(*xix*) Which ONE of the following statement is *false* ?

(*a*) Digital voltmeters measure dc voltage signals

(*b*) A digital voltmeter is essentially an A/D converter

(*c*) A CRO has usually a very low impedance at its input

(*d*) A CRO can be used to measure the magnitude of two independent signals and phase between them.

(*xx*) Which ONE of the following statement is *true* :

(*a*) A piezoelectric pressure transducer can be used for measuring both static and dynamic pressures

(*b*) A resistance strain gage type pressure transducer cannot be used for dynamic pressure measurement

(*c*) Pressures higher than 10 atm are usually very high

(*d*) Pressures of the order of 1 mm Hg or below are usually regarded as very low.

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A** , ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

All parts of a question (a, b, etc.) should be answered at one place.

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Group A

1. (*a*) Draw the piecewise linear volt-ampere characteristic of a *p -n* diode. What is the circuit model for the ON-state ?   6

(*b*) Define peak inverse voltage. What is the peak inverse voltage for a full wave circuit using ideal diode ?   6

(*c*) Sketch the circuit for a full wave rectifier. Derive the expression for (*i*) the dc current (*ii*) the dc load voltage (*iii*) the dc diode voltage (*iv*) the rms current.   8

2. (a) Sketch a family of CB output characteristics for a transistor. Indicate the active, cut-off and saturation regions. Explain the shapes of the curves qualitatively.
$$4 + 3$$

(b) What ratings limit the range of operation of transistor? Why is capacitive coupling used to connect a signal source to an amplifier? $4 + 3$

(c) Draw a family of CS drain characteristics of an n-channel JFET. Explain the shape of there curves qualitatively. 6

3. (a) Define the following modes of operation of an amplifier: 6

(i) Class A

(ii) Class B

(iii) Class AB

(iv) Class C.

(b) Define the frequency response magnitude characteristic of an amplifier and sketch a typical response curve. $4 + 3$

(c) Indicate the high and low 3-dB frequencies of an amplifier and define bandwidth. $4 + 3$

4. (a) Draw the volt-amp characteristics of the SCR as a function of gate current. 4

(b) Draw a half wave SCR circuit and indicate the current and voltage waveforms of the SCR. 4

(c) Draw the schematic diagram of an ideal non-inverting op-amp with voltage shunt feedback and derive the expression for the voltage gain. 6

(d) Draw the block diagram for an A/D converter and explain the operation of this system. 6

Group B

5. (a) Give a sketch showing the construction of a moving coil voltmeter and explain its working. 5

(b) The coil of a 300 mV moving coil voltmeter has 20 turns of copper wire each 0·274 mm diameter. The mean length per turn and depth of the coil are 13 cm and 4 cm respectively. A 4·24 Ω resistance is connected in series with the coil. The air gap flux density is 0·15 Wb/m². Calculate the controlling torque exerted by the springs when the reading is 300 mV. $\varrho_{cu} = 0\cdot0173 \times 10^{-6} \Omega m$. 10

(c) Derive an expression for the torque of a moving-iron ammeter. 5

6. (a) Explain with a neat sketch, the working principle of a dynamometer type wattmeter. Discuss the sources of error in such an instrument and also the remedy of the same. 10

(b) A wattmeter is used to measure the power in an inductive load having power factor 0·8. The load current is 20A and the potential difference applied is 50 V. The resistances of two coils of the wattmeter are 0·01 Ω and 1000 Ω respectively and both are non-inductive. Show the two ways in which the pressure coil can be connected and find the error in the reading of the meter in each case. 10

Group C

7. (a) What are the advantages of electronic voltmeters? Classify electronic voltmeters and explain with a neat circuit diagram, the working principle of any one type.   10

(b) In a cathode ray tube the distance between the deflecting plates is 0·5 cm, the length of the deflecting plates is 2·5 cm and the distance from their centre to the screen is 21 cm. The electron beam is accelerated by a potential difference of 2550 volt and is centrally projected between the plates. Calculate the deflection on the screen and the deflecting voltage. Also calculate the sensitivity and deflection factor of the tube.   10

8. (a) Name resistive transducers for measuring displacement and temperature. Explain with necessary diagrams the working principle of a resistive temperature transducer.   5

(b) Name inductive transducer for measuring displacement and explain its working with a neat sketch.   4

(c) What are strain gages? Explain one application of strain gage.   4

(d) A resistance strain gage with a gage factor 2·04 is fastened to a beam which is subjected to a strain of 1×10^{-6}. If the original resistance of the gage is $120 \, \Omega$, calculate the change in resistance.   7

9. Choose the *correct* answer: 1 x 20

(i) In an n-type material, the free electron concentration is approximately equal to

(a) concentration of acceptor ions

(b) density of donor atoms

(c) thickness of the material

(d) weight of the material.

(ii) In a p-n junction biased in the forward direction, the holes

(a) cross the junction from n-type into p-type region

(b) remain stationary in the p-type region

(c) cross the junction from p-type into n-type region

(d) remain stationary in the n-type region.

(iii) In the active region of the output characteristics of common emitter configuration, one of the following is correct

(a) collector junction is forward biased and emitter junction is also forward biased

(b) collector junction is reverse biased and emitter junction is forward biased

(c) collector junction is reverse biased and emitter junction is also reverse biased

(d) none of the above.

(iv) The amplifier is said to have negative feedback when :

(a) any decrease in the output signal results in a feedback signal into the input in such a way as to cause a decrease in the output signal

(b) any decrease in the input signal results in a feedback signal into the output in such a way as to cause an increase in the output signal

(c) any increase in the input signal results in a feedback signal into the input in such a way as to cause a decrease in the output signal

(d) any increase in the output signal results in a feedback signal into the input in such a way as to cause a decrease in the output signal.

(v) The p-channel MOSFET consists of

(a) a lightly doped n-type substrate into which two highly doped p^+ regions are diffused

(b) a lightly doped n-type substrate into which two highly doped n^+ regions are diffused

(c) a highly doped n-type substrate into which one highly doped p^+ region is diffused

(d) a highly doped p-type substrate into which two highly doped p^+ regions are diffused.

(vi) Input offset current of an op-amp is

(a) the difference between the separate currents entering the input terminals of a balanced amplifier

(b) the sum of the currents entering the input terminals of an amplifier

(c) the ratio of input and output currents of an amplifier

(d) the difference between the input and output currents of an amplifier.

(vii) The TRIAC is a three terminal silicon switch which

(a) cannot be triggered only with a positive gate pulse

(b) can be triggered only with a negative gate pulse

(c) can be triggered with either positive or negative gate pulses when the anode potentials are positive or negative respectively

(d) cannot be triggered only with a negative gate pulse.

(viii) The p-n-p-n diode when biased with the anode positive has

(a) one stable state

(b) two stable states

(c) no stable state

(d) three stable states.

(ix) Output offset voltage of an op-amp is

    (a) the sum of the input voltages

    (b) the difference between input and output voltages

    (c) the difference between the dc voltages present at the two output terminals when the two input terminals are grounded

    (d) none of the above.

(x) In case of an A/D converter using counter, which one of the following statement is *true*
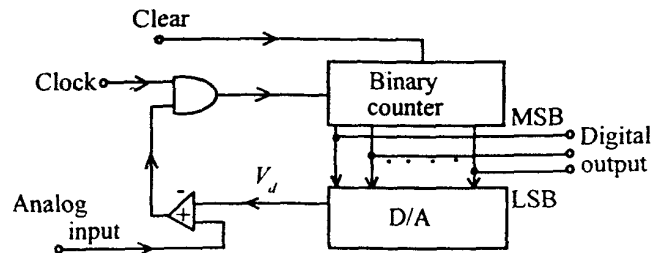
    (a) A continuous sequence of equally spaced pulses is not passed through a gate

    (b) The gate is normally opened and is closed at the instant of the beginning of a linear ramp

    (c) The gate remains open until the linear sweep voltage attains the reference voltage of a comparator, the level of which is set to equal to the analog voltage to be converted

    (d) The number of pulses in the train that pass through the gate is not proportional to the analog voltage.

(xi) A 150 V moving iron voltmeter has an inductance of 0·75 H and a total resistance of 2000 Ω. It is calibrated to read correctly on 50 Hz circuit. The series resistance required to increase its range to 600 V is

    (a) 500 Ω

    (b) 1000 Ω

    (c) 5000 Ω

    (d) 6036 Ω.

(xii) Kelvin double bridge is used for measuring

    (a) high resistance

    (b) low resistance

    (c) low capacitance

    (d) high inductance.

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(*xiii*) In case of a permanent magnet moving coil instrument which ONE of the following statement is *true*

   (*a*) It has low torque/weight ratio

   (*b*) Its scale is non-uniform

   (*c*) There is a possibility of using a single instrument with shunt or series resistors for covering a large range of current or voltage

   (*d*) It is not free from hysteresis error.

(*xiv*) For the measurement of sinusoidal voltage using CRO, the peak to peak value is obtained from its trace on the screen and the r.m.s. value of the voltage is given by

   (*a*) $\dfrac{V \text{ peak to peak}}{2\sqrt{2}}$

   (*b*) $\dfrac{V \text{ peak to peak}}{\sqrt{2}}$

   (*c*) $\dfrac{V \text{ peak to peak}}{2}$

   (*d*) $\dfrac{V \text{ peak to peak}}{4}$.

(*xv*) The Q-factor of a coil with resistance R and inductance L operating at frequency $W = 2\pi f$ is defined as

   (*a*) L/R

   (*b*) $2R/L$

   (*c*) $2L/R$

   (*d*) WL/R.

(*xvi*) LVDT, used for displacement measurement is

   (*a*) an active transducer

   (*b*) a passive transducer

   (*c*) a capacitive transducer

   (*d*) a digital transducer.

(*xvii*) Most sensitive type of sensing element for strain measurement is

   (*a*) potentiometric transducer

   (*b*) wire resistance strain gage

   (*c*) extensometer

   (*d*) semiconductor strain gage.

(*xviii*) The most usual value of resistance strain gage is

   (*a*) $12\,\Omega$

   (*b*) $50\,\Omega$

   (*c*) $120\,\Omega$

   (*d*) $2400\,\Omega$.

(*xix*) Which ONE of the following statement is *false* ?

  (*a*) Digital voltmeters measure dc voltage signals

  (*b*) A digital voltmeter *is* essentially an A/D converter

  (*c*) A CRO has usually a very low impedance at its input

  (*d*) A CRO can be used to measure the magnitude of two independent signals and phase between them.

