

Total No. of Questions :5]

SEAT No. :

P2207

[Total No. of Pages :2

[5331] - 11

M.Sc. - I

ELECTRONIC SCIENCE

EL1UTO1 : Foundation of Semiconductor Devices

(2008 Pattern) (Semester - I)

Time : 3 Hours]

[Max. Marks :80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Draw neat diagrams wherever necessary.*
- 3) *Use of non-programmable calculator is allowed.*

Q1) Attempt any two:

[2 × 8 = 16]

- a) What is the importance of pure crystal in semiconductor technology? List various methods used in growth of semiconductor material. Explain any one in detail.
- b) Explain the current -voltage (I_D versus V_{DS}) characteristics in n-channel JFET for voltages applied to the gate terminals. What is pinch-off voltage and mutual transconductance? Also give necessary interrelated mathematical relationships.
- c) Mathematically discuss position of Fermi level for n-type and p-type semiconductor. Comment on variation of E_f with doping concentration and temperature.

Q2) Attempt any two:

[2 × 8 = 16]

- a) Describe the operation of reverse bias p-n junction diode. Obtain the relation for junction capacitance.
- b) What is Hall effect? Obtain relation for Hall voltage, hole mobility and electron mobility.
- c) Obtain the expression for Ideal-diode equation.

P.T.O.

Q3) Attempt any four: **[4 × 4 = 16]**

- a) Explain imperfections and impurities in solids. How they are effective in characteristics of solid state devices?
- b) Explain the working of SCR. Draw I-V characteristics of SCR and explain the action of gate voltage control.
- c) Explain heterojunction bipolar transistor. Discuss its advantages over BJT.
- d) What is working principle of LED? Which materials are used in LED? Why the specific color LED are practically possible?
- e) Why CMOS technology is widely used than NMOS, PMOS and TTL?

Q4) Attempt any four: **[4 × 4 = 16]**

- a) Show that the diffusion current density is proportional to the carrier diffusion coefficient and carrier density gradient.
- b) Draw the small-signal equivalent circuit for JFET and explain ac response of this device.
- c) In a bipolar transistor, if collector current, $I_c = 10\text{mA}$ and $I_b = 40 \mu\text{A}$. Find out α , γ_e & γ_π for the transistor at 300°K .
- d) What is PIN photodiode? Explain its working in brief.
- e) Explain hybrid-pi equivalent circuit of BJT.

Q5) Attempt any four: **[4 × 4 = 16]**

- a) What is space lattice? Discuss unit cell and primitive cell.
- b) Discuss internal quantum efficiency of LED. How it is maximized?
- c) Explain construction and working of TRIAC. State any two applications of it.
- d) Explain the need of device modeling. Discuss any one model for MOSFET.
- e) Using energy band diagram, explain band structure of MOS capacitor at equilibrium.



Total No. of Questions : 5]

SEAT No :

P 2208

[5331]-12

[Total No. of Pages : 3

M.Sc. - I

ELECTRONIC SCIENCE

**ELIUT - 02 : Analog Circuit Design and Analysis
(2008 Pattern) (Semester - I)**

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions carry equal marks.*
- 2) *Neat diagrams must be drawn wherever necessary.*
- 3) *Figures to the right side indicate full marks.*
- 4) *Use of log table/Non programmable calculator is allowed.*

Q1) Attempt any two:

- a) Write short note on **[8]**
 - i) Attenuators
 - ii) Equalizers
- b) Explain the working of a two op-amps practical log amplifier circuit. Obtain necessary equation. **[8]**
- c)
 - i) Explain in detail integrating (Dual Slope) type analog to digital converter (ADC) **[4]**
 - ii) Explain the need of Low power design. **[4]**

Q2) Attempt any two:

- a)
 - i) Write short note on multiplying digital to analog converter (DAC) and its application. **[4]**
 - ii) Explain practical design consideration for an op-amp differentiator circuit. **[4]**

P.T.O.

