CSM – 25/17

Electrical Engineering

Paper – II

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any **three** of the remaining questions selecting at least **one** from each Section.*

SECTION – A

1. Answer any **three** of the following :

   (a) With a signal generator frequency of a Q-meter set to 1.25 MHz, the Q of a coil is measured as 98 when C = 147 pF. Determine the coil inductance and resistance. 20

   (b) Sketch and explain the spectrum analyzer displays that are likely to be produced by the following inputs :

      (i) Two pure sine-wave inputs with different frequencies and amplitudes. 10

      (ii) An amplitude-modulated sine waveform. 10

(c) The open-loop transfer function for unity feedback system is given by $G(s) = \frac{K}{s(1+s\tau_1)(1+s\tau_2)}$. Find the necessary conditions for the system to be stable using Routh-Hurwitz method. 20

(d) Draw and explain the timing diagram of "RST n" instruction of 8085 Microprocessor. 20

2. (a) Sketch the circuit of an electronic voltmeter using a voltage-to-current converter with full-wave rectification. Explain the operation of the circuit. 20

(b) Describe the power flow in (i) a HVAC and a HVDC line connected to parallel and (ii) an AC parallel transmission with a FACTS controller connected in series in one of the lines. 20

(c) A power system of capacity 3000 MW is supplying a normal load of 2000 MW in the stand-alone mode. Determine :

(i) Linear frequency dependency parameter D.

(ii) Area frequency response characteristic (AFRC) parameter β.

(iii) Static frequency drop for a load demand of 25 MW.

Assume regulation R = 2.0 Hz/per unit MW. 20

3. (a) Draw and explain the energy-band diagrams of a P-type semiconductor. If a semi-conductor is doped with both donors and acceptors of concentrations N_D and N_A, respectively, write the equation or equations from which the electron and hole concentrations (n and p) are determined. 20

(b) A constant load of 300 MW is supplied by two 200 MW generators, 1 and 2 for which the respective incremental fuel costs are :

$$\frac{dC_1}{dP_{G1}} = 0.10\, P_{G1} + 20.0$$

$$\frac{dC_2}{dP_{G2}} = 0.12\, P_{G2} + 15.0$$

with powers P_{G1} and P_{G2} in MW and cost C in Rs/hr. Determine (i) the most economical division of load between the generators and (ii) savings is Rs/day thereby obtained compared to equal load sharing between machines. 20

(c) For a discrete time system with $T = 0.1s$, the characteristic equation is given by $(Z - 0.99)(Z^2 - 0.5Z + 1.0) = 0$:

10+10 = 20

(i) Show that this system is marginally stable.

(ii) Find the frequency at which the system will oscillate.

4. (a) Draw the configuration of a general grid-connected solar PV system and explain its working. 20

(b) A PV system feeds a DC motor to produce 1.0 HP power at the shaft. The motor efficiency is 85%. Each module has 36 multi-crystalline silicon solar cells arranged in a 9×4 matrix. The cell size is 125 mm × 125 mm and the cell efficiency is 12%. Calculate the number of modules required in the PV array. Assume global irradiation incident normally to the panel as 1 KW/m^2. 20

(c) A 100 litre-per-day domestic solar water heater saves consumption of electricity in an electric geyser on 100 days of the year by heating 100 litres of water from 15°C to

60^{o}C. The useful life of the solar heater is estimated as 10 years. Determine the present worth of saving through the use of the solar water heater, if the efficiency of the electric geyser is 90% and the cost of electricity is Rs. 4 per KWh. Assume interest rate as 12%. 20

SECTION – B

5. Answer any **three** of the following :

(a) Three similar choke coils each having resistance of 10Ω and reactance 10Ω are connected in star across a 440V, 3-phase supply. Find the line current and reading of each of the two wattmeters connected to measure the power. 20

(b) The X-deflecting plates in a cathode ray tube are 5 mm apart and 25 mm long. The centre of the plates is 20 cm from the screen. The accelerating voltage is 3000V. Find the r.m.s value of the sinusoidal voltage applied to X-deflecting plates if the length of the trace obtained on the screen is 10 cm. Find also the electrostatic deflection sensitivity of the above CRT. 20

(c) (i) After the execution of RIM instruction the accumulator content is 77H. What information does it convey? 8

(ii) Four bytes of data are stored consecutively from location 2400H onwards. Write a 8085 program to transfer this data to start from 2500H onwards using minimum number of direct addressing type intructions. 12

(d) What is multiplexing technique in Fibre Optic System ? Differentiate between Time Division Multiplexing and Frequency Divison Multiplexing techniques. 20

6. (a) With the help of a schematic diagram, explain the working principle of a CW Doppler radar. Bring out the difference between CW Doppler radar and FMCW radar also. 20

(b) Find out SNR (in dB) of optimal receiver with PCM coded PSK modulated data for the following cases. Given, white noise PSD = 10^{-9} W/Hz, baseband cut-off frequency = 4000 Hz.

(i) Input signal energy 0.001, No. of level used for PCM coding = 8

(ii) Input signal energy 0.0, No. of level used = 256

Find also SNR in dB in each case. 20

(c) Explain various components of a Satellite Communication System. Draw also the schematic of a C-Band Satellite Transponder. What is the role of low noise amplifier (LNA) in this transponder ? 20

7. (a) What is the maximum mode in 8086 microprocessor ? What is its utility ? What signals are output in the maximum mode as against the minimum mode ? 20

(b) Plot the voltage level at the SOD pin of the 8085 microprocessor when the following instructions are executed : 20

```
MVI A,   FFH
SIM
MVI A,   8FH
SIM
MVI A,   C0H
SIM
MVI A,   80H
```

(c) What happens when RST 6.5 interrupt occurs at LDA 2400H ? 20

```
MVI A,    F1H
MOV B,    A
LXI H,    2400H
MOV M,    B
ADI       05
MVI A,    07
SIM
LDA       2400H
MOV D,    A
```

8. (a) Describe the photo-etching process in IC Technology. How many masks are required to complete an IC ? List the function performed by each mask. 20

(b) Explain the LPCVD technique for deposition of SiO_2. What are the reasons for forming the SiO_2 layers ? 20

(c) Compare between metallization and passivation with respect to IC technology. 20