency at 0.8 power factor lagging if the copper loss is 500 W with 6 A in high voltage winding. Also calculate the corresponding regulation if the equivalent leakage reactance referred to HV is 10 ohms.

3 (a) In a test for the determination of the losses of a 440 V, 50 Hz transformer, the total iron losses were found to be 2500 W at normal voltage and frequency. When the applied voltage and frequency were 220 V, 25 Hz, the iron loss were found to be 850 W. Calculate the hysteresis and eddy current losses at normal voltage and frequency.

(b) The following readings were obtained from OC and SC tests on 8 KVA, 400/120 V, 50 Hz, transformer.

OC Test on LV side 120 V, 4 A, 75 W

SC Test on HV side 9.5 V, 20 A, 110 W

Calculate the voltage regulation and efficiency at full load 0.8 P.F lagging.

4 (a) Explain the Scott connection in the transformer.

(b) A three phase 5000/500 V, 173.2 KVA star connected transformer has 75 turns on the secondary. Find the number of primary turns and secondary currents.

5 (a) Explain why the rotor of polyphase induction motor can never attain synchronous speed.

(b) Explain the constructional details of 3-phase induction motor.

Contd. in Page 2

6 (a) Explain the following terms:
(i) Maximum torque. (ii) Full load torque and (iii) Starting torque.

(b) A 8 pole 50 Hz 3-phase slip ring induction motor has effective resistance of 0.08 ohms/ph. The speed corresponds to maximum torque is 650 rpm, find the value of resistance to be inserted in rotor circuit to obtain maximum torque at starting.

7 A 4.5 KW, 400 V, 50 HZ, 3-phase delta connected induction motor gave the following test results.

No load test: 400 V, 4.2 A, 480 W

Blocked rotor test: 215 V, 15 A, 1080 W

The ratio of stator to rotor resistance referred to stator is 2:1. Calculate the torque, line current, power factor and efficiency at 125% of full load.

8 (a) Explain about the speed control of induction motor by Tandem operation and derive the formula of speed.

(b) The rotor of 4-pole 50 Hz slip ring the slip ring induction motor has a resistance of 0.3 Ω per phase runs at 1440 rpm, at full load. Calculate the external resistance per phase which must be added to lower the speed 1320 rpm, the torque being same as before.

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Code: 9A02407 **2**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTRICAL MACHINES - II

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Explain the principal of operation of transformer. Derive its e. m. f. equation.

(b) A 1-phase transformer has 180 turns respectively in its secondary and primary windings. The respective resistances are 0.233 Ω and 0.067 Ω. Calculate the equivalent resistance of (i) the primary in terms of the secondary winding, (ii) the secondary in terms of the primary winding, and (ii) the total resistance of the transformer in terms of the primary.

2 (a) Derive the approximate equation of regulation of a transformer

(b) A 5 KVA, 2300/230 V, 50 HZ transformer was tested for the iron loss with normal excitation and copper losses at full load, and these were found to be 40 watts and 112 watts respectively. Calculate efficiency of the transformer at (i) Full load. (ii) Half full load. Assume the power factor of the load as 0.8.

3 (a) Explain the various simple tests conducted on a single transformer to find the approximate equivalent circuit of transformer.

(b) OC test is preferred to conduct on LV side and SC test is preferred to conduct on HV side. Explain the reasons.

4 A 3phase delta/star connected 11000/440 V, 50 Hz transformer takes a line current of 5 A, when secondary load of 0.8 lagging pf is connected. Determine the output of transformer.

5 A 4 pole, 3-Ø, 50 Hz, 415 V induction motor runs at a speed of 1440 rpm. Calculate:
(i) The slip, (ii) Rotor frequency (iii) Take the power factor is 0.88.

Contd. in Page 2

6 (a) Explain the various losses taking place in an induction motor. Also derive the relationship between rotor power input and rotor copper loss.

(b) A 4-pole, 400 V, 3-phase induction motor has a stand still rotor e.m.f of 100 V per phase. The rotor has resistance of 50 ohms/ph and standstill reactance of 0.5 ohms/ph. Calculate the maximum torque and slip at which it occurs. Neglect stator impedance.

7 (a) Explain no load tests and blocked rotor tests for an 3-phase induction motor.

