Roll No.

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Total No. of Questions : 7   No. of Printed Pages : 12

SEM-2014(02)
ELECTRICAL ENGINEERING
Paper – I

Time : 3 Hours]   [Total Marks : 300

Instructions to the candidates :

Please read the following instructions carefully before attempting questions.

1. Candidates should attempt *FIVE* questions in all.

2. Question number **1** is compulsory. Out of remaining SIX questions, attempt any *FOUR*.

3. *All* questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

4. Answers must be written in **ENGLISH** only.

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

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

7. Neat sketches may be drawn wherever required.

8. All parts and sub-parts of a question are to be attempted together in the answer book.

9. Any pages left blank in the answer book must be clearly struck out.

1. All parts carry equal marks. $10 \times 6 = 60$

(a) If the voltage waveform in figure Q. 1 (a) is applied across the terminals of a 5-H inductor, sketch the current through the inductor with respect to time. Mark all the salient features like magnitude and time on the waveform. Assume that initial condition $i_L(0) = 0$.
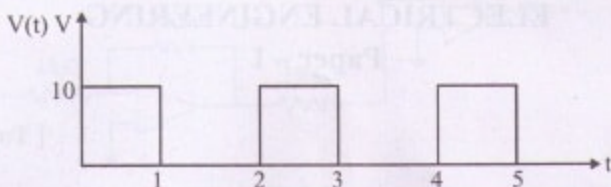

figure Q. 1 (a)

(b) The transfer function of the certain circuit is $H(s) = \dfrac{5}{s+1} - \dfrac{2}{s+3} + \dfrac{6}{s+4}$. Find the impulse response of the circuit.

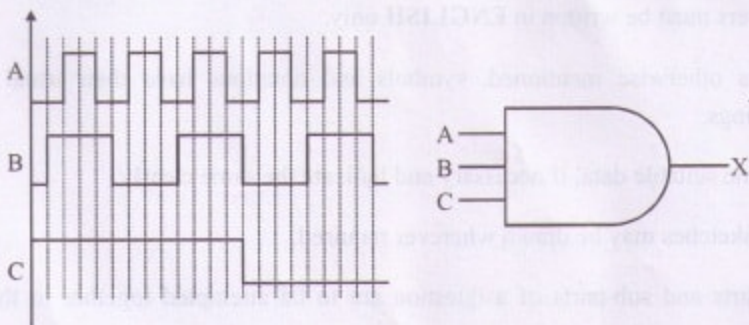(c) For the 3-input AND gate in figure Q. 1 (c), sketch the output waveform 'X' in relation to the inputs.

figure Q. 1 (c)

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(d) The thyristor in figure Q. 1 (d) has a dv/dt rating of 1000 V/μs. Determine the minimum value of C needed to avoid erratic turn ON when the power circuit is energized by closing the switch S.
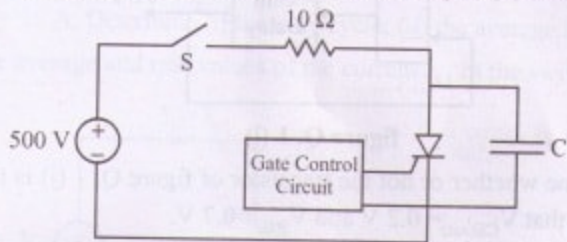

figure Q. 1 (d)

(e) In the circuit of figure Q. 1 (e), the transistor switch has been ON for a long time. It is turned OFF by removing the gate drive. Assume that the inductance L is very large. What will be the maximum voltage that collector will have to withstand during the turn OFF switching ?
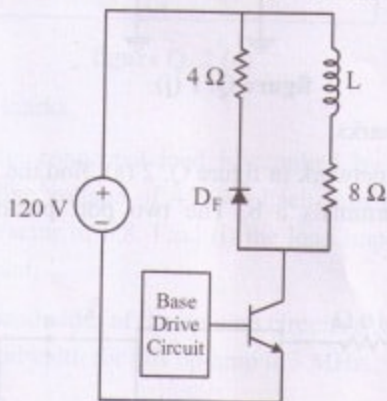

figure Q. 1 (e)

(f) State the Gauss' divergence theorem about electric flux and write its equation in integral form.