- b) i) Draw pole zero plot and find inverse Laplace transform for following transfer function. [4]

$$F(s) = \frac{20s}{(s+5)(s+2)}$$

- ii) Explain the working of micro power comparator. Compare performance with general purpose comparator. [4]
- c) i) Explain the working of current mirror. Where it is used? [4]
- ii) An audio signal is oversampled with a 12-bit ADC. Find the oversampling frequency needed to achieve a 16 bit resolution. What is the corresponding SNR_{\max} ? [4]

Q3) Attempt any two:

- a) What is order of filter? What are different types of active filters? Design 2nd order Butterworth high pass filter for cut-off frequency at 8KHz and pass band gain of 4 [8]
- b) State convolution theorem. Using convolution theorem determine the inverse laplace transform of the following network function [8]

$$F(s) = \frac{6}{s(s^2 + g)}$$

- c) i) Write short note on linear micropower design technique [4]
- ii) Explain mismatch effect in differential Amplifier. [4]

Q4) Attempt any two:

- a) Draw block diagram of op-amp. Explain the purpose of input block in detail. Derive the expression for common mode rejection ratio. [8]
- b) i) Explain applications of digital to analog converter (DAC). [4]
- ii) Explain working of charge redistribution type analog to digital converter (ADC). [4]

- c) i) In a series RLC circuit, there is no initial charge on capacitor if switch is closed at $t = 0$, find the resulting current, $R = 2\Omega$, $L = 1H$, $C = 0.5F$ and input voltage is $10V$. [4]
- ii) Find inverse Laplace transform of [4]

$$F(s) = \frac{2s + 5}{(s^2 + 5s + 6)}$$

Q5) Attempt any four:

- a) Explain the terms:- [4]
- i) Transfer Function
- ii) Poles and zeros
- iii) Complex plane
- iv) Dominant pole
- b) Explain with circuit diagram, how to boost the output current capability of an-op amp. [4]
- c) Compare inverting & Non inverting operational amplifiers. [4]
- d) Explain terms related to digital to analog converter (DAC) [4]
- i) Resolution
- ii) Accuracy
- iii) Full scale error
- iv) Monotonicity
- e) Explain supply independent biasing. How is it achieved? [4]
- f) Explain shielding & guarding techniques used in op-amp circuits. [4]

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Total No. of Questions : 5]

SEAT No :

P2209

[Total No. of Pages :4

[5331]-13

M.Sc.

ELECTRONIC SCIENCE

EL1UT03 : Instrumentation and Measurement Techniques

(2008 Pattern) (Semester-I) (Credit System)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *All questions carry equal marks.*
- 3) *Draw neat labelled diagram wherever necessary.*
- 4) *Use of logarithmic table and non-programmable calculator is allowed.*

Q1) Answer any Four of the following :

[4 × 4=16]

- a) State the characteristics of measurement system. Describe loading effect on measurement due to series connected instrument.
- b) State the dynamic characteristics of measurement system. What is dynamic response? Give time domain analysis for step input.
- c) State different types of errors involved in the measurement system. A multimeter having sensitivity of 2000 Ω/V is used for the measurement of voltage across a circuit having an output resistance of 10 k Ω . The open circuit voltage is 5 V. Find the reading of the multimeter when it is set to 10V range, also find percentage error. Comment on the result.
- d) State the different types of measurement systems. Describe deflection type and null type instruments with suitable examples.
- e) Draw the block diagram of generalised measurement system. Explain at least two elements in short.

Q2) Answer any Four of the following :

[4 × 4=16]

- a) What is a strain gage? Derive an expression of gage factor of simple wire type strain gage.
- b) List the transducers used for displacement measurement with neat circuit diagram explain working principle of LVDT.

P.T.O.

- c) State the methods of force measurement. Explain the use of variable reluctance/FM oscillator digital system for measurement of force.
- d) List the transducers used for temperature measurement. What is a thermistor? State advantages and disadvantages of it.
- e) List and draw at least four primary sensing elements used for displacement, force or torque measurement.

Q3) Answer any Four of the following :

[4 × 4=16]

- a) Give types of microphone used for sound measurement. Draw the block diagram of sound level meter.
- b) Describe the working principle of hotwire anemometer. State applications of it.
- c) Give working principle of ultrasonic flowmeter and electromagnetic flow meter. Write one application of each.
- d) Describe working principle of McLeod and Knudsen gages used for low pressure measurement.
- e) A resistance potential divider R_1, R_2 with a resistance of $10\text{ k}\Omega$ and a shaft stroke of 125 mm is used in the arrangement shown in Fig.1. The potentiometer R_3, R_4 has a resistance, of $10\text{ k}\Omega$ and i/p voltage $V_i=5\text{ V}$. The initial position is to be used as a reference point where $R_1 = R_2$, the wiper is at the midpoint.