(b) In a no load test, an induction motor took 10 A and 450 W with a line voltage of 110 V. If stator resistance per phase is 0.05 Ω and friction and windage losses amount to 135 W. calculate the exciting conductance and susceptance/ph.

8 (a) Describe how the speed control of induction motor is achieved from stator side?

(b) A cascaded set consists of 2 motors A and B with 4-pole and 6-poles respectively. The motor A is connected to 50 Hz supply, find

(i) Speed of the set.

(ii) Electric power transferred to motor B when the input to the motor A is 25 KW. Neglect losses.

*****

Code: 9A02407 **3**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTRICAL MACHINES - II

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Give the constructional features of “CORE” and “Shell” types of transformers, and give the advantages and disadvantages of each type.

(b) Derive the emf equation of a transformer.

2 (a) Draw the equivalent circuit of a transformer and show how the constants of primary and secondary windings may be combined to give a simplified equivalent circuit with the values of constants given in terms of secondary winding.

(b) Define and explain all day efficiency of a transformer

3 (a) With all necessary instruments draw a neat experimental set up to conduct OC and SC tests on a single phase transformer.

(b) A single phase 250/500 V transformer gave the following results:

OC test: 250 V, 1 A, 80 W on LV side.

SC test: 20 V, 12 A, 100 W on HV side.

Find the maximum efficiency of the transformer.

4 Two identical transformers each of rating 5 KVA, 200 V/100 V, 50 Hz transformers are connected in open delta. Calculate the KVA rating of the open delta bank when HV side is used as primary.

5 (a) Explain the constructional details of a 3-phase induction motor.

(b) A 3-phase induction motor runs at 1440 rpm at full load when supplied power from 50 Hz, 3-phase line. Calculate:

(i) The number of poles. (ii) Slip of full load.

(iii) Speed of the rotor field w.r.t rotor. (iv) Speed of the rotor field w.r.t stator.

Contd. in Page 2

6 (a) A 12-pole, 3-phase, 50 HZ, IM draws 280 Amp and 110 KW under the blocked rotor test. Find the starting torque when switched on direct rated voltage and frequency supply. Assume the stator and rotor copper losses to be equal under the blocked rotor test.

(b) Why the starting current of IM is very high? Justify statement 'Though the staring current of IM is very high, the starting torque is poor'.

7 Explain how the performance of induction motor can be predicted by circle diagram. Draw the circle diagram for a three-phase, mesh connected, 22.38 KW, 500 V. 4-pole, 50 Hz induction motor. The data below gave the measurements of line current, voltage and reading of two wattmeters connected to measure the input.

No-Load	500 V	8.3 A	2.85 KW	-1.35 KW
Short circuit	100 V	32 A	-0.75 KW	2.35 KW

Also find the line current, p.f., efficiency and the maximum output from the circle diagram.

8 (a) With neat diagram explain the operation of 3-phase IM as induction generator.

(b) Two motors A and B with 10-poles and 12-poles respectively are cascaded. The motor A is connected to a 50 Hz supply. Find:

(i) Speed of the set

(ii) The electrical power transferred to the motor B when the input to the motor A is 60 KW. Neglect losses.

*****

Code: 9A02407 **4**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTRICAL MACHINES - II

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Derive an emf equation of a single phase transformer.

(b) The maximum flux density in the core of 250/3000 Volts 50 HZ single phase transformer is 1.2 webers per square meter. If the emf per turn is 8 volts, determine primary and secondary turns and area of the core.

2 (a) Define all day efficiency? Also derive the condition for maximum efficiency of a transformer.

(b) A single phase 150 KVA transformer has efficiency of 96 % at full load, 0.8 pf and at half load, 0.8 pf lagging. Find maximum efficiency of transformer and corresponding load.

3 (a) What are the advantages of Sumpner's test? Give the related calculation to find the efficiency of a transformer.

(b) In Sumpner's test on two identical transformer rated 500 KVA, 11/0.4 KV, 50 Hz, the wattmeter reading on HV side is 6 KW on rated voltage and on LV side is 15 KW when circulated full load current. Find the efficiency of each transformer on $3/4^{th}$ load and 0.8 pf lagging. What will be the maximum efficiency of each transformer?

4 (a) With neat phasor diagram, explain the voltage regulation of 3-phase transformer.

