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WINTER-19 EXAMINATION

Subject Name: Microwave and RADAR **Subject Code: 22535**

Model Answer

1

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1	**(A)**	**Attempt any FIVE of the following:**	**10- Total Marks**
	(a)	**State the frequency range for following bands:** **(i) C Band** **(ii) X Band** **(iii) K Band** **(iv) Ku Band**	**2M**
	Ans:	(i) C Band = 4 GHz to 8 GHz (ii) X Band = 8 GHz to 12.5 GHz (iii) K Band = 18 GHz to 26.5 GHz (iv) Ku Band = 12.5 GHz to 18 GHz	**Correct frequency range for each band ½ M**
	(b)	**State different types of waveguides.**	**2M**

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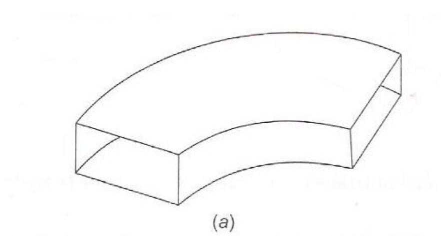
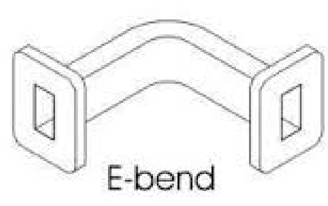
Model Answer

2

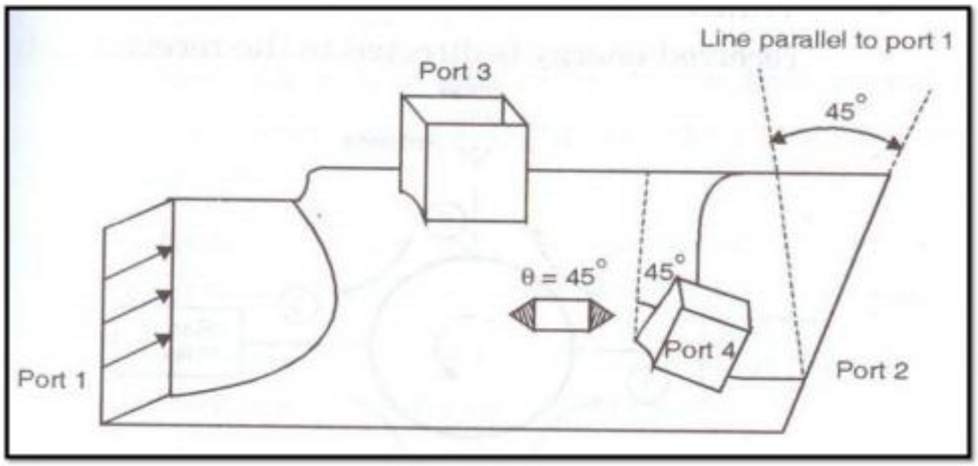
	Ans:	Types of waveguides (1) Rectangular waveguide (2) Circular waveguide (3) Elliptical waveguide	**Any two types 2M**
	(c)	**State the name of Tee Joint used as Duplexer and Mixer.**	**2M**
	Ans:	E-H plane Tee Joint used as Duplexer and Mixer.	**Correct answer 2M**
	(d)	**Draw neat sketch of bends.**	**2M**
	Ans:	 H-PLANE BEND OR  E-PLANE BEND	**Any one diagram 2M**
	e)	**List any two applications of PIN diode.**	**2M**
	Ans:	Applications of PIN diode: (1) It is used as switch. (2) It is used as phase shifter. (3) It is used as amplitude modulator. (4) It is used as limiter.	**Any 2 application 2 M**
	f)	**List the two advantages and two disadvantages of CW RADAR.**	**2M**

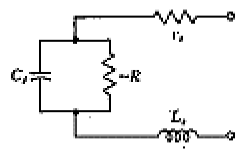
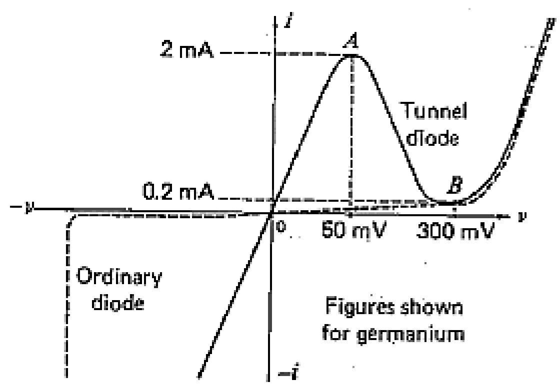
	Ans:	Advantages of CW RADAR. (1) Capable of giving accurate measurement of relative velocity. (2) Low transmitting powers. (3) Compact hence can be used for mobile applications like police radar. (4) Single frequency transmission and hence narrow receiver bandwidth. (5) Zero minimum range. (6) Ability to see moving targets in the presence of large echos from stationary target to which it is blind. (7) Simple in design and construction. Disadvantages of CW RADAR. (1) Maximum power transmitted is limited and hence limit on its maximum range. (2) It is unable to measure range. (3) Separate antennas are required for transmitter and receiver. (4) It rather easily confused by the presence of a large number of target.	**Any 2advantages and 2disadvantages 1M each**
	g)	**Give the applications of RADAR.**	**2M**
	Ans:	Applications of RADAR (1) It is used in navigation to measure the speed of distant objects. (2) It is used for measuring speed of cars and trucks. (3) It is used to measure relative velocity of the aircraft. (4) Tracking radar are used on missiles and planes to acquire a target. (5) Police radars for directing and detecting speeding vehicles. (6) Airborne radar for satellite surveillance. (7) Searching for submarines, land masses and buoys. (8) Radar altimeters for determining the height of planes above ground.	**Any 4 correct applications 2M**
Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total Marks**

4

	a)	**Compare waveguide and two wire transmission line (4 points).**	**4M**
	Ans:	(table below)	**Any correct 4 points 4M**
	b)	**State the working principle of circulator with neat sketch and state its two applications.**	**4M**

SR. NO.	WAVEGUIDES	TRANSMISSION LINES
1.	It acts as a High Pass Filter	All frequencies can pass through.
2.	It is one conductor transmission system. The whole body of the waveguide acts as ground. The wave propagates through multiple reflections from the walls of waveguide (WG).	It consists of two conductors. One or both conductors are used to carry the wave.
3.	The system of propagation in waveguide is in accordance with field theory.	The system of propagation in transmission line (TL) is in accordance with circuit theory.
4.	TE and TM modes exist in WG.	TEM mode exists in TL.
5.	Wave impedance (characteristic impedance) is a function of frequency.	Characteristic impedance in TL depends on the physical parameters of TL.
6.	The velocity of propagation of wave in WG is less than the free space velocity.	The velocity of propagation of waves is equal to free space velocity.
7.	WG handles greater power and possesses less resistance.	TL handles less power as compared to WG.
8.	Lower signal attenuation at high frequencies than TL.	Significant signal attenuation at high frequencies due to conductor and dielectric losses.