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ELECTRONICS AND INSTRUMENTATION

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Group A

1. (a) Discuss how charge carriers are made available for
controlled conduction in a semiconductor device.   4

(b) What is the potential energy barrier of a *p-n* junction
diode ? How does it arise and what is its order of
magnitude ?   4

(c) What is the value of series resistance required when
10 W, 10 V, 1000 mA zener diodes are connected
in series to obtain 20 V regulated output from a 35 V
d.c. source ?   4

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(*d*) Draw and explain a full wave bridge rectifier circuit. What is its rectification efficiency? 8

2. (*a*) Explain the construction and operational principle of *p-n-p* and *n-p-n* transistors. How does a transistor act as a switch? 8

(*b*) In *Fig.* 1, find the collector emitter voltage and base current. Given: $V_{CC} = 8\,V$, $R_C = 800\,\Omega$, and $\alpha = 0.96$. 6

Fig. 1
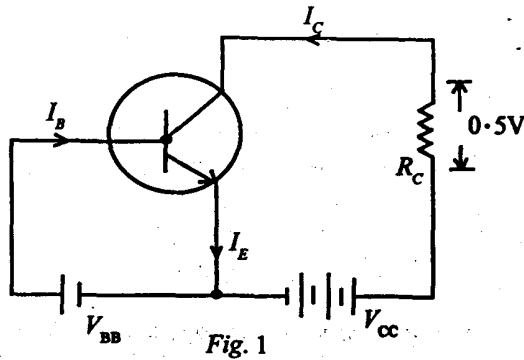
(*c*) Describe the salient construction features of the metal-oxide semiconductor field-effect transistor (MOSFET) and point out how it differs from the JFET. 6

3. (*a*) What do you understand by hybrid parameters? Draw the *h*-parameter equivalent circuit of a transistor. Are the *h*-parameters of the CE transistor amplifier constant over a small operating range or over a large operating range? Justify your answer. 8

(*b*) List the factors which cause a deterioration of the frequency response of a transistor amplifier. Explain how each factor affects the performance of the amplifier and the portion of the frequency range where it is effective. 6

(*c*) What are the conditions for oscillation? Explain why positive feedback is employed in oscillators? What are different types of oscillators? 6

4. (*a*) Describe the constructional features of a thyristor and explain its operational principle. Draw the V.I. characteristics of (*i*) an SCR, (*ii*) a Diac, and (*iii*) a Triac. 8

(*b*) Define (*i*) slew rate, and (*ii*) power supply rejection ratio of an op-amp. Show how an operational amplifier can be used as a buffer? 6

(*c*) Explain the working principle of a *D* to *A* converter, using a binary weighted network. Obtain the expression for its output voltage. 6

Group B

5. (*a*) What is the difference between a CRT and a CRO? Draw a neat functional block diagram of a general purpose CRO and explain functions of each block. 8

(*b*) What is oscilloscope probe compensation? How is this adjusted? What effects are noted when the compensation is not correctly adjusted? 5

4 AN : AN 208 (1408)   (2)   (*Continued*)

4 AN : AN 208 (1408)   (3)   (*Turn Over*)

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(c) The x-deflecting plates in a CRO are 5 mm apart and 25 mm long. The centre of the plates is 20 cm from the screen. The accelerating voltage is 3000 V. Find the rms value of the sinusoidal voltage applied to x-deflecting plates, if the length of trace obtained on the screen is 10 cm. Also, find the electrostatic deflection of the above tube.   7

6. (a) What are the differences in the following electronic voltmeters : (i) peak reading type, (ii) rms reading type, and (iii) average reading type. Explain briefly using schematic diagrams.   10

   (b) Describe, with functional block diagrams, a digital data acquisition system. What are the differences between an analog and a digital system?   5

   (c) A capacitive transducer consists of two plates of diameter 2 cm each, separated by an air gap of 0·2 mm. Find the displacement sensitivity.   5

7. (a) Describe, with a neat sketch, the constructional feature and working principle of a dynamometer type wattmeter. Deduce the expression for torque produced.   8

   (b) An alternating current is measured by a rectifier and a moving iron meter and the readings are formed to be 30 A and 32 A, respectively. Determine the form factor of the current wave. Show how the rectifier type instrument works.   4 + 4

   (c) Obtain the expression for torque produced in a PMMC meter.   4

8. (a) With a simple diagram, explain the basic principle of a Q-meter used for measurement of Q of a coil.   6

   (b) What are different means of designing a digital voltmeter? Describe, with a diagram, the principle of operation of a dual slope integrating type DVM.   7

   (c) What is the difference between a distortion meter and a spectrum analyzer? Explain the working principle of a spectrum analyzer.   7

Group C

9. Choose the *correct* answer for the following: 1 x 20

   (i) A Lissajous pattern, shown in *Fig.* 2, is observed on the screen of a CRO when voltages of frequencies f_x and f_y are applied to the x and y plates, respectively. $f_x : f_y$ is then equal to
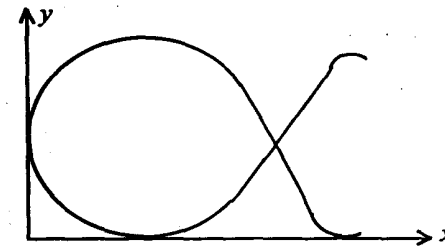

Fig. 2

   (a) 3 : 2

   (b) 2 : 3

   (c) 2 : 1

   (d) 1 : 2.

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(*ii*) The time base of a CRO is developed by

   (*a*) square waveform

   (*b*) sine waveform

   (*c*) sawtooth waveform

   (*d*) output from a built-in-clock.

(*iii*) The controlling torque in a spring controlled indicating instrument is proportional to

   (*a*) θ

   (*b*) θ^2

   (*c*) $1/\theta$

   (*d*) $1/\theta^2$.

(*iv*) A symmetrical square wave voltage in applied to an average responding a.c. voltmeter with a scale calibrated in terms of the rms value of a sine wave. What will be the percentage error in the meter indication ?

   (*a*) 0

   (*b*) + 11

   (*c*) + 63·7

   (*d*) − 70·7.

(*v*) In the measurement of three-phase power by two wattmeter method, if two wattmeter readings are equal, the power factor of the circuit is

   (*a*) 0

   (*b*) 0·8 lagging

   (*c*) 0·8 leading

   (*d*) unity.

(*vi*) Which of the following meter is integrating type ?

   (*a*) Moving iron voltmeter

   (*b*) Rectifier type ammeter

   (*c*) Induction type energy meter

   (*d*) Dynamometer type wattmeter.

(*vii*) A relaxation oscillator is one which

   (*a*) relaxes indefinitely

   (*b*) produces sinusoidal waves

   (*c*) produces non-sinusoidal waves

   (*d*) oscillates continuously.

(*viii*) An harmonic analyser, using crystal filter, has the level range of

   (*a*) − 10 db to 32 db

   (*b*) − 90 db to 32 db

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(c) 20 db to 60 db

(d) 40 db to 100 db.

(ix) The principle of operation of LVDT is based on variation of

(a) self-inductance

(b) mutual inductance

(c) reluctance

(d) performance.

(x) Which of the following is *not* true for semiconductor gauges as compared to conventional strain gauges ?

(a) Excellent hysteresis characteristics

(b) Least sensitive to temperature changes

(c) High fatigue life

(d) Smaller life

(xi) Which of the following pulse communication system is inherently immune to noise ?

(a) PPM

(b) PAM

(c) PWM

(d) PCM.

(xii) In digital telemetry, commonly used modulation is

(a) PCM

(b) PDM

(c) PPM

(d) PAM.

(xiii) The bandwidth over which the op-amp has constant gain ranges from

(a) 10 GHz to 100 GHz

(b) 1 MHz to 10 MHz

(c) 10 kHz to 100 kHz

(d) 0 to a few Hz.

(xiv) The major component in MOS IC is

(a) a BJT

(b) a JFET

(c) a MOSFET

(d) an SCR.

(xv) Transistor, as a digital device, operates in

(a) active region only

(b) cut-off condition only

(c) saturation condition only

(d) both cutoff and saturation conditions

(*xvi*) The full scale input voltage to an ADC is 10 V. The resolution required is 5 mV. The minimum number of bits required for ADC is

(*a*) 12

(*b*) 11

(*c*) 10

(*d*) 8.

(*xvii*) The full scale output potential for an 8-bit DAC with a reference potential of 10·00 V d.c. is

(*a*) 19·00 V

(*b*) 10·00 V

(*c*) 9·96 V

(*d*) 9·50 V.

(*xviii*) The minimum frequency response required of an oscilloscope that is to reproduce without distortion a pulse, that has a 15 ns rise time, is

(*a*) 67 MHz

(*b*) 23 MHz

(*c*) 15 MHz

(*d*) 1 MHz.

(*xix*) The common emitter amplifier provides phase shift of

(*a*) 360°

(*b*) 270°

(*c*) 180°

(*d*) 90°.

(*xx*) A transistor is operating in active region. Under this condition,

(*a*) both the junctions are forward biased

(*b*) both the junctions are reverse biased

(*c*) emitter-base junction is reverse biased, collector-base junction is forward biased

(*d*) emitter-base junction is forward biased, collector-base junction is reverse biased.

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W'07 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

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Group A

1. (*a*) Describe in your own words how 'diffusion' and 'transition' capacitance differ.   3 + 3

   (*b*) Define an intrinsic material, a negative temperature coefficient and covalent bonding.   2 + 2 + 2

   (*c*) Find the conductivity and resistivity of an intrinsic semiconductor at temperature of 300°K. It is given that $n_i = 2\cdot5 \times 10^{13}/\text{cm}^3$, $\mu_n = 3800$ cm^2/sV, $\mu_p = 1800$ cm^2/sV, $e = 1\cdot6 \times 10^{-19}$ C.   6 + 2

2. (*a*) What is a Zener diode and where it is mostly used ?   3 + 3

(b) Triac can be triggered by either a positive or a negative control pulse? Explain.   4

(c) Draw the hybrid parameter equivalent circuit of a common emitter configuration. A transistor amplifier using CE connection has the following set of h - parameters at the d.c. operating point of :

$$V_{cc} = 12\,V \quad and \quad I_c = 1\,mA$$
$$h_{ie} = 2500\,\Omega \qquad h_{re} = 10^{-3}$$
$$h_{fe} = 60 \qquad h_{oe} = 10^{-4}\,mho$$

Find the values of (i) input impedance, (ii) current gain, (iii) voltage gain, and (iv) power gain. The effective a.c. load resistance is $500\,\Omega$. $2 + 2 \times 4$

3. (a) What are different biasing arrangements for a CE amplifier? Develop a bias circuit, which is independent of transistor β(beta). $2 + 4$

(b) In the circuit shown in Fig.1, determine V_{CE} and I_C in the voltage divider biased transistor circuit. Given $\beta_{dc} = 100$ and neglect input resistance at the base. $4 + 4$
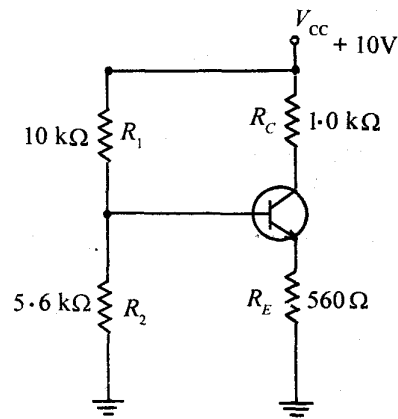

Fig. 1

(c) Discuss the advantages of ICs over the discrete components. Mention drawbacks also. $4 + 2$

4. (a) Why does the necessity arise of using A/D and D/A converters in an instrumentation system? Explain the operation of a digital to analogue converter using R-$2R$ network. $2 + 2 + 4$

(b) Discuss how a n-channel depletion type MOSFET can be operated in the enhancement mode.   6

(c) What is Barkhausen criterion of oscillations? Enumerate the different classes of oscillators. $4 + 2$

Group B

5. (a) Define the terms 'Indicating instruments' and 'Integrating instruments'? Give suitable examples in each case. $2 + 2 + 2$

(b) Discuss the normal procedure for testing energy meters. How do you adjust the speed error, phase angle between voltage and shunt magnetic flux? $2 + 2 + 2$

(c) A moving iron voltmeter has between its terminals a resistance of $1000\,\Omega$ and an inductance of $0.1\,H$. It reads correct at $50\,Hz$. What is the percentage correction required to be applied at $200\,Hz$?   8

6. (a) Explain briefly the principle of working of an integrating digital voltmeter.   6

(b) What do you mean by synchronisation in a CRO? How can you measure current with the help of CRO? $4 + 2$

(c) A capacitive transducer has a capacitance of 20 p.f. when it has plate separation of 0.2 mm. The capacitance change by a value of +2 p.f. during displacement measurement. Calculate the value of displacement.   8

7. (a) Discuss the theory and working of LCDs. Also, explain the advantages of LCDs.   3 + 2 + 2

(b) The self-capacitance of a coil is measured by a Q- meter. The circuit is set into resonance at 2 MHz and the tuning capacitor has a value of 460 pF. The frequency is now adjusted to 4 MHz and the resonance conditions are obtained with tuning capacitor set at a value of 100 pF. Calculate the value of self-capacitance of the coil. Prove the relationship used.   8

(c) With proper block diagram, describe a spectrum analyser.   5

8. (a) Explain, with block diagrams, the principle of operation of an RF signal generator. How do you obtain multiple frequency ranges ?   6 + 2

(b) What is a Data Acquisition System (DAS) ? Describe a DAS with functional block diagrams.   8

(c) A rectifier type instrument uses a bridge rectifier and has its scale calibrated in terms of r.m.s. values of a sine wave. It indicates a voltage of 2.22 V, when measuring a voltage of triangular wave shape. Estimate the peak and rms values of applied voltage. Also, calculate the error in the measurement of the rms voltage of the triangular waveform.   4

Group C

9. Choose the *correct* answer for the following :   1 x 20

(i) In a semiconductor material, doping is done to

(a) decrease the number of charge carriers

(b) change the chemical properties of semiconductor

(c) make semiconductor less than 100% pure

(d) all the crystal structure of the pure semiconductor.