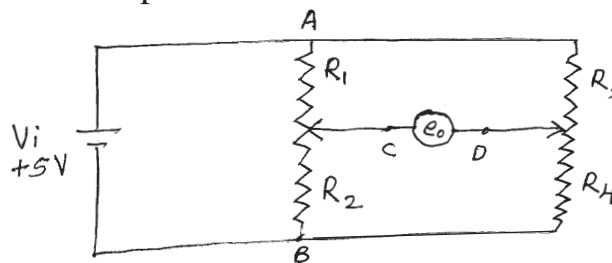


Fig.1

At the start of the test potentiometer R_3, R_4 is adjusted so that the bridge is balanced and $V_o = 0\text{V}$. The displacement is being measured will move a maximum distance of 12.5 mm towards point A. Calculate the value of output voltage.

Q4) Answer any Four of the following :

[4 × 4=16]

- a) Draw the block diagram of DFM. State different modes of measurement. Explain average mode of frequency measurement.

- b) Draw the following OPAMP circuits with their output equations
- i) Inverting Amplifier
 - ii) Schmitt trigger
 - iii) Voltage follower
 - iv) Instrumentation amplifier
- c) What is Telemetry? Draw circuit block diagram of voltage telemetry and current telemetry.
- d) Why signal conditioning required for measurement system? Draw the block diagram of AC signal conditioning system.
- e) Describe the direct method of tape recording with functional block diagram of tape recorder/reproducer.

Q5) Answer any Four of the following :

[4 × 4=16]

- a) Calculate the time constant of mercury in glass thermometer. The inside diameter of the bulb is 4 mm, assuming the bulb is to be spherical. The density of mercury is 13600 kg/m³ and specific heat is 0.15 kJ/kg °C, the heat transfer coefficient is 40 W/m²-°C. If the thermometer bulb is cylindrical having the same volume and diameter. What would be the time constant-
- i) neglecting both the end area of the cylinder.
 - ii) accounting for one end area.
- b) A link type load cell is to be designed using four strain gages, the strain gage factor $S_g = 2$ & $R_g = 120 \Omega$ and power dissipation capacity of 1W, the maximum load of 10,000 N. The load cell is constructed using steel of $E = 210 \text{ GPa}$, Poisson's ratio 0.3 and a fatigue strength of 700 MPa. Three voltage measuring systems are available with maximum range of 100, 150 and 200 mV. Choose the appropriate voltage measuring system.
- c) A resistance thermometer is to be constructed of nickel wire. The thermometer resistance at 20°C is 100Ω. What length of 0.4 mm diameter wire should be used ? What would be the length if 2 mm diameter wire is used ? Given resistivity =0.8 mΩm.

If resistance varies linearly with temperature then what would be the resistance, at $t = -50^\circ\text{C}$ and 100°C ? (Sensitivity = 0.2 Ω/°C).

- d) A 50 V range voltmeter is connected across terminal A and B as shown in fig.2. Find the reading of the voltmeter under open circuit and loaded condition. Find the accuracy and loading error. The voltmeter has resistance of $1\text{ M}\Omega$.

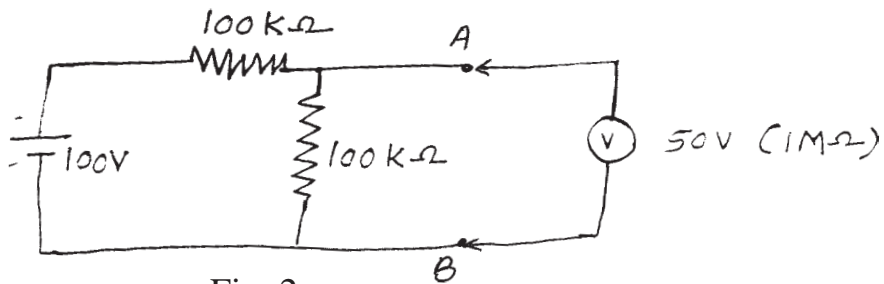


Fig. 2

- e) A steel cantilever is 0.25m long, 20 mm wide and 4 mm thick. Calculate the value of deflection at the free end of it when a force of 25 N is applied at this end.

(Modulus of elasticity is 200 GN/m^2)

An LVDT with sensitivity of 0.5 V/mm is used, the voltage read on 10 V voltmeter having 100 divisions. Two-tenth of a division can be read with certainty. Calculate the minimum and maximum value of force that can be measured with this arrangement.

