CSM – 25/18

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) A power station designated as station-A consists of two synchronous generators. The generator-1 has a rating of 50 MVA, 50 Hz, 1500 RPM and has an inertia constant of 8MJ/MVA. The generator-2 has a rating of 100 MVA, 50 Hz, 3000 RPM and has inertia constant of 4 MJ/MVA.

   (i) Find the inertia constant for the equivalent generator on a base of 100 MVA.

(ii) Another power station designated as station-B has 4 generators two each of the above type. Find the inertia constant for the equivalent generator on a base of 100 MVA.

(iii) If the two power systems are connected through an inter connector, find the inertia constant for the equivalent generator connected to infinite bus bar. 20

(b) (i) Two equal control areas have the following parameters :

R = 3.5Hz/pu MW, H = 4.5s, Normal operating frequency = 50 Hz. If the synchronizing coefficient = 0.2, determine the damping coefficient and angular frequency of the system.

(ii) Derive the expression for the change in tie line power and frequency when the two control areas have equal parameters. In such a system, what is the percentage load taken up by control area 2, when the step change load occurs in area 1 only ? 20

(c) Explain, in detail, about the conversion of wind energy into electrical energy. How the wind energy plant can be integrated with the electrical power grid to share loads of the grid ? 20

(d) Derive the expression for electrical energy produced from photovoltaic cells How can the solar plant share load of the grid if it is integrated with the national power grid ? 20

2. (a) The block diagram model of a plant is given in Figure-1. Draw a signal flow graph for the system and determine the transfer function of the system using Mason's gain formula : 20

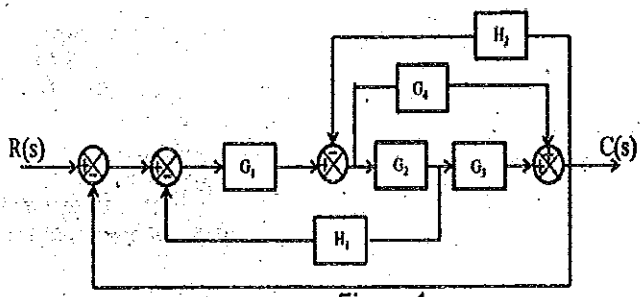


Figure-1

(b) The open loop transfer function of a closed loop system is given as : 20

$$G(s)H(s) = \frac{50}{(s+1)(s+2)(s+3)}$$

Draw the polar plot and determine the Gain Margin and Phase Margin of the system. Also, determine the stability of the system.

(c) The characteristics equation of a closed loop system is given as follows :

$s^3 + 5s^2 + 6s + 30 = 0$

Using Routh-Hurwitz stability criterion, investigate the stability of the system. 20

3. (a) Describe the protection system integrated with a power transformer connected with the power grid for the protection of the transformer. 20

(b) Describe the construction and principle of operation of a linear variable differential transformer. 20

(c) Describe the molecular structure and characteristics of optical fiber. Describe its various advantages and applications. 20

4. (a) A three phase, 10MVA, 6.6 kV generator is delivering a load of 8MW at 0.8 lagging power factor. Find out the value of the neutral resistance R, if 10.1% of the winding is kept unprotected. The relay setting is placed at 20%. The reactance per phase of the generator is 9.5%. 20

(b) Describe the construction and operation of a CRO (Cathode Ray Oscilloscope). 20

(c) Determine the controllability and observability of the following state model: 20

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix} u$$

$$y = [1\ 0\ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

SECTION – B

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

(a) Differentiate between amplitude shift keying (ASK) scheme and frequency shift keying(FSK) scheme with reference to modulator, modulated signal and power spectral density of the modulated signal. 20

(b) Consider an optical source having the peak emission at wavelength of 1.3μm. The source is used to launch optical power in a step index fiber with following characteristics :

Normalized frequency, V = 2.356 (for single mode operation of the fiber)

Radius of core = 5μm

Refractive index of core, $\mu_1 = 1.44$

Fractional refractive index, $\Delta = 0.02$

Determine the spectral width of the source to maintain the sigle mode operation of the fiber. 20

(c) Explain what is meant by the geostationary satellite ? What is its altitude ? What is its coverage on earth surface ? How do orbital periods of geostationary satellite and geosynchronous satellite differ ? 20

(d) (i) What are the basic operations involved in pulse code modulation (PCM) system ? How signal to quantization noise ratio for a PCM system can be improved ? 10