(g) Two resistors have the following ratings : $R_1 = 37\,\Omega \pm 5\%$, $R_2 = 75\,\Omega \pm 5\%$. Determine the magnitude error in ohm of the resistance if these resistances are connected in series.

(h) Write the z-domain equivalent of the following functions :

    (a) $x[n - n_0]$ (b) $z_0^n\, x[n]$

(i) Find the input-output relation of the feedback system shown in figure. Q. 1 (i).
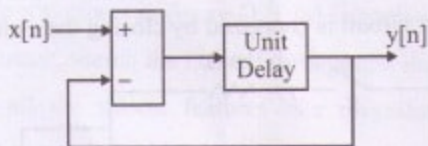

figure Q. 1 (i)

(j) Determine whether or not the transistor of figure Q. 1 (j) is in saturation. Assume that $V_{CE(sat)} = 0.2$ V and $V_{BE} = 0.7$ V.
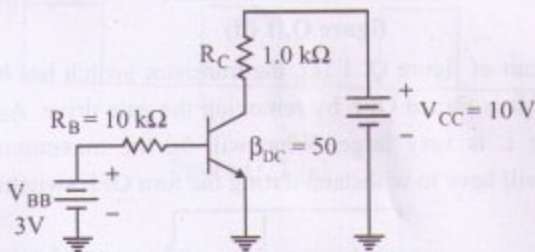

figure Q. 1 (j)

2. All parts carry equal marks. $4 \times 15 = 60$

(a) For the two port network in figure Q. 2 (a), find the Thevenin equivalent circuit at the terminals a–b. The two port parameters are given as

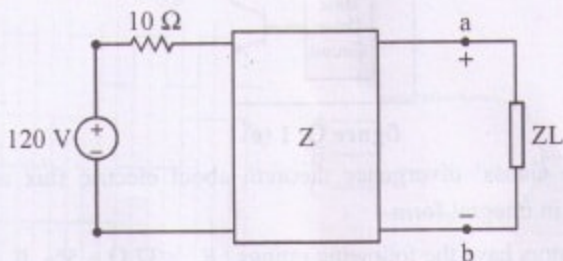$$z = \begin{bmatrix} 40 & 60 \\ 80 & 120 \end{bmatrix} \Omega.$$

figure Q. 2 (a)

(b) Simplify the following expressions by using DeMorgan's theorem :

(i) $\overline{(A + B) + CD}$

(ii) $\overline{(A + B)\, \overline{CD} + E + \overline{F}}$

(c) Find the potential at $r_A = 5$ m with respect to $r_B = 15$ m due to a point charge $Q = 500$ pC. The zero reference can be taken at infinity.

(d) For the ideal stepdown chopper of figure Q. 2 (d), $V_1 = 100$ V, $V_2 = 60$ V and $I_2 = 10$ A. Determine (i) the duty cycle; (ii) the average input current I_1 (iii) the average and rms values of the current I_{S1} in the switch S_1.
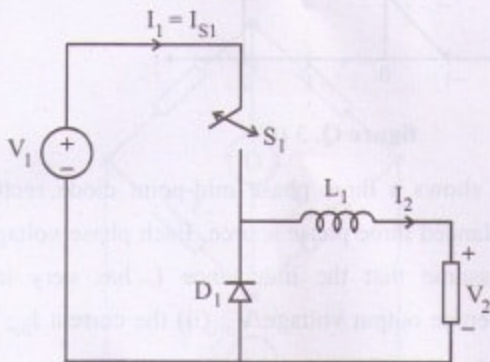

figure Q. 2 (d)

3. All parts carry equal marks. $4 \times 15 = 60$

(a) A balanced delta connected load is supplied by a 50 Hz three-phase source with a line voltage of 440 V. Each load phase draws 6 kW at lagging power factor of 0.8. Find (i) the load impedance per phase and (ii) the line current.

