SUPPLEMENT

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TEC & CGLI: GUIDANCE FOR STUDENTS

Contents

TECHNICIAN EDUCATION COUNCIL

Certificate Programme in Telecommunications

Sets of model questions and answers for TEC units are given below. They have been designed following analysis of assessment test papers actually set during the 1979–80 session by a number of colleges all over the country. The model questions and answers reflect the types and standard of question set and answer expected, and include the styles of both in-course and end-of-unit assessments.

The model questions and answers therefore illustrate the assessment procedures that students will encounter, and are useful as practice material for the skills learned during the course.

The use of calculators is permitted except where otherwise indicated.

Where additional text is given for educational purposes, it is shown within square brackets [ ] to distinguish it from the information expected of students under examination conditions.

We would like to emphasize that, because the model questions are based on work at a number of colleges, they are not representative of questions set by any particular college.

As a general rule, questions are given in italic type and answers in upright type. Answers are sometimes shown in bold upright type; this is because, for some objective questions, it is convenient to place the questions and answers side by side, and bold type enhances the distinction in such cases. Where possible, answers have been positioned such that they may be covered up if desired.

TELECOMMUNICATIONS SYSTEMS 1 1979–80

(Students are advised to read the notes above)

Q1 From the following list of words complete the statements below.

A Microphone B Telephone receiver
C Television camera D Loudspeaker

(a) Two transducers which convert electrical energy to sound energy are.....and.....

(b) A transducer which converts light energy to electrical energy is a.....

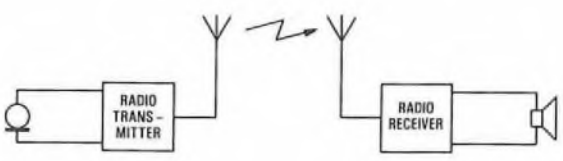
(c) A transducer which converts sound energy to electrical energy is a.....

A1 (*a*) **B** and **D** (*b*) **C** (*c*) **A**.

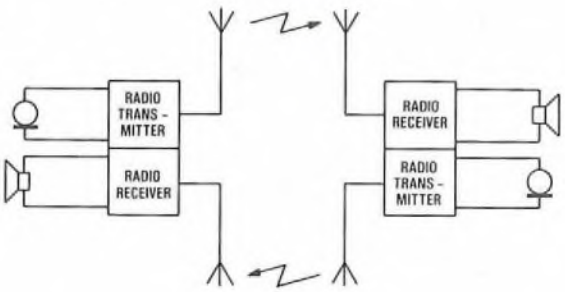
Q2 What is the main advantage of the teleprinter over the telephone?

A2 The teleprinter gives a printed record of the received and transmitted information.

Q3 The sketch represents a unidirectional radio system. Complete the sketch to make the system suitable for two-way radio communication.

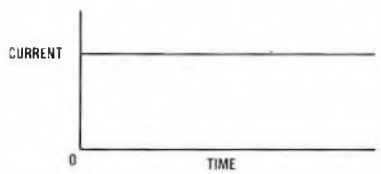


A3

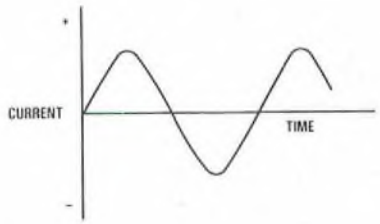


Q4 Draw graphs showing current plotted against time for
(a) a typical direct-current (DC) signal, and
(b) a typical alternating current (AC) signal.

A4 (*a*)



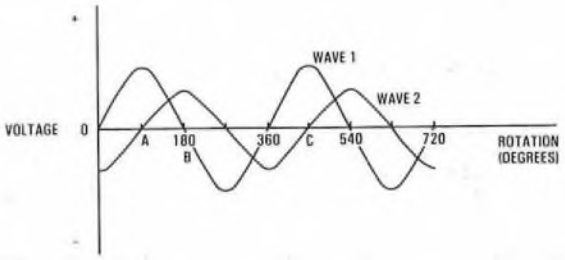
(*b*)



Q5 *State the velocity of electromagnetic waves in free space.*

A5 300×10^6 m/s.

Q6 *What is the phase difference between the two waves shown in the sketch? Give your answers in degrees.*



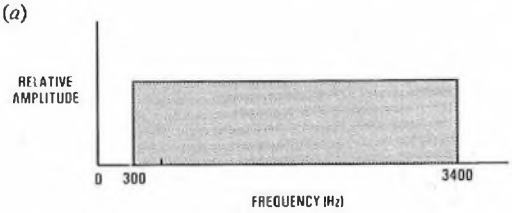
A6 [*Tutorial note*: Wave 1 has a maximum positive value at point A (90°); wave 2 has a maximum positive value at point B (180°); the phase difference is therefore the difference between these two values. However, since wave 1 also has a maximum positive value at point C (450°), the phase difference could also be expressed as the difference between 450° and 180°. For completeness it is also necessary to say whether one wave is leading or lagging on the other. If wave 1 is taken as the reference wave, then wave 2 may be regarded as lagging on wave 1. Conversely, if wave 2 is taken as the reference, wave 1 may be regarded as leading wave 2].

Wave 1 is leading wave 2 by 90° (see tutorial note for other possible answers).

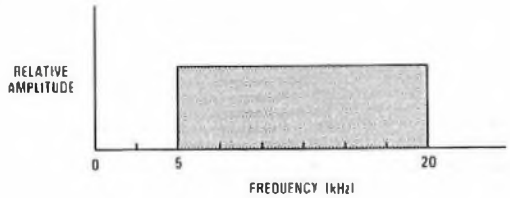
Q7 *Draw the frequency spectrum diagrams for*

(*a*) *the commercial speech frequency range, and*
(*b*) *a signal comprising frequencies from 5 kHz to 20 kHz.*

A7 (*a*)



(*b*)



Q8 *A complex wave is made up of the following frequencies: 2000 Hz, 1750 Hz, 1500 Hz, 1000 Hz, 750 Hz and 250 Hz.*
State which frequency is

(*a*) *the fundamental,*
(*b*) *the fourth harmonic, and*
(*c*) *the seventh harmonic.*

A8 (*a*) 250 Hz,
(*b*) 1000 Hz, and
(*c*) 1750 Hz.

Q9 *For amplitude modulation, if the amplitude of the modulating signal is decreased, does the minimum amplitude of the modulated waveform*

(*a*) *increase,*
(*b*) *remain the same, or*
(*c*) *decrease.*

A9 (*a*).

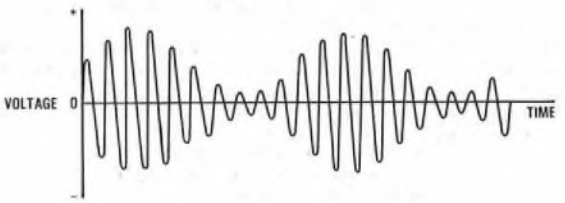
Q10 *For amplitude modulation, if the frequency of the modulating signal is increased, does the maximum amplitude of the modulated waveform*

(*a*) *increase,*
(*b*) *remain the same, or*
(*c*) *decrease.*

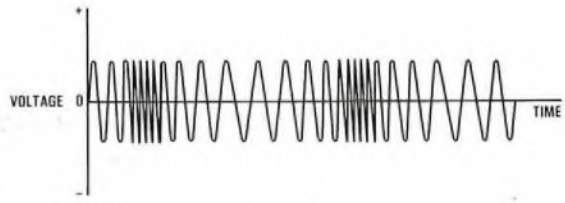
A10 (*b*).

Q11 *Which of the waves illustrated below represent*

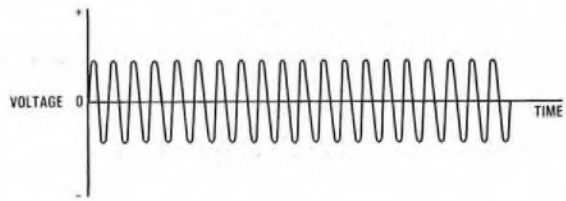
(*a*) *an unmodulated carrier,*
(*b*) *a carrier amplitude modulated by a sinusoidal signal,*
(*c*) *a carrier frequency modulated by a sinusoidal signal, and*
(*d*) *a carrier amplitude modulated by a pulse waveform?*



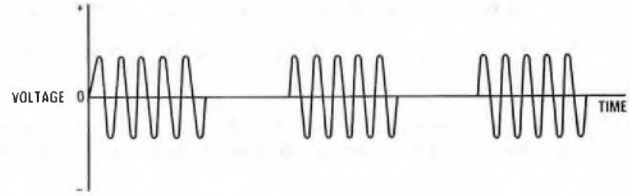
(*i*)



(*ii*)



(*iii*)



(*iv*)

A11 (*a*) (*iii*),
(*b*) (*i*),
(*c*) (*ii*),
(*d*) (*iv*).

Q12 A carrier with an amplitude of 2 V is amplitude modulated to a depth of 75% by a sinusoidal signal. What are the values of

(*a*) V_m,
(*b*) $V_c + V_m$, *and*
(*c*) $V_c - V_m$.

Show how you arrived at your answers.

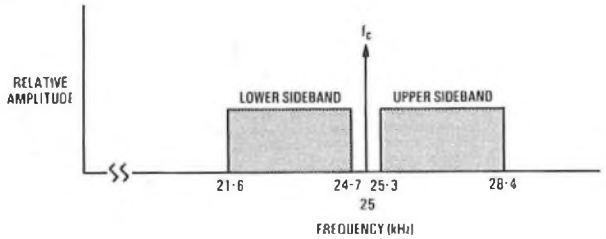
A12 (*a*) Depth of modulation $= 100 \times V_m/V_c$.
$\therefore \quad 75 = 100 \times V_m/2.$
$\therefore \quad V_m = 75 \times 2/100,$
$= \underline{1{\cdot}5\ \text{V}}.$

(*b*) Maximum amplitude of modulated waveform $= V_c + V_m,$
$= 2 + 1{\cdot}5,$
$= \underline{3{\cdot}5\ \text{V}}.$

(*c*) Minimum amplitude $= V_c - V_m,$
$= 2 - 1{\cdot}5,$
$= \underline{0{\cdot}5\ \text{V}}.$

Q13 Draw the frequency diagram of the modulated waveform produced when the speech baseband is used to amplitude modulate a 25 kHz carrier.

