Civil Services (Main) Examination, 2009

ELECTRICAL ENGINEERING

(Paper II)

Time Allowed : Three Hours **Maximum Marks : 300**

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.
Candidate has to attempt FIVE questions in all.
Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.
The number of marks carried by a question/part is indicated against it.
Wherever any assumptions are made for answering a question, they must be clearly indicated.
Word limit in questions, wherever specified, should be adhered to.

SECTION 'A'

1. (a) Determine the transfer function of the network shown in Fig.:

[Figure: Fig. – Two-section RC ladder: input V_i (+ at top) – series R_1 – node – shunt C_1 to the common bottom line – series R_2 – node – shunt C_2 to the bottom line; output V_o (+ at top) taken across C_2] **20**

(b) A 50-Hz, three-phase transmission line is 250 km long. It has a total series impedance of $(35+j140)\ \Omega$ and a shunt admittance of $930\times10^{-6}\angle90\ \mathrm{\mho}$. It delivers 40 MW at 220 kV with 0.9 power factor lagging. Find the voltage at the sending end by the nominal-π approximation. **20**

(c) The instruction OUT FFH of 8085 is stored from memory location 4048 H. The opcode for OUT instruction is D3H. Draw and explain the timing diagram for the execution of this instruction giving timings for signals like ALE, Address lines, data lines and memory. **20**

2. (a) (i) By giving suitable example explain clearly the difference between accuracy and precision. (ii) A power transformer was tested to determine losses and efficiency. The input power was measured as 3650 W and the delivered output power was 3385 W, with each reading in doubt by ± 10 W. Calculate the percentage uncertainty in the losses of the transformer and the percentage uncertainty in the efficiency of the transformer, as determined by the difference in input and output power readings. **20**

(b) (i) List the merits and demerits of outdoor SF_6 circuit breakers. (ii) Draw a simple one line diagram of a generator breaker using SF_6 breaker connecting the generator to EHV bus through a main transformer. **20**

(c) A 50 Hz turbogenerator is rated 500 MVA, 22 kV. It is Y-connected and solidly grounded and is operating at rated voltage at no load. It is disconnected from rest of the system. Its reactances are $X''=X_2=0.15$ and $X_0=0.05$ per unit. Find (a) the ratio of the subtransient line current for a single line-to-ground fault to the subtransient line current for a symmetrical three-phase fault, and (b) inductive reactance in ohms to be inserted in the neutral connection of the generator to limit the subtransient line current for a single line-to-ground fault to that for a 3-phase fault. **20**

3. (a) Determine the stability of the closed-loop system whose transfer function is given as:

$$T(s)=10/(s^5+2s^4+3s^3+6s^2+5s+3).$$ **20**

(b) Explain briefly what is the swing equation and use dynamics of angular motion with time to formulate the equation for a synchronous generator of inertia constant H in seconds run by a mechanical turbine with input power P_m in p.u. to deliver electrical power P_e in p.u. to the electrical network at f Hz in terms of power angle δ in radians measured from rotating reference of generator q-axis. Indicate briefly how the solution of the swing equation can be **20**

Optional Province · optionalprovince.com

obtained by point by point (steps of time) method of calculation.

(c) (i) Draw the Mho and Offset Mho characteristics of a distance relay for the protection of transmission lines and give the main applications of offset Mho relay. (ii) A 3 phase, 2 pole, 11 kV, 10,000 kVA alternator has neutral earthed through a resistance of 7 ohms. The machine has current balance protection which operates upon out of balance current that exceed 20% of full load. Determine % of winding protected against earth fault. Exclude the % reactance of generator winding for calculation. **20**

4. (a) Explain how the following adjustments are made in a single phase induction type energy meter: (i) Lag adjustment (ii) Adjustment for friction compensation (iii) Creep (iv) Overload compensation (v) Temperature compensation. **20**

(b) (i) With a neat sketch, show the block diagram of a PCM transmitter and receiver, clearly indicating the various parts. What are the different types of quantizers? Give a sketch of the two types of uniform quantizers. How will you reduce quantization error? (ii) Bandwidth of an input signal to the PCM is restricted to 4 kHz. Input signal varies in amplitude from −3.8 V to +3.8 V. It has an average power of 30 mW. Required signal to noise ratio is 20 dB. The PCM modulator produces binary output. Assuming uniform quantization, find number of bits required per sample. **20**

(c) (i) Sixteen bytes of data are stored in memory locations 7000 H to 700F H. Copy the data to locations A00F to A000 H such that the byte at 7000 H is copied at A00F H, the byte at 7001 H is copied at A00E H and so on. (ii) Describe the flags of 8085 microprocessor. **20**

SECTION 'B'

5. (a) With the help of a block diagram explain the principle of working of a digital storage oscilloscope. Discuss advantages of this oscilloscope over analog oscilloscope. **20**