	Ans:	**Circulator:** **Diagram :**  working principle of circulator: 1. A four port Faraday rotation circulator is shown in figure above. The power entering port 1 is $TE_{1,0}$ mode and is converted to $TE_{1,1}$ mode because of gradual rectangular to circular transition. 2. This power passes port 3 unaffected since the electric field is not significantly cut and is rotated through 45° due to the ferrite, passes port 4 unaffected and finally emerges out of port 2. 3. Power from port2 will have plane of polarization already tilted by 45° with respect to port 1. This power passes port 4 unaffected because again the electric field is not significantly cut. This wave gets rotated by another 45° due to the ferrite rod in the clockwise direction. This power whose plane of polarization is tilted through 90° finds port 3 suitably aligned and emerges out of it. 4. Similarly port 3 is coupled only to port 4 and port 4 only to port 1. Two applications: (1) It can be used as duplexer for a radar antenna system. (2) It can be used as coupling elements in reflection amplifier. (3) It can be used as an isolator.	**for neat sketch &** **working principle** **1.5M each** **Any two applications 1M**
	c)	**Draw equivalent circuit and VI characteristics of Tunnel diode.**	**4M**
	Ans:	**Equivalent circuit of Tunnel diode.**	**equivalent circuit**

		 Tunnel-diode equivalent circuit. **VI characteristics of Tunnel diode.**  Tunnel-diode voltage-current characteristic.	**and VI characteristics,2 M each**
	d)	**Describe with relevant sketch the working principle of the 'A' type of display used in RADAR system.**	**4M**
	Ans:	A-scope Display : • A beam is made to scan the CRT screen horizontally by applying a linear saw tooth voltage to the horizontal deflection plates in synchronism with the transmitted pulses. • The demodulated echo signals from the receiver is applied to the vertical deflection plates so as to cause vertical deflections from the horizontal lines. • In the absence of any echo signal, the display is simply a horizontal line(as in a ordinary CRO) • As indicated in the diagram, A-scope displays range v/s amplitude of the received echo signals. • The first 'blip' is due to the transmitted pulse, part of which is deliberately applied to the CRT for reference.	**Sketch & working principle** **2M each**

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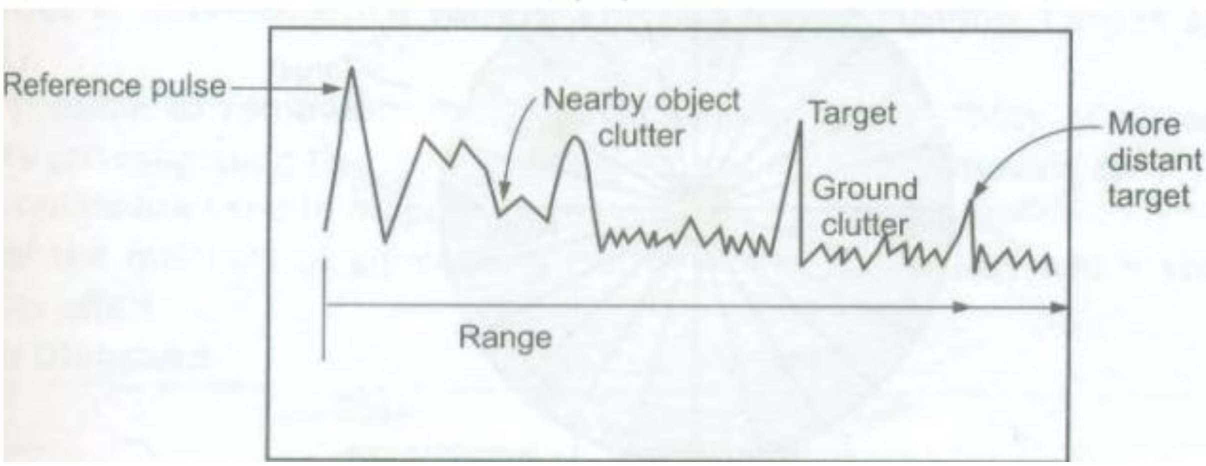
Model Answer

In addition to this there are blips corresponding to:

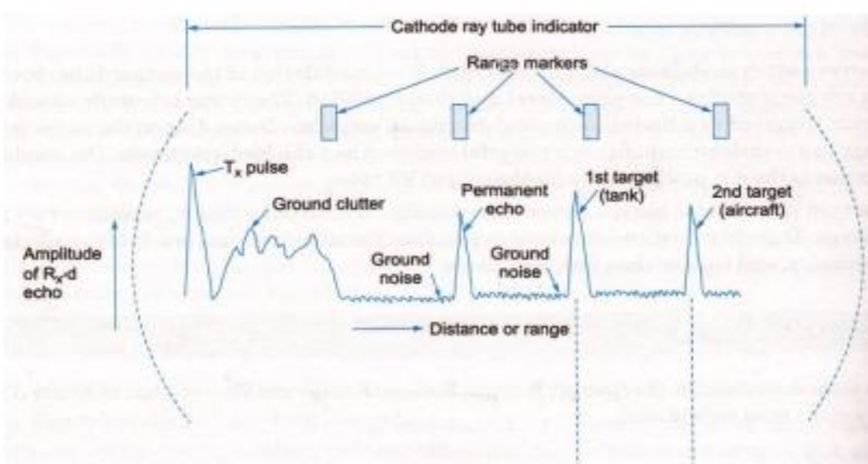
i. Ground clutter i.e., echoes from various fixed objects near the transmitter and from the ground.
ii. Grass noise i.e., an almost constant amplitude and continuous receiver noise.
iii. Actual targets. These blips are usually large.

