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Model Paper : Telecommunication Engineering

Q.1. Prove that an infinite line is equivalent to a finite line terminated in its characteristic impedance. (5)

Sol:

A finite line has an input impedance Z_0, when it is terminated in Z_0 or a finite line terminated by its Z_0 behaves as an infinite line.

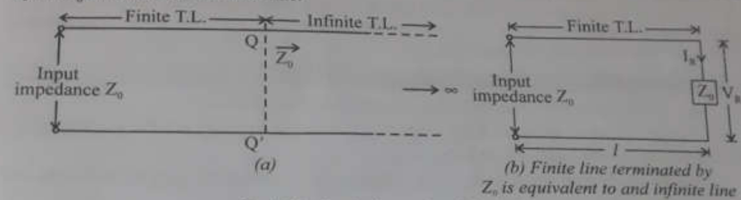

Fig. 1.19 : Equivalence of an infinite line

Let a finite line of length L is terminated by its characteristic impedance Z_0 and is having voltage and current as V_R and I_R at terminating end.

$$Z_0 = \frac{V_R}{I_R} \quad .....(1.28)$$

Putting $x = l$, $V = V_R$ and $I = I_R$ in general equation

$$V_R = V_S \cosh pl - I_S Z_0 \sinh pl$$

$$I_R = I_S \cosh pl - \frac{V_S}{Z_0} \sinh pl$$

Now by dividing, we get

$$\frac{V_R}{I_R} = \frac{V_S \cosh pl - I_S Z_0 \sinh pl}{I_S \cosh pl - \frac{V_S}{Z_0} \sinh pl} \quad .....(1.2$$

$$Z_0 = \frac{V_S \cosh pl - I_S Z_0 \sinh pl}{I_S \cosh pl - \frac{V_S}{Z_0} \sinh pl} \qquad \left[\because \frac{V_R}{I_R} = Z_0\right]$$

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$$V_S \cosh pl - I_S Z_0 \sinh pl = Z_0\left(I_S \cosh pl - \frac{V_S}{Z_0} \sinh pl\right)$$

$$V_S[\cosh pl + \sinh pl] = Z_0 I_S[\cosh pl + \sinh pl]$$

$$Z_0 = \frac{V_S}{I_S} = \text{input impedance of the line}$$

$$Z_S = \frac{V_S}{I_S} = \frac{V_R}{I_R} = Z_0$$

$$Z_S = Z_0$$

...impedance of a finite line terminated in ... Hence a finite trans...

Q.2. A transmission line has constants given as; R = 10.4 Ω, L = 3.666 mH, C = 0.00835 μF and G = 0.08 μ mho. Calculate Z_0, α, β and V_p at ω = 5000 radians per second. (5)

Sol:

...mH C = 0.00835 μFd. & G = 0.08 ... radians per sec.

Solution : $Z = R + j\omega L = R + j\,2\pi f L = 10.4 + j\,5000 \times 3.666 \times 10^{-3}$

$= 10.4 + j\,18.33 = 21.04 \angle 60°4$

Similarly shunt admittance

$$Y = G + j\omega C = 0.08 \times 10^{-6} + j5 \times 10^3 \times 0.00835 \times 10^{-6}$$

$$Y = (0.08 + j\,4\,1.75) \times 10^{-6} = 41.77 \times 10^{-6} \angle -14.75°$$

$$Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{21.05\angle 60.4°}{41.77 \times 10^{-6} \angle 89.9°}} = \sqrt{\frac{21.05}{41.77 \times 10^{-6}}} \angle \frac{60.4 + 89.9}{2} = 224.5\angle -14.75°$$

$$P = \sqrt{Z \times Y} = \sqrt{21.05 \times \angle 60.4° \times 41.77 \times 10^{-6} \angle 86.9°}$$

$$= \sqrt{21.05 \times 41.77 \times 10^{-6}} \angle \frac{60.4 + 89.9}{2}$$

$= 0.2961\angle 75.15 = 0.02961(\cos 75.15 + j\sin 75.15) = 0.29661\ (0.2554 + j\ 0.9681)$

$= \mathbf{0.007561 + j\ 0.2873}$

The real and imaginary parts of this will give respectively attenuation constant α and phase constant β.

Therefore $\alpha = 0.007561$ neper/km ; $\beta = 0.02873$ radians/km

Phase velocity V_p will be given by

$$V_p = \frac{\omega}{\beta} = \frac{5000}{0.02863} = \mathbf{1.746 \times 10^5\ km / sec}$$

Q.3. Explain different types of signaling tones and types of dialing. (5)

Sol:

(buzzer) ... acoustical converter

6.7 TYPES OF SIGNALING TONES

Various tones are generated in the exchange to indicate identification of the called party, ringing the bell of the called party, busy status of the called party, line unobtainable.

