CSM—29/23

PART—II/PAPER—VII

ELECTRICAL ENGINEERING

PAPER—II

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Time : 3 Hours

Full Marks : 250

The question paper contains **18 (Eighteen)** *questions in* **GROUP—A, (12)** *and* **GROUP—B, (06)** *together.*

GROUP—A

Candidates to attempt **10 *(ten)*** *questions within word limit of* **250**. *Each question carries* **15** *marks.*

1. The open loop transfer function of a unity negative feedback system is

$$G(s) = \frac{K}{s(as+1)}$$

By what factor the gain K is to be changed so that the peak overshoot is reduced from 25% to 16%.

Also find the factor by which the constant a is to be changed so as to reduce the damping ratio from 0·75 to 0·6.

Find the values of K and a so that the peak overshoot is 18% and the settling time is 1·6 seconds.

2. What range of temperature can a paraboloidal dish collector attain?

Calculate the average power per unit area that is incident on a 5 cm diameter focal area for a 10 m diameter parabolic dish.

Assume a midday insolation of 650 W/m^2 on a sunny day.

3. A 200 MW, 13·8 kV, 0·9 power factor 50 Hz, 3-phase Y-connected generator is protected by differential protection with CTs of ratio 10000/5 A, CT secondary resistance of 1·5 Ω and lead resistance of 0·15 Ω. The rated current of differential relay is 5 A and its setting range is 5-20% of the relay rated current. The relay burden is 1 VA. If a through fault occurs with the fault current 12 times the full load current of the generator, then determine the value of the stabilizing resistance.

Also find the suitable value of Knee Point Voltage (KPV) for the CT.

4. What are the main advantages and disadvantages of ocean wave energy?

A deep ocean wave of 2 m peak to peak appears at a period of 8 sec. Find the wavelength, phase velocity and power associated with the wave.

At this power rate, what is the average annual wave energy in MWh/m. Assume density of sea water as $\rho = 1025\ kg/m^3$.

5. The open loop transfer function of a negative feedback system is

$$G(s)H(s) = \frac{K}{s(s+2)}$$

Draw the Nyquist diagram and check for the stability of the closed loop system.

6. A 200 MW, 13·8 kV, 0·9 power factor, 50 Hz, 3-ph, Y-connected generator is protected by an earth fault relay. The relay is set to operate at 10%.

The CT ratio is 10000/1 A. A resistor is used in the neutral circuit of the generator to limit the earth-fault current to 50% of the normal load current.

Determine the value of the resistor and the percentage of stator winding protected.

7. Explain the functions of the ALE and IO/$\bar{M}$ signals of the 8085 microprocessor.

Why is it needed to demultiplex the bus $AD_7 - AD_0$?

8. Briefly explain the ion-implantation process for creating doped region in the IC fabrication.

How is this process superior to diffusion process?

Why is SiO_2 used in ICs?

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9. A 50 MVA, 11 kV, 3-phase alternator was subjected to different types of faults and corresponding fault currents are as follows :

3-phase fault — 1870 A

Line to line fault — 2590 A

Single line to ground fault — 4930 A

The alternator neutral is solidly grounded. Find the pu values of the three sequence reactances of the alternator.

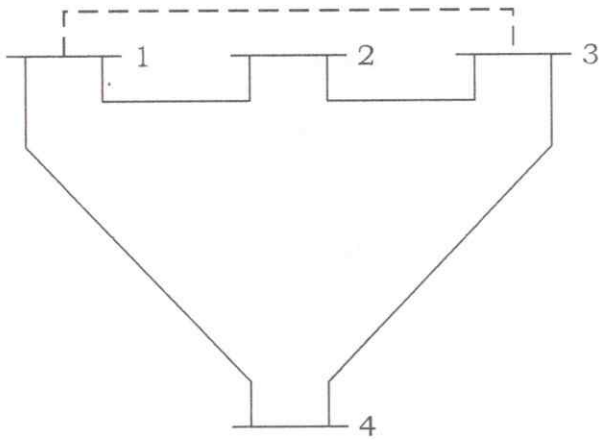
10. The figure shows a 4-bus system. The shunt admittances at the buses are negligible. The line impedances are as given below :

Line(bus to bus)	1-2	2-3	3-4	1-4
R(pu)	0·025	0·02	0·05	0·04
X(pu)	0·10	0·08	0·20	0·16

Assume that the line shown dotted (from bus 1 to bus 3) is not present. Formulate Y_{bus}. Which element of the bus Y_{bus} obtained above are affected when the line from bus 1 to bus 3 is added?

(The new line has no mutual coupling with the other lines)

If the pu impedance of the line is $0{\cdot}1 + j0{\cdot}4$, find the new Y_{bus}.



(4-Bus System)

11. The resistivity of pure germanium at room temperature is 0·47 ohm-m. Find out the carrier density of germanium at the room temperature for the electron mobility of 0·42 m^2/volt-sec and hole mobility of 0·20 m^2/volt-sec.

Also calculate the drift velocity of holes and electron if applied electric field is 50 V/cm.

12. Explain the memory address range of 1 K (1024 × 8) memory shown in the figure and explain the changes in the addresses if the hardware of the $\overline{CS}$ line is modified.

