

CSM – 25 / 15
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 **three** of the remaining questions, selecting at least **one** from each Section.*

Section – A

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

- (a) (i) Sketch the block diagram and system waveforms for a digital voltmeter that uses a dual-slope integrator. Explain how it operates and discuss the advantages of dual slope system. 12
- (ii) Calculate the maximum time t_1 for the ramp type digital voltmeter if the clock

generator frequency is 1.5 MHz. Also, suggest a suitable frequency for the ramp generator. 8

(b) Define polarization of a dielectric material. Explain the different types of polarization and the effect of frequency of applied electric field on them. 20

(c) (i) Calculate the figure of merit of an earth station in dB given the effective noise temperature for the antenna as 30 K, receiver noise temperature as 70 K and isotropic power gain of the antenna as 50 dB. 7

(ii) A high frequency radio link has to be established between two points at a distance of 2000 km on the earth's surface. Considering ionospheric height to be 300 km and its critical frequency 5 MHz, calculate the maximum usable frequency for the given path. 7

(iii) Name the frequency bands and the corresponding frequency and channel numbers and corresponding bandwidth allocated to TV, as per CCRB standards. 6

(d) Write an 8085 ALP to add 16-bit number in locations 5000 H (high byte) and 5001 H (low byte) with another 16-bit number stored in 5002 H (high byte) and 5003 H (low byte). Store the result in BC. 20

2. (a) Draw and explain the schematic arrangements of the series, shunt, combined series-series and combined series-shunt FACTS controllers. List their applications also. 20

(b) The power supplied by a 240 V single phase a. c. source to an inductive load is measured by a dynamometer type wattmeter as 700 watts. The pressure coil branch of the wattmeter has a phase angle of 2° . When the wattmeter is replaced by a second wattmeter having a phase angle of 1° for the resistance

of its pressure coil branch, a reading of 620 watts is obtained. Calculate the actual power and current taken by the load, assuming that all errors of the wattmeter except those due to pressure coil inductance are negligible. 20

- (c) The following data refer to measurement in a single phase a. c. load :

Instrument	Reading	Full scale value	Maximum uncertainty as% of full scale
Voltmeter	200V	240V	1
Ammeter	2 A	2 A	0.5
Wattmeter	320 W	480 W	1.0

Find the power factor of the load and estimate the maximum percentage uncertainty in the value obtained. 20

3. (a) What is a PMU and what does it measure ?
 With the help of a block diagram explain the operation of a synchronized phasor measurement unit. 20

- (b) The fuel cost curve of two generators are as follows : 20

$$C_A = 800 + 45 P_{GA} + 0.01 P_{GA}^2$$

$$C_B = 2000 + 43 P_{GB} + 0.003 P_{GB}^2$$

If the total load supplied is 700 MW, find the optimal dispatch with and without considering generator limits, where limits are :

$$50 \text{ MW} \leq P_{GA} \leq 200 \text{ MW}$$

$$50 \text{ MW} \leq P_{GB} \leq 600 \text{ MW}$$

Also compare the system incremental cost with and without generator limits.

- (c) The state equation of a linear time-invariant system is given below : 20

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & 0 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \text{ where, } u > 0.$$

Determine the following :

- (i) The state transition matrix
- (ii) Controllability of the system

4. (a) Draw the configuration of a typical Wind-PV system and explain its working. 20
- (b) A 2 KW_p PV roof-top plant costs Rs 2, 00,000 and has a useful life of 25 years. The annual average maintenance cost is 2% of the capital cost and the discount rate is 10%. Calculate the unit cost of a solar PV generated electricity if it supplies a load of 25% of its power rating for 10 hours daily. 20
- (c) How does a piezoelectric transducer work and what materials are typically used in their construction ? Discuss some common applications of this type device. 20

Section – B

5. Answer any three of the following :

- (a) A 1V signal with a source resistance of $R_s = 600 \Omega$ is connected to an oscilloscope which has an input capacitance of $C_i = 30 \text{ pF}$

in parallel with $R_i = 1\text{M}\Omega$. The coaxial cable has a capacitance of $C_c = 100\text{pF}$. Calculate the oscilloscope terminal voltage V_i when the signal frequency is 100 Hz. Also determine the frequency at which V_i is 3dB below V_s . 20

(b) Sketch the block diagram and system waveforms for a digital voltmeter that uses a dual-slope integrator. Explain how it operates, and discuss the advantages of dual slope system. 20

(c) (i) How many interrupt lines are there in Intel 8085 ? Name them in order of priority. Give their restart location also. 10

(ii) Write an ALP in 8085 to store the contents of its flag register in the memory location 2000 H. 10

(d) (i) The r. m. s pulse broadening resulting from intermodal dispersion within a

multimode optical fiber is 0.6 n sec/km .

Assuming this to be the dominant dispersion mechanism, estimate the dispersion equalization penalty over an unrepeated fiber link of length 8 km at bit rates of 25 Mb/sec and 150 Mb/sec .

In both cases evaluate the penalty without and with mode coupling. The pulses may be assumed to have a Gaussian shape. 12

(ii) Explain the phenomenon of current chopping in a circuit breaker. What measures are taken to reduce it? 8

6. (a) The available power required at a receiving antenna is 10^{-6} watt (that is, -60 dB with respect to 1 watt). Transmitting and receiving antennas have gains of 40 dB each. The carrier frequency used is 4 GHz and the distance between antennas is 30 miles . Find the required transmitted power. 20

- (b) Explain a typical satellite communication system with relevant block diagram. Assuming that the TV signal can be approximated by a Gaussian process, write the expression for received FM signal and also the expression for *rms* frequency deviation produced. 20
- (c) Compare the black-and-white and colour-TV transmission and receiver systems. 20
7. (a) Describe the priority structure for various interrupts in 8086. Write a simple program to set the TRAP flag. 20
- (b) The following settings for interrupts need to be made :
- RST 7.5 : Disable
 - RST 6.5 : Enable
 - RST 5.5 : Enable
 - INTR : Enable
 - TRAP : Enable
- Design the interrupt mask register bit pattern and write the assembly instructions to achieve the settings. 20

- (c) A subroutine PROG written in the 8085 assembly language is given below. At the entry to this program, the values of different registers in HEX are A = 05 ; BC = 0000 ; DE = 5472 ; HL = 4528. All the flags are set to 1. Determine the register contents and condition of the zero and carry flags after the execution of the program (i.e., after executing RET statement). What does the program accomplish ?

```
PROG      MOV A, E
          ADD L
          DAA
          MOV L, A
          MOV A, D
          ADC H
          DAA
          MOV H, A
          MVI A, 00H
          RAL
          RET
```

20

8. (a) Explain the steps involved in fabricating a monolithic circuit with suitable diagrams. 20
- (b) Compare the CVD and LPCVD techniques for deposition of poly-silicon. 20
- (c) Describe the design features of a computer communication network. Which of the seven OSI layers does routing job? What do you mean by SONET? 20