As in case of manual telephony we have some signalling tones to identify the functions of establishing, maintaining and releasing a telephone conversation. In automatic telephony we have various types of signalling tones. These are as follows:

(a) Dial Tone: This tone indicates that the exchange is ready to accept dialled number from the subscriber (calling subscriber) side. A subscriber lifts his handset and gets a continuous dial tone from the exchange. Dial tone is a continuous tone of 33 Hz or 50 Hz or 400 Hz. Fig 6.8 shows a dial tone.

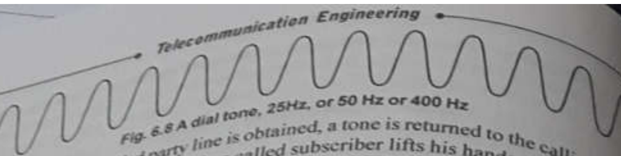

Fig. 6.8 A dial tone, 25Hz, or 50 Hz or 400 Hz

(b) Ring Tone: When a called party line is obtained, a tone is returned to the calling subscriber known as ring tone. This ring tone stops when called subscriber lifts his handset. Fig. (6.9) shows ring tone, in which a double ring pattern is shown

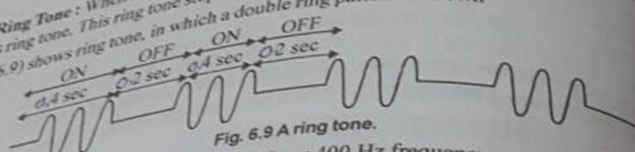

Fig. 6.9 A ring tone.

This ring tone is an interrupted tone of 133 Hz or 400 Hz frequency and bursty tone of 0.4 sec duration.

(c) Busy tone: When a calling subscriber wants to establish a connection with called subscriber and called party is engaged some where then a tone is returned to the calling subscriber from the selector. This tone is known as ***busy tone*** *or* ***engaged tone****. This tone is also returned to the calling subscriber when a called subscriber phone is faulty. So different busy tones on different conditions need to be introduced is system. This would not serve any useful purpose and subscriber gets confused. A busy tone is shown in Fig. (6.10). Busy tone is of 400 Hz of frequency. The duration for silence period and burst period is same either 0.375 sec or 0.75 sec. When the called party is busy the calling subscriber gets such tone.*

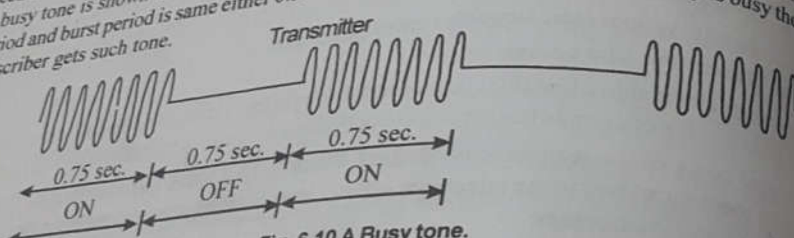

Fig. 6.10 A Busy tone.

(d) Number unobtainable Tone : It is continuous tone of 400 Hz signal frequency, that is shown in Fig. 6.11. This tone is returned to the calling subscriber when called party is out of order or disconnected or by any reason. It is also called NU tone.

Fig. 6.11 Number unobtainable tone.

(e) Call in Progress Tone: It is sometimes called routing call. It is of 400 Hz or 800 Hz signal. When a subscriber call passes through a number of different type of exchanges then

calling subscriber hears different calls in progress tones through different exchanges. This is shown in Fig.(6.12).

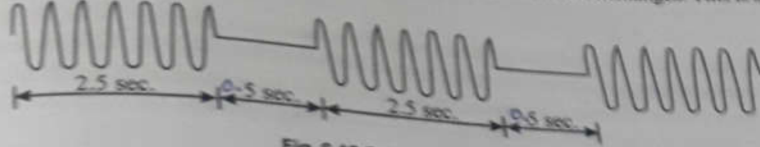

Fig. 6.12 Call in progress tone.

As a subscriber is having some difficulty to recognize various signalling tones, so recorded voice is used as announce messages like number you have dialled is busy, "try after some time" or "busy" are used in today's exchanges.