Diagram for A-scope display



Or

Diagram :



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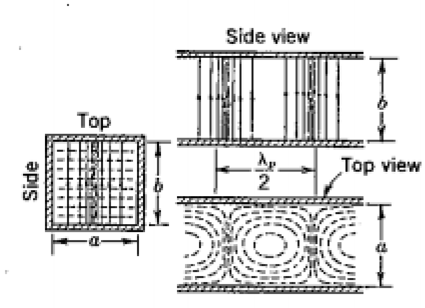
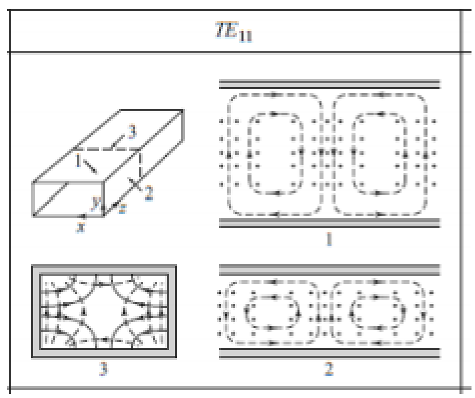
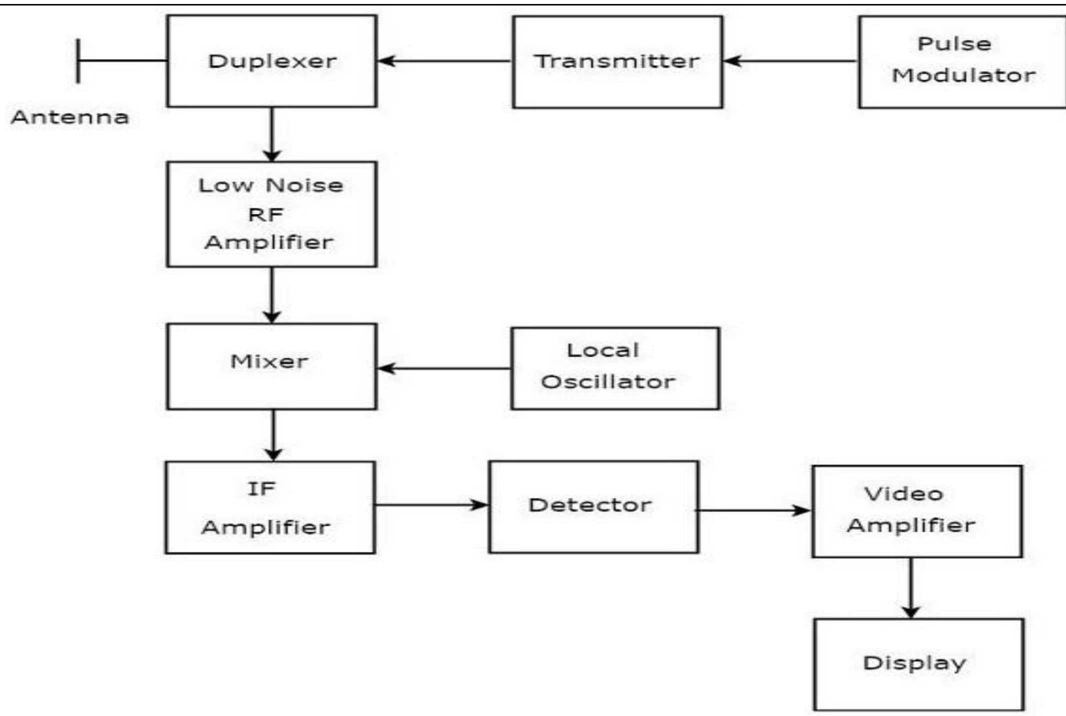
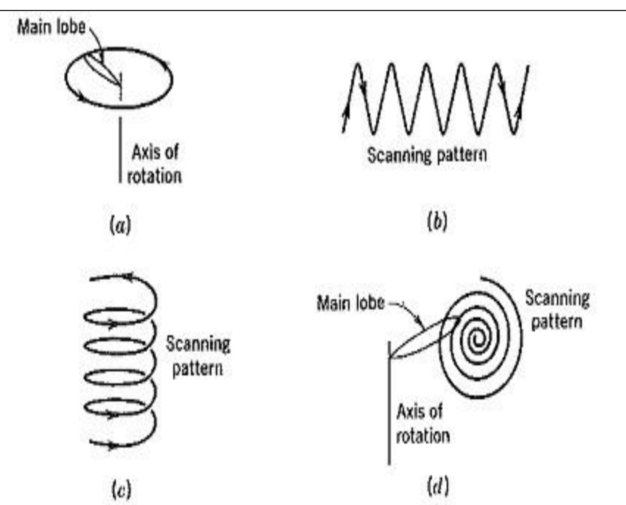
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	a)	**Sketch the field pattern of TE_{10} and TE_{11} modes of rectangular waveguide.**	**4M**
	Ans:	**TE10** **TE11**  (a) $TE_{1,0}$ mode 	**2M each**
	b)	**Draw the block diagram of pulsed RADAR system. Explain its operation with applications.**	**4M**
	Ans:		**block diagram & operation 1.5 M each** **for any 2 applications 1M**



the operation of Pulse Radar −

- **Pulse Modulator** − It produces a pulse-modulated signal and it is applied to the Transmitter.
- **Transmitter** − It transmits the pulse-modulated signal, which is a train of repetitive pulses.
- **Duplexer** − It is a microwave switch, which connects the Antenna to both transmitter section and receiver section alternately. Antenna transmits the pulse-modulated signal, when the duplexer connects the Antenna to the transmitter. Similarly, the signal, which is received by Antenna will be given to Low Noise RF Amplifier, when the duplexer connects the Antenna to Low Noise RF Amplifier.
- **Low Noise RF Amplifier** − It amplifies the weak RF signal, which is received by Antenna. The output of this amplifier is connected to Mixer.
- **Local Oscillator** − It produces a signal having stable frequency. The output of Local Oscillator is connected to Mixer.
- **Mixer** − We know that Mixer can produce both sum and difference of the frequencies that are applied to it. Among which, the difference of the frequencies will be of Intermediate Frequency (IF) type.
- **IF Amplifier** − IF amplifier amplifies the Intermediate Frequency (IF) signal. The IF

		amplifier shown in the figure allows only the Intermediate Frequency, which is obtained from Mixer and amplifies it. It improves the Signal to Noise Ratio at output. • **Detector** − It demodulates the signal, which is obtained at the output of the IF Amplifier. • **Video Amplifier** − As the name suggests, it amplifies the video signal, which is obtained at the output of detector. • **Display** − In general, it displays the amplified video signal on CRT screen. **Applications-** Military purpose • Remote sensing • Air traffic control • Weather interpretation • Ground probing • Aircraft safety & navigation • Tracking of icebergs on the sea • Planetary research • Highway safety and enforcement of speed limit system	
	c)	**Explain the relevant sketch the scanning methods used for RADAR.**	4M
	Ans:	 FIGURE 16-6 Representative antenna scanning patterns. (a) Horizontal; (b) nodding; (c) helical; (d) spiral.	**(2 marks for diagram ,2 marks brief explanation)**