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Total No. of Questions :5]

SEAT No. :

P2210

[5331]-21

[Total No. of Pages : 2

M.Sc.-I

ELECTRONIC SCIENCE

**EL2UT04 : Applied Electromagnetics RF & Microwave
(2008 Pattern) (Semester-II)**

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *All questions carry equal marks.*
- 3) *Neat diagrams must be drawn wherever necessary.*
- 4) *Figures to the eight side indicate full marks.*

Q1) Attempt any two of the following :

[2×8=16]

- a) What are different types of optical fibers? Draw necessary diagrams of their? mode and Index Profile.
- b) Write a short note on :
 - i) Patch Antenna
 - ii) Yagi-Uda antenna
- c) With necessary diagram explain the principle, construction and working of a magnetron.

Q2) Attempt any two of the following :

[2×8=16]

- a) Differentiate between waveguide & Transmission line. Why TEM mode is not possible in Rectangular waveguide?
- b) Explain Helical antenna with neat diagram.
- c) Explain working of Microwave Oven.

Q3) Attempt any four of the following :

[4×4=16]

- a) State the IEEE microwave ranges for HF, VHF and UHF bands. Give applications of each.
- b) A rectangular waveguide have dimensions :
 $a = 4.0\text{cm}$, $b = 2\text{ cm}$,
Calculate λ_c for TE_{10} , TE_{20} TM_{11}

P.T.O.

- c) A Hertzian dipole antenna has a length of $\lambda/10$. Find its radiation Resistance.
- d) What are the sources of EMI?
- e) Explain the Klystron system with labeled diagram.
- f) Calculate the skin depth at 10^8 Hz for copper.
Given : $\sigma = 5.80 \times 10^7$ s/m, $\mu_r = 1.0$, $\mu_0 = 4\pi \times 10^{-7}$.

Q4) Attempt any four of the following : [4×4=16]

- a) Write a short note on Tee microwave junctions.
- b) Write a short note on “Anechoic Chamber”.
- c) Calculate Directivity of short dipole Antenna.
Given : $A_c = 0.119\lambda^2$
- d) Explain methods of excitation of modes TM_{11} , TM_{21} in Rectangular waveguide.
- e) Derive an expression for intrinsic impedance for free space.
- f) Explain EMI control techniques.

Q5) Attempt any Four of the following : [4×4=16]

- a) Draw sketches of TE_{10} & TM_{11} modes in Rectangular waveguide.
- b) Explain Retarded Potential in brief.
- c) Give basic rules for boundary conditions at the boundary between two different materials.
- d) A certain GaAs MESFET has the following parameters.
 $g_m = 50$ mS, $C_{gs} = 0.60$ pF
Determine the cutoff frequency.
- e) Write characteristics of smith chart.
- f) Explain different types of losses in Microstrip line.



Total No. of Questions : 5]

SEAT No. :

P2211

[5331]-22

[Total No. of Pages : 2

M.Sc. - I

ELECTRONIC SCIENCE

EL 2 UT - 05 : Communication Electronics

(2008 Pattern) (Semester - II)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Draw neat diagrams wherever necessary.*

Q1) Answer any four of the following:

[4 × 4 = 16]

- a) With the help of circuit diagram, describe working of diode detector used for A.M. signal demodulation.
- b) Draw the neat diagram of RF tuned amplifier and explain its working.
- c) Explain the terms - signal to noise ratio and noise figure.
- d) Describe Infra-red data association (IrDA) module in brief.
- e) Explain any one method of error detection and correction.
- f) Explain telephone modems and cable modems in short.

Q2) Answer any two of the following:

[2 × 8 = 16]

- a) State the principle used in balanced modulator. With circuit diagram, explain working of balanced modulator.
- b) With proper diagram, explain collector and base neutralization method.
- c) What is delta modulation? With circuit diagram, explain the working of delta modulation. State its disadvantages.

Q3) Answer any four of the following:

[4 × 4 = 16]

- a) With the help of block diagram, describe superheterodyne receiver.
- b) What is QAM? Explain working of 8 QAM.
- c) Write short note on "Data Compression".
- d) Draw circuit diagram of transistor RF-amplifier for medium frequency and state the importance of RF amplifier.
- e) Describe the working of frequency shift keying modulator.
- f) Describe the working principle of bluetooth technology.

P.T.O.

Q4) Answer any two of the following: **[2 × 8 = 16]**

- a) What is pulse code modulation? Draw block diagram of it and explain terms Quantisation and Quantisation noise.
- b) What is ISDN? Draw the architecture of ISDN and explain function of it. State its applications.
- c) i) Explain XMODEM protocol.
ii) Explain SDLC format.