(ii) Current flow in a semiconductor depends on the phenomenon of

(a) drift

(b) diffusion

(c) recombination

(d) All of the above.

(iii) The term 'bias' means

(a) the ratio of majority carriers to minority carriers

(b) the amount of current across a diode

(c) a d.c. voltage is applied to control the operation of a device

(d) None of the above.

(*iv*) If one of the diodes in a bridge full-wave rectifier opens, the output is

(*a*) 0V

(*b*) one-fourth the amplitude of the input voltage

(*c*) a half-wave rectified voltage

(*d*) a 120 Hz voltage.

(*v*) When operated in cut-off and saturation, the transistor acts like

(*a*) linear amplifier

(*b*) a switch

(*c*) a variable capacitor

(*d*) a variable resistor.

(*vi*) Drain current in the constant-current area increases when the

(*a*) gate to source bias voltage decreases

(*b*) gate to source bias voltage increases

(*c*) drain to source voltage increases

(*d*) drain to source voltage decreases.

(*vii*) When the voltage gain of an amplifier is increased, the bandwidth

(*a*) is not affected

(*b*) increases

(*c*) decreases

(*d*) becomes distorted.

(*viii*) A certain inverting amplifier has a closed loop gain of 25. The op-amp has an open-loop gain of 100,000. If another op-amp with an open-loop gain of 200,000 is substituted in the configuration, the closed loop gain

(*a*) doubles

(*b*) drops to 12·5

(*c*) remains at 25

(*d*) increases slightly.

(*ix*) In an integrator, the feedback element is

(*a*) resistor

(*b*) capacitor

(*c*) Zener diode

(*d*) voltage divider.

(*x*) An oscillator differs from an amplifier because it

(*a*) has more gain

(*b*) requires no input signal

(*c*) requires no d.c. supply

(*d*) always has the same output.

(*xi*) A Wheatstone bridge is balanced with all the four resistances equal to $1\,k\Omega$ each. The bridge supply voltage is $100\,V$. The value of one of the resistances is changed to $1010\,\Omega$. The output voltage is measured with a voltage measuring device of infinite resistance. The bridge sensitivity is

(*a*) $10\,V/\Omega$

(*b*) $25\,mV/\Omega$

(*c*) $2\cdot5\,mV/\Omega$

(*d*) None of the above.

(*xii*) Fluid friction damping can be used in

(*a*) horizontally mounted instruments

(*b*) vertically mounted instruments

(*c*) both in horizontally and vertically mounted instruments

(*d*) None of the above.

(*xiii*) Swamping resistance is connected

(*a*) in series with the shunt to reduce temperature error in shunted ammeters

(*b*) in series with the ammeters to reduce errors on account of friction.

(*c*) in series with meter and have a high resistance temperature coefficient in order to reduce temperature errors in ammeters

(*d*) in series with the meter and have a negligible resistance coefficient in order to reduce temperature errors in shunted ammeters.

(*xiv*) In an electrodynamometer type wattmeter,

(*a*) the current coil is made fixed

(*b*) the pressure coil is fixed

(*c*) any of the two coils, i.e., current coil or pressure coil can be made fixed

(*d*) both coils should be movable.

(*xv*) A true rms reading voltmeter uses two thermocouples in order

(*a*) to increase sensitivity

(*b*) that the second thermocouple cancels out the non-linear effects of the first thermocouple

(*c*) to prevent drift in the d.c. amplifier

(*d*) All of the above.

(*xvi*) An aquadag is used in a CRO to collect

(*a*) primary electrons

(*b*) secondary emission electrons

(*c*) both primary and secondary emission electrons

(*d*) None of the above.

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(*xvii*) In a Q-meter, distributed capacitance of coil is measured by changing the capacitance of the tuning capacitor. The values of the tuning capacitor are C_1 and C_2 for resonant frequencies f_1 and $2f_1$, respectively. The value of distributed capacitance is

(*a*) $(C_1 - C_2)/2$

(*b*) $(C_1 - 2C_2)/3$

(*c*) $(C_1 - 4C_2)/3$

(*d*) $(C_1 - 3C_2)/2$

(*xviii*) A transducer converts

(*a*) mechanical energy into electrical energy

(*b*) mechanical displacement into electrical signal

(*c*) one form of energy into another form of energy

(*d*) electrical energy into mechanical form.

(*xix*) In an LVDT, the core is made up of a

(*a*) non-magnetic material

(*b*) a solid ferroelectric material

(*c*) high permeability, nickel-iron hydrogen annealed material in order to produce low harmonics, low null voltage, and high sensitivity. The core is slotted to reduce eddy current losses

(*d*) All of the above.

(*xx*) The output of the following circuit is
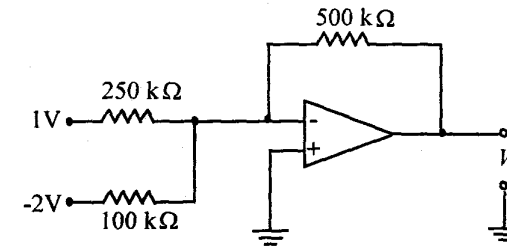
(*a*) $-8\,V$

(*b*) $+8\,V$

(*c*) $+12\,V$

(*d*) $-12\,V$.

S'08 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A**,
ANY TWO *from* **Group B** *and* ALL *from* **Group C**.

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answer may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*
Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Write down two main differences between a semiconductor, a conductor and an insulator. Draw the energy-band diagram of direct and indirect band gap semiconductors.   4 + 2

    (b) Define the following terms, which are related to a semiconductor : (i) Dopant; (ii) Donors; (iii) Ionization energy; (iv) p -type semiconductor.
    2 x 4

    (c) At 300 K the intrinsic carrier concentration of silicon is $1 \cdot 5 \times 10^{16} \, \text{m}^{-3}$. If the electron and the hole mobilities are $0 \cdot 13 \, \text{m}^2 / \text{V–s}$ and $0 \cdot 05 \, \text{m}^2 / \text{V–s}$, respectively, determine the intrinsic resistivity of silicon at 300 K.   6

2. (a) With a neat circuit diagram, explain the operation of a full wave rectifier circuit. Prove that its efficiency is 81·2%.   6 + 4

(b) With the help of two-transistor analogy, explain the operation of a silicon controlled rectifier (SCR) and draw its voltage-current characteristics.   8 + 2

3. (a) A silicon $n-p-n$ transistor having $\beta = 100$ and operated in CE–mode as shown in Fig .1. Assuming $V_{BE} = 0.7\,V$, determine the transistor currents and the region of operation of the transistor. What happens if the resistance R_c is indefinitely increased?   10
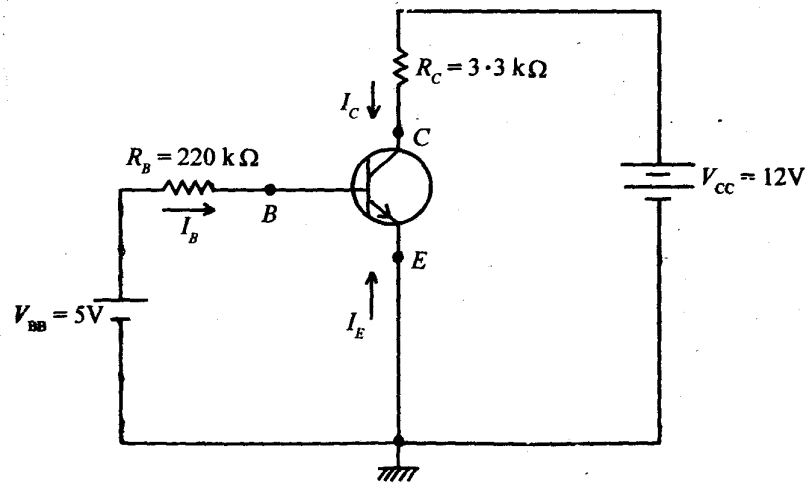

Fig. 1

(b) Make a comparative study between a 'Bipolar Junction Transistor (BJT) and a 'Junction Field Effect Transistor'(JFET).   5

(c) Explain, with a neat sketch, the structure and the working of a p -channel enhancement type MOSFET. Draw its voltage-current characteristics.   4 + 1

4. (a) Draw the equivalent circuit of an op-amp and write down the characteristics of an ideal op-amp.   3 + 3

(b) Design a circuit using op-amp that can add three voltages of 15 V, 25 V and 35 V.   4

(c) With a neat circuit, explain the operation of a weighted resistor type digital to analog converter. Mention its advantages and disadvantages over the $R - 2R$ ladder type digital to analog converter.   8 + 2

Group B

5. (a) What is a transducer? How an active transducer differs from a passive one?   2 + 2

(b) What is a strain gauge? With a neat schematic diagram, explain its operation. Prove that for a strain gauge, the gauge factor is given by

$$K = 1 + 2\mu$$

where μ is the Poisson's ratio.   1 + 4 + 7

(c) A resistance strain gauge, with a gauge factor of 2, is cemented to a steel member, which is subjected to a strain of 1×10^{-6}. If the original resistance value of the gauge is $130\,\Omega$, calculate the change in resistance.   4

6. (a) Discuss the normal procedure for testing energy meters. How do you adjust the speed error, phase angle between voltage and shunt magnetic flux?

$2 + 2 + 2$

(b) The inductance of a moving iron ammeter, with a full scale deflection of 90° at 1·5 A, is given by the expression $L = (200 + 40\,\theta - 4\theta^2 - \theta^3)$ μH, where θ is the deflection in radian from the zero position. Estimate the angular deflection of the pointer for a current of 1·0 A.

6

(c) Draw the block diagram of a general purpose CRO and explain the functions of the following controls : (i) Intensity, and (ii) Horizontal and vertical positioning.

$6 + 2$

7. (a) Mention some of the advantages of digital voltmeter over its analog counterpart. With a neat circuit, explain the operation of a dual slope type digital voltmeter.

$2 + 6$

(b) How can power of a three-phase system be measured by using two wattmeters.

8

(c) In a test with two wattmeters method for measurement of a balanced load, the readings of two wattmeters are 5920 W and 2610 W. Find total three-phase power and power factor of load.

