Civil Services (Main) Examination, 2013

ELECTRICAL ENGINEERING

(Paper II)

Time Allowed : Three Hours **Maximum Marks : 250**

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.
Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

SECTION 'A'

1. (a)(i) Giving classification of errors in measurement, explain these errors giving suitable examples. Explain how systematic errors can be minimised. **5**

(a)(ii) A circuit consists of two branches in parallel. The current in one branch is $I_1=10\pm0.2$ A and in other is $I_2=20\pm0.5$ A. Determine the value of the total current $I=I_1+I_2$, (i) considering the errors in I_1 and I_2 as limiting errors, (ii) considering the errors as standard deviations. Comment on the result. **5**

(b) A 3-phase 138-kV, transmission line is connected to a 49-MW load at a 0.85 lagging power factor. The line constants of the 80 km long line are $\bar{Z}=95\angle 78^\circ\ \Omega$ and $\bar{Y}=0.001\angle 90^\circ$ S. Using nominal-T circuit representation, compute: (i) The A, B, C and D constants of the line; (ii) Sending-end voltage; (iii) Sending-end current; (iv) Sending-end power factor; and (v) Efficiency of transmission. **10**

(c)(i) Draw the block diagram indicating the typical architecture of a microcomputer. Briefly discuss the salient features. **5**

(c)(ii) How can square wave generation with a variable bit rate, be done using the microprocessor? Output should be available on a chosen port, using bit 'O'. **5**

(d) Define the terms given below: (i) Pick up value (ii) Reset time (iii) Operating time and (iv) Reset value for protective relays. **10**

(e) State and explain various test inputs in control systems. **10**

2. (a) Using the Block diagram simplification method reduce the block diagram of the following control system to a block diagram of the following type:

[Figure: Given block diagram: R(s) enters summing junction 1 (+); its output goes to summing junction 2 (+), then through block 10 and block $1/(s+1)$ in cascade to a take-off point X. From X: (1) through block $1/s$ to summing junction 3 (+ input from the left); (2) through an upper parallel block 10 to summing junction 3 (+ input from the top); (3) through a feedback block s back to summing junction 2 (– input). The output of summing junction 3 is C(s), which is fed back directly (unity) to summing junction 1 (– input).]

[Figure: Required form: R(s) to a summing junction (+), forward block G(s) giving C(s), feedback block H(s) from C(s) back to the summing junction (– input).] **20**

(b) Time-current characteristic of an induction-type overcurrent relay is: It is desired to determine the time of operation of 5-ampere relay having a current setting of 125% and TMS of 0.6 connected to a supply circuit through a C.T. ratio 400/5 ampere when the circuit carries a fault current of 4,000 amperes. **20**

English version compiled from published transcriptions and cross-checked across sources; not a facsimile of the official UPSC question paper.

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I (Multiples of pick-up)	2	4	6	8	10	12	14	16	20
T (Seconds)	10	5.1	4	3.4	3	2.8	2.6	2.5	2.4

(c)(i) Classify different types of buses for load flow study in power systems. **3**

(c)(ii) Discuss formulation of Newton-Raphson method with mathematical details in polar co-ordinates. **7**

3. (a) The asymptotic approximation of the variation of gain with frequency of a control system (Bode Plot) is shown below. Determine the transfer function of the system.

[Figure: Asymptotic Bode gain plot: vertical axis Gain in dB (0 and –20 dB marked), horizontal axis w (log scale) with points 1, 2, 10, 50, 100 marked. From the left the plot falls at –6 dB/octave, crossing 0 dB before w=1 and reaching –20 dB at w=1 (dashed line to the –20 dB mark); it continues at the same slope to a corner at w=2; it is flat (horizontal) from w=2 to w=10; it falls at –6 dB/octave from w=10 to w=50, at –12 dB/octave from w=50 to w=100, and at –6 dB/octave beyond w=100. Dashed vertical lines mark w = 1, 2, 10, 50 and 100.] **10**

(b)(i) What are the main causes of low power factor and discuss measures by which low power factor can be avoided? **10**

(b)(ii) A consumer is taking a load of 20 kW at power factor 0.8 lagging. Find the rating of capacitor to raise the power factor to 0.95 lagging. **10**

(c) An 11-kV, 50-Hz generator was supplying power to a load when a three-phase fault occurred on the system. The inductive reactance and capacitance of the faulted section were 4.0 ohms and 0.01 μF respectively, and the resistance was negligible. Compute (a) the active recovery voltage, (b) peak value of the restriking voltage, (c) the frequency of transient oscillatory voltage and (d) the average rate-of-rise of restriking voltage (RRRV) up to the first peak of oscillations. **20**