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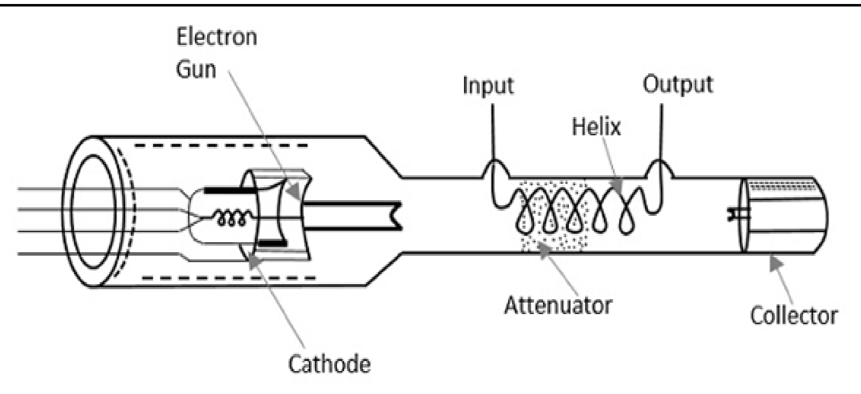
		Horizontal scan – The horizontal scan is the simplest antenna scan but a disadvantage of this scanning in the horizontal plane only however there are many applications for this type of scanning used. Helical scan – The radar antenna is continuously related to azimuth while it is simultaneously increase or decrease in an elevation. Spiral scan- If a limited area of more or less circular shape is to be covered, then the spiral scan may be used. Nodding scan- The nodding scan is produced by rocking the radar antenna rapidly in elevation and rotating more slowly in azimuth the scanning in both plane is obtained**.**	
	d)	**Describe the working principle of TWT and state its two applications.**	**4M**
	Ans:	 Physical construction of TWT Consider a typical TWT shown in above fig. An electron gun produces very narrow beam of electrons which travel through long axial helix. The electron beam is attracted towards the collector and acquires high velocity. the signal to be amplified is applied to the input terminal of helix through waveguide.	**(2 marks diagram, 2 marks for applications any two)**

		The travelling wave travels with speed equal to the speed of light. the axial speed of RF field is equal to the speed of light multiplied by ratio of helix pitch to circumference. The axial RF field and the electron beam can now interact continuously with electron beam bunching. As a result, complete bunching takes place and achieve high gain. Applications- • TWT is used in microwave receivers as a low noise RF amplifier. • TWTs are also used in wide-band communication links and co-axial cables as repeater amplifiers or intermediate amplifiers to amplify low signals. • TWTs have a long tube life, due to which they are used as power output tubes in communication satellites. • Continuous wave high power TWTs are used in Troposcatter links, because of large power and large bandwidths, to scatter to large distances. • TWTs are used in high power pulsed radars and ground based radars.	
Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any THREE of the following :**	**12- Total Marks**
	(a)	**Describe the operation with construction diagram IMPATT diode. State its two applications.**	**4M**

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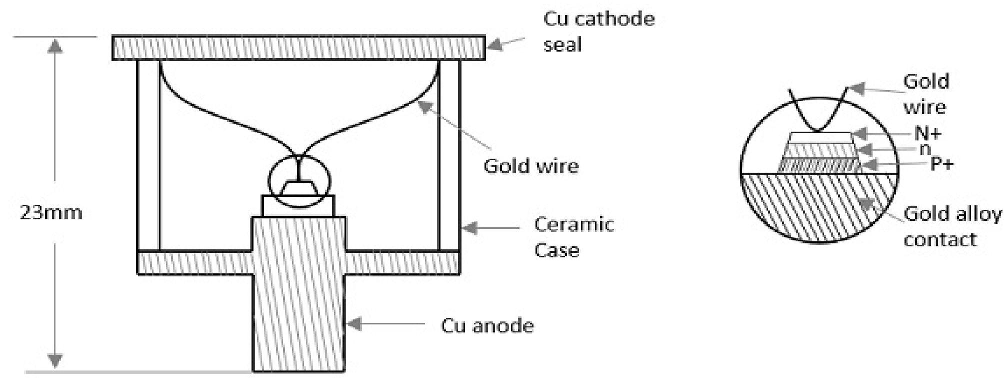
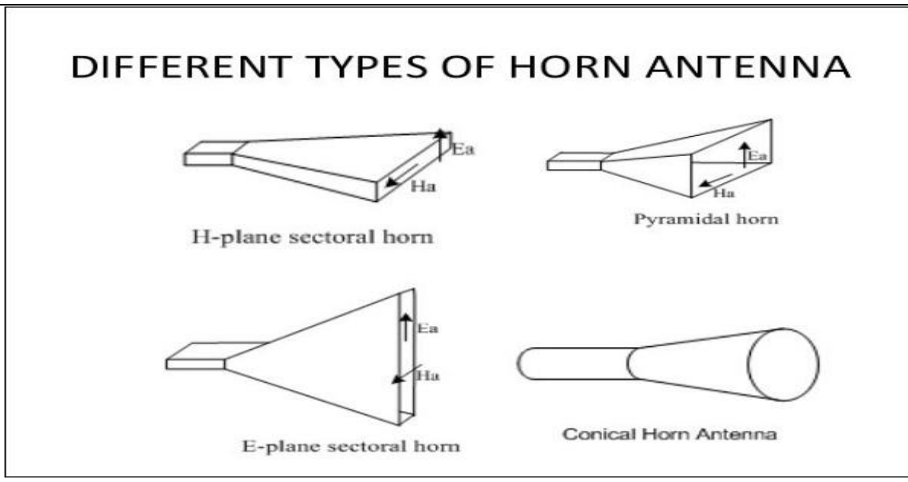
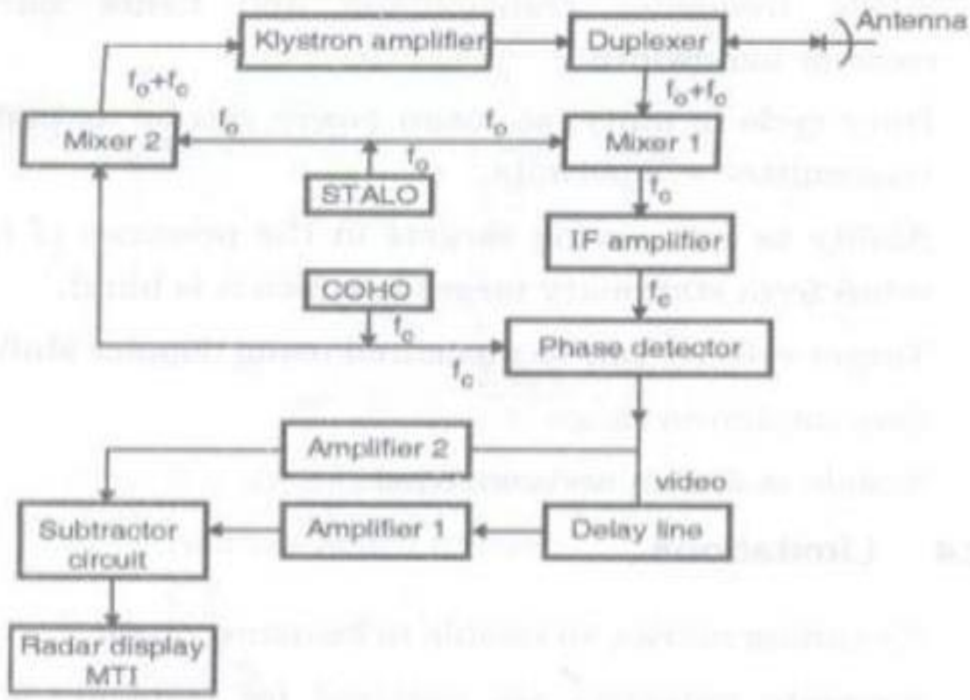
Model Answer