4

8. Write short notes on any *two* of the following : 10×2

(i) Linear variable differential transducer (LVDT)

(ii) Spectrum analyzer

(iii) RF signal generator

(iv) Distortion meters.

Group C

9. Choose the *correct* answer for the following : 1×20

(i) Mobility in a semiconductor

(a) decreases as the temperature increases

(b) increases as the temperature decreases

(c) has no effect on conductivity

(d) has no effect on resistivity.

(ii) In a *p - n* junction diode, with the increase of reverse bias, the reverse saturation current

(a) increases

(b) decreases

(c) remains constant

(d) may increase or decrease.

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(*iii*) For a transistor, common emitter current gain (β) is related with common base current gain (α) as

(*a*) $\beta = \alpha / (1 + \alpha)$

(*b*) $\beta = \alpha / (1 - \alpha)$

(*c*) $\beta = (1 + \alpha) / \alpha$

(*d*) $\beta = (1 - \alpha) / \alpha$.

(*iv*) In saturation region operation of a transistor,

(*a*) both junctions are reverse biased

(*b*) both junctions are forward biased

(*c*) emitter junction is reverse biased while collector junction is forward biased

(*d*) emitter junction is forward biased and collector junction is reverse biased.

(*v*) Reliability of ICs may be increased by

(*a*) reducing the number of interconnections

(*b*) additional testing

(*c*) reducing component size

(*d*) operation at high temperature.

(*vi*) One of the following is *not* the characteristics of a FET :

(*a*) High input impedance

(*b*) Less temperature sensitive

(*c*) High voltage gain

(*d*) Less noisy.

(*vii*) The efficiency of a class A power amplifier is

(*a*) 78·4%

(*b*) 50%

(*c*) 40·6%

(*d*) 25%.

(*viii*) Triac is a

(*a*) 2 terminal bidirectional switch

(*b*) 3 terminal bidirectional switch

(*c*) 2 terminal unilateral switch

(*d*) 3 terminal unilateral switch.

(*ix*) One of the following is *not* the characteristics of an ideal op-amp :

(*a*) common mode rejection ratio is infinite

(*b*) slew rate is infinite

(*xvii*) A DVM has a $4\frac{1}{2}$ digit display. The 1 V range can read up to

(*a*) 9999

(*b*) 9·99

(*c*) 1·9999

(*d*) 0·19999.

(*xviii*) An aquadag is used in a CRO to collect

(*a*) primary electrons

(*b*) secondary emission electrons

(*c*) both primary and secondary emission electrons

(*d*) None of the above.

(*xix*) Pressure gauge is an instrument falling under the following category :

(*a*) recording instruments

(*b*) indicating instruments

(*c*) controlling instruments

(*d*) integrating instruments.

(*xx*) The instrument used for a.c. measurement only is

(*a*) permanent magnet type

(*b*) hot wire type

(*c*) electrostatic type

(*d*) induction type.

S`08 :4AN : AN 208 (1408)   (10)   AG—2,000

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A**,
ANY TWO *from* **Group B** *and* ALL *from* **Group C**.

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be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answer may
result in loss of marks.*

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proper justification.*

Figures on the right-hand side margin indicate full marks .

Group A

1. (a) Make a comparative study amongst the following related to a semiconductor : 3 x 4

   (i) Intrinsic and extrinsic semiconductors.

   (ii) Degenerate and non-degenerate semiconductors.

   (iii) Drift and diffusion current.

   (iv) Donor and acceptor impurities.

(b) A specimen of silicon has square cross-section of 2×2 cm^2 and length of 2 cm. The current is due to electrons whose mobility is 1300 cm^2/V – S. An applied d. c. voltage of 1 V across the bar produces a current of 8 mA in it. Calculate (i) concentration of free electron, and (ii) drift velocity.   8

2. (a) Draw the circuit of a bridge-type rectifier and explain its operation. Also, calculate the ripple factor of a full-wave rectifier.   6 + 4

(b) Draw the structure of a triac and its V-I characteristics and explain its operation. Also, mention some of its applications.   4 + 4 + 2

3. (a) A transistor is operating in CE mode as shown in Fig. 1. Calculate V_{CE}, if $\beta = 125$ assuming $V_{BE} = 0.6$ V.   6
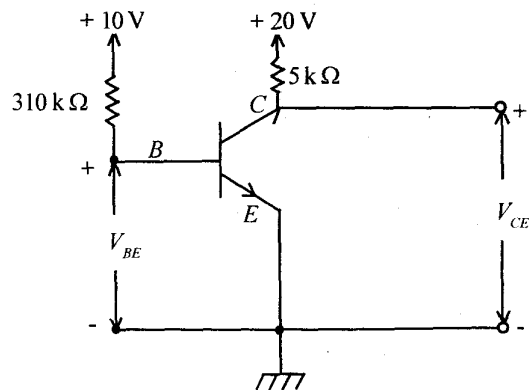

Fig. 1

(b) Draw the h-parameter equivalent circuit of a transistor operating in CB mode. Write down the two corresponding hybrid equations. Also, write the limitations of h-parameter operation of a transistor.   2 + 2 + 2

(c) Explain, with a neat schematic, the operation of an n-channel JFET. Draw its V-I characteristics. Make a comparative study between a JFET and a MOSFET.   4 + 1 + 3

4. (a) What is 'regenerative feedback'? Write the conditions for oscillation of an oscillator circuit.   2 + 2

(b) Design a circuit using op-amp that can make an average of three voltages 10 V, 20 V and 30 V.   4

(c) With a neat schematic, explain the operation of a 'successive approximation register' type analog to digital converter circuit using op-amp. Mention its advantages and disadvantages with respect to other methods of A/D converters.   10 + 2

Group B

5. (a) Explain how the phase and frequency of a signal can measure by Lissajous technique using a single trace CRO.   8

(b) With a neat schematic, explain the operation of a Q-meter.   6

(c) Mention the advantages of digital instruments over its analog counterpart. How many types of digital displays are there?   2 + 4

6. (*a*) Define the terms 'current sensitivity', 'voltage sensitivity' and 'megohm sensitivity' of a galvanometer. 3×3

(*b*) Explain, with a neat circuit, the operation of a shunt type ohmmeter. Mention some of its typical applications. $4 + 2$

(*c*) The law of deflection of a moving iron ammeter is given by $I = 4\theta^n$ ampere, where θ is the deflection (in radian) and n, a constant. The self-inductance, when the meter current is zero, is 10 mH. The spring constant is 0.16 N - m/rad. Determine an expression for self-inductance of the meter as a function of θ and n.   5

7. (*a*) Write the characteristics of a transducer. Explain the operation of a capacitive pressure transducer. $3 + 5$

(*b*) With a neat schematic, explain how the level of water in a tank of a multistoried building can measure without moving at the roof top.   8

(*c*) Name one inductive transducer and explain its operation.   4

8. Write short notes on any *two* of the following: 10×2

(*i*) Digital data acquisition system

(*ii*) Integrating meters

(*iii*) Distortion meter

(*iv*) RF signal generator.

Group C

9. Choose the *correct* answer for the following: 1×20

(*i*) To a metal, having conductivity α, an electric field E is applied. The total energy W dissipated/m³ is given by

(*a*) $W = (1/2)\,\alpha E^2$

(*b*) $W = \alpha E^2$

(*c*) $W = \alpha E$

(*d*) $W = \alpha^2 E$.

(*ii*) Donor impurity atoms in a semiconductor result in new

(*a*) wide energy band

(*b*) narrow energy band

(*c*) discrete energy level

(*d*) None of the above.

(*iii*) When a free electron is recaptured by a hole, the process is called

(*a*) diffusion

(*b*) recombination

(*c*) drift

(*d*) thermal equilibrium.

(*iv*) In a junction diode, the transition capacitance (C_T)
is proportional to

(*a*) W

(*b*) W^2

(*c*) $1/W$

(*d*) $1/W^2$.

where W is the width of the depletion layer.

(*v*) One advantage of MOSFET structure in IC
technology is

(*a*) lower resistance

(*b*) higher component density and lower cost

(*c*) loss capacitance

(*d*) faster switching.

(*vi*) A PNPN device having no gate is called

(*a*) UJT

(*b*) Triac

(*c*) Schottky diode

(*d*) SCR.

(*vii*) *n*-channel FETs are superior to *p*-channel FETs
because

(*a*) they have higher input impedance

(*b*) mobility of charge carrier electron in *n*-channel
FET is greater than mobility of charge carrier
hole in *p*-channel FET

(*c*) they have a lower switching time

(*d*) they have a lower pinch-off voltage.

(*viii*) The non-inverting mode feedback gain of an
op-amp is

(*a*) $1 + (R_F/R_1)$

(*b*) $1 + (R_1/R_F)$

(*c*) $-(R_F/R_1)$

(*d*) $-(R_1/R_F)$.

(*ix*) The efficiency of a full-wave rectifier is

(*a*) 81.2%

(*b*) 40.6%

(*c*) 100%

(*d*) 90% .

(*x*) Darlington circuit is obtained by connecting in
cascade

(*a*) two emitter followers

(*b*) two CB stages

(*c*) two CE stages

(*d*) CE stage followed by CB stage.

xi) Reproducibility measurement of an instrument gives an indication of

(*a*) resolution

(*b*) precision

(*c*) reliability

(*d*) accuracy.

xii) LVDT is an instrument used to measure

(*a*) pressure

(*b*) displacement

(*c*) temperature

(*d*) velocity.

xiii) Strain gauge is used to

(*a*) convert sound energy into electrical energy

(*b*) sense temperature

(*c*) convert electrical current into a mechanical displacement

(*d*) convert mechanical displacement into a change in resistance.

[*xiv*) The principle of operation of wattmeter depends upon

(*a*) magnetic effect

(*b*) electrodynamic effect

(*c*) electromagnetic effect

(*d*) electrostatic effect

(*xv*) If the current sensitivity of a galvanometer is increased, the voltage sensitivity

(*a*) decreases

(*b*) also increases

(*c*) may increase or decrease

(*d*) remains unaltered.

(*xvi*) Which of the following quantity cannot be measured on a ballistic galvanometer ?

(*a*) Charge

(*b*) Current

(*c*) Capacitance

(*d*) Inductance.

(*xvii*) The most efficient form of damping in an instrument is

(*a*) eddy current

(*b*) fluid friction

(*c*) air friction

(*d*) None of the above.

(*xviii*) The deflection system in a CRT is

  (*a*) magnetostatic

  (*b*) electrostatic

  (*c*) both electrostatic and magnetostatic

  (*d*) may be any one of (*a*) or (*b*) .

(*xix*) The function of a shunt in an ammeter is to

  (*a*) increase current in the coil

  (*b*) decrease voltage drop

  (*c*) by pass current

  (*d*) increase the meter's resistance.

(*xx*) The phenomenon creeping occurs in

  (*a*) ammeters

  (*b*) voltmeters

  (*c*) wattmeters

  (*d*) energy meters.

S'09 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A**,
ANY TWO *from* **Group B** *and* ALL *from* **Group C**.

