slightly. This is possible only in open wire and therefore on co axial line, single stub matching may become inaccurate in practice

Practically the two stubs must be separated by a distance $\frac{\lambda}{16}, \frac{\lambda}{8}, \frac{3\lambda}{16}, \frac{3\lambda}{8}$ etc. But the most commonly used separation between the two stubs.

PART A

1. **State the disadvantages of reflection**

   i) Reflected wave appears as echo at the sending end

   ii) The efficiency is reduced

   iii) Since some part of the energy is rejected by the load, the output reduces.

2. **What are the primary and secondary constants of the line?**

   The constants which do not vary with frequency like, R, L, G and C are called primary constants of the line. The constants which vary with frequency like $\propto, \beta, \gamma$ and Z_0 are called secondary constants of the line.

3. **What is a transmission line and its types?**

   The electrical lines which are used to transmit the electrical waves along them are called transmission lines. It is a conductive method of guiding electrical energy from one place to another. Various types are open-wire lines, cables, co-axial line, and waveguides.

4. **Define characteristic impedance**

   It is defined as the ratio of voltage to current at the input of an infinite line. It is independent of length of the line and the terminating load. It is dependent on the characteristics of the line per unit length,

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

   R is the series resistance per unit length of the line

   L is the series inductance per unit length of the line

   G is the shunt conductance between conductors

   C is the shunt capacitance between conductors

5. **What are the significances of characteristic impedance?**

   a) When the line is terminated in its characteristic impedance, there is no reflection

   b) A line of finite length terminated in characteristic impedance acts as an infinite line.

   c) When a uniform transmission line is terminated in its characteristic impedance. Its Input impedance will be equal to the characteristic impedance.

   d) A network terminated in characteristic impedance at the input as well as at the output terminals is said to be correctly terminated network.

6. **Define *propagation constant***

   It is defined as the natural logarithm of ratio of current or voltage at any point to that at a point unit distance away from the first point. $\gamma = \left[\frac{I_1}{I_2}\right]$ or $\gamma = \left[\frac{V_1}{V_2}\right]$. Propagation constant is a complex quantity and can be represented as $\gamma = \propto + \beta$ where $\propto$ is the attenuation constant and β is the phase constant. It is also represented as $\gamma = \sqrt{(R + j\omega L)(G + J\omega C)}$

7. **Define attenuation constant**

When the signal flows from the sending end to the receiving end it gets attenuated. The attenuation constant $\propto$ indicates the rate at which the signal gets attenuated while flowing along the line. It is measured in nepers/km or dB/km.

8. **Define phase constant**

When the signal travels along the line, its phase changes because of distortions. The phase constant β indicates the rate at which the phase of the signal changes along the line. It is measured in radians/km or degrees/km.

9. What is wavelength of a line?

The distance that a wave travels along the line in order that the total shift is 2π radians. It's unit is meter. $\lambda = 2\pi / \beta$ where β is the phase constant.

10. For a transmission line terminated in Z_0 prove that (i) $Z_0 = \sqrt{\frac{Z_{OC}}{Z_{SC}}}$

$Z_{OC} = Z_0/\tanh\gamma l \; and \; \frac{Z_0}{\tan h\gamma l}$

$$Z_{OC} Z_{SC} = \frac{Z_0}{tanh\gamma} . Z_0 \, tanh\gamma l$$

$$Z_{OC} Z_{SC} = Z_0^2$$

$$\sqrt{\frac{Z_{OC}}{Z_{SC}}} = Z_0$$

$$\sqrt{\frac{Z_{OC}}{Z_{SC}}} = \frac{\sqrt{\frac{Z_0}{tanh\gamma l}}}{\frac{Z_0}{tanh\gamma l}}$$

$$\sqrt{\frac{Z_{OC}}{Z_{SC}}} = tanh\gamma l$$

11. What is the application of the quarter wave matching section?

a. One of the important applications is the impedance transformation in coupling a transmission line to a resistive load such as an antenna.

b. The quarter wave line may be used to provide mechanical support to the open wire line or centre conductor of coaxial cable.

12. Explain impedance matching using stub.

Another mean of accomplishing impedance matching is the use of an open or short circuited line of suitable length, called stub at a designated distance from the load. This is called stub matching. There are two types of stub matching. They are

i) Single stub matching

ii) Double stub matching

13. Give the formula to calculate the length of the short circuited stub.

Single stub:

The desired length of the stub l_t to be yield b_s is,

$$bs = \frac{\lambda}{2\pi} tan^{-1} \sqrt{\frac{Z_R Z_0}{Z_R - Z_0}}$$

Double Stub:

Stub1 is located at point AA[1] at a distance l = d, from the load. $Y_S = g_i + jb_i$

When a stub 1 having a susceptance jb_i is added at this point, the new admittance value will be, $Y_s^1 = g_i$. The point BB[1] should located such that the normalized admittance at this point is given by, $Y_B^1 = 1 + jbe$. Finally the length of stub 2 is adjusted such that susceptance of the stub 2 is $\mp jb_2$. Practically the two stubs must be separated by a distance $\frac{\lambda}{16}, \frac{\lambda}{8}, \frac{3\lambda}{16}, \frac{3\lambda}{8}$ etc. But the most commonly used separation between the two stubs.