	Ans:	 Constructional details of IMPATT This is a high-power semiconductor diode, used in high frequency microwave applications. The full form IMPATT is **IMPact ionization Avalanche Transit Time diode**. A voltage gradient when applied to the IMPATT diode, results in a high current. A normal diode will eventually breakdown by this. However, IMPATT diode is developed to withstand all this. A high potential gradient is applied to back bias the diode and hence minority carriers flow across the junction. Application of a RF AC voltage if superimposed on a high DC voltage, the increased velocity of holes and electrons results in additional holes and electrons by thrashing them out of the crystal structure by Impact ionization. If the original DC field applied was at the threshold of developing this situation, then it leads to the avalanche current multiplication and this process continues. **Application –** 1. Microwave generators 2. Modulated output oscillators 3. Receiver local oscillators 4. High Q IMPATTs are used in Intrusion alarm network, police radar and low power microwave transmitters. 5. Low Q IMPATTs are useful in FM transmitters and CW Doppler radar transmitters.	**For diagram and working, 1.5 marks each** **for any two applications 1M**
	(b)	**Explain the working principle of Horn Antenna with neat sketch.**	**4M**

	Ans:	 Working of Horn Antenna A horn antenna is used to transmit radio waves from a waveguide (a metal pipe used to carry radio waves) out into space, or collect radio waves into a waveguide for reception. It typically consists of a short length of rectangular or cylindrical metal tube (the waveguide), closed at one end, flaring into an open-ended conical or pyramidal shaped horn on the other end. The radio waves are usually introduced into the waveguide by a coaxial cable attached to the side, with the central conductor projecting into the waveguide to form a quarter-wave monopole antenna. The waves then radiate out the horn end in a narrow beam.	**2 marks diagram, 2 marks for working**
	(c)	**Draw the block diagram of MTI RADAR. Explain its operation.**	**4M**

Ans:



Explanation :

- The echo pulse from the target is received by MTI radar antenna. If echo is due to moving target, the echo pulse undergoes a Doppler frequency.
- The received echo pulses then pass through mixer 1 of the receiver. Mixer 1 heterodynes the received signal of frequency (Fo+Fc) with the output of the stalo at Fo. Mixer 1 produces a difference frequency Fc at its output.
- This difference frequency signal is amplified by an IF amplifier. Amplifies output is given to phase detector. The detector compares to IF amplifier with reference signal from the COHO oscillator
- The frequency produced by COHO is same as IF frequency so called coherent frequency. The detector provides an output which depends upon the phase difference between the two signals.
- Since all received signal pulses will have a phase difference compared with the transmitted pulse. The phase detector gives output for both fixed and also moving targets. Phase

(2 marks block diagram, 2 marks for operation)

difference is constant for all fixed targets but varies for moving targets

. • Doppler frequency shift causes this variation in the phase difference. A change of half cycle in Doppler shift would cause an output of opposite polarity in the phase detector output.

• The output of phase detector will have an output different in magnitude and polarity from Successive pulse in case of moving targets. And for fixed target magnitude and polarity of output will remain the same as shown in figure.

