PART A

1. **What are lumped and distributed parameters?**

The parameters which are physically separable and can be shown to be at one place in the circuit in the lumped form are lumped parameters. The parameters which are not physically separable and are distributed all over the length of the circuit like transmission line are called distributed parameters. The distributed parameters are R, L, G & C.

2. **State the properties of infinite line.**

i) It is like finite line terminated in Z_0

ii) No energy is reflected from the load. Hence known as smooth line.

3. **State the conditions for minimum attenuation with L and C variable**

With L variable, $L = \frac{CR}{G}$

With C variable, $C = \frac{LG}{R}$

In general, RC = LG or $\frac{R}{G} = \frac{L}{C}$

4. **What should be the values for R and G for minimum attenuation?**

Ideally R and G must be Zero for Zero attenuation

Practically R and G must be as small as possible for minimum attenuation.

5. **What are the various types of distortions?**

(i) Due to Z_0 varying with frequency

(ii) Frequency distortions due to $\propto$ varying with frequency

(iii) Phase distortion due to β varying with frequency due to which velocity varies with frequency.

6. **State the condition for distortion less line and what are the value of $\propto$ and β for distortion less line.**

RC = LG

$\propto = \sqrt{RG}$ and $\beta = \omega\sqrt{LC}$

7. **State the advantages and disadvantages of continuous loading**

Adv: (i) $\propto$ is independent of frequency.

(ii) Attenuation can be reduced by increasing L, provided R is not increased greatly. Thus no distortions.

Disadv:(i) Costly method

(ii) Existing lines cannot be modified

(iii) Size and capacitance increases

(iv) Large eddy current and hysteresis losses

8. **What is patch loading?**

In submarine cables, the cable is not loaded continuously but loaded cable is separated by the section of unloaded cable. Such a loading is called patch loading.

9. **What is the importance of cut-off frequency in lumped loading?**

In the lumped loading, the line behaves like low pass filter. Up to the cut-off frequency it behaves properly. Once cut-off frequency is crossed, $\propto$ increases rapidly. Hence cut-off frequency must be designed as high as possible.

10. **State the advantages of lumped loading**

(i) L can be increased to any value
(ii) Cost is small
(iii) The existing lines can be modified
(iv) Losses are small

11. **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.

12. **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.

13. **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.

14. **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

15. **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.

16. **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. $\gamma = [I_1/I_2]$ or $\gamma = [V_1/V_2]$. 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 $\gamma = \sqrt{(R + j\omega L)(G + J\omega C)}$

17. **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.

18. **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.

19. **What is the general from of voltage and current at any point on the transmission line?**

$$E = E_R(Z_R + Z_0)/2Z_R[e^{\gamma S} + \left(Z_R + \frac{Z_0}{Z_R} + Z_0\right) e^{-\gamma S}]$$

$$I = I_R(Z_R + Z_0)/2Z_0[e^{\gamma S} - \left(Z_R - \frac{Z_0}{Z_R} + Z_0\right) e^{-\gamma S}] \qquad \text{Or}$$

$$E = E_R \text{Cosh}\, \gamma s + I_R Z_0 \sinh\gamma s$$

$$I = I_R \text{Cosh}\, \gamma s + E_R/Z_0 \sinh\gamma s, \text{ where } \gamma = \sqrt{ZY}$$

E_s is the receiving end voltage, Z_R is the terminating impedance, s is the distance measured from the receiving end to the point of observation, Z_0 is characteristic impedance, Z is series impedance and Y is shunt admittance.

20**. 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.

21. **Define velocity of propagation**

Velocity with which a wave travels along the line to complete one cycle is called velocity of propagation. It is also defined as the velocity with which a signal of single frequency propagates along the line at a particular frequency f. $V_P = \omega/\beta$

22. **What is waveform distortion?**

When the received signal is not the exact replica of the transmitted signal, then the signal is said to be distorted. Two types of distortion are frequency distortion and phase distortion.

23. **Define reflection coefficient**

The ratio of amplitudes of reflected voltage wave to the incident voltage wave at the receiving end is called reflection coefficient $K = (Z_R - Z_0)/(Z_R + Z_0)$ Z_R is the terminating impedance and Z_0 is characteristic impedance. The sign of K is dependent on angles and magnitudes of Z_R and Z_0

24. **What are the required conditions for a distortion less line?**

a) Should not have frequency and phase distortion

b) $\propto$ and V_P should not be the functions of frequency.

c) LG = RC where R is the series resistance per unit length of the line. L is the series inductance per unit of length of the line, G is the shunt conductance between conductors and C is the shunt capacitance between conductors.