6.8 TOUCH TONE DIAL TYPES

(i) Decadic Dialing *(ii) DTMF Dialing*

6.8.1 Decadic Dialing

It is also called **Loop Disconnect Dialing or Pulse Dialing** because in this loop is make or break continuously depend upon the number or key pressed. In decadic telephone, the dialing of the telephone number is in the form of pulses of standard 33/66 make–break ratio time. Suppose we dial a number 5, there are five pulses of the above make–break ratio. Between the two numbers, which are continuously dialed, there is 800 ms pause to distinguish two numbers. Time required to distinguish between two digits is called IDP **(Inter Digit Pause)** or **IDS (Inter Digit Space)**. The make break ratio may vary to 2:3. The dialing with the decadic phone is slow. But the exchanges, which have already installed in various cities in India, accept only PULSE dialing, so DECADIC PHONES, are commonly used in India. If we press 532 then total time taken is 5* 100 + 800 + 3* 100 + 800 + 2* 100 = 2600 msec.

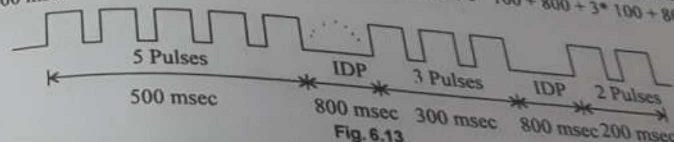

Fig. 6.13

6.8.2 Dual Tone Multi Frequency (DTMF) Dialing

This type of dialing is also known as **touch tone dialing**. This is faster dialing technique as compared to pulse dialing. The dial is replaced by an array of push buttons. Touching a button generates a ***"tone"*** which is a combination of two frequencies, one from the lower band and other from the upper band. For example when button 5 is pressed the transmitted frequencies are 770 Hz and 1336 Hz. The frequencies in DTMF are carefully selected so that these are not confused with other tones on the line. The DTMF tones are present for a minimum specified time (40 msec) so that these are detected properly at the exchange. The Inter Digit Pause for DTMF is 40 msec. If we press **532** the total time taken is 40 + 40 + 40 + 40 + 40 = 200 msec.

Q.4. What are repeaters. Explain the working of a repeater. (5)

Sol:

6.10 TWO WIRE CIRCUITS REPEATERS

Amplifier with associated circuit elements are called repeaters.

Hybrid transformer :

(i) It is a four port network.

(ii) It is used as an impedance matching device.

(iii) it can also be used to provide directional coupling such that a voltage appearing across port 1 will not produce any current at port 2, but will produce currents at port 3 and 4.

(iv) Similarly, a voltage across port 3 will produce currents across ports 1 and 2 but no current across port 4.

(v) Hybrid coil (transformers) are balanced differential transformers by means of which the two wire lines are converted to four wire lines.

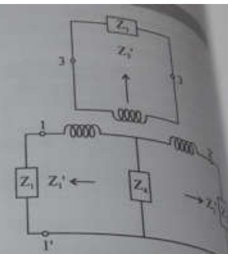

Fig. 6.30 : Hybrid Transformer

Two–wire repeater circuits

Types of voice frequency repeaters are :

(i) single amplifier two–wire repeater, *(ii)* two amplifier two–wire repeater,

(iii) four wire repeater, and, *(iv)* negative impedance repeater.

The two wire lines is converted to a four wire line at each repeater installation and then amplification of speech can be obtained from the two directions of transmission.

Single amplifier two–wire repeater

(i) It requires only one amplifier and a hybrid transformer.

(ii) **Function of hybrid transformer :**

It enables the amplifier which can amplify only in one direction to amplify signals coming from west and east lines.

(iii) Because of the hybrid transformer, if the impedance of west line is equal to the east line, i.e. of $Z_1 = Z_2$, then any voltage coming at port 4 does not go to port 3, but is equally divided towards port 1 and 2.

(iv) Similarly, if $Z_3 = Z_4$ any voltage coming at port 1 or 2 does not go to the opposite port but is divided equally between port 3 and 4.

(v) let the loss suffered by a speech wave of level 1 db in travelling over the west line be L dB.

(vi) If the input impedance of the repeater is the same as the two–wire line, the transformer will give rise to a 3 dB loss.

(vii) So, after passing through the hybrid coil, its level at the input of the amplifier is $1 - L - 3$ dB.

(viii) If the gain of the amplifier is A db, then the level at the port 4 is $1 - L - 3 + A$ dB.

(ix) It's level at port 2, and therefore at east line is $1 - L - 3 + A - 3$ db i.e. $1 - L + A - 6$ dB.

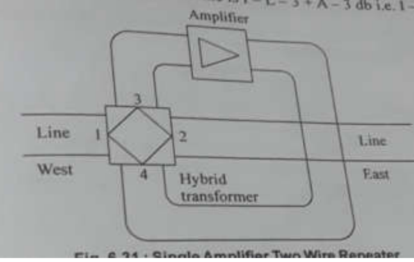

Fig. 6.21 : Single Amplifier Two Wire Repeater