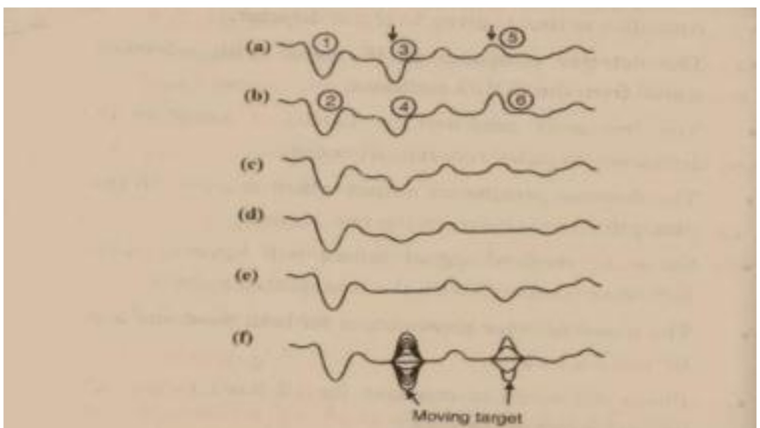
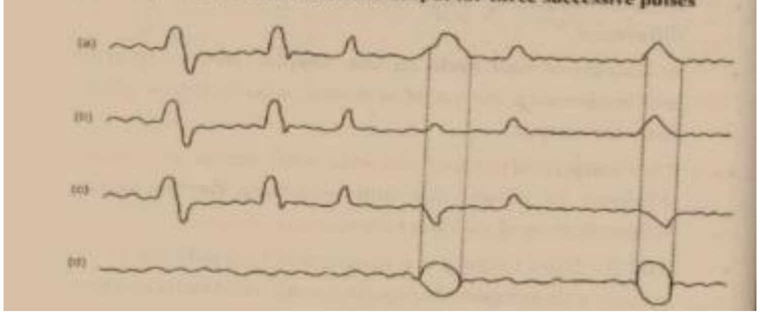
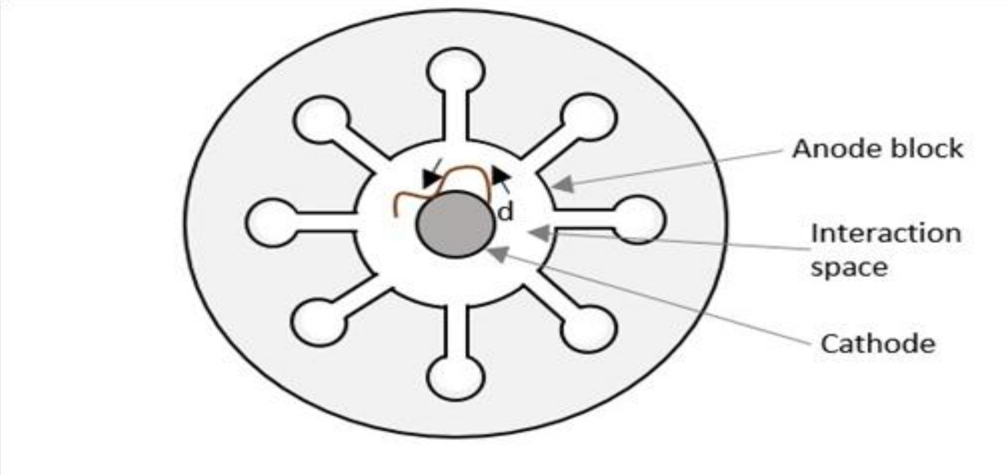
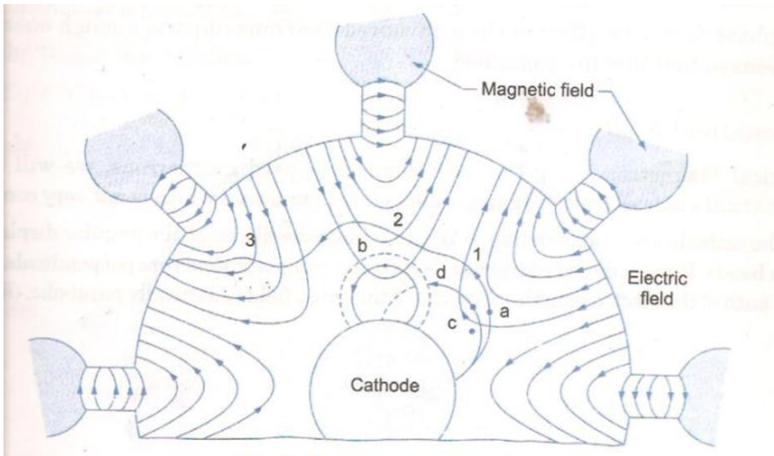


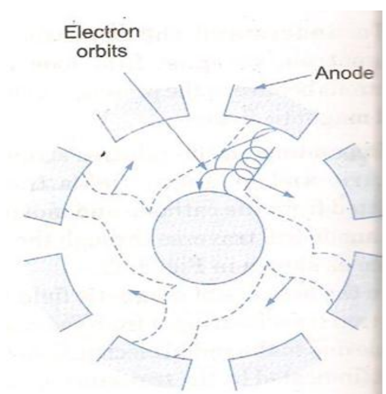
Fig. 3.3.2(i) : Phase detector output for three successive pulses



	(d)	**Describe the working principle of magnetron with the help of constructional diagram.**	**4M**

	Ans:	 1. Now assume RF oscillations are initiated due to some noise transient within the magnetron, the oscillations will be sustained by device operation.  Fig. 8.33 π-mode of magnetron 2. Self-oscillations will be obtained if the phase difference between adjacent anode poles is nπ/4 (*N*=8), where n is an integer. n=4 results in π mode. Here the anode poles are π radians apart. 3. The dotted lines refer to the path of electrons in case of static field. The solid lines refer to the electron trajectories in the presence of RF oscillations in the interaction space.	**(2 marks for diagram, 2 marks for working principal)**

4. The electron 'a' is seen to be slowed down in the presence of oscillations thus transferring energy to the oscillations during its longer journey from cathode to anode. Such electrons which participate in transferring energy to the RF field are called as favored electrons and these electrons are responsible for bunching effect.
5. An electron 'b' is accelerated by the RF field. Instead of imparting energy to the oscillations, it takes energy from the oscillations resulting in increased velocity. Hence bends more sharply, spends very little time in the interaction space and is returned back to the cathode. Such electrons are called un-favored electrons which do not participate in the bunching process; rather they are harmful as they cause back heating.
6. Similarly electron 'c' which is emitted little later to be in correct position moves faster and tries to catch up with electron 'a' and an electron emitted at d will be slowed down to fall back in step with the electron 'a'.
7. This result in all favored electrons like a, c, d to form a bunch and are confined to electron clouds or spokes as shown in fig below. This process is called **phase focusing effect** corresponding to the bunch of favored electrons around the reference electron 'a'. The spokes so formed in the π-mode rotate with an angular velocity corresponding to 2 poles/cycle.



8. The phase focusing effect of these favored electrons imparts enough energy to the RF oscillations so that they are sustained.

	(e)	**Explain Doppler effect and draw block diagram of CW Doppler RADAR.**	**4M**