25. **What are the features of telephone cable?**

a) It is an underground cable which consists of twisted pairs of cables insulated with paper.

b) In the audio frequency range, inductance and conductance is very small and can be neglected.

c) Both $\propto = \frac{\sqrt{\omega RC}}{2}$ and $V_P = \sqrt{2\omega/RC}$ contain frequency componenet. Hence frequency and phase distortions are dominant.

d) The velocity of propagation V_P is directly proportional to $\omega(2\pi f)$. Hence as frequency increases, the waves propagate very fast.

26. **What is loading?**

The condition for distortion less line is LG=RC. If the primary constants do not satisfy this condition, then it is achieved artificially by increasing inductance L. This process is called loading of a line. Two types of loading are continuous loading and lumped loading.

27. **State the Campbell's equation**

$\text{Cos}(N\gamma') = [Z_0 \sinh(N\gamma)/2Z_0] + \cosh(N\gamma)$ where γ' is the propagation constant of loaded line. γ is the propagation constant of unloaded line, $Z_C$is the impedance of loading coil, N is number of miles between coils and is Z_0 characteristic impedance.

28. **What is transfer impedance? State its expression**

The ratio of sending end voltage to the receiving end current is called transfer impedance.

$Z_R = E_S/I_S$ where E_S is sending end voltage and I_R is receiving end current.

$$Z_r = Z_R \cosh \gamma s + Z_0 \sinh \gamma s$$

29. **What is reflection factor?**

The ratio of current actually flowing in the load to that which would flow under matched condition is called reflection factor. It is denoted as k.

$K = 2\sqrt{Z_1 Z_2}/[Z_1 Z_2]$ where Z_1 is the source impedance andZ_2 is the load impedance.

30. **What is reflection loss?**

The reflection loss is defined as the number of nepers or decibels by which the current in the load under impedance matched conditions would exceed the current actually flowing through the load, Reflection loss in nepers in
ln [($Z_1Z_{2)}$ /2 $\sqrt{Z_1Z_2}$]. Reflection loss in decibel is 20 log [($Z_1Z_{2)}$ /2 $\sqrt{Z_1Z_2}$].

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

$$Z_{OC} = Z_0/\tanh\gamma l \text{ and } Z_0/\tanh\gamma l$$
$$Z_{OC}Z_{SC} = Z_0/\tanh\gamma \,.\, Z_0 \tanh\gamma l$$
$$Z_{OC}Z_{SC} = Z_02$$
$$\sqrt{Z_{OC}/Z_{SC}} = Z_0$$
$$\sqrt{Z_{OC}/Z_{SC}} = \sqrt{Z_0/\tanh\gamma l\,)}/Z_0/\tanh\gamma l$$
$$\sqrt{Z_{OC}/Z_{SC}} = \tanh\gamma l$$

PART – B

1. Obtain the general solution of Transmission line?
2. Explain about waveform distortion and distortion less line condition?
3. Explain about insertion loss?
4. Discuss in details about inductance loading of telephone cables and derive the attenuation constant and phase constant and velocity of signal transmission for the uniformly loaded cable?
5. Derive the equation of attenuation constant and phase constant of TL in terms of R, L, C, G?
6. Explain in details about the reflection on a line not terminated in its characteristic impedance (z_0)?
7. Explain in following terms
   (i) Reflection factor (ii) Reflection loss (iii) Return loss
8. Explain about physical significance of TL?
9. Derive the equation for transfer impedance?
10. Derive the expression for input impedance of lossless line?
11. Explain about telephone cable?
12. Explain about different type of TL?
13. A line has R = 8.4 ohm/km, L = 2.67 mH/km, G = 1.8 μ mho/km and C = .00835μF/km. Determine Z_o, γ, V for f = 1000 Hz. Vs = 4.0 volts and length = 100 km.
14. A telephone cable 34 km long has a R = 23 ohm/km and C = 0.008 μF/km. Calculate attenuation constant, velocity and wavelength of line at 2000 Hz.