A13



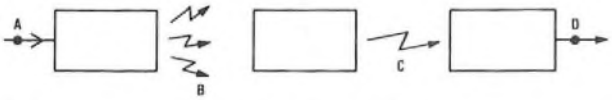
Q14 For Q13, state

(*a*) *the lowest frequency in the modulated wave,*
(*b*) *the highest frequency in the modulated wave, and*
(*c*) *the bandwidth of the modulated wave.*

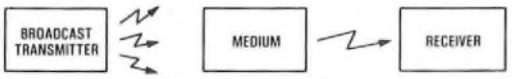
A14 (*a*) 21·6 kHz,
(*b*) 28·4 kHz, and
(*c*) 6·8 kHz.

Q15 The following blocks represent a radio broadcasting system. Label each block using one of the following words:

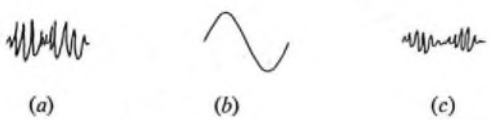
(*a*) *medium* (*b*) *receiver* (*c*) *broadcast transmitter.*



A15



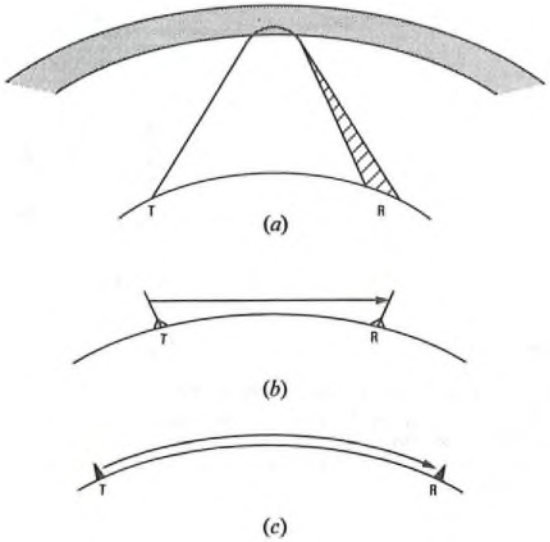
Q16 Which of the following waveforms would be associated with the points marked A, B, C and D on the diagram shown in Q15?



(*a*) (*b*) (*c*)

A16 A (*b*) B (*a*) C (*c*) D (*b*).

Q17 Associate each of the 3 following types of radio wave path with its name and frequency range.

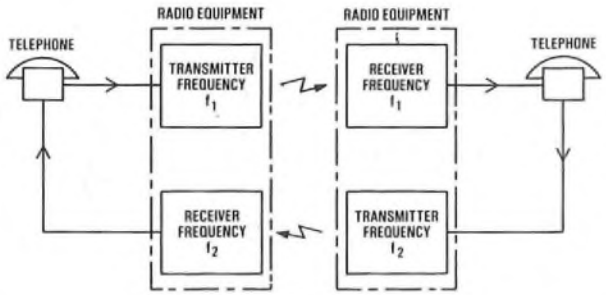


List of options:

(*i*) *Space wave (above 30 MHz),*
(*ii*) *Ionospheric wave (3 MHz–30 MHz), and*
(*iii*) *Surface or ground wave (below 300 kHz).*

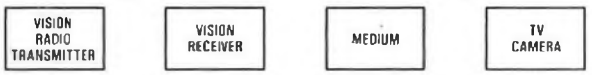
A17 (*a*) (*ii*),
(*b*) (*i*),
(*c*) (*iii*).

Q18 The sketch shows a radio-telephone system. Give a reason why f_1 is not the same as f_2.

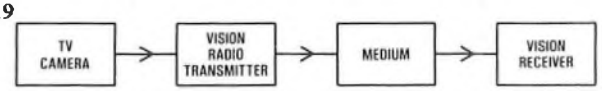


A18 Because, if they were the same, the output of the transmitter would be fed into its own receiver.

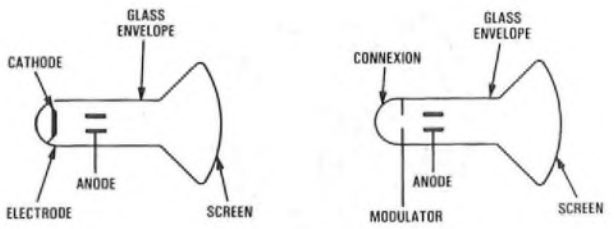
Q19 Rearrange the boxes shown in the sketch so that they represent a sequence which could process a picture-information signal on its path from a camera to a receiver.



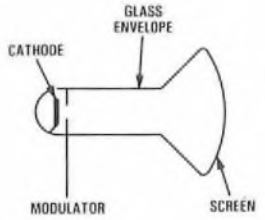
A19



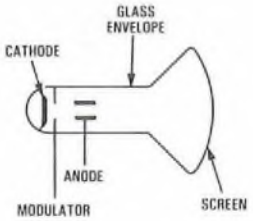
Q20 Which of the following sketches shows correctly the labelled components of the electron gun of a television tube.



(*a*) (*b*)



(*c*)



(*d*)

A20 (*d*).

Q21 Which of the following statements is true?

(*a*) *Line scan of a television picture is concerned with vertical movements of the electron beam.*
(*b*) *Field scan causes the electron beam to be deflected to the next line down to be traced.*

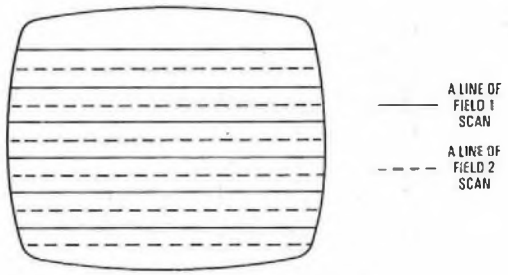
A21 (*b*).

Q22 For the UK television system state

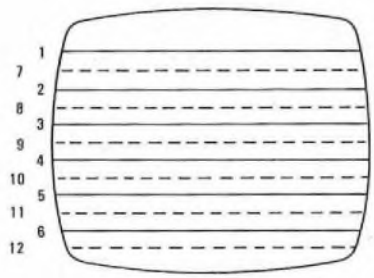
(*a*) *the number of field scans per second,*
(*b*) *the number of frames per second,*
(*c*) *the number of interlaced lines used on the more recent system, and*
(*d*) *the number of interlaced lines used on the older system.*

A22 (*a*) 50
(*b*) 25
(*c*) 625
(*d*) 405

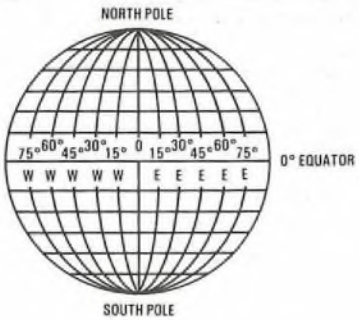
Q23 For the interlaced scan shown, indicate the order in which the lines would be scanned.



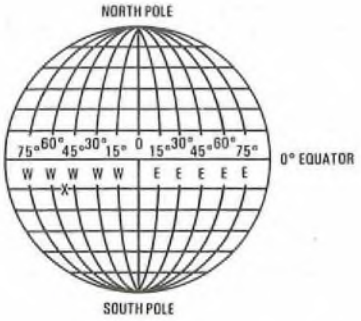
A23



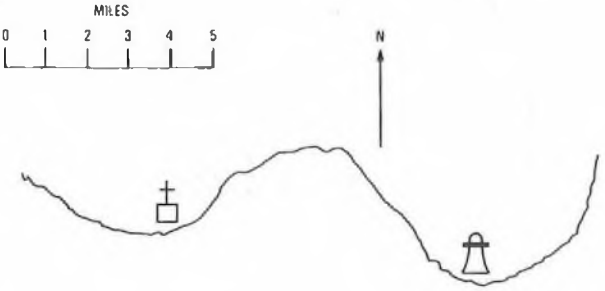
Q24 Given that the co-ordinates of Brasilia are 15S 48W, indicate on the diagram the approximate position of Brasilia.



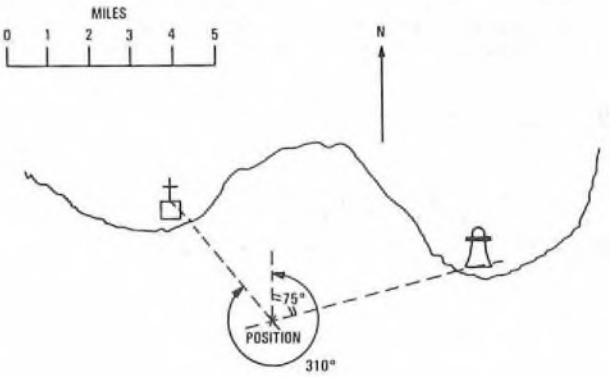
A24



Q25 A ship takes bearing on a church and a lighthouse. The bearing relative to north of the church is 310° and the bearing relative to north of the lighthouse is 75°. On the chart provided, plot the position of the ship showing the relevant bearings.

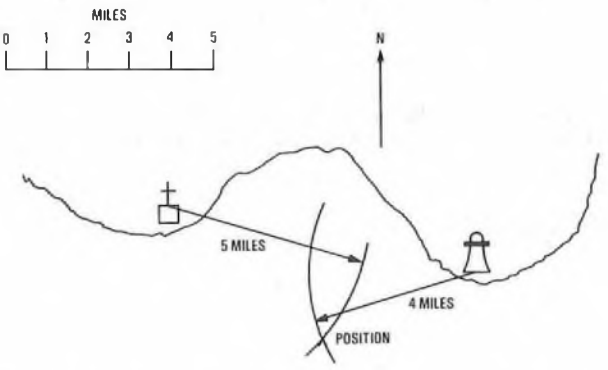


A25



Q26 If, for the ship in Q25 at a later time, the range measured to the church is 5 miles and from the lighthouse is 4 miles, plot the new position of the ship on the chart in Q25.