(b) Determine the bandwidth of the op-amp circuits shown in figure Q. 3 (b). A unity-gain bandwidth for this op-amp is 3 MHz.
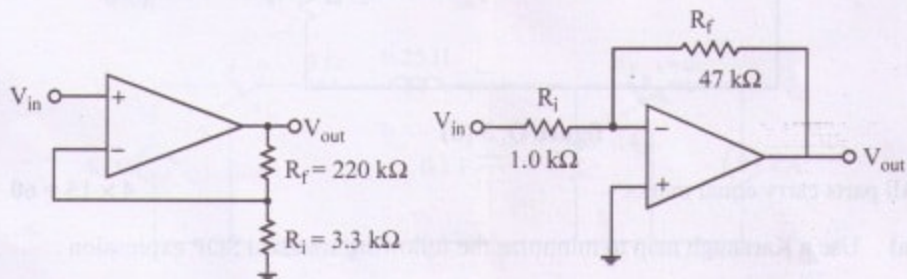

figure Q. 3 (b)

(c) A continuous time signal x(t) is shown in figure Q. 3 (c). Sketch and label each of the following signals : (a) $x(t)u(1-t)$, (b) $x(t)[u(t) - u(t-1)]$
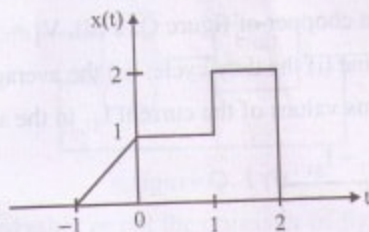

figure Q. 3 (C)

(d) Figure Q. 3 (d) shows a three phase mid-point diode rectifier circuit supplied by a balanced three phase source. Each phase voltage is 230 V rms, 50 Hz. Assume that the inductance L has very large value. Determine (i) average output voltage V_o; (ii) the current I_{dc}; (iii) sketch the input current I_R with respect to input phase voltage V_{RN} and mark all the salient features like time and magnitude and (iv) average value of the input current I_R.
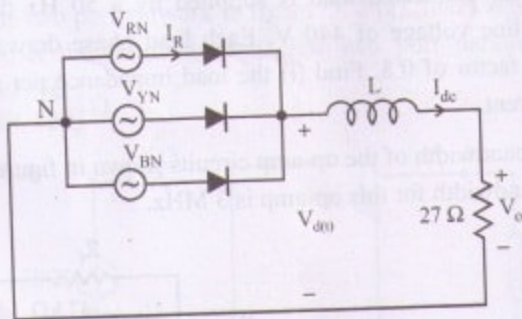

figure Q. 3 (d)

4. All parts carry equal marks.

$$4 \times 15 = 60$$

(a) Use a Karnaugh map to minimize the following standard SOP expression :

$$\overline{A}B\overline{C} + \overline{A}BC + \overline{A}\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\overline{C}$$

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(b) For an AC bridge as shown in figure Q. 4 (b), $Z_1 = 800 \angle -90° \, \Omega$, $Z_2 = 300 \angle -10.6° \, \Omega$, $Z_3 = 500 \angle 0° \, \Omega$. What will be the impedance Z_4 such that the bridge is balanced ? What are the elements in Z_4(R, L or C) ? Justify.
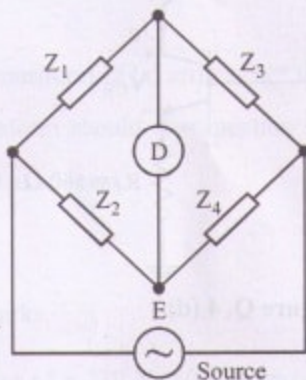
figure Q. 4 (b)

(c) In a circuit of figure Q. 4 (c), switches change their position at t = 0 as shown. $\begin{pmatrix} S_1 \text{ from } a_1 \text{ to } b_1 \\ S_2 \text{ from } a_2 \text{ to } b_2 \end{pmatrix}$

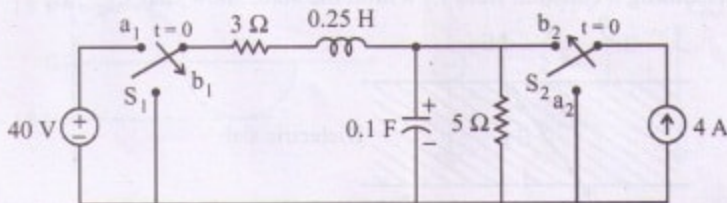Find (i) $v(0^+)$ and $i(0^+)$, (ii) $dv(0^+)/dt$ and $di(0^+)/dt$ and (iii) $v(\infty)$ and $i(\infty)$.

figure Q. 4 (c)