(b) (i) Give two reasons for using c.t.s. for over-current protection in ac medium voltage distribution and subtransmission of power systems. Explain the term ‘Plug Setting’ (P.S.), define ‘Plug Setting Multiplier’ (P.S.M.) and draw a typical time of operation t (in seconds) versus P.S.M. characteristic of an Inverse Definite Minimum Time Lag (IDMTL) overcurrent relay showing its speciality. (ii) Draw the c.t.s., phase and ground fault overcurrent relay connection diagram at a substation for the minimum number of relays to cater for all types of fault on a 3-phase overhead line. What modification is necessary to extract information about the type of fault? (iii) For a radial 3 phase 11 kV, 50 Hz line ABCD fed at A only, a relay at substation C clears the 3-phase 200 MVA fault close to C in section CD of very short length in 0.1 sec. Find the P.S., P.S.M. and the Time Setting Multiplier (T.S.M.) of the IDMTL overcurrent relay at substation B connected via 400/5 amp c.t.s. to provide a discrimination time of 0.5 seconds. The nomograph of the relay for TSM = 1.0 is as follows:

t (in secs)	31.6	3	2.4	2.2
P.S.M.	1.3	10	16	20

Justify the discrimination time of 0.5 seconds based on a 5 cycle breaker. For choosing P.S., P.S.M. should be as close to 20 as possible. **20**

(c) (i) What are the advantages and disadvantages of delta modulation compared to PCM? With the help of sketch, mention the various noises associated with delta modulation. How will you overcome these noises? (ii) A sine wave of frequency f_m and amplitude A_m is applied to a delta modulator of step size Δ. Show that the slope overload distortion will occur if:

$$A_m > \Delta/2\pi f_m T_s$$

where T_s is sampling period. What is the maximum power that may be transmitted without slope overload distortion? **20**

6. (a) Consider the system shown in Fig. 6(a) where the damping ratio ξ=0.6 and the natural frequency ω_n=5 rad/sec. Obtain the values of rise time t_r, peak time t_p, maximum overshoot **20**

Optional Province · optionalprovince.com

M_p and settling time t_s for the 2% criterion when the system is subjected to a unit-step input.
[Figure: Fig. 6(a) – Unity negative feedback loop: R(s) enters a summing junction (+), whose output feeds the forward block $\omega_n^2/(s(s+2\xi\omega_n))$ giving C(s); C(s) is fed back directly to the (−) input of the summing junction]

(b) (i) Write a segment of 8085 Assembly language program to execute the instruction NOP 1000 times. (ii) In I/O mapped I/O mode of 8085, how many maximum input devices and maximum output devices can be connected? What will be their addresses? (iii) Which flags are set or reset by the following instructions? (a) INX B (b) CALL < address > (c) MOV A, B **20**

(c) Give the block diagram to recover baseband signal from a BPSK signal. Also plot the power spectral density of BPSK signal. From that plot, show that minimum bandwidth of BPSK signal is equal to twice of the highest frequency contained in baseband signal. Mention one major drawback of BPSK receiver. **20**

7. (a) (i) How is the differential output taken from an inductive transducer? Explain the advantages when inductive transducers are used in push-pull configuration. (ii) A LVDT has an output of 6 V rms when the displacement is 0.4×10^{-3} m. Determine the sensitivity of this instrument in volt/mm. A 10 V voltmeter with 100 scale divisions is used to read the output. Two tenths of a division can be estimated with ease. Determine the resolution of the voltmeter. The above arrangement is used in a pressure transducer for measuring the deflection of a diaphragm. The diaphragm is deflected by 0.5×10^{-3} m, by a pressure of 1000 N/m^2. Determine the sensitivity and resolution of this instrument. **20**

(b) An 8085 processor based interrupt system requires handling of 11 interrupting devices, excluding TRAP interrupt. Show schematically how this can be achieved. Indicate any one interrupt vector address. **20**

(c) (i) A (6, 3) linear block code have the following parity-check matrix H:

$$H=[[1\ \ 0\ \ 1\ \ 1\ \ 0\ \ 0\ ;\ 0\ \ 1\ \ 1\ \ 0\ \ 1\ \ 0\ ;\ 1\ \ 1\ \ 1\ \ 0\ \ 0\ \ 1]].$$

Determine: (i) generator matrix G and (ii) code word for the data bit 101. (ii) Give a basic sketch illustrating a convolutional encoder with k = 3, k = 1 and n = 2. What are its advantages and disadvantages over block codes? **20**

8. (a) Consider the state equation:

$$[[\dot{x}_1(t)\ ;\ \dot{x}_2(t)]]=[[0\ \ \ 1\ ;\ -2\ \ -3]][[x_1(t)\ ;\ x_2(t)]]+[[0\ ;\ 1]]r(t).$$

Find the state vector X(t) for $t\geq0$ when the input r(t) is a unit step input. **20**

(b) A 50-Hz generator is rated 500 MVA, 20 kV, with X''_d=0.20 per unit. It supplies a purely resistive load of 400 MW at 20 kV. The load is connected directly across the terminals of the generator. If all three phases of the load are short-circuited simultaneously, find the initial symmetrical current in the generator (RMS value) in per unit on a base of 500 MVA, 20 kV. **20**

(c) Draw the block diagram of a microprocessor based distance relay for protection of transmission line. **20**

Optional Province · optionalprovince.com