A26

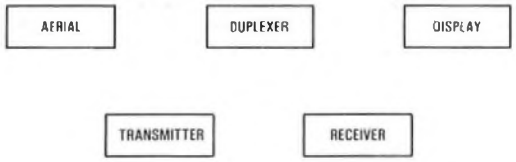


Q27 A primary radar displays as echoes on a cathode ray tube

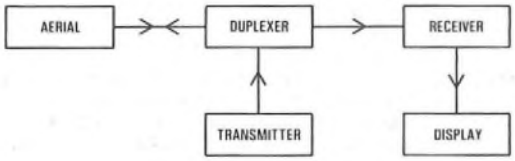
(*a*) *lightwave reflexions,*
(*b*) *radiowave reflexions, or*
(*c*) *soundwave reflexions.*

A27 (*b*).

Q28 Connect the following boxes in the right order to form a primary radar system.



A28



Q29 Which of the following is a primary radar and which is a secondary radar.

(*a*) *A radar which transmits, receives and displays.*
(*b*) *A radar which transmits or receives and transmits.*

A29 (*a*) is a primary radar and (*b*) is a secondary radar.

Q30 State the FOUR basic functions which the telephone performs.

A30 (*a*) Converting sound waves into their electrical equivalent.
(*b*) Converting electrical signals into their sound equivalent.
(*c*) Provide a means of sending call-routeing codes to distant switching equipment under the control of the dial or keypad.
(*d*) Provides a means of indicating that a call has arrived by actuating a calling device such as a bell or tone caller.

Q31 Complete the following statements.

(*a*) *Using one large exchange instead of several smaller ones means that, on average, the length of each subscriber's line will be.....*
(*b*) *In the case stated in part (a), the size of the exchange building would need to be.....*
(*c*) *If more exchanges are used, the average length of each subscriber's line will be.....*
(*d*) *Ideally a telephone exchange should be sited so that the amount of cable used is the.....possible.*
(*e*) *In terms of cost, it is more.....(i).....to provide more exchanges, but so is the use of.....(ii).....cable.*
(*f*) *In terms of cost, the method adopted is normally the.....*
(*g*) *The initial site for a telephone exchange must take account of the area that is to be served and the area's future.....*
(*h*) *The nearby exchanges are connected together by circuits called .....(i).....and each exchange is allocated a dialling .....(ii).....*

A31 (*a*) longer
(*b*) large
(*c*) reduced
(*d*) least
(*e*) (*i*) expensive (*ii*) more
(*f*) cheapest
(*g*) growth
(*h*) (*i*) junctions (*ii*) code

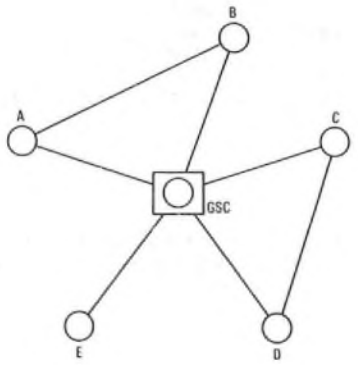
Q32 Choose two correct statements from the following.

A local call is one which
(*a*) *always requires the assistance of an operator to complete the connexion.*
(*b*) *connects two subscribers on the same exchange.*
(*c*) *involves two subscribers in a given area, which may include more than one exchange area.*
(*d*) *always involves the use of a junction.*

A32 (*b*) and (*c*).

Q33 Referring to the sketch, complete the following statements by crossing out the word which is wrong.

(*a*) *The routes from the group switching centre (GSC) to the local exchanges A, B, C, D and E are called BASIC/AUXILIARY routes.*
(*b*) *A call from exchange A to exchange B would be routed via a BASIC/AUXILIARY route.*
(*c*) *A call from exchange E to exchange C would be routed via a BASIC/AUXILIARY route.*
(*d*) *The GSC is acting as a DIRECT/TANDEM switching point.*



A33 The words which should have been *deleted* are:

(*a*) AUXILIARY
(*b*) BASIC
(*c*) AUXILIARY
(*d*) DIRECT

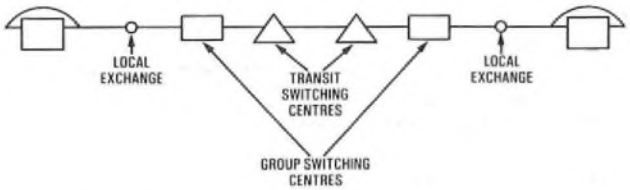
Q34 State whether the following statements are true or false.

(*a*) *Every group switching centre (GSC) in the country is directly connected to all other GSCs.*
(*b*) *Every GSC, however distant, can be reached simply by using as many intermediate GSCs as necessary as switching points.*
(*c*) *A call leaving a specified area known as the local call area is referred to as a trunk call.*
(*d*) *Trunk calls are routed directly from a local exchange to the objective GSC.*
(*e*) *The main consideration to take into account when deciding whether a direct trunk circuit will be provided between any two GSCs is the distance between them.*

A34 (*a*) False
(*b*) False
(*c*) True
(*d*) False
(*e*) False

Q35 Draw a simple block diagram showing a trunk call set up over the transit network between two subscribers on local exchanges. Involve only two transit switching centres and label all exchanges.

A35



Q36 Select the right answers from the list given after each statement.

(*a*) *Group switching centres (GSCs) are connected to an international exchange by*
(*i*) *auxiliary trunk circuits,*
(*ii*) *junctions, or*
(*iii*) *high-speed signalling trunk circuits.*

(*b*) *The overall circuit from a GSC to an international switching centre could involve*
(*i*) *an additional GSC,*
(*ii*) *more than one additional GSC, or*
(*iii*) *transit switching centres.*

(*c*) *The indication that an international call is about to be made is by the subscriber (in the UK) dialling*
(*i*) *999,*
(*ii*) *192,*
(*iii*) *01, or*
(*iv*) *010.*

A36 (*a*) (*iii*).
(*b*) (*iii*).
(*c*) (*iv*).

Q37 A Telex system is one which

(*a*) *connects telephone users to each other,*
(*b*) *connects, on a point-to-point system, one teleprinter to another,*
(*c*) *a teleprinter-connecting system which uses central connecting units which are automatic, or*
(*d*) *a teleprinter-connecting system which uses central connecting units which are operated manually.*

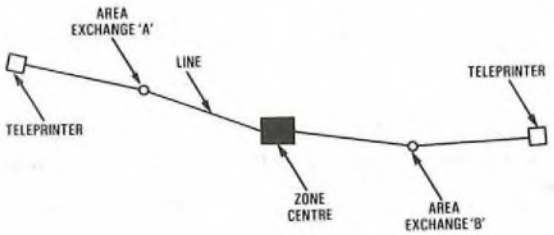
A37 (*c*).

Q38 (*a*) *Given two teleprinters, two Telex area exchanges, and one Telex zone exchange, illustrate how connexions between the teleprinters could be established.*

(*b*) *State the functions of*

(*i*) *zone exchanges, and*
(*ii*) *area exchanges.*

A38 (*a*).



(*b*) (*i*) The function of a Telex zone exchange is to connect Telex calls between any two area exchanges in the same zone. It will also act as a switching point for calls both incoming to and outgoing from the zone.
(*ii*) The function of a Telex area exchange is to connect calls between any two teleprinters in a given area.

Q39 Select the correct statements from the following.

(*a*) *The line distribution cables start from*

(*i*) *the main distribution frame line side, or*
(*ii*) *the main distribution frame exchange side.*

(*b*) *The internal and external cables are connected across the distribution frame by using*

(*i*) *flexible cross-connecting jumpers, or*
(*ii*) *stiffened bare copper wire on insulators.*

(*c*) *Provision for circuit fuses is provided on the*

(*i*) *line side, or*
(*ii*) *exchange side.*

(*d*) *Interception blocks on the exchange side allow testing of*

(*i*) *the external circuits, or*
(*ii*) *both internal and external circuits.*

A39 (*a*) (*i*)
(*b*) (*i*)
(*c*) (*i*)
(*d*) (*ii*)

Q40 Match up the type of cable and the situation in which it is likely to be used.

(*a*) *From the distribution point to the subscriber.*
(*b*) *From the local exchange to the group switching centre.*
(*c*) *From the primary cross-connexion point to the secondary cross-connexion point.*
(*d*) *From the group switching centre to another group switching centre.*

Choose from the following types of cables:

(*i*) *junction-type quad cable,*
(*ii*) *coaxial cable,*
(*iii*) *dropwire, or*
(*iv*) *branch distribution cable.*

A40 (*a*) (*iii*)
(*b*) (*i*)
(*c*) (*iv*)
(*d*) (*ii*)

Q41 Table 1 lists some supervisory signals and Table 2 lists information which supervisory signals might convey. Select each supervisory signal in turn and, from Table 2, select the correct statement.

