1. (a) A typical PCB substrate consists of Al_2O_3 with a relative dielectric constant of 10 and a loss tangent of 0·0004 at 10 GHz. Find the conductivity of substrate. 5

(b) Starting with basic definition for the Standing Wave Ratio (SWR) :— 5

$$SWR = \frac{|V_{max}|}{|V_{min}|} = \frac{|I_{max}|}{|I_{min}|}$$

Show that it can be re-expressed as,

$$SWR = \frac{1+|\Gamma_0|}{1-|\Gamma_0|}$$

(c) For GaAs we find at T = 300 °K the effective densities of state $N_C = 4{\cdot}7 \times 10^{17}$ cm^{-3}, $N_V = 7{\cdot}0 \times 10^{18}$ cm^{-3}. Assuming that the band gap energy of 1·42 eV remains constant, 5

(i) Find the intrinsic carrier concentration at room temperature.

(ii) Compute n_i at T = 400 °K.

(d) Explain simplified Ebers-Moll model for forward active mode of transistor. 5

2. (a) A 100 Ω microstrip line is connected to a 75 Ω line. Determine Γ, SWR, percentage power reflected, return loss, percentage power transmitted and insertion loss. 10

(b) Derive expressions for internal, external and loaded quality factors for the standard series and parallel resonance circuit. 10

3. (a) An abrupt pn-junction made of Si has the acceptor and donor concentrations of $N_A = 10^{18}$ cm^{-3} and $N_D = 5 \times 10^{15}$ cm^{-3}, respectively. Assuming that the device is at room temperature. Determine — 10

(i) barrier voltage

(ii) the space charge width in the p and n type semiconductors.

(b) An unknown load impedance is connected to a 0·3 λ long, 50 Ω lossless transmission line. The SWR and phase of the reflection coefficient measured at the input of line are 2·0 and –20 °, respectively. Using the Smit chart, determine the input and load impedances. 10

4. (a) An N = 3 Chebyshev bandpass filter is to be designed with a 3 dB passband ripple for a communication link. The centre frequency is at 2·4 GHz and the filter has to meet a bandwidth requirement of 20 %. The filter has to be inserted into a 50 Ω characteristic line impedance. Find inductive and capacitive elements. Show the attenuation response from 1 to 4 GHz. 12

(b) Explain Schottky diode with cross sectional view and circuit model. 8

5. (a) Obtain the h-parameter representation for a BJT in common base configuration, neglecting base, emitter and collector resistances (r_B, r_E and r_C). **10**
   (b) Explain construction and functionality of High Electron Mobility Transistor. **10**

6. (a) Prove the first three Kuroda's identities by computing the appropriate ABCD matrices. **10**
   (b) A radio transmitter is capable of producing 3 W output power. The transmitter is connected to an antenna having characteristic impedance of 75 Ω. The connection is made using lossless co-axial cable with a 50 Ω characteristic impedance. Calculate the power delivered to antenna if the source impedance is 45 Ω and cable length is 11 λ. **10**

7. Write short notes on :—
   (a) RF behaviour of resistor **5**
   (b) Micro strip Transmission Lines **5**
   (c) Butterworth filter **5**
   (d) Measurements of AC parameters of BJT. **5**

Table Chebyshev filter coefficients; 3 dB filter design (N = 1 to 10)

N	g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9	g_{10}	g_{11}
1	1.9953	1.0000									
2	3.1013	0.5339	5.8095								
3	3.3487	0.7117	3.3487	1.0000							
4	3.4389	0.7483	4.3471	0.5920	5.8095						
5	3.4817	0.7618	4.5381	0.7618	3.4817	1.0000					
6	3.5045	0.7685	4.6061	0.7929	4.4641	0.6033	5.8095				
7	3.5182	0.7723	4.6386	0.8039	4.6386	0.7723	3.5182	1.0000			
8	3.5277	0.7745	4.6575	0.8089	4.6990	0.8018	4.4990	0.6073	5.8095		
9	3.5340	0.7760	4.6692	0.8118	4.7272	0.8118	4.6692	0.7760	3.5340	1.0000	
10	3.5384	0.7771	4.6768	0.8136	4.7425	0.8164	4.7260	0.8051	4.5142	0.6091	5.8095