*All parts of a question (a, b, etc.) should
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Group A

1. (a) How can an intrinsic semiconductor be extrinsic?
       Make a comparative study between a p-type and
       n-type of extrinsic semiconductor.   2 + 3

   (b) Make a comparative study between an avalanche p-n
       junction diode and a Zener diode.   5

   (c) Draw the circuit of a full-wave rectifier and explain
       its operation. Also, find out the efficiency of a full
       wave rectifier.   6 + 4

(Turn Over)

2. (a) An $n-p-n$ transistor is used in CE configuration and has the collector to base bias method of biasing. Given $\beta = 99$, $V_{BE} = 0.7\,V$, $V_{CC} = 12\,V$, $R_L = 2\,k\Omega$, and $R_B = 100\,k\Omega$. Find the Q-point analytically and the stability factors S, S' and S''.   10

(b) Draw the h-parameter equivalent circuit of a transistor at CE mode. Also, write down the limitations of h-parameter analysis of a transistor.   5

(c) State the important features of the CB, CE and CC modes of operation of a transistor.   5

3. (a) With a neat circuit, explain the operation of a two stage R-C coupled amplifier. Draw its gain frequency response and explain why gain falls at low and high frequency region of operation.   6 + 2 + 4

(b) With a neat schematic, explain the operation of a p-channel MOSFET and also make a comparison between a MOSFET and a JFET.   5 + 3

4. (a) Mention the effects of feedback in amplifier circuit. Also, explain why positive feedback is essential for the operation of an oscillator circuit.   4 + 2

(b) How can an op-amp be used to add four voltages of 5 V, 10 V, 15 V and 20 V?   4

(c) With a neat schematic, explain the operation of a 'dual slope type' A/D converter.   10

Group B

5. (a) Explain the principle of operation of any *one* type of moving iron instrument, showing how it is suitable for use on d.c. and a.c. systems.   10

(b) Explain, with a neat schematic, how the power of a three-phase system can measure by using two watt-meters. In a two-wattmeter measuring system, wattmeter W reads the power 2875 W and wattmeter 2 reads the power 3925 W. What is the total power of three-phase system and also find out the power factor.   6 + 4

6. (a) What is a transducer? How an active transducer differs from a passive transducer? Also, write down the characteristic of a transducer.   2 + 3 + 3

(b) What is a strain gauge and write down some of its applications? Prove that, for a strain gauge, the 'gauge factor (K)' relates with the Poisson's ratio (μ) as $K = 1 + 2\mu$.   2 + 2 + 8

7. (a) Draw a block diagram showing the principal parts of a cathode ray oscilloscope arrangement. What is the purpose of synchronization in a CRO? Also, mention the role of delay line in a CRO.   6 + 2 + 2

(b) Write down the differences between a peak, an rms and an average reading type voltmeter.   4

(c) With a neat circuit, explain the operation of a 'Q-meter'.   6

8. Write short notes on any *two* of the following :   10 x 2

(*i*) Data acquisition system

(*ii*) Spectrum analyzer

(*iii*) RF signal generators

(*iv*) Digital display devices.

Group C

9. Choose the *correct* answer for the following :   1 x 20

(*i*) An intrinsic semiconductor at absolute zero temperature

(*a*) has a few holes and a few electrons

(*b*) has a large number of holes

(*c*) behaves like a metallic conductor.

(*d*) behaves like an insulator.

(*ii*) The rate at which the diffusion occurs

(*a*) depends on the concentration gradient only

(*b*) depends on the mobility only

(*c*) depends on the concentration gradient and the mobility

(*d*) is always the same.

(*iii*) The band gap energy for silicon is

(*a*) 0·7 eV

(*b*) 1·1 eV

(*c*) 0·3 eV

(*d*) 0·1 eV.

(*iv*) For a transistor, β is related to α as

(*a*) $\beta = \alpha/(1+\alpha)$

(*b*) $\beta = \alpha/(1-\alpha)$

(*c*) $\beta = (1+\alpha)/\alpha$

(*d*) $\beta = (1-\alpha)/\alpha$.

(*v*) Ripple factor of a full wave rectifier is

(*a*) 1·21

(*b*) 0·406

(*c*) 0·48

(*d*) 0·816.

(*vi*) One of the following is not the characteristics of an ideal op–amp :

(*a*) Infinite voltage gain

(*b*) Infinite slew rate

(*c*) Infinite offset voltage

(*d*) Infinite input resistance.

(*vii*) When a free electron is recaptured by a hole, the process is called

(*a*) diffusion

(*b*) recombination

(c) drift

(d) thermal equilibrium.

(viii) The main drawback of a JFET is its relatively

(a) higher input impedance

(b) lower output impedance

(c) lower gain

(d) higher noise.

(ix) Holding current in PNPN diode is the

(a) maximum operating current

(b) normal operating current

(c) current corresponding to break over voltage

(d) minimum current to keep device 'ON'.

(x) A unijunction transistor

(a) is a two terminal device

(b) has only one junction

(c) is made from germanium

(d) is a unipolar device.

(xi) Knudsen gauge is for measuring

(a) high pressure

(b) low pressure

(c) medium pressure

(d) None of the above.

(xii) A LVDT is used for measuring

(a) temperature only

(b) pressure only

(c) displacement

(d) flow only.

(xiii) Which one of the following is not true ? A load cell

(a) does not use aluminium

(b) uses four strain gauges

(c) is used to measure load

(d) cannot measure varying parameters.

(xiv) Moving coil instruments have

(a) uniform scale

(b) non-uniform scale

(c) non-linear scale

(d) None of the above.

(xv) A CRO uses

(a) electromagnetic focussing

(b) electrostatic focussing

(c) both electrostatic and magnetostatic focussing

(d) no focussing techniques.

(xvi) Piezoelectric transducer can be used to measure

(a) static changes only

(b) dynamic changes only

(c) both static and dynamic changes

(d) None of the above.

(*xvii*) The dynamic characteristics of capacitive transducers are similar to those of

(*a*) low-pass filter

(*b*) high-pass filter

(*c*) notch filter

(*d*) band stop filter.

(*xviii*) Primary sensing element, which does not convert velocity to pressure, is

(*a*) venturi tube

(*b*) orifice plate

(*c*) pitot tube

(*d*) vanes.

(*xix*) The device used for measurement of temperatures exceeding 1500°C is

(*a*) radiation pyrometer

(*b*) RTD

(*c*) thermocouple

(*d*) thermopile.

(*xx*) Which one of the following is used to measure the leakage resistance of a capacitor?

(*a*) Megger

(*b*) Schering bridge

(*c*) Potentiometer

(*d*) Loss of change method.

W'09 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

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proper justification.*

Figures on the right-hand side margin indicate full marks .

Group A

1. (*a*) What is the important difference between the characteristics of a simple switch and those of an ideal diode ?   8

    (*b*) Define the following :   2 x 3

    (*i*) Intrinsic semiconductor

    (*ii*) Extrinsic semiconductor

    (*iii*) Mobility of hole.

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(c) Distinguish between the half-wave rectifier and full-wave rectifier.   6

2. (a) List the features of CB, CE and CC modes of operation of a transistor.   12

   (b) Draw the h-parameter equivalent circuit of a transistor in CB mode. Also, write the limitations of h-parameter analysis of a transistor.   8

3. Draw a two transistor amplifier circuit with a feedback. Explain the operation of the circuit with and without feedback.   20

4. (a) Discuss the operation of the class-B amplifier. Drive an expression for output (AC) power and efficiency. 10

   (b) What are different types of feedback connections? List the advantages using feedback in the circuits.   5

   (c) Draw the circuit diagram of cascade amplifier using transistors.   5

Group B

5. Explain, with a neat sketch, the operation of moving coil galvanometer (PMMC)? Also, explain its dynamic behaviour. Derive the expression for torque and deflection.   8 + 6 + 6

6. (a) What is a transfer instrument? Why is an electrodynamometer a transfer instrument?   8

   (b) What is meant by a waveform error? Which are the a.c. meters most likely to be affected by this form of error?   8

(c) What are the advantages of a thermocouple for measurement of temperature?   4

7. (a) Explain the concept of Q-meter with a neat sketch. 10

   (b) Show and explain a scheme of displacement measurement using variable resistor. Express its input-output relationship. What is the output loading effect?   4 + 4 + 2

8. (a) What are the differences between a photo-emissive, a photo-conductive and a photo-voltaic cell? Name one application of each cell.   15

   (b) What are the problems associated with the measurement of pulsed signals?   5

Group C

9. Choose the correct answer for the following :   1 x 20

   (i) In a forward biased photodiode, with increase in incident light intensity, the diode current

      (a) increases
      (b) remains constant
      (c) decreases
      (d) voltage drop across diode increases.

   (ii) Under high electric fields in a semiconductor, with increasing electric field, the

      (a) mobility of charge carriers decreases
      (b) mobility of charge carriers increases
      (c) velocity of charge carriers increases
      (d) None of the above.

(*iii*) *n*-type silicon is obtained by doping silicon with

(*a*) germanium
(*b*) aluminium
(*c*) boron
(*d*) phosphorus.

(*iv*) A unijunction transistor

(*a*) is a two terminal device
(*b*) has only one junction
(*c*) is made from germanium
(*d*) is a unipolar device.

(*v*) One of the following is not the characteristics of an ideal op-amp :

(*a*) infinite voltage gain
(*b*) infinite slew rate
(*c*) infinite offset voltage
(*d*) infinite input resistance.

(*vi*) The gain of a transistor amplifier falls at high frequencies due to the

(*a*) internal capacitances of the device
(*b*) coupling capacitor at the input
(*c*) skin effect
(*d*) input impedance.

(*vii*) The action of a JFET in its equivalent circuit can be represented as a

(*a*) current controlled current source
(*b*) current controlled voltage source
(*c*) voltage controlled voltage source
(*d*) voltage controlled current source.

(*viii*) The bandwidth of an RF tuned amplifier is dependent on

(*a*) Q-factor of the tuned output
(*b*) Q-factor of the tuned input
(*c*) Quiscent operating point
(*d*) None of the above.

(*ix*) With feedback, which one of the following gets reduces ?

(*a*) System gain
(*b*) System stability
(*c*) Q-factor
(*d*) None of the above.

(*x*) In a full-wave rectifier, the transformer is

(*a*) not essential
(*b*) may be used
(*c*) essential
(*d*) None of the above.

(*xi*) The input resistance of a cathode ray oscilloscope is of the order of

(*a*) tens of ohms
(*b*) mega ohm
(*c*) kilo ohms
(*d*) fraction of an ohm.

(*xii*) Uncertainty distribution is used for analysis of

(*a*) multisample data
(*b*) single sample data
(*c*) both single and multi sample data
(*d*) None of the above.

(*xiii*) A set of readings has a wide range and therefore it has

(*a*) low precision

(*b*) high precision

(*c*) low accuracy

(*d*) high accuracy.

(*xiv*) In liquid level systems, the units of capacitance of a tank are

(*a*) Ms

(*b*) Qs

(*c*) 1/Ms

(*d*) 1/Qs .

(*xv*) A quantity, whose magnitude has a definite repeating time cycle, is called a

(*a*) transient

(*b*) steady state periodic

(*c*) steady state aperiodic

(*d*) transient state periodic.

(*xvi*) In force-current analogy, stiffness constant k is analogous to

(*a*) inductance

(*b*) reciprocal of inductance

(*c*) capacitance

(*d*) reciprocal of capacitance .

(*xvii*) Permanent magnets used in instruments are hard core materials because

(*a*) they have broad hysteresis loop

(*b*) their energy density is high

(*c*) they have a high $(BH)_{max}$ product

(*d*) All of the above.

(*xviii*) A Meggar is used for measurement of

(*a*) low valued resistances

(*b*) medium valued resistances

(*c*) high valued resistances, particularly insulation resistance

(*d*) All of the above.

(*xix*) Horizontally mounted moving iron instruments use

(*a*) eddy current damping

(*b*) electromagnetic damping

(*c*) fluid friction damping

(*d*) air friction damping.

(*xx*) Which one of these has the highest accuracy in the prescribed limit of frequency range ?