Table 1

(*a*) *dial tone*
(*b*) *ring tone*
(*c*) *busy tone*
(*d*) *number-unobtainable (NU) tone*
(*e*) *equipment-busy tone*
(*f*) *ringing current*

Table 2

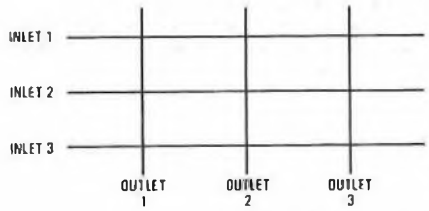
(*i*) *informs the called subscriber that a call requires answering.*
(*ii*) *informs the called subscriber that dialling can commence.*
(*iii*) *informs the calling subscriber that dialling can commence.*
(*iv*) *informs the called subscriber that it is not possible to connect him to the calling subscriber.*
(*v*) *informs the calling subscriber that the called line is already occupied.*
(*vi*) *informs the called subscriber that the switching equipment is occupied.*
(*vii*) *informs the calling subscriber that it is not possible to connect him to the called subscriber.*
(*viii*) *informs the calling subscriber that the switching equipment is occupied.*
(*ix*) *informs the calling subscriber that the dialled number is being called.*

From Table 1	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
From Table 2						

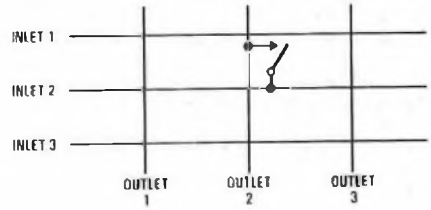
A41

From Table 1	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
From Table 2	(*iii*)	(*ix*)	(*v*)	(*vii*)	(*viii*)	(*i*)

Q42 Insert on the following sketch, a switching contact which enables inlet 2 to be connected to outlet 2.



A42



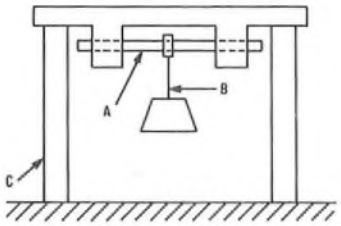
Q43 What is the maximum number of simultaneous calls that can be carried by a switching matrix having 5 inlets and 7 outlets?

A43 5.

(The acceleration due to gravity may be taken to be 9·81 m/s²)

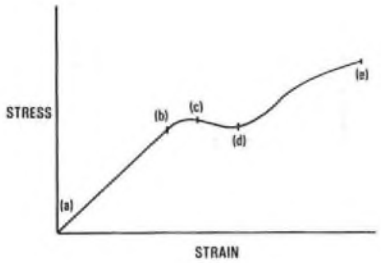
Q1 For the structure shown, state the type of stress in each of the labelled members:

A
B
C



A1 A Shear
B Tensile
C Compressive.

Q2 Indicate the part of the graph for which the sample obeys Hooke's Law.



A2 (*a*)–(*b*)

Q3 A metal bar 0·4 m long having a cross-sectional area of 10 mm² is extended by 1·2 mm when a tensile force of 200 N is applied to it. Calculate

(*a*) *the stress on the bar, and*

(*b*) *the strain on the bar.*

A3 (*a*) Stress = Force (*f*)/Cross-sectional area (*A*),
= 200/10 × 10⁻⁶ = 20 MPa.

(*b*) Strain (*s*) = Extension (*x*)/Original length (*l*),
= 1·2 × 10⁻³/0·4 = 3 × 10⁻³.

Q4 Define the joule.

A4 A joule is the work done when a force of 1 N moves a distance of 1 m in the direction of the force.

Q5 Give an example of

(*a*) *the conversion of heat energy to another form of energy, and*

(*b*) *the conversion of electrical energy to sound energy.*

A5 (*a*) For example, to mechanical energy in a turbine and to chemical energy in a chemical reaction.

(*b*) For example, a telephone receiver and a loudspeaker.

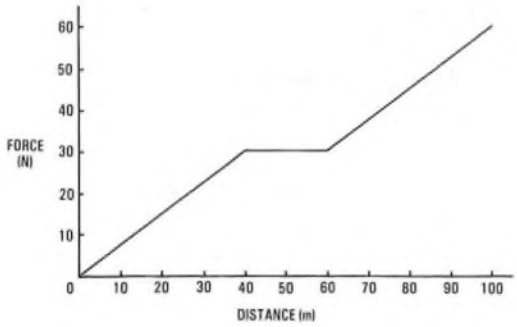
Q6 Calculate the power required to raise a mass of 500 kg through a height of 20 m in 20 s.

A6 Force = mass × acceleration = 500 × 9·81 N.
Work done = force × distance = 500 × 9·81 × 20 J.
Power = work done/time = 500 × 9·81 × 20/20,
= 4·905 kW.

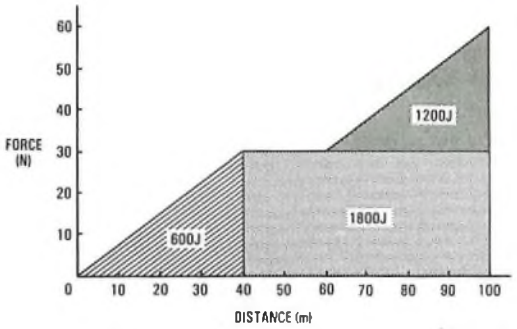
Q7 If, in Q6, the lifting machine is 90% efficient, calculate the power which must be supplied to the machine.

A7 5·45 kW

Q8 From the graph of force plotted against distance moved, estimate the work done in moving a load a distance of 100 m.



A8 [*Tutorial note*: Work done = area under the graph, which may be determined by splitting the area into appropriate triangles and rectangles as shown in the sketch.]
Work done = 3·6 kJ.



Q9 Which of the following has the greatest heat energy?

(*a*) *A lighted match, or*

(*b*) *a swimming pool.*

A9 (*b*).

Q10 How long will it take 1·5 kg of water initially at 14°C to boil in a 2 kW kettle (Ignore the energy required to heat the metal of the kettle.) (The specific heat capacity of water is 4186 j/kg°C.)

A10 [*Tutorial note*: The boiling point of water is 100°C. The energy required is the specific heat capacity × the weight of water × the temperature rise.]

Energy = 4186 × 1·5 × 86 J.
Time = 4186 × 1·5 × 86/2 × 10³,
= 270 s = 4·5 min.

Q11 For each of the following statements state whether heat transfer is by conduction, radiation or convection.

(*a*) *Heat reaching the earth from the sun,*

(*b*) *heat reaching the tip of a soldering iron,*

(*c*) *heat reaching a body from a fire, and*

(*d*) *heat reaching the upper parts of a room.*

A11 (*a*) Radiation
(*b*) Conduction
(*c*) Radiation
(*d*) Convection

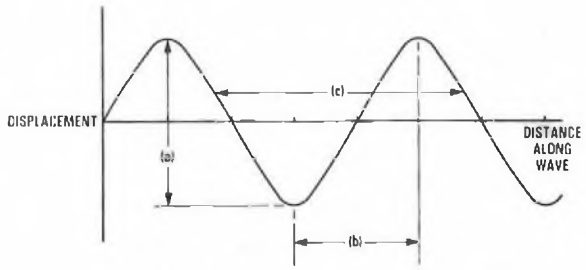
Q12 State the physical property on which a mercury-in-glass thermometer depends.

A12 Expansion with heat.

Q13 Give two examples of wave motion.

A13 For example,
(*a*) ripples on water,
(*b*) sound, and
(*c*) electromagnetic radiation

Q14 The wavelength of the wave shown is indicated by



A14 (*c*)

Q15 The SI unit of frequency is
(*a*) *the cycle,*
(*b*) *the cycle per second,*
(*c*) *the hertz, or*
(*d*) *the hertz per second.*

A15 (*c*)

Q16 State the formula relating velocity, frequency and wavelength. State the meaning of the symbols you use and their units.

A16 $v = f\lambda$
where v is the velocity in metres/second, f is the frequency in hertz and λ is the wavelength in metres.

Q17 Calculate the frequency of a wave which has a wavelength of 1500 m and is propagated with a velocity of 300 × 10⁸ m/s.

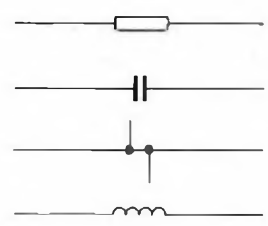
A17 $v = f\lambda$
$\therefore \quad = v/\lambda = 300 \times 10^8/1500 = 2 \times 10^7$ Hz,
$= \underline{20 \text{ MHz.}}$

Q18 Add 2·1 kV, 3·3 MV and 980 V.

A18 3·30308 MV.

Q19 Draw the preferred symbols for
(*a*) *a resistor,*
(*b*) *a capacitor,*
(*c*) *four conductors meeting at a point, and*
(*d*) *an inductor.*

A19

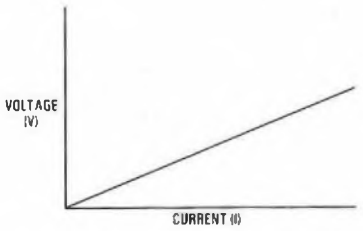


Q20 How must a meter be connected in order to measure the current flowing in a circuit?

A20 In series with the circuit.

Q21 Draw a graph which represents Ohm's law.

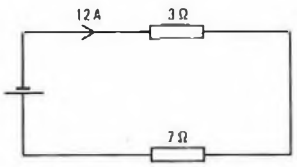
A21



Q22 In Q21, what does the slope of the line represent?

A22 The resistance of the circuit.

Q23 For the circuit shown, calculate the voltage of the battery.

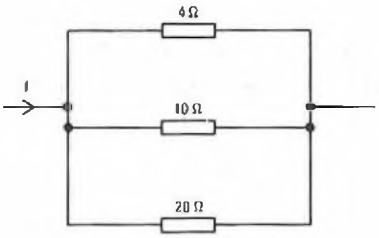


A23 120 V.

Q24 For the circuit in Q23, calculate the power dissipated in the 3 Ω resistor.

A24 $P = I^2R = 144 \times 3 = 432$ W.

Q25 For the circuit shown, calculate the total resistance.



A25 2·5 Ω.

Q26 State three factors which affect the resistance of a conductor.

A26 (*a*) Its material,
(*b*) its cross-sectional area, and
(*c*) its length.

Q27 State a formula which connects the three factors given in Q26.

A27 $R = \rho l/a$
where R is the resistance, ρ is the resistivity, l is the length of the conductor and a is its cross-sectional area.