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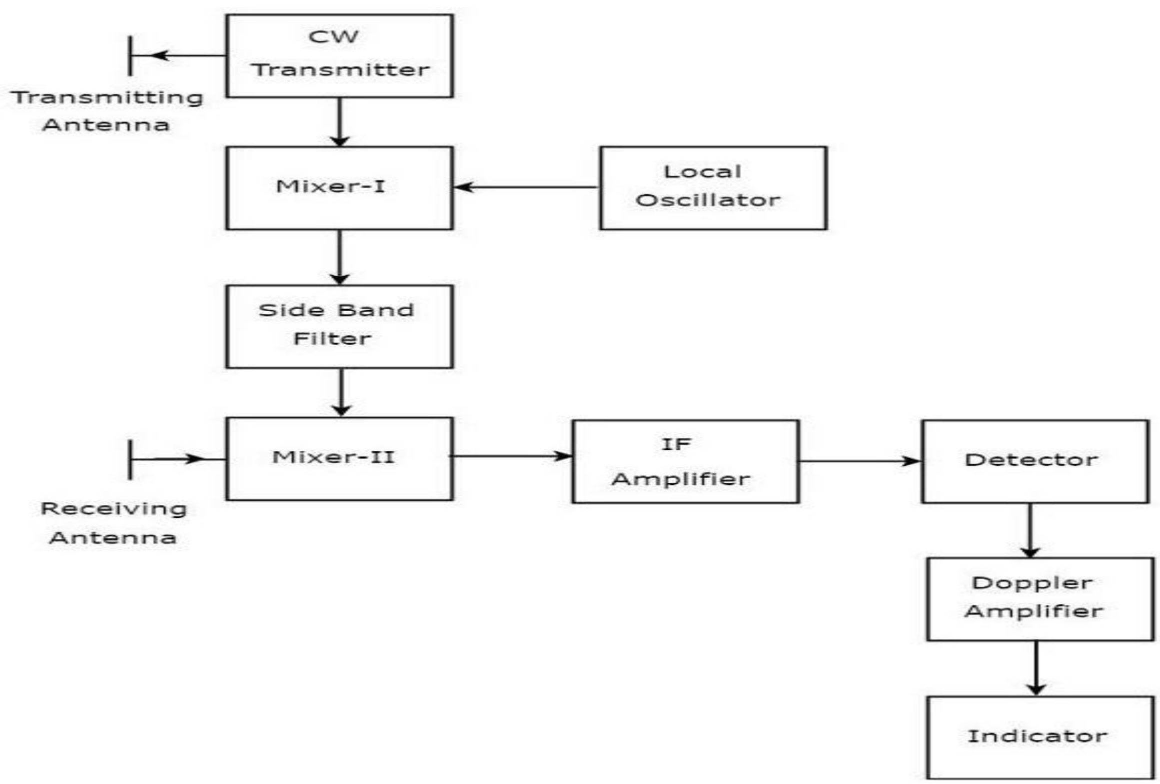
	Ans:	**Doppler effect-** If the target is not stationary, then there will be a change in the frequency of the signal that is transmitted from the Radar and that is received by the Radar. This effect is known as the **Doppler effect** .with the help of Doppler effect it is possible to determine the relative speed (V_r) between the RADAR unit and the observed object . $V_r = F_d\ \lambda/2$ Where V_r = relative speed between the two objects (m/s) F_d = Doppler frequency (Hz) λ = wavelength of transmitted signal (m)  **OR**	**(2 marks block diagram, 2 marks for Doppler effect)**

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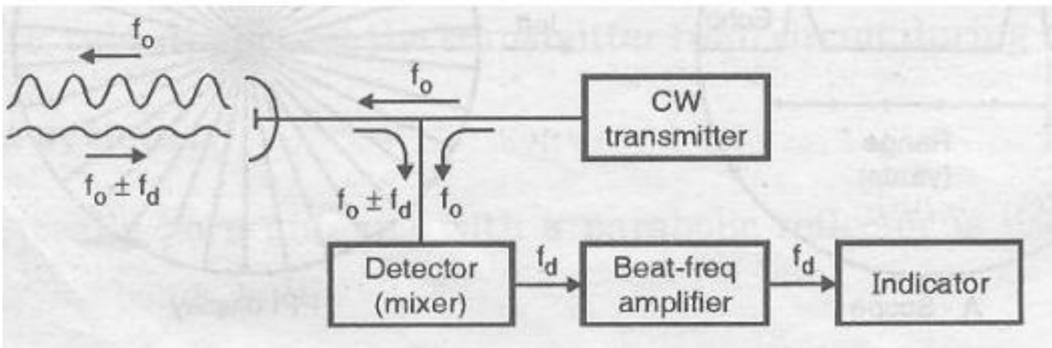
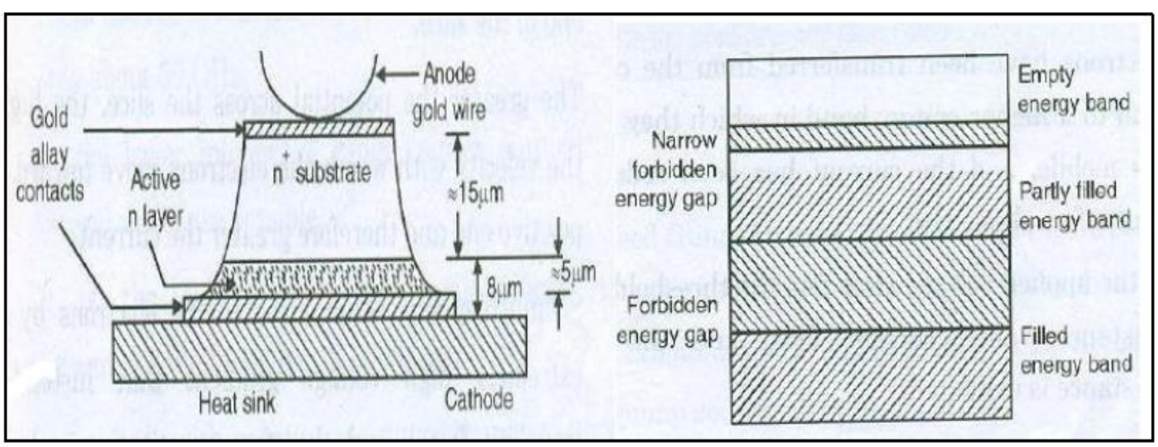
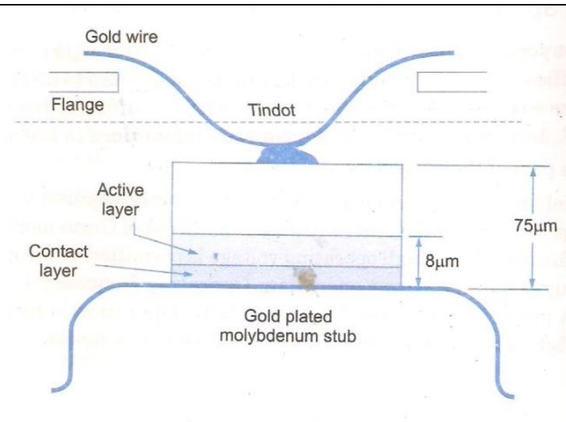
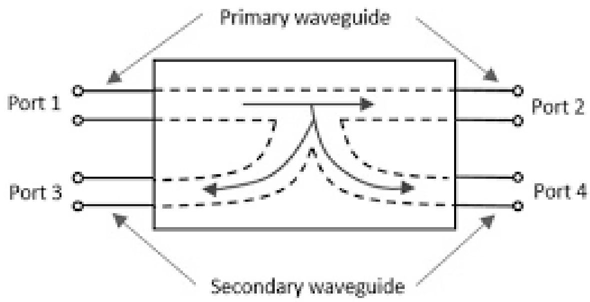
			

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Draw the construction of GUNN diode and describe the application of it.**	**6M**
	Ans:	Construction of GUNN Diode:-  or	**3 M for construction**