(b) An ideal 3-phase step down transformer connected in delta/star delivers power to a balanced 3-phase load of 120 KVA at 0.8 pf. The input line voltage is 11 KV and the turn's ratio of transformer (phase to phase) is 10. Determine the line voltage line currents, phase voltages, phase currents on both primary and secondary sides.

5 (a) Discuss the production of rotating magnetic field in induction motors.

(b) A 3-phase induction motor is wound for 4-poles and is supplied from 50 Hz system. Calculate:
(i) Synchronous speed. (ii) Rotor speed when slip is 4% and
(iii) Rotor frequency when rotor runs at 600 rpm.

Contd. in Page 2

6 (a) Draw and explain the phasor diagram of 3-phase induction motor.
(b) Discuss the phenomenon of crawling and cogging in an induction motor.

7 (a) A 10 KW, 420 V, 3-phase, 4-pole, 50 HZ delta connected squirrel cage induction motor gave the following data on blocked rotor test. 210 V, 20 A, 5 KW stator core loss at rated voltage and frequency is 300 watts. The dc resistance measured between any two terminals of stator is 0.6 ohm. Determine the starting torque.
(b) A 10 KW, 400 V, 4-pole delta connected squirrel cage induction motor gave the following test results.
No load test : 400 V, 8 A, 250 W
Blocked rotor test : 90 V, 35 A, 1350 Watts.
DC resistance per phase of stator is 0.6, calculate equivalent circuit parameters.

8 (a) Explain briefly how the speed control of induction motor is achieved from rotor side?
(b) Two 50 Hz, 3-Φ induction motor having 6 and 4-poles respectively are cumulatively cascaded. The 6-pole motor being connected to the main supply.
Determine frequencies of rotor currents and the slips referred to each stator field. If the set has slip of 2%.

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Code: 9A04401

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

SWITCHING THEORY AND LOGIC DESIGN

(Common to EEE, EIE, E.Con.E, ECE and ECC)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Distinguish between weighted and non-weighted codes with examples.

(b) Represent the decimal number 8620 in: (i) BCD (ii) XS3 (iii) Gray codes

2 (a) What are universal gates? Realize AND, OR, NOT, XOR gates using universal gates.

(b) Given Boolean expression AB' + A'B = C. Show that AC' + A'C = B.

(c) Prove that OR-AND network is equivalent to NOR-NOR network.

3 (a) What are the advantages of tabulation method over K-map?

(b) Simplify the following Boolean function using tabulation method.

$Y(A,B,C,D) = \sum(1,3,5,8,9,11,15)$

4 Design BCD to XS3 code converter and realize using logic gates.

5 (a) The following memory units are specified by the no of words times the number of bits per word. How many address lines and input-output data lines are needed in each case? (i) 5K × 16 (ii) 3G × 8 (iii) 32M × 32 (iv) 256K × 64.

(b) Give the number of bytes stored in the memories listed above.

6 (a) Distinguish between a state table and a flow table.

(b) Draw the logic diagram and write functional table of an SR latch using NAND gates. Explain the operation.

7 (a) Define state equivalence and machine equivalence with reference to sequential machines.

(b) A clocked sequential circuit with single input and single output Z is defined by the following D - flip-flop input equations and output equations of Z.

$$D_1 = \overline{Q_1}Q_2\overline{Q_3}x$$
$$D_2 = Q_1\overline{Q_2Q_3}$$
$$D_3 = \overline{Q_1Q_3}\overline{x} + \overline{Q_1}Q_3\overline{x}$$
$$Z = Q_1Q_2Q_3x$$

(i) Obtain state table.

(ii) Draw the state diagram.

8 Draw the state diagram for mod-6 counter and obtain ASM chart.

*****

Code: 9A04401

2

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

SWITCHING THEORY AND LOGIC DESIGN

(Common to EEE, EIE, E.Con.E, ECE and ECC)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Why 8421 BCD code is widely used in computers?

(b) What are the rules for 8421 BCD addition? Add the two decimal numbers 7546 and 3462 in 8421 code.

(c) Distinguish between weighted and non-weighted codes with examples.

2 (a) State duality theorem. List Boolean laws and their duals.

(b) Simplify the following Boolean functions to minimum number of literals.
(i) F = ABC + ABC' + A'B. (ii) F = (A+B)' (A'+B').