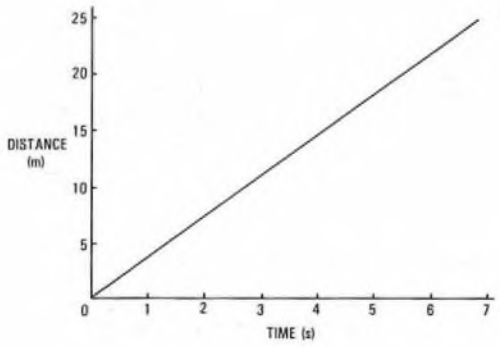
Q28 Give one example each of the three main effects of an electric current.

A28 (*a*) Magnetic effect: an electromagnet.
(*b*) Chemical effect: electroplating.
(*c*) Heating effect: an electric fire.

Q29 Draw a graph from the following data.

Time (s)	*1·1*	*2·2*	*3·3*	*4·4*	*5·5*	*6·6*
Distance (m)	*4*	*8*	*12*	*16*	*20*	*24*

A29



Q30 From the graph which you drew in Q29, calculate the speed of the object.

A30 The speed is represented by the slope of the line which is 3·64 m/s.

Q31 A missile is shot vertically into the air and reaches a maximum height of 100 m in 12 s. With what velocity was the missile fired?

A31 [*Tutorial note*: If v is the final velocity, u is the initial velocity, a is the acceleration and t is the time

$$v = u + at.$$

In this case, $v = 0$, $a =$ minus the acceleration due to gravity (because the acceleration is acting in the opposite direction to the motion) and $t = 12$ s.]

$$0 = u - 9{\cdot}81 \times 12.$$

$$\therefore \quad u = 117{\cdot}72 \text{ m/s.}$$

Q32 The engine of a spaceship in outer space (that is, the spaceship is not affected by any gravitational force) is suddenly switched on. What effect will this have on the spaceship?

A32 It will accelerate.

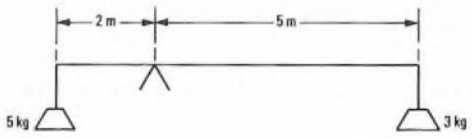
Q33 If the engine of the spaceship in Q32 is then switched off, what will be the effect?

A33 The spaceship will continue to move at the new final velocity.

Q34 State the difference between a scalar quantity and a vector quantity.

A34 A scalar quantity has magnitude only and a vector quantity has magnitude and direction.

Q35 For the thin rod shown, in which direction will movement take place?



A35 The 3 kg weight will move downwards.

Q36 For the condition in Q35, what weight must be added to which of the existing weights in order for equilibrium to be achieved?

A36 It is necessary to add 2·5 kg to the existing 5 kg weight.

Q37 What comprises an oxide?

A37 An oxide is a compound of an element with oxygen.

Q38 The presence of which two substances are necessary for the rusting of iron to take place?

A38 Oxygen and water.

Q39 The electrochemical series is shown on the right.
(a) for each of the following pairs, state which will be the anode if the two metals are used for electrodes of a cell.
(i) Aluminium and copper.
(ii) Zinc and silver.
(iii) Tin and gold.
(b) Which of these will give the lowest EMF?

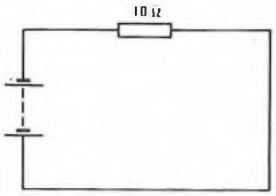
1. *Lithium*
2. *Potassium*
3. *Calcium*
4. *Sodium*
5. *Magnesium*
6. *Aluminium*
7. *Manganese*
8. *Zinc*
9. *Iron*
10. *Cobalt*
11. *Nickel*
12. *Tin*
13. *Lead*
14. (*Hydrogen*)
15. *Copper*
16. *Mercury*
17. *Silver*
18. *Gold*
19. (*Carbon*)

A39 (*a*) (*i*) Copper
(*ii*) Silver
(*iii*) Gold
(*b*) (*iii*)

Q40 State the laws of reflection for a plane mirror.

A40 (*a*) The angle of reflection is equal to the angle of incidence, and
(*b*) the image is located as far behind the mirror as the subject is in front.

Q41 The battery shown in the diagram has an internal resistance of 2 Ω and an EMF of 3 V. What potential difference will be measured across the battery terminals?



A41 [*Tutorial note*: The circuit may be represented as a 12 Ω resistor across a battery having zero internal resistance. Therefore, a current of 0·25 A will flow and the potential difference across the battery terminal will be given by the EMF minus the voltage drop across the internal resistance.]

Potential difference = EMF − $0{\cdot}25 \times 2$,

$= 3 - 0{\cdot}5 =$ 2·5 V.

(Students are advised to read the notes on p. 33)

Q1 Which of the following statements are true?

The telephone can be used in commerce and industry for.....

(a) inter-office communications

(b) inter-branch communications

(c) printing invoices

(d) placing orders with other firms

(e) receiving orders from customers

(f) keeping in touch with family and friends

A1 (*a*), (*b*), (*d*) and (*e*).

Q2 Insert one of the following words to complete the statements below.

remote/emergency/renters/public

Public call offices provide.....

(a) access to the.....services

(b) access to the telephone network from.....places

(c) access to the telephone network for non-telephone.....

A2 (*a*) emergency

(*b*) public

(*c*) renters

Q3 Suggest the appropriate telephone facilities needed for the following situations by inserting the appropriate letter from the key below.

(a) An executive who wishes to have all his incoming calls filtered by his secretary and also needs to speak to her frequently without leaving his office.

(b) A large business having a large number of incoming and outgoing calls and a need for fast internal communication for a large number of employees.

(c) A household which will receive calls at any time.

(d) A business with a large number of departments which need to communicate with one another but do not need to receive or make external calls.

Key: A A PABX with a multiposition switchboard
B An internal telephone system
C A telephone in the hall and an extension at the bedside
D A telephone in the study or hall
E A main telephone with an extension with facilities for inter-communication between the "main" and the "extension"

A3 (*a*) ***E***

(*b*) ***A***

(*c*) ***C***

(*d*) ***B***

Q4 What is the objective of a telecommunications system?

A4 To provide a communications link between two parties.

Q5 Define a system.

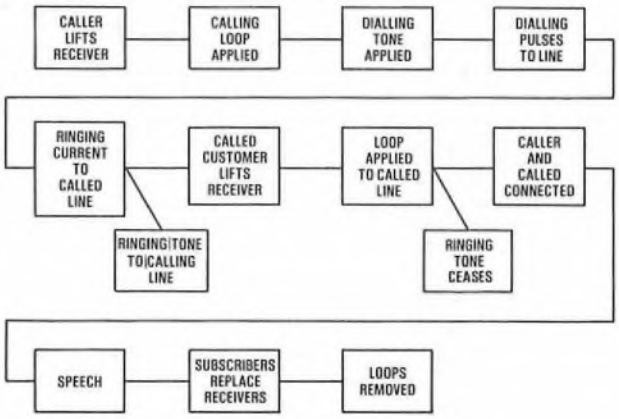
A5 A system is a set of component parts working together to achieve an objective.

Q6 Where is a telephone exchange located within the exchange area?

A6 In the centre of the area which it serves, in relation to the telephone density.

Q7 Draw a block diagram showing the signalling operations for a call connected via an automatic telephone exchange.

A7



Q8 What factors are taken into account in a charging tariff for telephone calls?

A8 (*a*) The duration of the call

(*b*) The distance between the calling and called customers

(*c*) Different rates may be charged at different times of the day

Q9 The normal method of applying a calling signal at the customer's station is by means of.....

A9 DC loop calling

Q10 Earth calling is used when it is required to.....

A10 connect 2 customers to the same line.

Q11 Name two devices which may be used to pass call set-up information to an automatic telephone exchange.

A11 (*a*) A dial

(*b*) A keypad

Q12 Which of the senses can be used to attract the attention of a called customer?

A12 (*a*) Hearing

(*b*) Sight

Q13 What two items are necessary to allow information to be transferred between two telephone customers?

A13 (*a*) A transmitter

(*b*) A receiver

Q14 How is a call disconnected when it is routed via a switchboard?

A14 By removal of a plug or by restoring a key.

Q15 What information is recorded to assist in forecasting the demand for telephone service?

A15 (*a*) The number of customers, and

(*b*) the amount of telecommunications traffic.

Q16 The amount of local-line plant required is mainly dependent on

(a) the telecommunications traffic, or

(b) the number of customers?

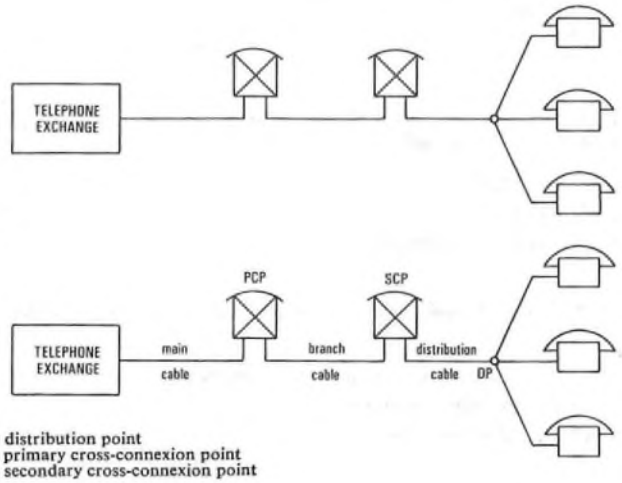
A16 (*b*).

Q17 Define "penetration factor".

A17 Penetration factor = number of connexions divided by number of tenancies.

Q18 Label the cables and flexibility points on the diagram.

A18



DP: distribution point
PCP: primary cross-connexion point
SCP: secondary cross-connexion point

Q19 In general, a low growth rate means a.....(a)..... economic planning period and a high growth rate means a..... (b).....economic planning period.

A19 (*a*) long
(*b*) short

Q20 Telecommunications traffic may be defined as the calls passing over a group of telephone circuits, taking into account the..... (a).....and their.....(b).....