(*a*) PMMC

(*b*) Moving coil

(*c*) Electrodynamometer

(*d*) Rectifier.

S'10 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A** ,
ANY TWO *from* **Group B** *and* ALL *from* **Group C**.

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks .

Group A

1. (a) With the help of energy band diagram, explain the
       differences between a conductor, insulator and a
       semiconductor.   6

   (b) Make a comparison between the avalanche
       breakdown and zener breakdown principles.   6

   (c) Define the following terms :   2 + 2
       (i) 'cut-in voltage' of a *p-n* junction diode
       (ii) 'knee voltage' of a *p-n* junction diode.

   (d) Make a comparative study between different types
       of rectifier circuits.   4

2. (a) A n-p-n transistor is used as CE amplifier and has the collector–to–base bias arrangement. Given $\beta = 99$, $V_{BE} = 0.7\,V$, $V_{cc} = 12\,V$, $R_L = 2\,k\Omega$ and $R_B = 100\,k\Omega$. Find the Q-point for the transistor and three stability factors S, S', and S''.   8

(b) Draw the h-parameter-equivalent circuit of a transistor for common emitter configuration. Write the limitations of h-parameter analysis of a transistor.   8

(c) Explain how a transistor can work as an amplifier?   4

3. (a) Draw the structure of n-channel JFET and explain its operation. Draw its V-I characteristics curve.
$$2 + 4 + 2$$

(b) Make a comparison between field effect transistor (FET) and bipolar junction transistor (BJT).   6

(c) What is feedback to an amplifier and how feedback network can be classified? Mention the effect of negative feedback in amplifier.   3 + 3

4. (a) Draw the equivalent circuit of an op-amp and write the characteristics of an ideal op-amp.   3 + 3

(b) With a neat circuit, explain how an op-amp can be used to add three voltages of 10 V, 20 V and 30 V.   6

(c) Explain the operation of a 'weighted resistor-type digital-to-analog converter circuit. Mention its drawback.   7 + 1

Group B

5. (a) Draw the functional block diagram of a single trace CRO and explain the function of each block.   10

(b) How phase and frequency of any unknown waveform can measure by Lissajous technique?   8

(c) Whether current can be measured by using a CRO? If yes, then how?   2

6. (a) What is the transducer? How a transducer differs from a sensor? How can a transducer be classified? Write some important characteristics of a transducer.   1 + 2 + 3 + 4

(b) What is strain gauge? Define the term gauge factor (k) of a strain gauge. Prove that for a resistive–bonded strain gauge, the gauge factor is $k = 1 + 2\mu$, where μ is the Poisson's ratio.   1 + 1 + 8

7. (a) With a neat circuit, explain the operation of a Q-meter.   6

(b) Write the differences between peak, average and rms reading-type voltmeters.   4

(c) How a moving coil type of meter differs from a moving iron-type meter?   4

(d) Explain, with a neat circuit, the operation of a dynamometer-type instrument.   6

8. Write short notes on any *two* of the following: 10 + 10

(i) Data aquisition system

(ii) Digital voltmeter

(iii) RF signal generator

(iv) Spectrum analyzer.

Group C

9. Choose the *correct* answer for the following :   2 × 10

(*i*) Intrinsic concentration of charge carriers in a semiconductor varies as

(*a*) T

(*b*) T^2

(*c*) T^3

(*d*) $1/T^2$.

where T is the temperature in deg k.

(*ii*) The forward and reverse resistance of an ideal diode are

(*a*) $R_f = 10\,\Omega$; $R_r = 20\,M\Omega$

(*b*) $R_f = 0\,\Omega$; $R_r = \infty\,\Omega$

(*c*) $R_f = \infty\,\Omega$; $R_r = 0\,\Omega$

(*d*) $R_f = 20\,M\Omega$; $R_r = 10\,\Omega$.

(*iii*) Which one of the following is not the characteristic of an ideal op-amp ?

(*a*) Infinite voltage gain

(*b*) Zero offset resistance

(*c*) Zero input and infinite output resistance

(*d*) Infinite bandwidth.

(*iv*) For a transistor, two current gains, α and β, are related as

(*a*) β = α/(1 + α)

(*b*) β = α/(1 - α)

(*c*) β = (1 + α)/α

(*d*) β = (1 - α)/α.

(*v*) A semiconductor photodiode uses the

(*a*) photoconductive effect

(*b*) photoemissive effect

(*c*) photovoltaic effect

(*d*) None of the above.

(*vi*) A measure of the reproducibility of measurement is known as

(*a*) resolution

(*b*) fidelity

(*c*) precision

(*d*) accuracy.

(*vii*) Moving coil instrument can be used to measure

(*a*) high frequency a.c.

(*b*) low frequency a.c.

(*c*) both d.c. and a.c.

(*d*) only d.c.

(*viii*) LVDT

(*a*) converts linear motion into electrical signal

(*b*) translates electrical signal into linear motion

(*c*) helps measuring temperature

(*d*) can be used to sense angular displacement.

(*ix*) Megger is an instrument for

(*a*) measuring current

(*b*) measuring voltage

(*c*) measuring power

(*d*) testing insulation.

(*x*) The essential requirement of a measuring instrument is that

(*a*) its resistance should be low

(*b*) its introduction into the circuit under measurement does not alter the circuit conditions and the power consumed by it for its operation is small

(*c*) its resistance should be infinite

(*d*) it is always connected in series in the circuit.

W'10 : 4AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,**
ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Draw the simple circuit of one half wave rectifier using diode. With half wave rectifier, using sinusoidal input having diode of forward resistance r and load resistance R_L, find the expressions for (i) average value of current, (ii) rms value of current, (iii) rectifier efficiency, and (iv) ripple factor.   8

    (b) Draw the simple circuit for one full wave rectifier using two diodes. For full wave rectifier, find the above four expressions.   6

    (c) Find and compare the values of maximum efficiency and ripple factor for half wave and full wave rectifiers mentioned above.   6

(a) With an appropriate circuit diagram for CE mode operation, explain fixed bias and emitter bias of transistor. With a suitable circuit parameters, find the expressions for stability of collector current with respect to I_{co} (reverse saturation current), V_{BE} (base-emitter voltage), and beta. **10**

(b) Explain the concept of mobility and conductivity of a semiconductor material in an electric field. Derive an expression for its current density. Modify the expression considering diffusion current. **5**

(c) Why is Zener diode used in a circuit? Explain why a series resistance is used with a Zener from an unregulated supply to have a fixed reference voltage. Mention the procedure for appropriate choice of the value of series resistance with the Zener diode. **5**

3. (a) For FET small signal model, establish the relation of amplification factor with transconductance and drain resistance. **7**

(b) Define pinch off voltage in FET. Establish a relation of the pinch off voltage with gate voltage, channel width, and width of the depletion region at certain distance. **6**

(c) Describe enhancement and depletion modes of MOSFET. Explain their drain current characteristics. **7**

4. (a) For one operational amplifier, explain the following: (i) Output offset voltage, (ii) CMRR, and (iii) Slew rate. **3 × 2**

(b) Explain how (i) integrator, and (ii) differentiator using operational amplifier, can be realized. **3 + 3**

(c) For operational amplifier used in inverting mode and non-inverting mode with external input and feedback resistances of values 1 Kohm and 2 Kohm, respectively, find the value of the output voltage with input as + 2 V. **8**

Group B

5. (a) Explain the operation of rectifier-type meter for measurement of current and voltage. **4**

(b) Explain, with a diagram, the operation of electro-dynamometer-type wattmeter for measurement of single-phase power. **6**

(c) In a circuit, two resistances of 100 Kohm and 50 Kohm are connected in series with 150 V d.c. source. To measure voltage across 50 Kohm resistance, two voltmeters are available: Voltmeter I with sensitivity 1000 ohm/V and voltmeter II with sensitivity 20,000 ohm/V. Both the meters are used on their 50 V range. Calculate the (i) reading of each meter, and (ii) error in each reading expressed as percentage of the true value. **5 + 5**

6. (a) With a block diagram, describe fundamental suppression distortion analyser. **5**

(b) With a block diagram, explain the operation of spectrum analyser. **5**

(c) Describe, with principle, the operation of successive approximation-type DVM. **10**

7. (a) Describe, with a block diagram, the principle of operation of frequency synthesized signal generator. 7

    (b) Describe the principle of operation of (i) turbine flow meter, and (ii) electromagnetic flow meter. 4 + 4

    (c) Describe LVDT and its use for measurement of differential pressure. 5

8. Write short notes on *any two* of the following : 10 + 10

    (a) Digital display device

    (b) Electronic voltmeters

    (c) Sensor and signal conditioning

    (d) Applications and use of CRO.

Group C

9. Answer the following in brief : 10 × 2

    (i) What is the ideal value of the output offset voltage of an op amp ?

    (ii) What are the ideal values of input impedance and output impedance of an op amp ?

    (iii) What is the maximum voltage gain of an emitter follower ?

    (iv) What are the main advantages and disadvantages of FET over BJT ?

    (v) What is the type of ADC used for accurate value and what type for fast response ?

    (vi) What is the type of feedback (+ve or –ve) applied for amplifier and oscillator ?

    (vii) What are the domains of operation of CRO and spectrum analyser ?

    (viii) What is the rms value of voltage of a sine wave with peak value V_m ?

    (ix) What is the principle of strain gauge ?

    (x) What is the torque developed in a coil with N number of turns having effective area A carrying current I placed in a magnetic field of flux density B.

S'11 : 4 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A**,
ANY TWO *from* **Group B** *and* ALL *from* **Group C**.

All parts of a question (a, b, etc.) should
be answered at one place.

Answer should be brief and to-the-point and be supplemented
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result in loss of marks.

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proper justification.

Figures on the right-hand side margin indicate full marks .

Group A

1. (a) Distinguish between majority and minority carriers in a semiconductor. Also, define and explain mobility of charge carriers.   8

(b) The intrinsic resistivity at 27°C is $2 \cdot 8 \times 10^3 \, \Omega - m$. The electron and hole mobilities are $0 \cdot 38 \, m^2/V-s$ and $0 \cdot 18 \, m^2/V-s$, respectively. Obtain intrinsic carrier density at the given temperature.   6

(c) What is Zener breakdown ? How is it different for Avalanche breakdown ? Explain.   6

(Turn Over)

2. (a) Explain thermal runaway of BJT.   6

   (b) Distinguish between a.c. and d.c load lines. Obtain
       the load line equation of BJT in CE configuration.   8

   (c) Explain the emitter follower with a suitable circuit
       diagram.   6

3. (a) Define h-parameters. What are advantages of
       adopting h-parameters in design of amplifier
       — elaborate. Derive expression for (i) voltage gain,
       (ii) current gain, (iii) input resistance, and
       (iv) output resistance of common emitter amplifiers
       using h-parameters.   4 x 3

   (b) What is meant by depletion region in JFET ? Explain,
       with a suitable diagram, the basic difference between
       BJT and JFET.   8

4. (a) What are the requirements of an ideal operational
       amplifier ? Explain the terms : CMRR, slew rate,
       input off set and output offset voltage in an operational
       amplifier.   8

   (b) A differential amplifier has inputs $V_{s1} = 10\,mV$ and
       $V_{s2} = 9\,mV$. It has a differential mode gain of 60 db
       and CMRR of 80 db. Obtain the percentage error in
       output voltage and the error voltage.   6

   (c) What are the differences between a transistor and
       a thyristor ? Discuss operation of a thyristor with help
       of its characteristics. Also, mention at least *three*
       applications of thyristors.   6

Group B

5. (a) What are essential requirements in an indicating
       instruments ? Why are controlling and damping
       essential ? Also, discuss methods used for producing
       controlling torque and damping torque in above
       instruments.   8

   (b) Describe the construction and working of an
       attractive-type moving iron instrument.   6

   (c) A moving iron voltmeter has resistance of 1000 ohms
       and inductance of 0·10 Henry between its terminals.
       The meter indicates correct voltage at
       50 Hz-frequency. If it is used at 100 Hz, obtain the
       percentage correction required to be applied to get
       correct voltages.   6

6. (a) Give a block diagram representation of CRO and
       describe functioning of its major blocks.   8

   (b) Calculate for the velocity of electrons that have been
       accelerated through a potential of 2500 V. Derive the
       relation used.   6

   (c) How are the following measured using a CRO ?
       (i) Frequency of a waveform (ii) Phase angle of the
       waveform, and (iii) Delay measurement.   3 x 2

7. (a) Give technical specifications of a digital voltmeter
       including all essential and optional features. Also,
       suggest classification of these meters.   8

   (b) Discuss functioning of any type of digital voltmeter
       with the help of a block diagram.   6

(c) Why are digital display devices used in an instrumentation system ? Discuss the basic system of a digital display device.   6

8. Write technical notes on the following :   8 + 6 + 6

(i) Analog and digital data acquisition system

(ii) Q- meter and its applications

(iii) LVDT transducer for displacement measurement.