(c) Realize XOR gate using minimum number of NAND gates.

3 (a) List the Boolean function simplification rules using tabulation method.

(b) Simplify the following Boolean function using tabulation method.
$Y(A, B, C, D) = \sum(0, 1, 2, 3, 5, 7, 8, 9, 11, 14)$

4 (a) Implement full adder using decoder and OR gates.

(b) Realize the Boolean function $T(X, Y, Z) = \sum(1, 3, 4, 5)$ using logic gates for hazard free.

5 (a) Design a combinational circuit using ROM that accepts 3-bit number and generates output binary number equal to the square of the input number.

(b) Write short notes on types of read only memory.

6 (a) Design a serial binary adder using D-Flip Flop.

(b) Draw the circuit diagram of J-K Flip-Flop with NAND gates with positive edge triggering and explain its operation with the help of truth table. How race around condition is eliminated?

7 Define:
(i) Finite state machine.
(ii) State equivalence and machine minimization.
(iii) Distinguishable states and sequence.

8 Design a half adder and half subtractor circuit using multiplexer.

*****

Code: 9A04401

3

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

SWITCHING THEORY AND LOGIC DESIGN

(Common to EEE, EIE, E.Con.E, ECE and ECC)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Explain error detection codes.

(b) What is the drawback of error detection codes?

(c) Construct even parity 7 bit hamming code for the message 0100.

2 (a) Draw the symbols and truth tables of all logic gates and explain.

(b) Simplify the following Boolean functions to minimum number of literals.

(i) xy + y'z' + wxz' (ii) w'x' + x'y' + w'z' + yz

(c) Realize XOR gate using minimum number of NAND gates.

3 (a) Define prime implicant and essential prime implicant with example using K-map.

(b) Find all the prime implicants for the following Boolean function using K-map and determine which are essential.

$$F(A,B,C,D) = \sum(1,3,4,5,9,10,11,12,13,14,15)$$

4 Design a combinational circuit that converts a decimal digit from 8, 4,-2,-1 code to 8,4,2,1 BCD code.

5 (a) Find the minimal threshold-logic realization for the function:

$$f(A, B, C, D) = \Sigma m\ (2, 3, 6, 7, 10, 12, 14, 15)$$

(b) Compare programmable logic devices.

6 (a) Design a mod-6 asynchronous counter using T-flip flop.

(b) Compare synchronous and asynchronous sequential circuits.

7 A clocked sequential circuit is provided with a single input x and single output z. Whenever the input produce a string of pulses 1 1 1 or 0 0 0 and at the end of the sequence it produce an output z = 1 and overlapping is also allowed.

(a) Obtain state diagram.

(b) Also obtain state table.

(c) Find equivalence classes using partition method.

8 (a) Write short notes on ASM chart.

(b) Draw the state diagram for a full adder and convert it to ASM chart and realize the circuit.

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Code: 9A04401

4

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

SWITCHING THEORY AND LOGIC DESIGN

(Common to EEE, EIE, E.Con.E, ECE and ECC)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Explain the method of error detection in binary codes.

(b) Construct the BCD code with even parity and odd parity bit for decimal 0 to 9.

(c) Construct 7 bit hamming code for data1001. Use even parity.

2 (a) State duality theorem. List Boolean laws and their duals.

(b) Simplify the following Boolean functions to minimum number of literals.

(i) xy + xy' (ii) (x + y)(x + y')

(c) Realize XOR gate using minimum number of NAND gates.

3 (a) Draw 3-variable and 4-variable K-map and define pair, quad and octet.

(b) Simplify the following Boolean function for minimal POS form using K-map and implement using NOR gates.

F(W, X, Y, Z) = ∑(1, 2, 5, 6, 9) + d(10, 11, 12, 13, 14, 15)

4 (a) Design 4-bit even parity generator. Mention truth table.

(b) Design BCD to XS3 code converter using a 4-bit full- adders MSI circuit.

5 (a) Design a combinational circuit using PROM that converts a 3-bit binary number to equivalent excess-3 code.

(b) Write short notes on threshold logic.

6 (a) Convert SR-flip-flop into JK-flip-flop.

(b) Compare sequential and combinational circuits.

