This question paper contains 8+2 printed pages]

# HPAS (Main)—2011

## 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*) Describe the working of a single-phase one-pulse SCR controlled converter with RLE load through the waveforms of supply voltage, load voltage, load current and voltage across the SCR. Hence, derive expression for the load current in terms of supply voltage, load impedance, firing angle and load voltage. 15

(*b*) A three-phase, 400 V, 50 Hz, 6-pole, 925 rpm, Y-connected, induction motor has the following parameters :

$r_1 = 0.2\ \Omega$, $r'_2 = 0.3\ \Omega$, $x_1 = 0.5\ \Omega$, $x'_2 = 1\ \Omega$.

The motor is fed from a VSI with a constant V/*f* ratio.

(*i*) Calculate the maximum torque and the corresponding speed for 50 Hz and 20 Hz. Do the above values change, if $r_1$ is neglected ?

(*ii*) Find the V/*f* ratio at 20 Hz, so that the maximum torque at this frequency remains the same as at 50 Hz. 15

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

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

(b) Find the dynamic error coefficients of the unity feedback system whose forward transfer function is $G(s) = \frac{10}{s(s+1)}$. Find the steady-state error to the polynomial input $r(t) = a_0 + a_1 t + a_2 t^2$. 15

## Section B

3. (a) Discuss the working, operating characteristics and applications of Metadyne. 15

(b) A 1 MVA, 3-phase, 11 kV, Y-connected synchronous motor has negligible resistance and a synchronous reactance of 35 Ω/phase.

(i) What is the excitation emf of the motor if the power angle is 10° and the motor takes rated current at lagging power factor.

(*ii*) What is the mechanical power developed and the power factor in part (*i*) ?

(*iii*) At what power angle will this motor operate if it develops an output of 500 kW at the rated line voltage and with an excitation emf of 10 kV (line) ? What is the corresponding power factor ?

(*iv*) What is the minimum excitation at which the motor can deliver 500 kW at the rated line voltage without losing synchronism ? 15

4. (*a*) Describe the method(s) to control the speed of double cage induction motor. 15

(*b*) What are the various methods used for braking of d.c. motors ? Describe these methods in detail. 15

5. (*a*) What do you understand by the term 'String Efficiency' ? What are the various methods to improve string efficiency of insulators ? Discuss these in detail. 15

(*b*) A 3-phase, 200 kVA, 11/0.4 kV transformer is connected as Δ/Y. The protective transformers on the 0.4 kV side have turn ratio of 500/5. What will be the CT ratios on the high voltage side ? Also, obtain the circulating current when the fault of 750 A of the following types occur on the low voltage side :

(*i*) Earth fault within the protective zone.

(*ii*) Earth fault outside the protective zone.

(*iii*) Phase to phase fault within the protective zone.

(*iv*) Phase to phase fault outside the protective zone. 15

6. (*a*) A synchronous motor connected to an infinite bus bar is driving a load corresponding to its rated capacity, with a torque angle of 30°. If the load is suddenly increased to $\sqrt{2}$ times that rated load, determine whether or not the drive is stable. Calculate the maximum additional load that can be thrown suddenly on the shaft of the motor without affecting the stability of the drive. 15

(*b*) The dimensions of plywood board which is to be heated by dielectric heating employing a frequency of 50 MHz is of length 0.5, width 0.1 m and thickness 0.1 m. The weight of the plywood board is 450 kg/m$^3$. The final temperature to be attained and initial temperature of the plywood board are 170°C and 20°C respectively and the

heating process is to be completed in 10 minutes. Assuming specific heat of the plywood as 0.34, relative permittivity as 5 and power factor as 0.04. Determine power required, voltage across the board and current through it during the process of heating. 15

## Section C

7. (*a*) Compare the following : 15

(*i*) Modulator and Demodulator;

(*ii*) TE and TM waves;

(*iii*) Broad side and Collinear Antenna Arrays.

(*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

8. (*a*) Derive an expression for the input impedance of a folded $\lambda/2$ dipole in terms of the input impedance of a centre fed $\lambda/2$ dipole. How does the input change, if at all, when the unfed limb is of the thicker wire than the fed limb ? Discuss conditions under which a parasitic dipole placed near and parallel to a driven pole can act as a reflector. 15

(*b*) A lossless transmission line having a characteristic impedance of 75 Ω is terminated in an unknown impedance $Z_L$. The VSWR measured is 3. The nearest minimum from the load is found to be at 20 cm. Calculate $Z_L$ if the frequency is 150 MHz. 15

9. (*a*) A rectangular wave guide is to be designed to propagate 10 GHz signal under the dominant mode. Calculate the dimensions of wave guide, velocity, guide wavelength and propagation constant. 15

(*b*) What are the various methods of modulation ? Discuss these, in detail. Compare these methods and discuss the application of each. 15

10. (*a*) The message signal input to a Delta modulator is :

$$m(t) = 3 \sin(5000\ t) + 2 \sin (10000\ t)\text{V},$$

where $t$ is in seconds. Determine the minimum pulse rate that will prevent slope overload. 15

(*b*) For the cascade amplifier shown in Fig. 1, find input impedance, output impedance, current gain and voltage gain for individual stages as well as for overall amplifier. Take $R_S$ = 1 kΩ, $R_{C1} = R_{e2}$ = 2 kΩ and use standard values of *h*-parameters. 15

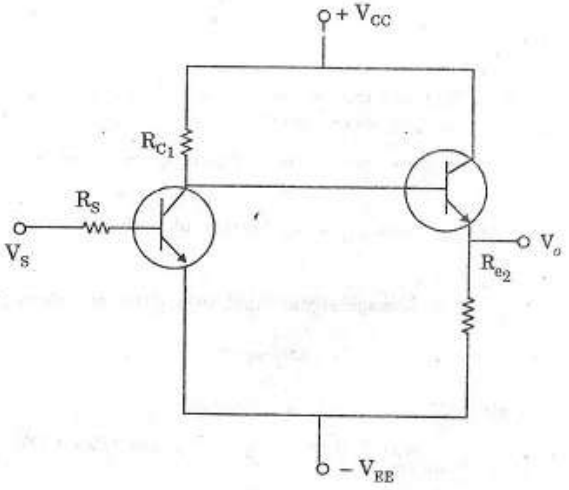


Fig. 1