(d) Determine I_C and V_{CE} in a stiff voltage divider biased transistor circuit as shown in figure Q. 4 (d) if $\beta_{DC} = 100$. Also assume that $V_{BE} = 0.7$ V.
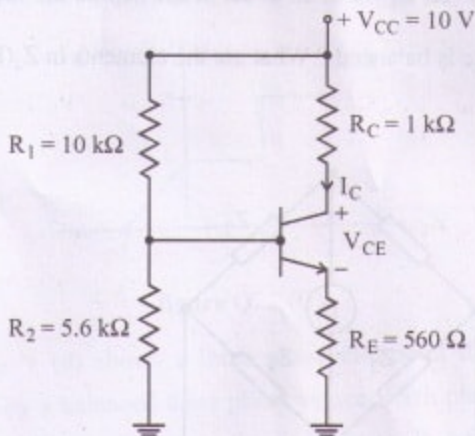

figure Q. 4 (d)

5. All parts carry equal marks. $4 \times 15 = 60$

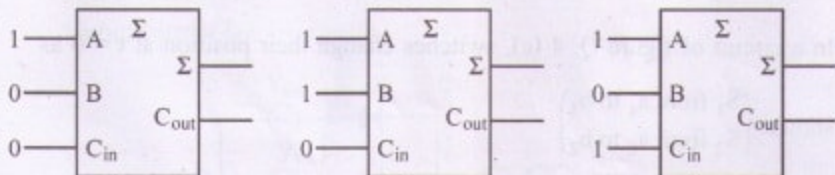(a) For each of the three full adders in figure Q. 5 (a), determine the outputs for the input shown.

figure Q. 5 (a)

(b) Figure Q. 5 (b) shows a planar dielectric slab with free space on either side. Assuming a constant field E_2 within the slab, show that $\vec{E}_3 = \vec{E}_1$.
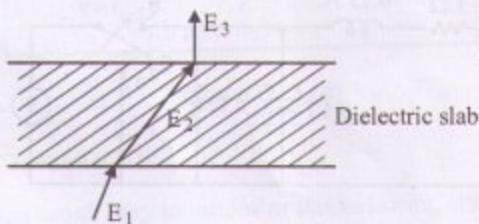

figure Q. 5 (b)

(c)   A thermistor has a resistance of 3980 Ω at the ice point (0 °C) and 794 Ω at 50 °C. The resistance temperature relationship is given by $R_T = aR_0\exp(b/T)$, where R_0 is resistance at 0 °C and T is an absolute temperature. Calculate the constants a and b. Calculate the resistance R_T at 40 °C.

(d)   Find the Laplace transform of (a) $x(t) = - e^{-at} u(-t)$ and (b) $x(t) = e^{at} u(-t)$. The Laplace transform should also mention its Region of Convergence (ROC). Assume that a is real.

6.   All parts carry equal marks. $4 \times 15 = 60$

(a)   The meter constant of a 230 V, 10 A energy meter is 1800 revolutions per kWh. The meter is tested at half load and rated voltage and unity power factor. The meter is found to make 80 revolutions in 138 s. Determine the meter error at half load.

(b)   Figure Q. 6 (b) shows a positive limiter. Sketch the output voltage waveform. Assume that the diode forward voltage drop is 0.7 V.
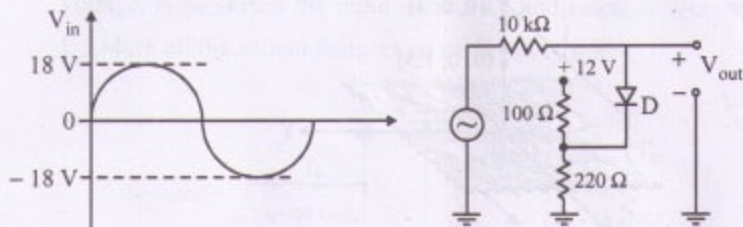
figure Q. 6 (b)

(c) The continuous time system shown in figure Q. 6 (c) consists of two integrators and two scalar multipliers. Write a differential equation that relates the output y(t) and the input x(t).

figure Q. 6 (c)