14. List the applications of the smith chart.

1. Plotting an impedance
2. Measurement of VSWR
3. Measurement of reflection coefficient K [magnitude and phase]
4. Measurement of I/P impendence of the line
5. Impendence to admittance conversion

12. Write a note on smith chart.

"Smith Chart is a special polar diagram containing constant resistance circles, constant reactance circles, circles of constant standing wave ratio and radius lines representing line-angle loci; used in solving transmission line and waveguide problems" The basic difference between circle diagram and smith chart is that in the circle diagram the impedance is represented in a rectangular form while in the smith chart the impedance is represented in a circular form. Smith Chart is based on two sets of orthogonal circles. The tangents drawn at the points of intersection of two circles would be mutually perpendicular one set of circles represent the rate of the resistive component(R) of the line impedance to the characteristic impedance (Zo) of the line, which for a lossless line is purely resistive. The second set of circles represent the ratio of the reactive component(X) of the line impedance to the characteristic impedance (Zo) of the line.

13. What are the difficulties in single stub matching?

The main disadvantage is that this technique is suitable for fixed frequency only. So as frequency changes, the location of the stub will have to be changed. Another disadvantages is that, for adjusting the stub for final position, along the line, the stub has to be moved or repositioned. This is possible for open wire conductor transmission line. But in case of co-axial cable it is difficult to locate Vmin point
without a slotted section.

14. Give reason for an open line not frequently employed for impedance matching.

At high frequencies, open circuited stubs radiated some energy which is not the case with short circuited stub. Hence over open circuited stubs, short circuited stubs are preferred.

14. Why Double stub matching is preferred over single stub matching?

The main disadvantage of single stub matching is that this technique is suitable for fixed frequency changes the location of the stub will have to be changed. Another disadvantage is that, for adjusting the stub for final position along the line, the stub has to be moved or repositioned. To overcome the disadvantages a double stub impedance matching technique is used. In this technique two different short circuited stubs of length l_1 and l_2 are used for impedance matching.

15. Write a note on quarter wave line.

A quarter wave line may be used as a transfer for impedance matching of load Z_R with input impedance $Z_{in} = Z_R$. For matching impedance Z_R& Z_{in}, the line characteristic impedance R_0 may be selected such that conditions.

$$R_0 = \left|\sqrt{Z_R}.Z_{in}\right|$$

A quarter wave line can transform a low impedance into a high impedance and vice versa, thus it can be considered as an impedance inverter.

16. Write the properties of smith chart.

1. The smith chart may be used for impedance as well as for admittance.
2. The smith chart consists of constant x; - circles & constant x; circles super positioned on the chart. The values of r; and x; are normalized and they are given by r;=$\frac{R}{R_0}$ and x; =$\frac{jxR}{R_0}$
3. The smith chart is based on the assumed that $1 - |K| \llcorner \phi - 2\beta_S = \mu + jV$. The maximum magnitude of U + jV is the maximum value of $|K|$ie, unity.
4. For properly terminated line and any length the impedance is represented by the point (1,0) which acts as the centre of the smith chart.
5. The outer rim of the chart is scaled into either degrees or wavelengths with an arrow. This arrow indicates the direction of travel along the line. The circles called βSscale of the chart which indicates the electric length of the line.

17. What is the relation between primary constant and secondary constants of the line

- **characteristic impedance**

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

- **propagation constant**

$$\gamma = \sqrt{(R + j\omega L)(G + J\omega C)}$$

18. Write the Comparison between Transmission lines and Waveguides

S.No	Waveguides	Transmission lines
1	Wave having frequency greater than the cut off frequency fc only will be propagated. Hence	All frequency can be passed through.

	wave guide acts as a high pass filter with fc as cut off frequency	
2	One conductor system. The whole body of the wave guide acts as ground and wave propagates through multiple reflection from the walls of the waveguide.	Two conductor system.
3	Wave Impedance	Characteristic Impedance
4	Propagation waves in wave guide is accordance with field theory.	It is in accordance with circuits.
5	Any irregularity in wave guide produces reflection.	Any irregularity in a transmission line produces reflection.

PART B

1. i. A transmission line has the following per unit length parameters : L = 0.1µ H, R=5 ohms, C = 300 pF and G = 0.01 mho. Calculate propagation constant and characteristic impedance at 500 MHz. (8)

   ii. Characteristic impedance of transmission line at 8 MHz is (40-2j) Ω and the propagation constant is (0.01 + j 0.18) per meter. Find the primary constants. (8)
2. i. Explain the parameters of Transmission lines.

   ii. Derive the Expression for the line at Cascade T section also fond Z_0 and γ. (8)
3. i. The characteristic impedance of a uniform transmission line is 2309.6 ohms at a frequency of 800 MHz. At this frequency, the propagation constant is 0.054(0.0366 + j 0.99). Determine Rand L. (6)

   ii. A transmission line has L=10mH/m, C= 10^{-7} F/m R=20Ω/m G=10^{-5}mho/m find the input impedance of the line at $\left[\frac{5000}{2\pi}\right]$Hz if the line is very long. (10)
4. A generator of 1 volts 1000 cycles supplies power to a 100 KHz open wire line terminated in 200 Ω Resistance with following Parameters R=10.4 Ω/ KHz L=0.00367H/ KHz G=0.8 µ f / KHz C= 0.00835µ ℧ / KHz. Calculate Z_o, propagation constant and transmission efficiency.(16)
5. i. Derive the equation of attenuation constant and phase constant of TL in terms of R, L, C, G? (8)

   ii. Explain about Wave equations? (4)

   iii. Explain Reflection discontinuities (4)
6. A generator of 1 volts 1000 cycles supplies power to a 100 miles open wire line terminated in Z_o with following Parameters R=10.4 Ω/miles L=0.00367H/miles