A20 (*a*) number
(*b*) duration

Q21 What is the amount of plant related to for
(*a*) *exchange switching equipment,*
(*b*) *exchange multiple, and*
(*c*) *junction line plant?*

A21 (*a*) The volume and nature of the traffic
(*b*) The number of customers
(*c*) The number of instantaneous calls

Q22 (a) The grade of service is defined as "the ratio of the..... (a)..... that are allowed to .....(b)..... compared to those .....(c)..... in the .....(d)..... due to insufficiency of exchange switching equipment."

A22 (*a*) the number of calls
(*b*) fail
(*c*) offered
(*d*) in the busy hour

Q23 The speed of a dial is controlled by a .....

A23 governor

Q24 Which other factor of a dial needs to be controlled?

A24 The pulse ratio.

Q25 Name the three types of signalling which may be sent from a keypad.

A25 (*a*) 10 pulses/s,
(*b*) multifrequency, and
(*c*) DC (code C).

Q26 What are the two facilities required by a keypad to signal at 10 pulses/s.

A26 Storage and sending facilities.

Q27 Complete the following sentences by inserting one of the numbers 2, 4, 8 or 16.

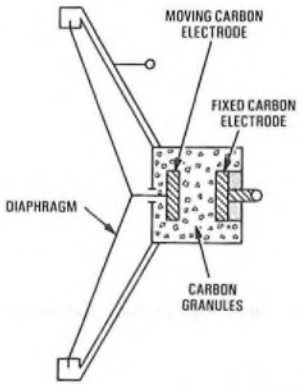
(a) In the MF signalling system used with a keypad there are..... (i)..... possible combinations of tones available for the transmission of digits. The tones are obtained from .....(ii)..... oscillators from each of which .....(iii)..... tones are derived.

(b) In the DC (Code C) signalling system used with a keypad one out of .....(i)..... plus one out of .....(ii)..... DC conditions are employed, which give .....(iii)..... possible combinations of line conditions. One of the .....(iv)..... DC conditions is applied to the A wire of the line and one of the..... (v)..... DC conditions is applied to the B wire of the line.

A27 (*a*) (*i*) 16
(*ii*) 2
(*iii*) 4
(*b*) (*i*) 4
(*ii*) 4
(*iii*) 16
(*iv*) 4
(*v*) 4

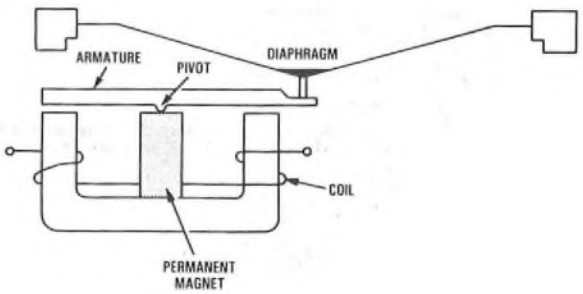
Q28 Draw a diagram of a transmitter, labelling the following components:
(*a*) *Moving carbon electrode*
(*b*) *Fixed carbon electrode*
(*c*) *Diaphragm*
(*d*) *Carbon granules*

A28



Q29 Draw a diagram of a rocking-armature receiver, labelling the following components:
(*a*) *Diaphragm*
(*b*) *Coil*
(*c*) *Permanent magnet*
(*d*) *Pivot*
(*e*) *Rocking armature*

A29



Q30 What is the purpose of the permanent magnet in the rocking armature receiver?

A30 The permanent magnet produces similar poles at each end of the armature, resulting in a balance which is upset by the superimposed magnetic field produced by the speech coil.

Q31 In a CB telephone system, from where does the telephone instrument receive its electrical energy?

A31 The telephone exchange.

Q32 What is the reason for the induction coil in a telephone instrument?

A32 To match the line impedance to that of the telephone instrument.

Q33 When more than one telephone is connected to an extension system, the bells are connected in .....(a)..... and the telephone circuits in .....(b).....

A33 (*a*) series
(*b*) parallel

[*Note:* See article on the Ambassador Range of telephones on p. 70 of this issue of the *Journal*.]

Q34 Why is the use of keys for co-ordinate switching limited to small switchboards?

A34 Because the number of keys would be too great on a large switchboard.

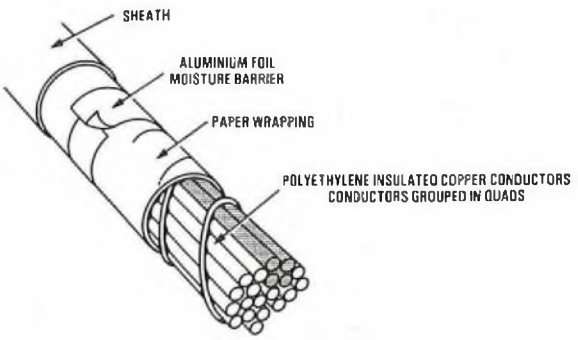
Q35 Explain the enquiry facility on a PABX.

A35 The enquiry facility allows an exchange-line call to be held while a call is made to another extension, the original call then being reconnected to the original extension.

Q36 Which of the following facilities are found on
(*a*) *a PABX, and*
(*b*) *a public exchange?*
(*i*) *First-party clear*
(*ii*) *Call charging*
(*iii*) *MF keyphone signalling*
(*iv*) *Ring when free*
(*v*) *PBX hunting*
(*vi*) *Call transfer*

A36 (*a*) (*i*), (*ii*), (*iv*), (*vi*)
(*b*) (*iii*), (*v*)

Q37 Identify the type of cable shown in the diagram and complete the following statements.
(*a*) *The sheath consists of .....*
(*b*) *The copper conductors are insulated with .....*
(*c*) *The cable is used between .....(i)..... and between .....(ii)..... and .....(iii).....*



A37 The cable is a junction cable.
(*a*) polyethylene
(*b*) polyethylene
(*c*) (*i*) exchanges (*ii*) exchanges (*iii*) group switching centres.

Q38 List the primary coefficients of a cable.

A38 Resistance
Inductance
Capacitance
Conductance

Q39 Name three items of plant used to ensure that the cable network is as accessible as possible.

A39 (*a*) Ducts
(*b*) Manholes
(*c*) Footway jointing boxes

Q40 Name the points in the local distribution network at which flexibility is achieved.

A40 (*a*) The exchange main distribution frame
(*b*) Cross-connexion points
(*c*) Distribution points

Q41 What four considerations have to be taken into account when selecting a material for a specific purpose?

A41 (*a*) Suitability
(*b*) Ease of manufacture of the item it will compose
(*c*) Availability
(*d*) Cost

Q42 Steel is more ductile as its carbon content is
(*a*) *increased, or*
(*b*) *decreased?*

A42 (*b*).

Q43 The corrosion of steel is caused by ..... action.

A43 electrolytic

Q44 An overhead polyethylene-sheathed cable is coloured black, but a similar cable placed in a duct is natural coloured. Give a reason for this.

A44 Ultra-violet light, which is contained in sunlight, causes polyethylene to deteriorate. This can be overcome by the addition of carbon black to the polyethylene used for cables which will be exposed to sunlight, but it is not necessary for cables which are shielded from sunlight.

Q45 State three uses of timber for line plant construction.

A45 (*a*) Poles
(*b*) Support for trenches and tunnels
(*c*) Shuttering for concrete jointing chamber construction

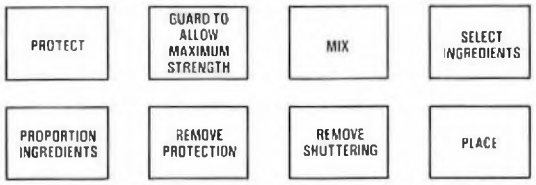
Q46 State two types of project work with which local-line planning is usually concerned.

A46 (*a*) New development areas, and
(*b*) providing relief to the existing system.

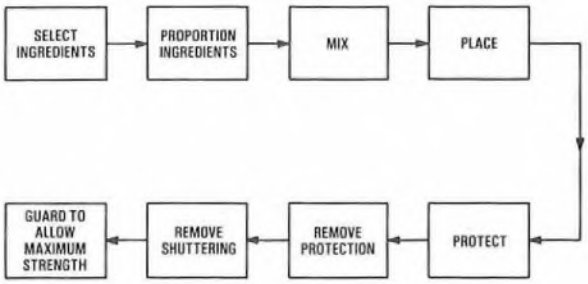
Q47 Name the three resources employed on project work.

A47 (*a*) Labour,
(*b*) tools and equipment required to do the job, and
(*c*) materials and components consumed by the project

Q48 Arrange the following boxes as a sequence of operations for concreting.



A48



Q49 State the five factors which are determined from survey information.

A49 (*a*) The type and amount of materials required,
(*b*) the amount of plant required,
(*c*) the amount of labour required,
(*d*) the field date, and
(*e*) an estimate of the cost of the project.

CITY AND GUILDS OF LONDON INSTITUTE

Questions and Answers

Answers are occasionally omitted or reference is made to earlier Supplements in which questions of substantially the same form, together with the answers, have been published. Some answers contain more detail than would be expected from candidates under examination conditions.

LINE PLANT PRACTICE C 1980

Students were expected to answer any 6 questions

Q1 (*a*) *Explain how a radio transmitter can cause audible interference with a telephone circuit.*

(*b*) *Describe the measures that can be taken to overcome interference of this type.*

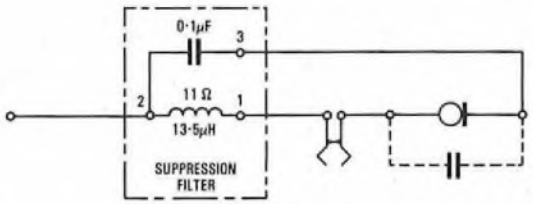
A1 (*a*) A subscriber's telephone may be subjected to interference from a high-powered radio transmitter when open-wire spans serving the telephone are in the vicinity of the transmitter. The open-wire spans act as a receiving aerial, a longitudinal EMF being induced in the same direction in each wire of the span. The subscriber's circuit is normally sufficiently unbalanced, with respect to these induced EMFs, for transverse currents to be created in the telephone circuit. These transverse currents give rise to radio-frequency (RF) potentials which, if non-linear components exist in the subscriber's circuit, may become rectified, producing audio-frequency currents and causing interference. Typical non-linear devices are the carbon-granule transmitter in the telephone and any high-resistance joints in the circuit.