Q5) Answer any four of the following: **[4 × 4 = 16]**

- a) Describe with diagram, the working of stagger tuning.
- b) Explain any one type of digital subscriber line (DSL).
- c) State the types of transmission media and explain any one of them with diagram.
- d) The frequency modulated wave is represented by the equation $V = 12 \sin (8 \times 10^8 t + 4 \sin 1500 t)$, calculate carrier frequency, modulating frequency, modulation index and maximum deviation.
- e) Explain CDMA techniques.
- f) Describe the working of local loop of land-line telephone.



Total No. of Questions : 5]

SEAT No :

P 2212

[5331]- 23

[Total No. of Pages :3

M.Sc. - I

ELECTRONIC SCIENCE

EL2UTO6 : Digital System Design Using VHDL

(2008 Pattern) (Semester - II)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Neat diagrams must be drawn wherever necessary.*

Q1) Attempt any two of the following: [16]

- a) Explain design flow for digital system design using VHDL. What are the tools used for hardware testing of digital circuits developed with VHDL?
- b) What is entity & architecture in VHDL? Write a VHDL code to implement a multiplexer with following truth table using “switch-case” statement in process block.

Set		Y (7 : 0)
0	0	0
0	1	a (7 : 0)
1	0	b (7 : 0)
1	1	z

- c) Explain with proper syntax, functions and procedures in VHDL. Write a procedure that accepts three integers, compares them and provides smaller and larger numbers as output.

Q2) a) Attempt any two of the following: [16]

- i) What are code converters? State any four of them and design a BCD to excess - 3 encoder.
- ii) Design a two bit magnitude comparator circuit. Build a 8-bit word comparator using two 4-bit magnitude comparator ic's 7485.
- iii) Write a VHDL code for BCD to seven segment decoder for common anode display using if-else statement in process block.

P.T.O.

- b) Attempt any one of the following: [4]
- i) Design a full adder using 3 : 8 decoder.
 - ii) Design a circuit for even parity generator and checker for 3-bit message.

Q3) Attempt any two of the following: [16]

- a) Design a sequence generator using T-flip flops to generate the sequence 0, 1, 2, 4, 6 and repeat.
- b) Write a VHDL code for stepper motor controller using FSM, which rotates motor in clockwise direction if control input is '1' and in anticlockwise if control input is '0'.
- c) Explain with a neat diagram 3-bit up - down asynchronous counter. Also draw a timing diagram associated with it.

Q4) Attempt any two of the following: [12]

- a) Write a VHDL code for 4-bit ALU to perform arithmetic operations such as addition, subtraction, increment, decrement and logical operations such as AND, OR, NAND, NOR.
- b) Draw a block diagram of PAL. Simplify & implement the following using PAL.

$$W(A, B, C, D) = \Sigma (2, 12, 13)$$

$$X(A, B, C, D) = \Sigma (7, 8, 9, 10, 11, 12, 13, 14, 15)$$

$$Y(A, B, C, D) = \Sigma (0, 2, 3, 4, 5, 6, 7, 8, 10, 11, 15)$$

$$Z(A, B, C, D) = \Sigma (1, 2, 8, 12, 13)$$

- c) What is GAL? Write features of GAL 16V8 and implement $Y = AC + B\bar{C} + \bar{A}BC$, using GAL in simple mode.

Q5) Attempt any two of the following:

[16]

- a) Explain Architecture of FPGA. Write applications of FPGA.
- b) Explain in brief ROM'S with reference to types, data storage principle, control inputs and applications.
- c) Draw basic memory cell of DRAM. Explain how data is stored in DRAM. Compare SRAM and DRAM.



Total No. of Questions :5]

SEAT No. :

P2213

[Total No. of Pages :2

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M.Sc. - II

ELECTRONIC SCIENCE

EL3UT05 : Embedded Systems

(2008 Pattern) (Semester - III)

Time : 3 Hours]

[Max. Marks :80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Draw neat diagrams wherever necessary.*

Q1) Attempt any FOUR of the following:

[4 × 4 = 16]

- a) Distinguish between RISC and CISC architecture.
- b) With the help of neat block diagram explain timer/counter section of 8051.
- c) Explain different port registers of AVR microcontroller.
- d) Explain ADC module and associated registers in PIC microcontroller.
- e) Discuss asynchronous data transfer technique in 8051.