Group C

9. Answer the following in brief :   10 x 2

(i)   Give three applications of A/D converters.

(ii) Differentiate between 'resolution' and 'accuracy' with reference to an A/D converter.

(iii) Name types of MOSFETs in which they are available. Show characteristics of enhancement-type MOSFET.

(iv) Briefly describe accuracy and conversion type of a D/A converter.

(v)   Define slew rate (SR) of an op-amp. Obtain maximum closed loop voltage gain that can be used when the input signal varies by 0.5 V in $10\,\mu s$. Assume SR of op-amp as $2\,V/\mu s$.

(vi) Show a functional block diagram of a CRO.

(vii) Define a transducer and distinguish between a sensor and a transducer.

(viii) Give diagrams showing basic construction and characteristics of the TRIAC.

(ix) Enumerate *three* applications/areas of data acquisition system (DAS).

(x)   List important elements of a digital data acquisition system.

W'11:4AN:AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,**
ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Draw and explain the circuit of a bridge rectifier. Derive expressions for average and rms output currents for a 10 ohm load.   10

    (b) Differentiate between intrinsic and extrinsic semiconductors and find relation between dopants concentrations.   4

    (c) Draw and explain v-i characteristics of Zener diode.   6

2. (a) Draw the circuit of a CE amplifier. Also, draw its small signal equivalent circuit. Derive expressions for input impedance, output impedance, voltage gain, and current gain.   14

    (b) What is meant by self-bias CE circuit of BJT transistor ? How does it differ from negative feedback ?   3

(c) What are the advantages of FET over BJT ? Give reasons in support of your answer.   3

3. (a) Draw and explain operating point and characteristics of *n-p-n* transistor.   10

(b) An *n*-channel JFET has $V_{GS} = -4\,V$, $I_{DS} = 0.45$ mA. If V_{GS} is changed to $-3\,V$, I_{DS} becomes 1.8 mA. Find I_{DSS} and pinch-off voltage.   6

(c) Explain the term 'negative feedback' and state its advantages.   4

4. (a) Draw and explain two transistor model of thyristor. How do the parameters of two transistors jointly affect the performance.   8

(b) Draw an op-amp circuit to obtain

$$v_0 = 3v_1 - 4v_2$$

where v_1 and v_2 are the input voltages and v_0, the output voltage. Give typical values of resistance used in the circuit.   8

(c) What is the necessity of analog-to-digital conversion ? Describe its function with the help of a diagram.   4

Group B

5. (a) Draw a neat diagram of a permanent magnet moving coil instrument and explain its working.   10

(b) Write the advantages and disadvantages of moving iron instruments.   5

(c) Compare induction and dynamometer-type wattmeters.   5

6. (a) Explain the working of peak reading electronic voltmeter.   6

(b) How can a signal be displayed on the CRO screen ?   6

(c) What are the different settings of a time base of cathode ray tube ? Explain their working.   8

7. (a) Explain the principle of resistance thermometer.   6

(b) Draw a simple diagram of potentiometric position transducer and explain its working.   8

(c) Explain the working of phase shift oscillator.   6

8. Write short notes on the following :   7 + 6 + 7

(a) Spectrum analyser

(b) Q-meter

(c) Measurement of energy.

Group C

9. Give reasons for the following in brief :   10 × 2

(i) *p-n-p* and *n-p-n* transistors are known as bipolar junction transistors.

(ii) In a transistor, the collector and emitter currents are nearly equal where the CE current gain is very high.

(iii) Bridge rectifier is not suitable for low voltage circuits as compared to other full wave rectifier.

(iv) CE amplifier is a commonly used circuit.

(v) Op amp has very high input impedance circuits.

(vi) Wheatstone bridge cannot be used to measure low resistances.

(vii) A moving iron instrument has non-linear scale.

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(*viii*) A true rms voltmeter can be formed by using thermocouples.

(*ix*) Time base generator in a CRO needs five adjustments for stable pattern.

(*x*) Some transducers are classified as active transducers.

S'12:6AN:AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,**
ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Group A

1. (*a*) Describe the operation of successive approximation
    A/D converter.   10

    (*b*) Calculate the conversion time of 8-bit successive
    approximation A/D converter having clock frequency
    640 kHz.   4

    (*c*) Explain the operation of weighted resistance D/A
    converter. Indicate the limitations.   6

2. (*a*) Give the design of one CE mode transistor amplifier
    with a self-bias.   6

    (*b*) A silicon n-p-n transistor is with $V_{cc} = 22.5$ V;
    $R_C = 5.6$ kΩ ; $R_e = 1$ kΩ, $R_2 = 10$ kΩ, $R_1 = 90$ kΩ.

(Turn Over)

$\beta = 55$ (Fig. 1). Find the operating point of the transistor.   6

Fig. 1
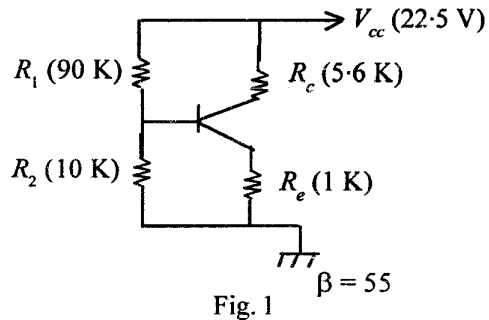
(c) Define bias stabilization factors. How does it depend upon operating point ?   3

(d) Describe full wave rectifiers with capacitive filters. How do you find its ripple factor ?   5

3. (a) Describe static V-I characteristics of a thyristor for different gate currents. Explain reverse blocking and forward blocking conditions in it.   2 + 6

(b) Explain gate triggering of thyristor. Describe R and RC firing methods.   6

(c) Using op-amp, draw and explain operation for (i) differentiator, and (ii) non-inverting integrator.   3 + 3

4. Write short notes on *any two* of the following :   10 + 10

(i) C-MOSFET switch

(ii) Feedback gain of −ve and +ve feedback systems and condition for oscillation

(iii) Fermi levels in intrinsic and extrinsic semiconductors

(iv) Input and output impedances of amplifier.

Group B

5. (a) Describe the working principle of permanent magnet moving coil (PMMC) meter.   5

(b) A PMMC having 100 turns, 20 mm width, 30 mm depth placed in the gap with 0·1 Wb/m^2 flux density carries a current of 10 mA. Calculate the deflecting torque and the deflection of the coil, its spring constant being 2×10^{-6} Nm/degree.   5

(c) Describe electrodynamometer-type voltmeter and ammeter. Mention advantage and disadvantage of this type of meter.   8 + 2

6. (a) Describe rectifier, peak responding and rms-type voltmeter.   12

(b) Describe the principle of Q-meter working by susceptance method.   8

7. (a) Describe swept frequency spectrum analyzer using a block diagram.   6

(b) Describe harmonic distortion analyzer using bridged T network.   4

(c) Describe integrating-type digital voltmeter.   10

8. Write short notes on *any two* of the following :   10 + 10

(a) Wheatstone bridge
(b) Seven segment display
(c) RC phase shift oscillators
(d) Bellow and Bourdon-type pressure gauges.

Group C

9. Answer the following in brief :   10 × 2

(i) What is latching current of thyristor ?

(*ii*)   How can the resolution of A/D converter be increased ?

(*iii*)   What is cut in voltage of semiconductor diode ?

(*iv*)   What is the offset voltage of an op-amp and why does it occur ?

(*v*)   What is the common case of Zener diode, and in what mode of biasing this is used ?

(*vi*)   What is the resolution of a three-and-half digit display DVM ?

(*vii*)   What is the basic functional difference between CRO and spectrum analyser ?

(*viii*)   What are the advantage and disadvantage of thyristor-based temperature sensor ?

(*ix*)   What is the rise time for a rectangular pulse ?

(*x*)   What is CMRR and how does it affect amplifier quality ?

W'12 : 6AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,**
ANY TWO *from* **Group B** *and* ALL *from* **Group C.**

*All parts of a question (a,b,etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Group A

1. (*a*) Give the simple circuit diagram for half wave and full
wave rectifiers using semiconductor diode. Find the
expressions for efficiency of these rectifiers.   4 + 6

   (*b*) What are the values of ripple factors for these recti-
fiers. Comment on the improvement of ripple factor
on the type of rectification. Describe the operation of
capacitive filter in this context on further improvement
of ripple factor.   2 + 2 + 6

2. (*a*) Give two transistor models of thyristor. Mention ways
of increasing anode current for thyristor turn on.
Describe the simple circuit for protection against high
rate of change of current.   2 + 3 + 3

   (*b*) Describe (*i*) phase control thyristor, (*ii*) fast switching
thyristor, and (*iii*) gate turn off (GTO) thyristor.

(Turn Over)

Mention advantages of GTO in low power application. Describe V-I characteristic of thyristor for different gate currents.   2 + 2 + 2 + 2 + 4

3. (*a*) Explain the operations of A/D converter of (*i*) successive approximation-type, and (*ii*) dual slope-type.   6 + 6

   (*b*) Draw and explain basic sample and hold (S/H) circuit. Mention the necessity of S/H circuit and criterion of sampling rate in the context of A/D converter.   4 + 2 + 2

4. Write short notes on *any two* of the following :   10 + 10

   (*i*) Op amp application for (*a*) low pass and high pass filters, adder and subtractor, attenuator.

   (*ii*) Comparative study of BJT, FET and MOSFET.

   (*iii*) Feedback amplifier, regenerative feedback and condition of oscillation.

   (*iv*) Diode breakdown and Zener diode.

Group B

5. (*a*) Draw and explain, with a block diagram, one general purpose cathode ray oscilloscope (CRO). Explain the function of delay line in deflection system.   8 + 2

   (*b*) Explain, with a block diagram, the dual trace arrangement of CRO. Mention the difference between dual trace and dual beam CRO.   4 + 2

   (*c*) Describe the use of CRO for measurement of frequency, period, phase, amplitude of a signal.   4

6. (*a*) Using a circuit diagram, explain the operation of single-phase wattmeter. Describe compensated wattmeter.   8 + 2

(*b*) For a series L-C-R circuit operated by an a.c. source, mention the Q-value. Describe one practical Q-meter circuit.   3 + 7

7. (*a*) Describe measurement of temperature using variation in resistance with positive and negative temperature coefficients. Mention superiority in sensitivity in temperature measurement with concerned type of resistance.   4 + 4 + 2

   (*b*) Explain and describe working of the strain gauge for force measurement. Mention the principle of piezo sensor in this context and compare the measurements in these types.   6 + 2 + 2

8. Write short notes on *any two* of the following :   10 + 10

   (*a*) LVDT and its use for pressure measurement.
   (*b*) Data acquisition system and its application.
   (*c*) Audio and RF signal generators
   (*d*) Distortion meter.