7 A Clocked sequential circuit with two inputs x and y and a single output z is defined by the following J - K flip-flops state equations and output equation of z.

$$Q_1^+ = Q_1\overline{x} + Q_1 y + Q_2 x + \overline{Q_1 Q_2}\,\overline{y}$$
$$Q_2^+ = \overline{Q_1} Q_2 \overline{x} + \overline{Q_1} Q_2 y + \overline{Q_1 Q_2}\, x$$
$$Z = (Q_1 + Q_2)\overline{xy}$$

Where Q+1, ξQ+2 are the next states and Q1, ξQ2 are the present states of JK flip-flops. (a) Obtain state table. (b) Obtain state diagram.

8 (a) Explain in detail the block diagram of ASM chart.

(b) Draw the portion of an ASM chart that specifies the conditional operation to increment register R during state T_1 and transfer to state T_2, if control inputs z and y are = 1 and 0 respectively.

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Code: 9A02403 **1**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

GENERATION OF ELECTRIC POWER

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 What are the nuclear materials used in nuclear power plants?

2 Explain the different methods of solar energy storage.

3 Why pulverized fuel is preferred? What are the types of pulverized fuel burners?

4 (a) Explain the role and potential of wind energy option.

(b) Why wind energy is is considered as a renewable energy source. Mention its demerits as a source of energy.

5 What are the techniques suggested for maintaining the biogas production? Explain.

6 Discuss the advantages and disadvantages of geothermal plants compared with conventional thermal plants.

7 (a) Can the load factor of the system be 100%?

(b) A generating station has a maximum demand of 80 MW, a load factor of 65%, a plant capacity factor of 40% and a plant use factor of 85%. Find

(i) Daily energy produced.

(ii) Reserve capacity of plant.

(iii) Maximum energy that could be produced daily if the plant was running all the time and maximum energy that could be produced daily if the plant was running as per operating schedule.

8 Explain what is meant by ‘two part tariff and give the economic basis for adopting such a tariff.

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Code: 9A02403 **2**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

GENERATION OF ELECTRIC POWER

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 What are the advantages and disadvantages of the nuclear power station?

2 Explain the thermal analyses of a flat plate collector.

3 Write a short note on super heaters and reheaters.

4 What are the design considerations of horizontal axial machines?

5 With the help of neat diagrams, explain the working of biogas plants of floating type and fixed type systems. Discuss their relative merits and demerits.

6 Bio fueling is one major problem in developing OTEC plant. Discuss, explain and suggest the methods to prevent it.

7 (a) What is meant by depreciation of a power station?

(b) A generating station has maximum demand of 10 MW. Calculate the cost per unit generated from the following data:
Annual load factor = 30%.
Capital cost = Rs. 12,50,000.
Annual cost of fuel and oil = Rs. 8,00,000.
Taxes, wages and salaries = Rs. 7,00,000.
Interest and depreciation = 10%.

8 Explain giving examples:
(i) Flat rate tariff
(ii) Block rate tariff
(iii) Two part tariff
(iv) Power factor tariff. Give the advantages and disadvantages of each.

*****

Code: 9A02403 **3**

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

GENERATION OF ELECTRIC POWER

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 Write short notes on the following:
   (a) Atomic number and mass number.
   (b) Atomic mass unit.
   (c) Isotope.

2 How a concentrating collector differ from flat plate collector?

3 What are the functions of economizer and super heater in a thermal power plant?

4 Explain the various types of wind mills.

5 Write in brief about biomass resource development.

6 Explain with justification the potential of wave energy available in India. What factors are considered in selecting a site for wave power plant?

7 Define the load factor and maximum demand. Explain how the load factor affects the cost of energy generated.

8 A customer is offered power at Rs. 50 per annum per KVA of maximum demand plus 5 paise per unit. He proposes to install a motor to carry his estimated maximum demand of 300 b.h.p.(metric). The motor available has power factor of 0.83 at full load. How many units will be required at 30% load factor and what will be the annual bill? The motor efficiency is 90%.

*****

Code: 9A02403

4

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

GENERATION OF ELECTRIC POWER

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 Write a short note on fast breeder reactor and also advantages and disadvantages.

2 Briefly explain the role and potential of solar energy generation.

3 Write a note on types of boilers and their characteristics.

4 Describe with a neat sketch the working of a wind energy system with main components.

5 What is meant by anaerobic digestion? What are the factors which affect bio digestion? Explain briefly.

6 What factors are considered in finding out the power potential of a tidal plant? Discuss with the merits of each factor.