(ii) A video signal, having maximum frequency of 5MHz, is to be transmitted through a PCM system. What is the Nyquist rate ? The signal is sampled at a rate 20% more than the Nyquist rate. For uniform quantization with 1024 quantization levels, what will be the data transmission rate for the PCM system ? 10

6. (a) (i) Explain how subroutine linkage is done in 8085 microprocessor. How stack is useful in this regard ? What instructions make subroutine linkage possible ? 10

(ii) Explain the function of ALE and IO/$\bar{M}$ signals of 8085 microprocessor. 5

(iii) Explain the operations that take place when following 8085 microprocessor instructions are used : 5

XTHL, DAA, RAL, RLC

(b) (i) A TV standard has 819 scan lines and picture scan rate of 50Hz with 2 : 1 interlace. Assuming 15% as the blanking time find the video band width requirement of the system. Assume Kell factor = 0.69 and aspect ratio = 4/3. 10

(ii) Discuss the modualtion schemes employed for video signal and audio signal in a TV transmission system. What does a composite video signal of a monochrome TV system comprise of ? 5

(iii) Draw the frequency spectrum of CCIR-B TV broadcasting channel 54 – 61MHz showing different carrier frequencies, guard bands and other details. 5

(c) (i) What are the advantages of integrated circuits (IC) ? What do you mean by monolithic IC ? 5

(ii) State the reasons of using following tasks during IC fabrication : 10

Etching, Oxidation, Diffusion, Metallization, Optical masking

(iii) How chemical vapor deposition (CVD) technique is useful in IC fabrication process ? 5

7. (a) Explain, in brief, the working principle of a basic pulsed radar system. Derive the radar range equation. Hence discuss how the maximum range, covered by the radar, can be increased. 20

(b) (i) What is the structure of an optical fiber ? How dies light propagate along a fiber in any optical fiber system ? Of what materials are optical fibers made ? What are the types of optical fibers ? 10

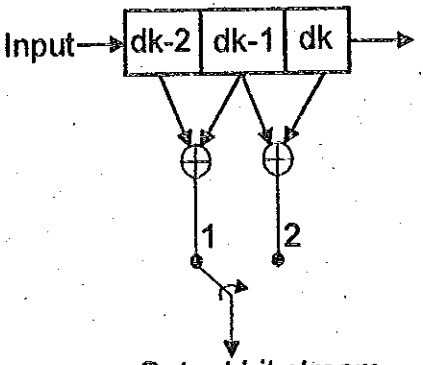
(ii) Calculate the numerical aperture (NA), acceptance angle and critical angle of the step index fiber having following characteristics : Refractive index of core, $\mu_1 = 1.44$ and refractive index of cladding, $\mu_2 = 1.0$. 10

(c) The block diagram of a binary convolutional encoder is shown in Figure-2 :

(i) Draw the state transition diagram for the encoder.

(ii) Draw the trellis diagram for the encoder.

(iii) What is d_{free}, the minimum free distance for the encoder ? 20



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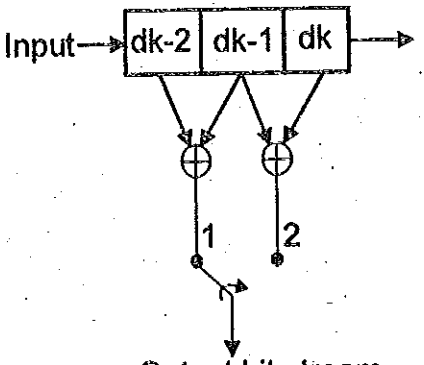

Figure-2

8. (a) Explain how a binary phase shift keying (BPSK) signal is generated. The baseband signal data b(t) consits of the bit stream 001011001. Assume that the bit rate f_b is equal to carrier frequency f_0 and sketch the BPSK signal $v_{BPSK}(t)$ and power spectral density of the BPSK signal. 20

(b) (i) Why in satellite communication up-link frequency is different from down-link frequency ? In 6/4GHz band which one is up-link frequency and why ? 5

(ii) What is meant by escape velocity of a satellite in a circular orbit at a particular altitude ? What is the shape of the trajectory when the velocity reaches beyond the escape velocity ? 5

(iii) Discuss two multiple access techniques used in satellite communication. 10

(c) (i) Explain the working principle of a delta modulator (DM). Draw the block diagram for DM encoder and decoder. State limitations of DM. 15

(ii) The input to a DM is m(t) = 0.1t. The DM operates at a sampling frequency of 20Hz and has a step size of 2 mV. Sketch the delta modulator output for the duration t = 0 – 0.5 second. 5