Q2) Attempt any FOUR of the following:

[4 × 4 = 16]

- a) Write 'C' program for AVR microcontroller to generate triangular wave using DAC.
- b) Explain 'Interrupt system' of 8051.
- c) Explain CAN protocol in brief.
- d) Explain data and program memory organization of PIC microcontroller.
- e) Write a 'C' program for 8051 microcontroller to monitor P1.6 continuously. Send 55H when it is high and send AAH when it is low to port 0.

P.T.O.

Q3) Attempt any TWO of the following: **[2 × 8 = 16]**

- a) Describe RS232C communication standard. Explain features and show the connection between 8051 microcontroller and PC.
- b) Write short note on Compiler, Assembler, Linker and Simulator.
- c) What is embedded system? Explain different features and applications of it.

Q4) Attempt any TWO of the following: **[2 × 8 = 16]**

- a) Draw interfacing diagram between stepper motor, a switch and 8051 microcontroller. Write 'C' program to rotate stepper motor clockwise if switch is open and anticlockwise when it is closed.
- b) Draw interfacing diagram of 2×16 LCD with PIC16 F877A. Write, 'C' program to display 'Embedded system' on first line of LCD.
- c) Explain in brief I2C and SPI protocol.

Q5) Attempt any TWO of the following: **[2 × 8 = 16]**

- a) Draw and explain PIC microcontroller architecture.
- b) Write 'C' program for one digit BCD counter using common anode seven segment display interfaced to port of AVR.
- c) Write 'C' program to read 4 keys and display its status on LED's for 8051 microcontroller.



Total No. of Questions :5]

SEAT No. :

P2214

[5331]-41

[Total No. of Pages : 3

M.Sc.-II

ELECTRONIC SCIENCE

**EL4UT-06 : Control Systems : Theory and Applications
(2008 Pattern) (Semester-IV)**

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of log table/calculator is allowed.*
- 4) *Neat diagrams must be drawn wherever necessary.*

Q1) Solve any two :

[2×8=16]

- a)
 - i) Explain the following terms :
 - 1) Process load
 - 2) Process lag
 - 3) Control lag
 - 4) Dead Time
 - ii) Explain feed forward control strategy.
- b)
 - i) Compare feedback control with open loop control.
 - ii) Explain the block diagram of control system
- c)
 - i) Define pole, zero, characteristic equation and order of transfer function. What is meant by dominant pole?
 - ii) Explain significance of Laplace transform in the analysis of control system.

Q2) Solve any two :

[2×8=16]

- a)
 - i) State advantages and limitations of Routh's method for checking stability of the system.
 - ii) What is feedback control? Draw a block diagram and explain its working.

P.T.O.

- b) i) Comment on the following statements.
 - 1) Derivative mode cannot be used alone.
 - 2) High gain proportional mode works like ON-OFF controller
- ii) Define stability of control system. Differentiate between absolute stability and relative stability.
- c) Explain Zeigler-Nichols method for process loop tuning.

Q3) Solve any two : **[2×8=16]**

- a) Explain the working of PLC with suitable block diagram.
- b) Compare performance of proportional, integral and derivative control modes.
- c) i) Explain PLC Sequences Output Instruction (SOQ).
- ii) What is watch dog timer? What is its function?

Q4) Solve any two : **[2×8=16]**

- a) i) Find the range of values of K so that the system with following characteristic equation will be stable.

$$F(s) = s(s^2 + 5s + 1)(s + 4) + k = 0$$
- ii) What type of battery is typically used in PLC processor? How it should be handled? How it should be disposed off?
- b) What is local or base PLC? Explain local expansion and remote I/O expansion.
- c) i) Discuss serial communication between PC and PLC.
- ii) Explain PLC counter instructions.

Q5) Solve any four : **[4×4=16]**

- a) Differentiate between PLC ladder logic and relay ladder logic.
- b) Write a short note on control valves.
- c) Using a single opamp. Design ON-OFF controller with neutral zone of 4V and central voltage of 3.2V, $V_{sat} = 10V$.
 Give the circuit diagram and find V_{UTP} and V_{LTP} .

- d) i) Explain the working of bottle filling plant.
- ii) What information should be included in PLC documentation?
- e) Explain the rules of reduction of block diagram for a control system.
- f) i) Give advantage of using software to program PLC.
- ii) Explain BIT or RELAY instructions for PLC.