7 (a) Define the following terms for generating station:
(i) Load factor. (ii) Utilization factor. (iii) Load curves

(b) Load factor of a consumer is 35% and the monthly consumption is 504 KWh. If the rate of electricity is Rs.180 per KW maximum demand plus Rs 20. per KWh, find
(i) The monthly bill and the average cost per KWh.
(ii) The overall cost per KWh if the consumption is increased by 20% with the same load factor.
(iii) The overall cost per KWh if the consumption remains same her load factor is increased to 40%.

8 (a) Can a power factor clause be included in a tariff?

(b) A factory has a maximum load of 300 KW at 0.72 p.f lagging with an annual consumption of 40,000 units. The tariff in force is Rs. 4.5 per KVA of maximum demand plus 2 paise per unit. Calculate the flat rate of energy consumption. What will be the annual saving if p.f. is raised to unity?

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Code: 9A02404

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 An infinitely large cylinder has a radius and a uniform charge of one micro coulomb per meter. Calculate the potential at a point 10 m away from the cylinder if zero potential point is taken to be at a radial distance of 1m.

2 (a) Explain: (i) Dipole and (ii) Dipole moment.
(b) Find electric potential due to electric dipole.

3 A parallel plate capacitor consists of two square metal plates with 500 mm side and separated by 10 mm. A slab of sulphur (ε_r = 4) 6 mm thick is placed on the lower plate and air gap of 4 mm. Find capacitance of capacitor.

4 (a) State and explain Biot-savart's law.
(b) Develop an expression for the magnetic field at any point on the line through the centre at a distance 'h' from the centre and perpendicular to the plane of a plane circular loop of radius 'a' and carrying current 'I' amperes.

5 A steady current of 1000 A is established in a long straight hollow aluminum conductor of inner radius 1 cm and outer radius 2 cm assume uniform resistivity and calculate B as a function of radius r from the axis of the conductor and also derive the formula used.

6 (a) Derive the expression for the magnetic moment of a planar coil.
(b) A magnetic field B = 3.5 x 10^{-2} a_z wb/m^2 exerts a force on a 0.3 m conductor along the x-axis. If the conductor current is 5 A in the -a_z direction what force must be applied to hold the conductor in position. Also derive the formula used.

7 (a) Determine the self inductance of a coaxial cable of inner radius a and outer radius b.
(b) A coaxial cable consists of an inner conductor of radius 1.2 cm and an outer conductor of radius 1.8 cm the two conductors are separated by an insulating medium($\mu_r = 4\mu_o$). If the cable is 3 m long and carries 25 mA current, calculate the energy stored in the medium.

8 Write Maxwell's equations in good conductors for time varying fields and static fields both in differential and integral form.

*****

Code: 9A02404

2

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) State and prove Gauss's law in integral form, considering static charges in free space.

(b) $\nabla V = xa_x + ya_y + za_z$. If (2, 2, 2) m is at zero volts, find the potential V(x, y, z).

2 (a) Derive Laplace and Poisson's equation.

(b) Derive the expression for potential and field between two co-axial cylinders.

3 (a) What are boundary conditions for potential?

(b) Derive the boundary conditions for a current density at a conductor boundary.

4 A single phase circuit comprises of two parallel conductors A and B, 1cm radius and 1m apart. The conductors carry + 10 A and – 10 A respectively. Determine the magnetic field intensity at the surface of each conductor and also in the space exactly mid way between A and B. Establish the relations used.

5 (a) Using the amperes circuital law find the magnetic field intensity due to an infinite current sheet of current density J and hence prove that magnetic field intensity at any point in between two infinite surface current sheets carrying current in opposite direction is equal to the sheet current density of each sheet .

(b) Using amperes circuital law, find H and B inside a long straight non magnetic conductor of radius 8 mm carrying a current density of 50 kA/m^2.

6 (a) Device the expression for force on a straight current carrying conductor placed in a magnetic field.

(b) If a point charge of 3 coulombs moves with a velocity of $7a_x + 4a_y – 6a_z$ m/s, find the force exerted (i) if the electric field intensity is $12a_x + 7a_y – 6a_z$ V/m (ii) if the flux density is $6a_x + 5a_y + 7a_z$ wb/m^2.

