This question paper contains 8+2 printed pages]

HPAS (Main)—2012

ELECTRICAL ENGINEERING

Paper II

Time : 3 Hours *Maximum Marks : 150*

Note :— Attempt *Five* questions in all, taking at least *one* from each Section. Question Nos. **1** and **2** are compulsory.

Section A

(Compulsory)

1. (*a*) The open loop transfer function of a unity feedback system is :

$$G(s) = \frac{k}{s(s+30)}.$$

Its magnitude is 1.884 db at the frequency of 15 rad/sec. Find the closed loop transfer function and peak resonance, resonant frequency, cut-off frequency and bandwidth. 15

P.T.O.

(*b*) Describe the working of a three-phase, six-pulse SCR controlled converter with RL load through the waveforms of supply voltage, load voltage, load current and voltages across SCRs. Also, derive the expression of load current in 3-phases. 15

2. (*a*) Plot the root locus pattern of a system whose forward path function is :

$$G(s) = \frac{k(s+3)}{s^2+3s+4}.$$ 15

(*b*) Explain the term 'electric drive'. What are group and individual drives ? Give examples to illustrate the difference. State advantages of electric drive over other types of drives. 15

Section B

3. (*a*) Describe the principle of induction heating at high frequency and highlight a few applications of the eddy current heating. Explain the difference between core type and coreless induction type furnaces. 15

(*b*) Discuss the working, operating characteristics and applications of Amplidyne. 15

4. (*a*) Discuss the various methods to control speed of induction motors. 15

(*b*) List the various factors to be considered while choosing the driving motor for a given service. Suggest suitable motors for the following applications giving suitable reason(s) : 15

(*i*) Electric lift

(*ii*) Electric train

(*iii*) Lathe

(*iv*) Ceiling fan

(*v*) Crane.

5. (*a*) A 3-phase cable supplies an industry whose maximum demand is 1 MW and its total energy consumption is 5×10^6 kWh at 0.85 p.f. lagging. The capital cost of the cable is Rs. $(80{,}000\ a + 20{,}000)$ per km, where a is its cross-sectional area in cm^2 per core. The energy costs 5 paise/kWh. The rate of interest and depreciation is 10%. The specific resistance of copper is 1.72×10^{-6} ohm-cm. The voltage at which power is supplied to industry is 11 kV.

Loss Load factor = 0.25 (load factor) + 0.75 (load factor)^3. Determine the most economical cross-section of the conductor. 15

(*b*) Explain with the help of a neat diagram, the scheme of differential protection for an alternator. 15

6. (*a*) The fuel cost in Rs./hour for two 800 MW plants is given by :

$$F_1 = 0.004\, P_{G_1}^2 + 6\, P_{G_1} + 400$$

$$F_2 = a\, P_{G_2}^2 + b\, P_{G_2} + 500$$

where P_{G_1}, P_{G_2} are in MW.

(*i*) The incremental cost of power is Rs. 8/MWh when total demand is 550 MW. Determine optimal generation schedule neglecting losses.

(*ii*) The incremental cost of power is Rs. 10/MWh when total demand is 1300 MW. Determine optimal generation schedule neglecting losses.

(*iii*) From (*i*) and (*ii*) find coefficients a and b. 10

(*b*) A Y-connected, three-phase synchronous motor has a per-phase voltage of 125 V and a synchronous reactance of 5 Ω. Suppose the motor input power is 6 kW and the torque angle is 27°. Determine the power factor of the motor. Draw the phasor diagram of this motor. 10

(*c*) Discuss characteristics of impedance, mho, admittance and offset mho relays on R-X plane. 10

Section C

7. (*a*) An angle modulated signal with carrier frequency $\omega_c = 2\pi \times 10^6$ rad/sec described by the equation :

$$\phi_{EM}(t) = 12\cos(\omega_c t + 5\sin 1500t + 10\sin 2000\pi t)$$

(*i*) Determine the power of the modulating signal.

(*ii*) What is Δf ?

(*iii*) What is β ?

(*iv*) Determine the phase deviation $\Delta\phi$.

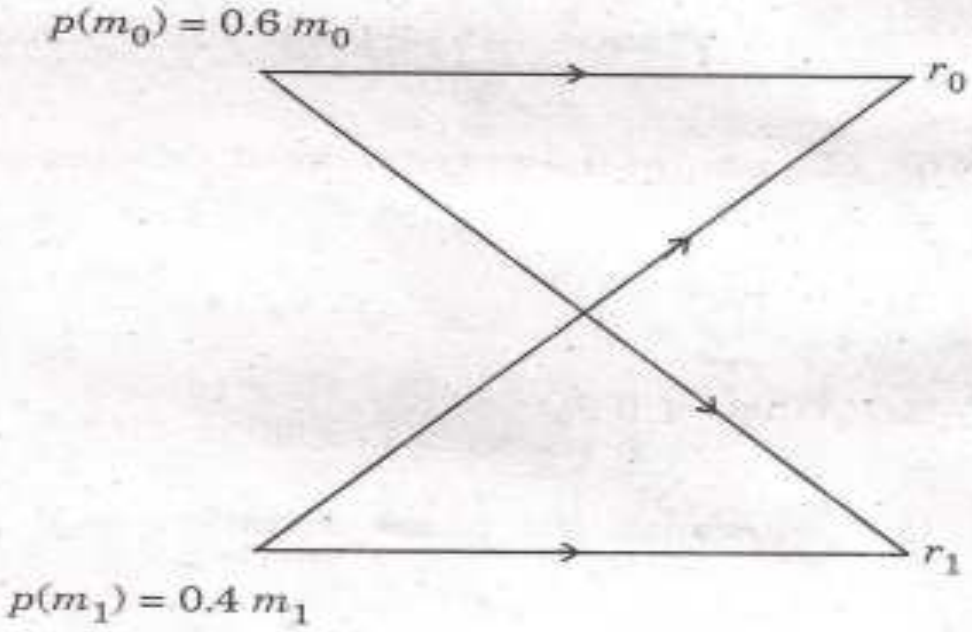
(*v*) Estimate the bandwidth $\phi_{EM}(t)$. 15

(*b*) A binary communication channel has the following apriori probabilities and conditional probabilities :

$$p(m_0) = 0.6,\ p(m_1) = 0.4,\ p(r_0 \mid m) = 0.8$$

$$p(r_1 \mid m_0) = 0.2,\ p(r_0 \mid m_1) = 0.4,\ p(r_1 \mid m_1) = 0.6$$

The details are shown in figure below. Apply the optimum receiver algorithm to the above receiver and comment on the results. 15



8. (a) A lossless transmission line having a characteristic impedance of 100 Ω is terminated in an unknown impedance Z_L. The VSWR measured is 3.2. The nearest minimum from the load is found to be at 25 cm. Calculate Z_L if the frequency is 150 MHz. 15

(b) A cylindrical wave guide is to be designed to propagate 12 GHz signal under the dominant mode. Calculate the dimensions of wave guide, velocity, guide wavelength and propagation constant. 15

9. (a) Discuss the working and applications of direct coupled amplifiers and difference amplifiers. 15

(b) What are choppers ? Discuss its classification ? How are choppers realized ? Also, enumerate its applications. 15

10. (a) Explain the following :

(i) Sampling Theorem

(ii) Cavity Resonators

(iii) Generation and detection of pulse modulated signals using oscillators. 15

(*b*) State the theory of images and reciprocity theorem. Discuss the effect of height above ground on the radiation pattern of a half-wave horizontal dipole. How does the soil conductivity affect the field strength and radiation pattern in such cases ? 15