(*b*) Interference may be reduced in the following ways.

(*i*) *Reducing the RF currents flowing in the circuit.*
Air-cored RF inductors of 700–1000 μH are used to limit the longitudinal RF current flowing in the telephone line. The overhead circuit is broken at a suitable point and an inductor is connected in series with each leg of the line. Each coil is provided with two tails of 18 SWG wire to facilitate connexion, and is designed to be accommodated in the top cavity of an insulator.

(*ii*) *Ensuring that no faulty joints exist in the circuit.*
Faulty joints in the subscriber's circuit may be avoided by ensuring that joints are correctly made during installation, and that subsequent maintenance is properly carried out.

(*iii*) *Fitting a suppression device in the subscriber's telephone.*
The suppression device installed in the telephone instrument consists



of a 0·1 μF capacitor and a 13·5 μH RF inductor, and is designed to operate as a transmitter filter. It is connected as shown in the sketch. The unit eliminates most radio interference in the telephone instrument but, exceptionally, it may be necessary to fit capacitors of a value up to 0·15 μF across the telephone transmitter.

Q2 (*a*) *List and describe briefly SIX documents which could comprise a contract for civil engineering work.*

(*b*) *Explain the difference between a cost reimbursement contract and a measure-and-value contract.*

A2 (*a*) The following documents could comprise a contract for civil engineering work:

(*i*) *Agreement or Articles of Agreement.* This normally sets out the date, the parties, the intended works and the prices.

(*ii*) *Conditions.* These provide, as far as possible, for the various problems which can arise during and after the execution of the works.

(*iii*) *Plans and Drawings.* These can be used for determining quantities as well as giving a pictorial representation of the works.

(*iv*) *Bills of Quantities.* These state every obligation or service which will be required in carrying out the project. They may be submitted to the contractor for tender but only become part of the contract if specifically referred to in the Articles of Agreement.

(*v*) *Specification.* This describes the work the contractor must execute and the materials to be supplied. It does not normally act as a Bill of Quantities, so either a Specification or a Bill of Quantities should form part of the contract documents to avoid discrepancies.

(*vi*) *Other Documents.* These include letters, estimates, memoranda or the tender or invitation to tender.

(*b*) A cost reimbursement contract is one where the contractor is paid for all labour, plant, materials and services used on the site plus a fixed fee or a percentage for his overheads and profit. On the other hand a measure-and-value contract is where the contractor receives a Bill of Quantities with the tender drawings and the contract price is fixed.

Q3 *Describe, in detail with the aid of sketches, the method of pipe-jacking a 1·2 m diameter concrete pipe under a railway for a distance of 30 m.*

A3 See A8, Line Plant Practice C 1976, *Supplement*, Vol. 70, p. 75, Oct. 1977.

Q4 (*a*) *Describe* TWO *methods of determining the Practical Centre of a telephone exchange area.*

(*b*) *Fig. 1 below shows the existing, 10 and 20 year forecasts for routes leading to three possible exchange sites A, B and C. Show how the Practical Centre is found.*

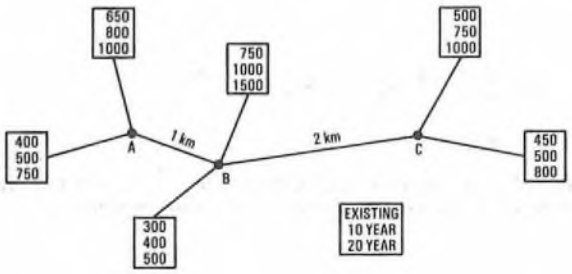


Fig. 1

A4 (*a*) The Practical Centre of a telephone area can be determined by using one of the following methods:

(*i*) A north-south line is drawn on a map showing the subscriber and junction forecast distribution, with the junction forecasts marked at the points at which the existing or proposed routes enter the exchange area, in such a position that it divides the forecast into two equal parts. A similar east-west line is then drawn and the intersection of the two lines indicates where the Practical Centre may be expected to lie.

(*ii*) If the straight-line diagram shows three or more principle routes radiating from one point, and the number of lines forecast on any one route does not exceed the sum of those on the remaining routes, then that point is likely to be the Practical Centre.

(*iii*) A density map is prepared and the location of the Practical Centre is normally found to lie within the densest part of the area. If the summary map shows only one point of intersection of principle routes within the densest area, then that point is likely to be the Practical Centre.

(*b*) Pair-kilometres

with exchange sited at A $= 1 \times (1500 + 500) + 3 \times (1000 + 800)$,
$= 2000 + 5400 = 7400$;

with exchange sited at B $= 1 \times (1000 + 750) + 2\,(1000 + 800)$,
$= 1750 + 3600 = 5350$;

with exchange sited at C $= 3 \times 1750 + 2 \times 2000 = 9250$.

Thus it can be seen from these results that the Practical Centre would be at point B.

Q5 *Fig.2 below shows a cable system supported by steel brackets spaced 1 m apart. The brackets are fixed rigidly into the wall of a concrete manhole. Cable A weighs 75 N/m and cable B weighs 50 N/m. The density of steel is 7250 kg/m³.*

(*a*) *Draw a shear force diagram of the system.*

(*b*) *Draw a bending moment diagram of the system.*

(*c*) *Calculate the shear stress on the bracket where it enters the wall.*

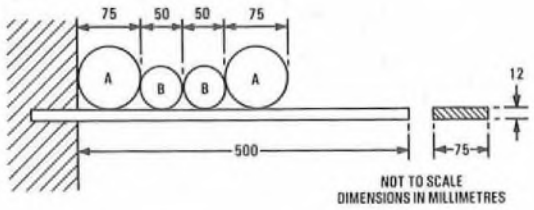
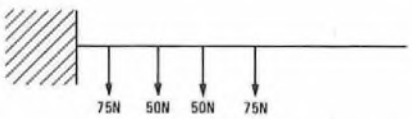
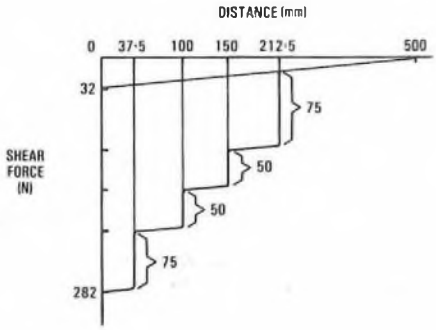


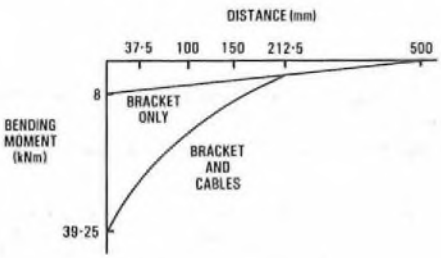
Fig. 2

A5 (*a*)





(*b*)



(*c*) Weight of bracket $= 500 \times 12 \times 75 \times 10^{-9} \times 7250$,
$= 3{\cdot}26$ kg.

Total weight of the cables $= 2 \times 50 + 2 \times 75$,
$= 250$ N.

Thus, total weight at the wall end of the bracket $= 250 + (3{\cdot}26 \times 9{\cdot}81)$,
$= 282$ N.

Thus, the stress on the bracket $= \dfrac{282}{75 \times 12} = \underline{0{\cdot}313\ \text{N/mm}^2}$.

Q6 (*a*) *Explain the principle and use of the psophometer.*

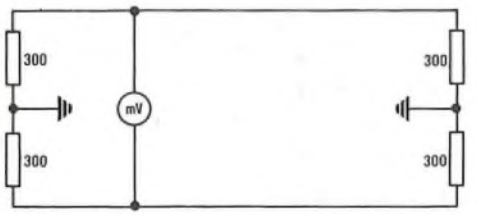
(*b*) *Give details of* THREE *types of measurement that can be made with this apparatus to determine the magnitude of disturbance in a telephone circuit.*

A6 (*a*) A psophometer is an instrument which gives a visual indication of the aural effect of circuit noise. The instrument consists essentially of a network which has a response equivalent to the combination of a telephone receiver and the human ear. This network is followed by a valve-voltmeter calibrated in millivolts. In order that the instrument should disturb the circuit to which it is connected as little as possible the psophometer must have an input impedance greater than 10 000 Ω. Also, it must be sensitive enough to give clear readings of input voltages of the order of 0·05 mV at 800 Hz. This is achieved by inserting a resistance-capacitance coupled amplifier between the weighting network and the valve-voltmeter. As the latter must record the effects of circuit noise in the same manner as the human ear, a square law detector is employed.

(*b*) (*i*) Sketch (*a*) illustrates the method of measuring longitudinal psophometric voltage. The psophometer is connected in series with one wire of the telephone pair which is earthed at both ends. Thus the psophometer measures the voltage induced into the wire.

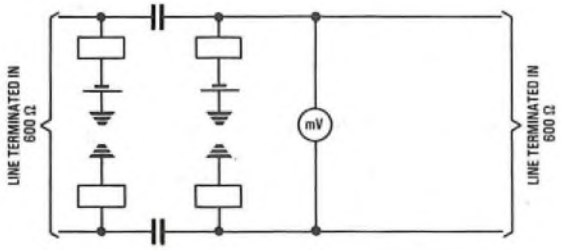
(*a*)

(*ii*) Sketch (*b*) illustrates the method of measuring the transverse psophometric voltage across a telephone pair. The test is made with a balanced 600 Ω termination at each end of the pair and the psophometer connected across the pair at one of the terminations. In this case the psophometer measures the transverse voltage due to the unbalance of the line.



(*b*)

(*iii*) Sketch (*c*) illustrates the method of making a transverse measurement across a circuit when a call has been set up. The telephones at either end of the line are replaced by 600 Ω terminations and the psophometer is connected across the line side of the transmission bridge.