7 (a) The vector magnetic potential A due to a direct current in a conductor in free space is given by A = $(x^2 + y^2)\ a_z$ micro wb/m^2. Determine the magnetic field produced by the current element at (1, 2, 3).

(b) What is the inductance of a pair of transmission lines separated by 2 m in air and the diameter of each wire is 5 cm the line is 15 m in length?

8 (a) State Poynting's theorem. What is pointing vector?

(b) A copper wire carries a current of 1 A. Determine the displacement current in the wire at 1 MHz. for copper $\epsilon = \epsilon_0$ and $\sigma = 5.8 \times 10^7$.

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Code: 9A02404

3

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Explain Gauss's law with example.

(b) Using gauss law find E at any point due to long infinite charge wire.

2 A square cube of a dielectric side dimensions D is centered on the right of a rectangular coordinate system with its sides parallel to the x, y, z coordinate axes. The polarization vector within the dielectric is given by $\mathrm{P} = P_o(xa_x + ya_y + za_z)$. Determine the surface and the volume charge densities and show the total bound charge is zero.

3 Explain the phenomenon of polarization when a dielectric slab is subjected to an electric field with neat diagrams.

4 (a) Derive Biot-Savart law and relate it to amperes law. Show that the divergence magnetic induction is always zero.

(b) If $H = x^2ya_x + 0.1xa_z$ A/m, find the current density.

5 (a) Find the magnetic field intensity due to a hollow conductor of radius R_1 and outer radius R_2.

(b) Derive the boundary conditions at the magnetic interfaces and show that $tan\,{}^{\theta_1}/_{\theta_2} = {}^{\mu r_1}/_{\mu r_2}$.

6 (a) 'A current carrying conductor kept in magnetic field experience a force' justify the statement.

(b) A cylindrical conducting shell of radius ρ = 4 mm and negligible thickness forms the inner conductor of a co-axial line. The outer conductor is a co-axial conducting cylinder of 20 mm radius and negligible thickness. The cylinders carry equal and opposite total currents of 100 A. What is the magnitude of force per unit length acting to split the outer cylinder apart longitudinally?

7 (a) Explain scalar magnetic potential and its limitations.

(b) Compute energy density in free space on account of field having H = 1000 A/mt.

8 (a) Show that in a capacitor the conduction current and displacement current are equal.

(b) A capacitor has a capacitance of 1.5 pF. Find the displacement current at t = 0, if a voltage 5 sin 100(πt) is applied to it.

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Code: 9A02404

4

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) Define rectangular co-ordinate system.

(b) Electric potential in an electric field is given by $v(x, y, z) = -3x^2yz$. Compute the electric field intensity as a function of x, y and z coordinates. Derive the formula used.

2 Find the magnetic dipole movement of an electron in a circular orbit of radius a normal to the uniform magnetic field of flux density of B_0. Compute its value for a = 10^{-3} m and $B_0 = 5\times10^{-5} wb/m^2$.

3 (a) Derive the conditions at a boundary between two dielectrics.

(b) Define capacitance. Obtain the expression for capacitance of concentric spheres.

4 A current filament of 10 A in the + y direction lies along the y-axis, at a current sheet k = 2.0 a_x A/m, is located at z = 4 m. Determine H at the point (2, 2, 2) m.

5 (a) Find the magnetic field intensity H due to a solenoid carrying current I and having length L = 4 m.

(b) Write down Maxwell's second and third equation in point and integral form. Also state the basic laws from which these two equations were derived.

6 (a) Justify the statement 'most of the electrical machines are working on electro-magnetic principles rather than the electrostatic principles'.

(b) A galvanometer has a rectangular coil side of 10 mm × 30 mm pivoted about the center of shorter side. It is mounted in a radial magnetic field so that a constant magnetic field of 0.4 T always acts across the plane of the coil. If the coil has 1000 turns and carries current 2 mA, find the torque exerted on it.

7 (a) Explain the difference between self inductance and mutual inductance.

(b) Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm and of diameter 6 cm given that the medium is air. Derive the formula used.

8 Assuming Maxwell's equations show that the quantity given by the expression $\oint(\overline{E}\ X\ \overline{H})\overline{ds}$ is equal to the total power flowing out the volume enclosed by the closed surface surrounding the volume.

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