Group C

9. Explain the following in brief :   10 × 2

   (*i*) Using op amp in inverting mode, give the circuit arrangement of one basic low-pass filter. Mention distinctly *i/p*, *o/p*, inverting and non-inverting points in the circuit.

   (*ii*) Using op amp in inverting node, give the circuit arrangement of one basic differentiator. Mention distinctly *i/p*, *o/p*, inverting and non-inverting points in circuit.

   (*iii*) Give, with justification, the efficiency of full wave rectifier for zero forward resistance of diode.

(iv)   State, with justification, the type of d.c. power supply filter— low pass, high pass, band pass, band rejection.

(v)   What is the power supply needed for TTL (digital) IC devices ? Name some such IC devices.

(vi)   What are the advantages and disadvantages of TTL, MOS devices in terms of power handling and noise immunity ?

(vii) What is the type of ADC suitable for higher accuracy ?

(viii) What is the principle of operation of platinum resistance thermometer ?

(ix)   What is the specific advantage of using differential transformer in LVDT ?

(x)   What is the working principle of Q-meter ?

S'13 : 6 AN : AN 208(1408)

ELECTRONICS AND INSTRUMENTATION

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,**
ANY TWO *from* **Group B** and ALL *from* **Group C.**

*All parts of a question (a, b, etc.) should be
answered at one place.*

*Answer should be brief and to-the-point and be supple-
mented with neat sketches. Unnecessary long answer may
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giving proper justification.*

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Group A

1. (a) Explain clearly the differences in the band structure
   of a conductor, an insulator, and a semiconduc-
   tor.   4

   (b) Explain the operation of a bridge rectifier circuit
   with a neat sketch. Calculate its efficiency.   4 + 4

   (c) How Zener breakdown differs from avalanche
   breakdown ? Also, explain, with a circuit, that how
   a Zener diode can work as a reference voltage
   source.   4 + 4

2. (a) An n-p-n transistor is used as a CE amplifier and
   has the collector to base bias arrangement with
   $\beta = 99$, $V_{BE} = 0.7$ V, $V_{CC} = 12$ V, $R_L = 2$ kΩ,
   $R_B = 100$ kΩ. Find the Q-point analytically and the
   stability factors s, s' and s''.

(b) Prove that the efficiency of a 'class A' power amplifier is 25%.   6

(c) Explain the operation of an n-channel enhancement-type MOSFET and make a comparison between a MOSFET and a JFET.   4 + 2

3. (a) A transistor amplifier in CE configuration couples a source of internal resistance $1 \, k\Omega$ to a load of $20 \, k\Omega$. Find the input and output resistances, if h_{ie} = $1 \, k\Omega$, h_{re} = 2.5×10^{-4}, h_{fe} = 150 and $1/h_{oe}$ = 40 $k\Omega$.   6

(b) Explain how a negative feedback to an amplifier increases the stability and input resistance of an amplifier.   3 + 3

(c) With two transistor analogy, explain the operation of an SCR. Also, explain different methods for turn-off an SCR.   4 + 4

4. (a) Draw the equivalent circuit of an op-amp and write the characteristics of an ideal op-amp.   2 + 3

(b) Find an expression for feedback gain of an op-amp when operating in non-inverting mode. How is this concept used to design an adder circuit which can add three voltages 3 V, 5 V and 7 V.   4 + 4

(c) Explain the operation of a weighted resistor-type D/A converter with a neat circuit. Write drawbacks of this circuit.   5 + 2

Group B

5. (a) Draw the block diagram of a general purpose CRO and indicate the basic components. Why is delay line used in the vertical deflection system of a CRO ? Whether current can be measured by using a CRO ? If yes, then how ?   6 + 2 + 2

(b) Explain the operation of a three-phase wattmeter with a neat circuit.   6

(c) What is integrating meter ?   4

6. (a) With a neat circuit, explain the operation of a Q-meter.   6

(b) Draw a.c. voltmeter section of a multimeter and explain its operation. How an analog voltmeter can be converted to a digital voltmeter ?   4 + 4

(c) Write a technical note on different types of digital displays.   6

7. (a) What is a transducer ? How a transducer differs from a sensor ? Also, write the differences between an active and a passive transducer. Write the characteristics of a transducer.   1 + 2 + 2 + 3

(b) Explain, with schematics, how can the level of water in a tank of a multistoried building be measure using an LVDT ?   6

(c) How is platinum resistance thermometer used to measure very high temperature. Mention some of its advantages and disadvantages.   6

8. Write short notes on *any two* of the following :   2 × 10

(a) Spectrum analyzer

(b) Digital data aquisition and transmission system

(c) Strain gauge

(d) Dual shape-type A/D converter.

Group C

9. Choose the *correct* answer for the following :		10 × 2

(*i*) In a p-n junction diode, with the increase of reverse bias, the reverse saturation current

(*a*) increases.

(*b*) decreases.

(*c*) remains constant.

(*d*) may increase or decrease.

(*ii*) Ripple factor of a full wave rectifier is

(*a*) 0.24

(*b*) 0.48

(*c*) 0.96

(*d*) 1.21

(*iii*) For a transistor, β is related to α as

(*a*) $\beta = \alpha/(1+\alpha)$

(*b*) $\beta = \alpha/(1-\alpha)$

(*c*) $\beta = (1+\alpha)/\alpha$

(*d*) $\beta = (1-\alpha)/\alpha$

(*iv*) One of the following is not the characteristic of an ideal op-amp :

(*a*) CMRR is α

(*b*) Slew rate is α.

(*c*) Offset voltage is α.

(*d*) Bandwidth is α.

(*v*) One of the following is not the feature of a FET :

(*a*) Very high input impedance

(*b*) Less temperature-sensitive

(*c*) Low noise

(*d*) Very high gain as an amplifier.

(*vi*) A measure of the reproducibility of measurement is known as

(*a*) resolution.

(*b*) fidelity.

(*c*) precision.

(*d*) accuracy.

(*vii*) Strain gauge is used to

(*a*) convert sound energy into electrical energy.

(*b*) sense temperature.

(*c*) convert electrical current into a mechanical transducer.

(*d*) convert mechanical displacement into a change in resistance.

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(*viii*) Which one of the following methods is used for measurement of high resistances :

(*a*) Loss of charge method

(*b*) Wheatstone bridge

(*c*) Potentiometer method

(*d*) Kelvin bridge method

(*ix*) Megger is an instrument for

(*a*) measuring current.

(*b*) measuring voltage.

(*c*) testing insulation.

(*d*) measuring power.

(*x*) A galvanometer cannot be used for

(*a*) determining the equality of two currents.

(*b*) measuring currents and voltages of small magnitudes.

(*c*) measuring the voltage impulse.

(*d*) measuring the quantity of electricity or current impulse.

W'13 : 6 AN : AN 208 (1408)

ELECTRONICS AND INSTRUMENTATION

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Maximum Marks : 100

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Group A

1. (a) Explain, with a simple circuit diagram and output waveform, the working of one half wave rectifier for one sinusoidal input.   5

   (b) For half wave rectifier, find expression for (i) efficiency, and (ii) ripple factor. Define PIV and state its significance. Mention the value of PIV for half wave rectifier.   5 + 3 + 2

   (c) What is capacitive filter and how does it work ?   2 + 3

2. (a) Explain active region, saturation region and cut-off region of transistor operation.   6

   (b) Find the transistor current for circuit shown in Fig.1 for

transistor with $\beta = 100$, $I_{co} = 20$ nA. Consider the silicon transistor. 7

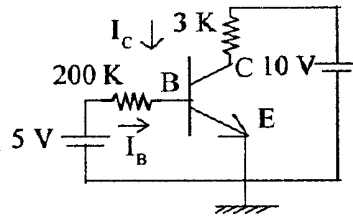Fig. 1

(c) Repeat part b, if a 2 K emitter resistor is added to the circuit of Fig. 1 7

3. (a) Find an expression for the closed loop gain of one regenerative feedback system. Hence, find the condition of oscillation in terms of open loop gain and feedback gain. 5 + 2

(b) With V-I characteristics, describe the operation of thyristor for different gate currents. How can triac be realized using thyristor? 5 + 2

(c) For op amp, define and explain (i) offset voltage, (ii) CMRR, and (iii) slew rate. 3 × 2

4. Write short notes on *any two* of the following : 10 + 10

(i) Use of op amp as (a) phase inverter, (b) attenuator, (c) differentiator, (d) integrator, and (e) adder. All in inverting mode.

(ii) Successive approximation A/D converter

(iii) Enhancement mode *vs.* depletion mode MOSFET.

(iv) Intrinsic and extrinsic semiconductors

Group B

5. (a) Explain the operation of PMMC-type voltmeter. Establish the working formula. A moving coil instrument has the following data : Number of turns = 100, width of coil = 20 mm, depth of coil = 30 mm, flux density in the gap = 0.1 Wb/m^2. Calculate the deflecting torque when carrying a current of 10 mA. Also, calculate the deflection, if the control string constant is 2×10^{-6} Nm /degree. Ignore friction involved. 6 + 4 + 4

(b) Describe dynamometer-type power meter. 6

6. (a) Define sensitivity of voltmeter. Explain loading of a voltmeter and its significance in sensitivity. 3 + 5

(b) It is desired to measure the voltage across the 50 kΩ resistor in the circuit of Fig. 2. Two voltmeters are available for this measurement (Fig. 2) : Voltmeter 1 with sensitivity of 1000 Ω/V, and voltmeter 2 with sensitivity of 20,000 Ω/V. Both meters are used on their 50 V range. Calculate the (i) reading of each meter, and (ii) error in each reading expressed as a percentage of true value. Comment on the sensitivity effect in the reading. 8 + 4
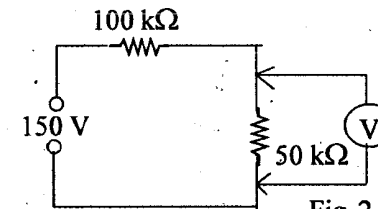

Fig. 2

7. (a) Describe rectifier-type PMMC meter for measurement of rms voltage. 6

(b) Give the measure of total harmonic distortion. Explain, with a neat circuit diagram, the operation of tuned

circuit harmonic analyser. Name the instrument for measurement of spectral parity of a signal and explain.   3 + 8 + 3

8. Write short notes on *any two* of the following :   10 + 10

   (a) Q meter and its application

   (b) Digital voltmeter

   (c) Strain gauge

   (d) RF signal generator

Group C

9. Answer the following in brief : 10×2

   (i) What is Fermi level ?

   (ii) What is varicap ?

   (iii) What is the speciality of Zener diode and how is it biased ?

   (iv) What are advantages and disadvantages of TTL and MOS devices in terms of power handling capacity and noise immunity ?

   (v) What is the type of ADC suitable for higher accuracy ?

   (vi) What is the working principle of Q meter ?

   (vii) What is the principle of thermocouple-type temperature sensor ?

   (viii) What is the ideal value of CMRR of op amp ?

   (ix) What is the ideal value of offset voltage of op amp and why it differs from practical value ?

   (x) What is the main difference between CRO and spectrum analyser in terms of domain of operation ?

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