(*c*)

Q7 (*a*) *Explain the term "pneumatic resistivity" as applied to cable pressurization.*

(*b*) *The pneumatic resistivity of a cable having 0·5 mm conductors is 60 mbar h/g km for each 100 pairs. If the cable has 1000 pairs calculate the rate of air flow under conditions of maximum leak at the far end of a 750 m length if air is applied at a pressure of 600 mbar at the exchange end.*

A7 (*a*) The pneumatic resistivity of a cable is its resistance to gas flow through the air spaces between the insulated conductors. Thus, the pneumatic resistance of a cable is dependent on the length, type and size of cable concerned. To determine the rate of gas flow through a cable the pneumatic analogy to Ohm's law is used. Thus, if Q is the rate of gas flow through the cable, then $Q = \frac{P}{R}$ where P is the total pressure drop along the length of the cable and R is the pneumatic resistance of the cable. The analogy between pneumatic resistance and resistivity is given by $R = \frac{rl}{d^2}$ where r is the pneumatic resistivity, l is the length of the cable and d is its diameter.

(*b*) For the cable given pneumatic resistivity (r) is 60 mbar h/g km for each 100 pairs, P is 600 mbar.

Thus, pneumatic resistance is $60 \times \frac{750}{1000} \times \frac{100}{1000}$,

$= 4{\cdot}5$ mbar h/g.

Thus, $Q = \frac{600}{4{\cdot}5} = 133$ g/h.

Q8 *A 60 m span of wire from a telephone to a house is tensioned at 100 N. As a result of ice forming on the wire the tension increases to 250 N. Assuming the ice is uniform over the length of the wire, find the mass of the ice coating per metre run. The mass of the wire without ice is 0·074 kg/m, the conductor cross section is 0·1 mm² and E = 12000 hbar. Neglect the strength of ice coating.*

A8 The original length of the wire l_1 is given by

$$l_1 = L + \frac{8d^2}{3L} \text{ m},$$

where L is the span length and d is the dip at the centre of the span.

But,

$$d = \frac{WL^2}{8T_1} \text{ m},$$

where W is the weight of wire per unit length in newtons/metre and T_1 is the original tension in the wire.

Thus, $l_1 = 60 + \frac{W^2L^3}{24T_1^2}$,

$= 60 + \frac{9{\cdot}81^2 \times 0{\cdot}074^2 \times 60^3}{24 \times 100^2}$,

$= 60{\cdot}474$ m.

If l_2 is the length of the wire when carrying ice, and T_2 is the new tension

$$\frac{l_2 - l_1}{l_1} = \frac{T_2 - T_1}{EA} \quad \text{(Hooke's Law)}.$$

Thus, $l_2 = l_1\left(\frac{T_2 - T_1}{EA}\right) + l_1$.

$= 60{\cdot}474\left(\frac{250 - 100}{120 \times 10^9 \times 0{\cdot}1 \times 10^{-6}}\right) + 60{\cdot}474$,

$= 61{\cdot}229$ m.

If w_2 is the weight of the wire per metre with the ice coating, then

$$l_2 = L + \frac{w_2^2L^3}{24T_2^2}$$

$$\therefore \quad w_2^2 = \frac{24T_2^2(l_2 - L)}{L^3},$$

$$= \frac{24 \times 250^2(61{\cdot}229 - 60)}{60^3},$$

$= 8{\cdot}53$ N/m,

$= 0{\cdot}870$ kg/m.

Thus, the ice coating weighs

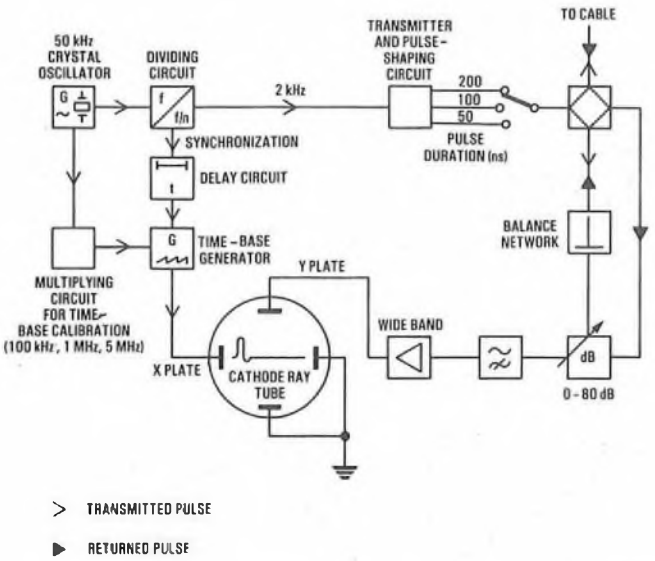
$0{\cdot}867 - 0{\cdot}074$,

$= 0{\cdot}793$ kg/m.

Q9 (*a*) *Draw a labelled schematic diagram of a pulse echo test set suitable for locating an impedance irregularity in a coaxial cable.*

(*b*) *Describe briefly how a fault is located using this test set.*

A9 (*a*) A labelled block diagram of a pulse echo test is shown in the sketch.



(*b*) The pulse testing method of fault location, used on coaxial cables, is based on the principle that if an electric pulse is applied to a line on which an impedance irregularly exists (possibly due to a fault) a portion of the pulse will be reflected back to the sending end. The time interval between the transmitted and reflected pulse is measured by displaying the reflected pulses on a cathode ray tube having a specially calibrated time base. As the velocity of propagation of the pulse is constant in a cable of uniform construction, the time delay between the transmitted and reflected pulse is a measure of the distance between the fault and the testing end. A simplified block diagram of a complete pulse-echo test set is illustrated in part (*a*).

The pulse-echo method of testing enables the type of fault to be established. A fault which produces an increase of impedance at the fault point (series fault) produces a pulse in the same direction as the incident pulse. A fault which reduces the impedance at the fault point (a shunt fault) produces a pulse in the opposite direction to the incident pulse.

A unidirectional pulse is used and, while the shape of the pulse is not critical, a pulse shape in which the lower frequencies have been removed will avoid distortion of the waveshape of the reflected pulse. The removal of the lower frequencies from the pulse before amplification allows the output of the higher frequencies to be increased without overloading the amplifier equipment associated with the test set.

The duration of the pulse is indicated by the width, in microseconds, at half-pulse height. The pulse width must be narrow enough to allow the completion of the pulse transmission before any reflexion is likely to be returned from the nearest fault. A narrow pulse also enables a greater sensitivity to be obtained, in that the smaller impedance irregularities may be detected. The use of a narrow pulse has disadvantages when used for testing on long lengths of cable. The high frequencies making up the narrow pulse will suffer considerable attenuation in a long cable and the reflected pulse may therefore be distorted beyond recognition. In order to accommodate these conflicting factors three pulse widths are provided. The smallest pulse width is used for short lengths of cable (for example, factory lengths) while the longest width is used for overall tests on repeater sections.

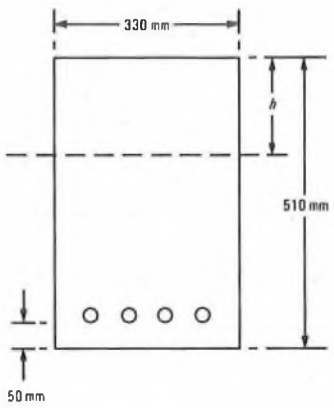
The pulse repetition rate must be such that the interval between each pulse is sufficient to allow any reflexions from the most distant fault point of a cable to be returned before the next pulse is transmitted. For coaxial cables where the distance between repeater points is in the region of 10 km (a return path of 20 km) a pulse repetition rate of 2000 pulses/s is used.

Q10 *A reinforced concrete beam 330 mm wide and 510 mm deep has four 25 mm diameter steel bars placed 50 mm from the lower surface and is used to bridge two walls 4 m apart. The compressive stress in the concrete is 4·2 MPa and the modular ratio is 15.*

(*a*) *Calculate the load the beam will carry if uniformly distributed.*

(*b*) *What is the tensile stress in the steel when maximum stress in the concrete is reached?*

A10



(*a*) The total cross-sectional area of the bars

$$= 4 \times \frac{\pi}{4} \times 25^2,$$

$$= 1960 \text{ mm}^2.$$

The ratio of the area of concrete to reinforcement (r)

$$= \frac{1960}{330 \times 460} = 0{\cdot}013.$$

The modular ratio (m) = 15.

Thus, $rm = 15 \times 0{\cdot}013 = 0{\cdot}195.$

$\therefore \quad r^2m^2 = 0{\cdot}038.$

The neutral axis (h) is given by $\frac{h}{d} = \sqrt{(r^2m^2 + 2rm)} - rm$, where d is the depth of the reinforcing bars.

Thus, $$\frac{h}{d} = \sqrt{\{0{\cdot}038 + (2 \times 0{\cdot}195)\}} - 0{\cdot}195,$$

$$= 0{\cdot}459.$$

But, d = 460 mm.

$\therefore \quad h = 210$ mm.

The internal resisting moment $(M) = \frac{1}{2}f_c bh\left(d - \frac{h}{3}\right)$,

$$= \frac{4{\cdot}2}{2} \times 330 \times 210 \times \left(460 - \frac{210}{3}\right),$$

$$= 56{\cdot}75 \text{ kN m}.$$

The maximum bending moment at the centre $(M) = \frac{wl^2}{8}$.

Thus, $$w = \frac{8M}{l^2} = \frac{8 \times 56{\cdot}75 \times 10^3}{4^2} \text{ N/m},$$

$$= \underline{28{\cdot}4 \text{ kN/m}}.$$

(*b*) If f_c is the permissible compressive stress, f_s is the permissible tensile stress and A_s is the total cross-sectional area of the reinforcing,

$$\tfrac{1}{2}f_c bh = f_s A_s,$$

$$\therefore \quad \frac{4{\cdot}2}{2} \times 330 \times 210 = 1960 f_s.$$

$$\therefore \quad f_s = \underline{74{\cdot}1 \text{ MPa}}.$$

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