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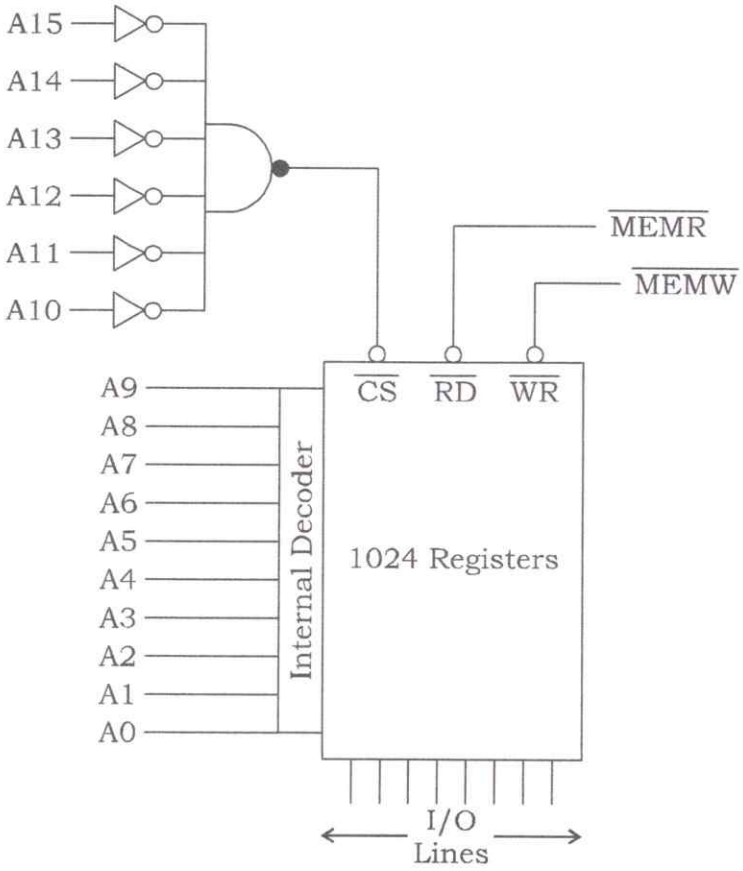


Memory Address Range : 1024 Bytes of Memory

GROUP—B

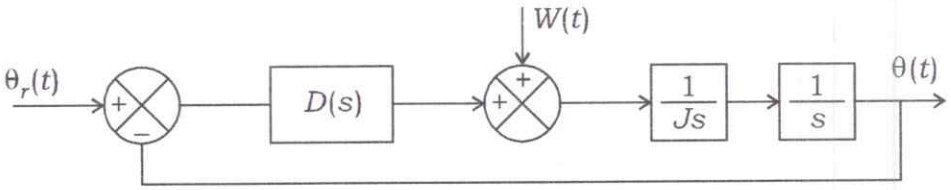
Candidates to attempt **05** ***(five)*** *questions within word limit of* **300**.
Each question carries **20** *marks.*

13. A circuit breaker is meant for the discontinuation of a 220/132 kV, 250 MVA, 50 Hz power transformer during no load condition.

Find out the worst condition of over voltage induced across the contacts of the circuit breaker. The no load current of transformer is 1% of the full load current. The capacitance of the system is 10000 pF/phase.

Why is it difficult to interrupt a fault current with low lagging power factor compared to load current with high power factor?

14. Consider the closed loop control system shown in the figure below :



Use PID control $D(s) = K_P + \frac{K_I}{s} + K_D s$.

Discuss the effect of this controller on the stability and steady state errors of the system.

What are the two system types with the above PID control action?

15. Two machine codes - 0011 1110 (3EH) and 0011 0010 (32H) are stored in memory locations 2000 H and 2001 H respectively as shown. The first machine code (3EH) represents the opcode to load a data byte in the accumulator and the second code (32 H) represents the data byte to be loaded in the accumulator. Illustrate the bus timing as these machine codes are executed.

Calculate the time required to execute the opcode fetch and the memory read cycles and the entire instruction cycle, if the clock frequency is 2 MHz.

Memory Location

2000 H	0011 1110	→ 3EH
2001 H	0011 0010	→ 32H

Instruction : MVI A, 32H : Load byte 32H in the accumulator.

16. Draw a block diagram showing the principal parts of a Cathode Ray Oscilloscope (CRO).

What is the purpose of synchronization in an oscilloscope and why is it essential to process the waveform display in a CRO?

17. Outline the relative features of Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT).

Represent the block diagram of a Wind Energy Conversion System (WECS) and explain briefly the function of various blocks.

An HAWT is installed at a location having free wind velocity of 15 m/sec. The 80 m diameter rotor has three blades attached to the hub. Find the rotational speed of the turbine for optimal energy extraction.

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18. The figure below shows the single line diagram of a transmission system. The transformer ratings, generator rating, line impedance and load impedance are shown.

Draw impedance diagram. Find actual values of generator current, line current, load current, load voltage and load power factor. Carry out the calculations in per unit (pu).

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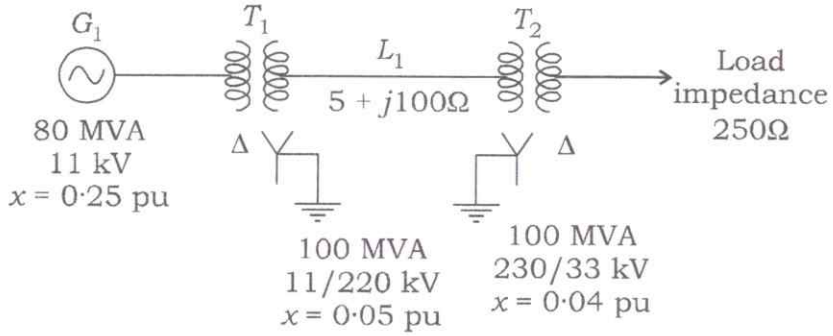
Neglect phase shift in transformers.



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