4. (a)(i) Draw a functional block diagram and explain the working of a digital frequency meter. **10**

(a)(ii) Describe the circuit and working of a wave analyser for audio frequency and Megahertz frequency. **10**

(b) Draw the timing diagram for memory read cycle and memory write cycle and explain the significance of the time periods therein. **10**

(c) A systematic (7, 4) linear code has the parity matrix P given as:

$$[P]=[[1\ \ 1\ \ 1\ ;\ 1\ \ 1\ \ 0\ ;\ 1\ \ 0\ \ 1\ ;\ 0\ \ 1\ \ 1]]$$

(c)(i) Find the code vectors for message vectors 1000, 0001, 0010 and 0111. **8**

(c)(ii) Draw the corresponding encoding diagram. **8**

(c)(iii) If the received vector [0111110] has a single error, detect the error and correct it. **4**

SECTION 'B'

5. (a)(i) Determine the break-in point in the root locus of a control system with:

$$G(s)\,H(s)=(K(s+2))/((s^2+s+10)).$$ **5**

(a)(ii) For the control system: the steady state error for unit ramp input is 0.01. Determine the value of K.

[Figure: Unity negative feedback system: R(s) to a summing junction (+), forward block $K/(s(sJ+f))$ giving C(s); C(s) fed back directly to the summing junction (– input). Data beside the figure: $f=10^{-1}$ Newton m per rad/sec; $J=5\times10^{-3}$ kg-m^2.] **5**

(b) What is the need for a multi input comparator? Show with diagrams how to obtain the quadrilateral characteristic in the R—X plane using 4-input phase comparator. **10**

(c)(i) What is the need for sending digital data over analog carriers? In this regard how is FSK better than PSK? **5**

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(c)(ii) With reference to the 7 layer architecture of data networks, distinguish between Protocol Data Unit (PDU) and Service Data Unit (SDU). **5**

(d) State various insulating materials used for cables and comparatively discuss any two widely used materials. **10**

(e) What do you mean by Thermistor? Explain briefly resistance-temperature characteristic curve of Thermistor and compare the same with thermocouple. **10**

6. **(a)(i)** What is a digital voltmeter? **3**

(a)(ii) What are its advantages as compared to analogue voltmeters? **3**

(a)(iii) Listing different types of DVMs explain any one type for the measurement of current. **4**

(b)(i) Show how DAC 1200 can be interfaced to the 8255. Write the schematic diagram. Use 'double buffering' to prevent glitches. **14**

(b)(ii) Write 8085 subroutine to transfer 12 bits of data stored in two sequential memory locations to the DAC interface carried out in part (i). Assume that the address of the first byte is stored in the HL pair. **6**

(c)(i) How is DPCM better than PCM? With the help of illustrations, show how DPCM signals are generated and decoded. **10**

(c)(ii) Consider the convolutional encoder shown in the figure below. The code is systematic: (a) Draw the state diagram using the State Transition Table (b) Draw the Code Tree.

[Figure: Convolutional encoder: the Input line goes to a node; from the node one path goes through flip-flop FF1 whose output is fed back up to the right-hand input of a modulo-2 adder (+); the node also feeds the left input of the adder directly (wire up from the node and right into the adder). The adder output is taken up and across to switch contact $C^{(1)}$; the node is also connected along the bottom directly to switch contact $C^{(2)}$. A commutator switch selects $C^{(1)}$ or $C^{(2)}$ to the Output.] **10**

7. **(a)(i)** Describe the functioning of a charge amplifier using an OPAMP with piezoelectric transducer used at the input for measurement of displacement. **10**

(a)(ii) Derive the expression for the transfer function and draw its curve showing frequency response. **10**

(b)(i) List the features of 8086's segmented memory. **5**

(b)(ii) What are the different addressing modes available in 8086? Indicate their features. Write the mnemonics for each of them taking 'MOV' as an example. Indicate the symbolic notation also for each of them. **15**

(c) What are the advantages of digital carrier systems over Baseband digital transmission? Develop the mathematical formulation for a BPSK signal. **10**

8. **(a)** A control system is represented by the state space equations:

$$\dot{x_1} = x_2$$

$$\dot{x_2} = x_3 - u_1$$

$$\dot{x_3} = -2x_2 - 3x_3 + u_2$$

and the output equations are:

$$y_1 = x_1 + 3x_2 + 2u_1$$

$$y_2 = x_2$$

Draw the state transition signal flow graph and find the characteristic roots of the system. **20**

(b)(i) With the help of single line diagrams, discuss the classification of HVDC transmission links. **14**

(b)(ii) State their comparative advantages and disadvantages. **6**

(c) Draw the block diagram of a Digital Relay and name all the blocks of this relay. **10**

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