(d) A current sheet $\vec{K} = 6.0\ \vec{a}_x$ A/m, lies in the z = 0 plane and a current filament carrying current I is located at $-\infty < X < +\infty$, Y = 0, Z = 4 m as shown in figure Q. 6 (d). Determine I and its direction if $\vec{H} = 0$ at (0, 0, 1.5) m.
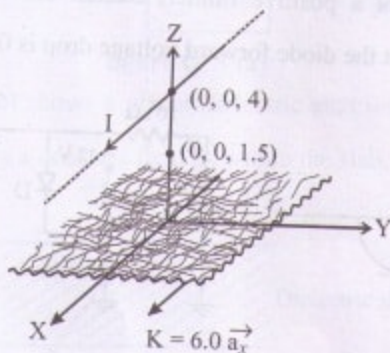
figure Q. 6 (d)

7. All parts carry equal marks. $4 \times 15 = 60$

(a) Find the skin depth δ at a frequency of 1.6 MHz in a metal, where conductivity $\sigma = 38.2$ MS/m and $\mu_r = 1$. Also find propagation constant γ and the wave velocity u.

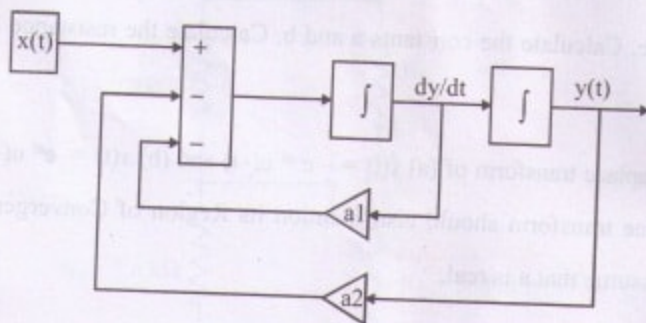(b) Determine I_D and V_{GS} for the JFET with voltage divider bias in figure Q. 7 (b). Given that for a particular JFET the parameter values are such that $V_D \cong 7V$.
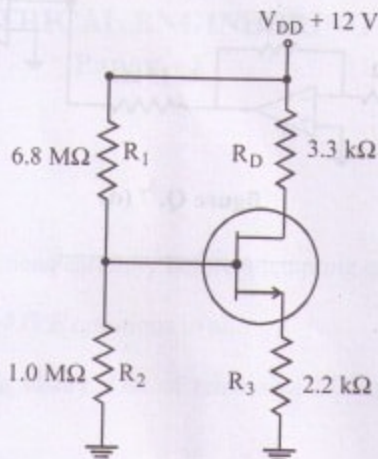
figure Q. 7 (b)

(c) Figure Q. 7 (c) shows a single phase fully controlled bridge rectifier. It is operating at firing angle $\propto = 60°$. Assume that the inductance L has very high value. Sketch the voltage V_d and determine the average output voltage. Also sketch the input current I_{ac} and calculate the rms value of I_{ac}. Mark all the salient features on each waveform.
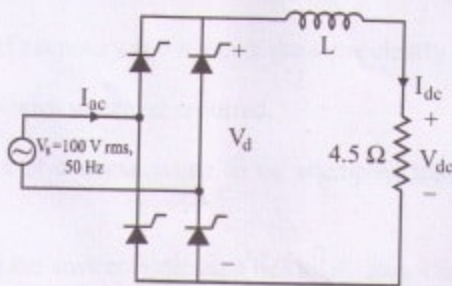
figure Q. 7 (c)

(d) If $V_1 = 2$ V and $V_2 = 1.5$ V, find V_o in the op-amp circuit of figure Q. 7 (d).
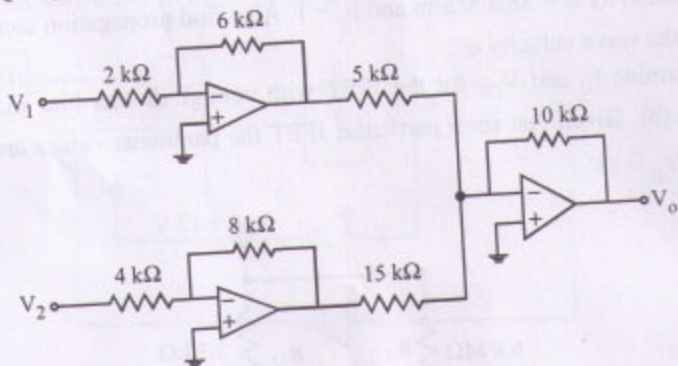
figure Q. 7 (d)

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SEM-2014(02)
ELECTRICAL ENGINEERING
Paper – II

Time : 3 Hours]

[Total Marks : 300

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- Neat sketch should be drawn whenever required.

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1. All parts carry equal marks. $10 \times 6 = 60$

(a) Differentiate 'word size' and 'byte size' for microprocessor 8085. Classify the instructions of microprocessor 8085, according to the word size with atleast two examples for each.   6

(b) List the four operations commonly performed by the micro-processing unit. Also write the steps performed by micro-processing unit to communicate with peripherals.   6

(c) Define stability of a control system. Differentiate absolute and relative stability. How are they measured ?   6

(d) What is Subroutine ? Which will be the last mandatory instruction in Subroutines ? Show with the help of necessary structure, if a subroutine is called, what will be the effect on the content of SP, PC ?   6

(e) List various methods of speed control of dc motor. Which method is used for speed control above base speed ? List its advantages and drawbacks.   6

(f) Which method of speed control of 3 phase induction motor is preferred, in fan and pump drives, and why ?   6

(g) Show that in a single phase inductive circuit, the power pulsates around the average power at double the supply frequency.   6

(h) The antenna current of an AM transmitter is 8A when only carrier is sent, but it is increased to 9A when carrier is modulated by a sine wave. Find the percentage modulation. Determine the antenna current when the percentage modulation is changed to 0.5.   6

(i) What is Effective Isotropic Radiated Power ? Determine the EIRP for an Earth Station transmitter with an antenna output power of 40dBW, a back-off loss of 3dB, a total branching and feeder loss of 3dB and a transmit antenna gain of 40 dB. **6**

(j) Explain any four important characteristics of Light Detector. **6**

(a) (i) Draw the hardware and the programming model of the 8085. Why PC and SP are 16-bit registers ? **15**

(ii) Instructions of 8085 are classified into different groups. List them with atleast two example of each. **5**

(b) (i) What do you mean by timing diagram ? Draw and explain timing diagram for the instruction MVI A, 05 H. **15**

(ii) The memory location 2100H holds the data byte A8H. Write instructions to transfer it to the accumulator using three different opcodes. **5**

(c) (i) Write a program to interface ADC 0808 from port A of 8255. Assume the port addresses. Connect the end of conversion and start of conversion pins from PC7 and PC3 respectively. Draw the necessary diagram and flow chart in support. **18**

(ii) How many address lines are necessary to address two megabytes of memory ? **2**

3. (a) A unity negative feedback control system has an open-loop transfer function consisting of two poles, two zeros, and a variable gain K. The zeros are located at -2 and -1; and the poles are at 0.1 and 1.   20

State Routh-Hurwitz stability criterion, and using it, determine the ranges of values of K for which the closed-loop system has no pole, 1 pole or 2 poles in the right-half s-plane.

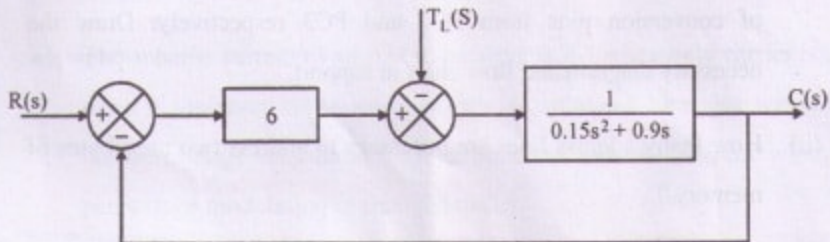(b) A translational spring mass damper system is shown below. Draw its analogy with equivalent electrical circuit.   20
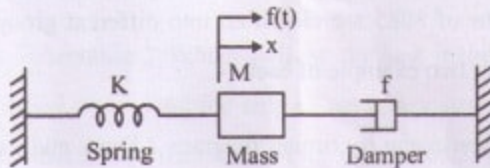
(c) For the control system shown in Fig below, determine :   20

  (i) Peak overshoot % for a unit step input

 (ii) Steady state error for unit ramp input.

4. (a) A 2000/1000/500 V single phase three-winding transformer is to be used as an auto-transformer, with supply voltage of 3000 V. Two loads, one of 1050 kVA at 3500 V and the other of 180 kVA at 1000 V, are to be energized from this auto-transformer output. Draw a suitable diagram of connections and find the currents in various parts of the circuit. Assume the loads to have the same power factor. **20**

(b) (i) Compare the working of an induction motor with a synchronous motor. (preferably in tabular form) **12**

(ii) List a few important drawbacks of Rectifier-fed dc drives. **8**

(c) A 220 V, 1500 rpm, 50 A separately excited motor with armature resistance of 0.5 Ω, is fed from a 3-phase fully controlled converter, available AC source has a line voltage of 440 V, 50 Hz. A star-delta connected transformer is used to feed the armature so that motor terminal voltage equals rated voltage when converter firing angle is zero. **20**

(i) Calculate the transformer turns ratio.

(ii) Determine the value of firing angle when (a) motor is running at 1000 rpm and rated torque (b) when motor is running at 800 rpm and twice the rated torque.

Assume continuous conduction.

5. (a) A 100 MVA 33 kV 3-phase generator has a subtransient reactance of 15%. The generator is connected to the motors through a transmission line and transformers. The motors have rated inputs of 30 MVA, 20 MVA and 50 MVA at 30 kV with 20% subtransient reactance. The 3 phase transformers are rated at 110 MVA, 32 kV/110kV (delta-star) with leakage reactance 8%. The line has a reactance of 50 ohms. Selecting the generator rating as base quantities in the generator circuit, determine the base quantities in other parts of the system and evaluate the corresponding pu value.

20

100 MVA, 33 kV
15%

j50 Ω
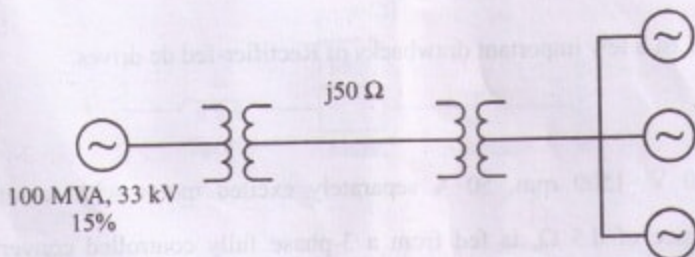
(b) (i) What do you mean by bundled conductor ? What are its advantages ?

5

(ii) What is Ferranti-effect ? Explain with phasor diagram.

5

(iii) The line currents in amperes in phase A, B and C respectively are $500 + j150$, $100 - j600$ and $-300 + j600$ referred to the same reference vector. Find the symmetrical components of current.

10

(c) (i) Define following terms related to protective relays - 08

Pick-up Level, Reset Level, Operating Time, and Reach.

(ii) A 3 phase 345/34.5 transformer is rated at 50 MVA and its short-term emergency rating is 60 MVA. Using standard CT ratios available, determine the CT ratios, CT connections and the current in the power transformer and the CTs. The 345 kV side is Y-connected, while the 34.5 kV is Δ - connected. 12

(a) Explain with the proper circuit diagram a technique to recover DSBSC AM signal with $x_s(t) \geq 0$. Also explain its advantages and limitations. 20

(b) What is FSK ? Explain the relationship between the minimum bandwidth required for an FSK system and the bit rate. Determine (a) the peak frequency deviation (b) minimum bandwidth (c) modulation index and (d) baud rate for the binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2 kbps. 20

(c) For a (6, 3) code, the generator matrix G is 20

$$\begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

For all eight possible data words, find the corresponding code words and verify that this code is a single-error correcting code. Also draw the possible encoder circuit for this code.

7. (a) Explain Pulse Radar. What is Radar Equation ? Derive its expression and determine the maximum range of a pulse radar operating at 10 GHz, and has an antenna with gain of 28 dB, transmitter power of 2 kW (pulse power). If it is desired to detect a target with a cross section of 12 m², and minimum detectable signal is $P_{min} = -90$ dBm.　　　　20

(b) What is velocity modulation in Klystrons ? Explain working of two cavity Klystrons amplifier with the help of a suitable diagram.　　20

(c) Differentiate between the following types of satellite systems :　　20

   (i) Active and Passive Satellite System

   (ii) Synchronous and Non-Synchronous Satellite System

   (iii) Geostationary and Geosynchronous satellite system