		 Application: 1.In Radar transmitters (police Radar, CW Doppler Radar) 2. Pulsed Gunn diode oscillators used in transponders, for air traffic control and in industry telemetry system. 3. Fast combination and sequential logic circuit. 4. As pump sources in preamplifier. 5. In microwave receiver as low and medium power oscillator.	**Any three applications 1 M for each**
	b)	**Determine cutoff wavelength for the dominant mode in rectangular waveguide of breadth 10 cm for 2.5 GHz signal propagates in this waveguide in the dominant mode. Calculate cut off wavelength and group velocity.**	**6M**
	Ans:		**1M for cut off wavelength**

		Sol^n: In a rectangular waveguide the dominant mode is the TE_{10} mode λ_c for $TE_{10} = 2a = 2\times10 = 20cm$ $f = 2.5\,GHz$ $\lambda_g = \frac{\lambda}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}}$ But $\lambda = \frac{c}{f} = \frac{3\times10^{10}}{2.5\times10^{9}} = 12cm$ $\lambda_g = \frac{12}{\sqrt{1-\left(\frac{12}{20}\right)^2}} = \frac{12}{0.8} = 15cm$ $V_p = \frac{c}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}} = \frac{3\times10^{10}}{0.8}$ $= 3.75\times10^{10}\,cm/sec$ $V_p \cdot V_g = c^2$ $V_g = \frac{c^2}{V_p} = \frac{(3\times10^{10})^2}{3.75\times10^{10}}$ $= 2.4\times10^{10}\,cm/sec$	formula, 2M for final answer 1M for group velocity formula 2M for final answer
	c)	**Explain the working principle of two hole directional coupler and state its applications.**	**6M**

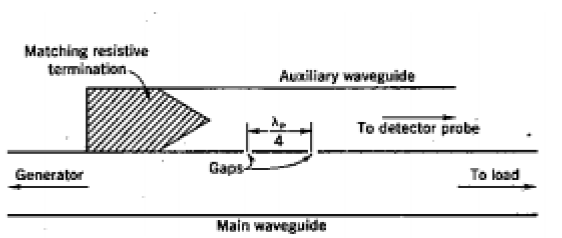
Ans:



Directional Coupler

or

2M



Two-hole directional coupler.

Working principle :

2M

i. The principle of operation of a two-hole directional coupler is shown in figure above. It consists of two guides; the main and the auxiliary with two tiny holes common between them as shown.

ii. The two holes are at a distance of $\frac{\lambda_g}{4}$ where λ_g is the guide wavelength.

iii. The two leakages out of holes 1 and 2 both in phase at position of 2nd hole and hence they add up contributing to P_f. But the two leakages are out of phase by 180° at the position of the 1st hole and therefore they cancel each other making P_b = 0(ideally).

iv. The magnitude of power coming out of the two holes depends on the dimension of the holes.

v. Although a high degree of directivity can be achieved at a fixed frequency, it is quite difficult over a band of frequencies. The frequency determines the separation of the two holes as a fraction of the wavelength.

Application :

2M

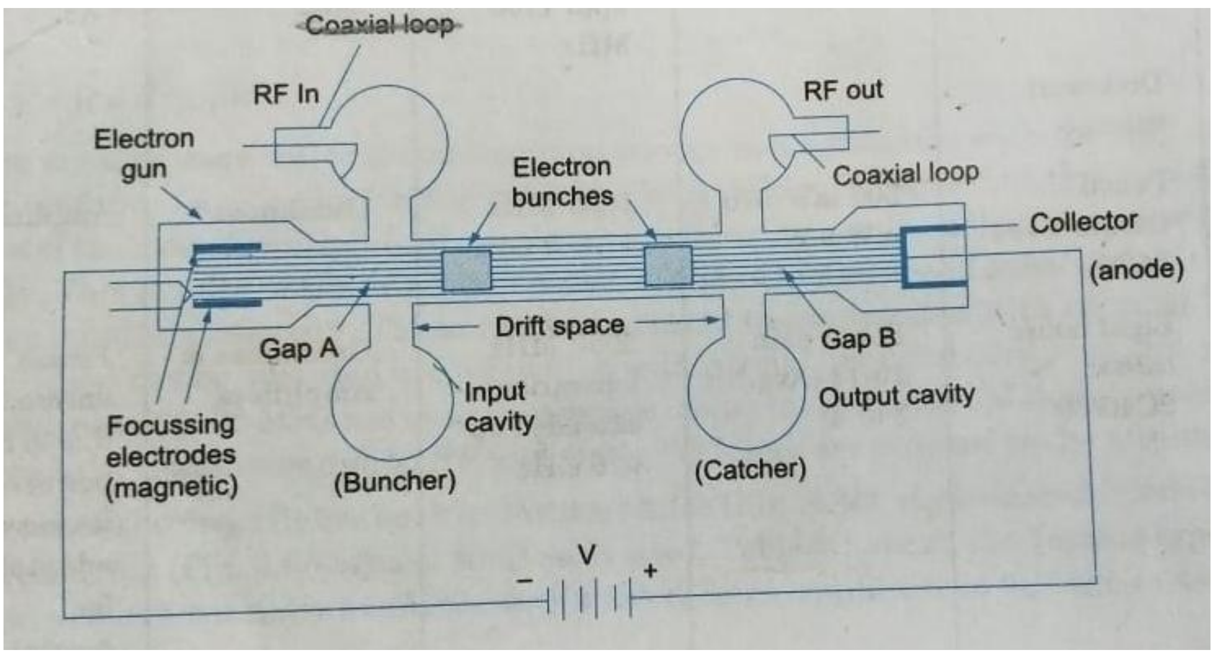
1. Directional couplers are used to measure incident or reflected powers, standing wave ratio values.

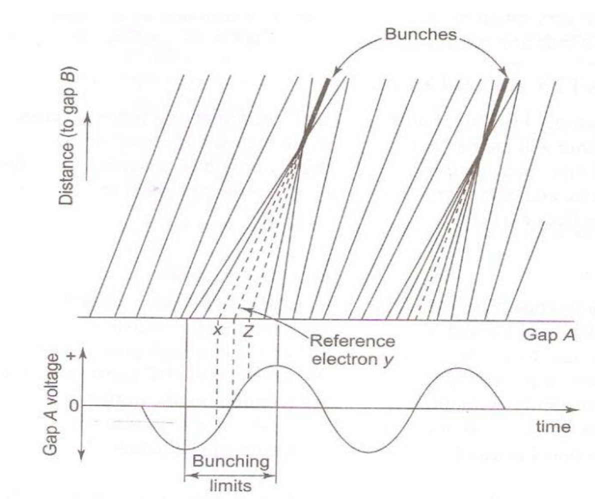
2.Directional coupler provides a single path to receiver .

WINTER-19 EXAMINATION

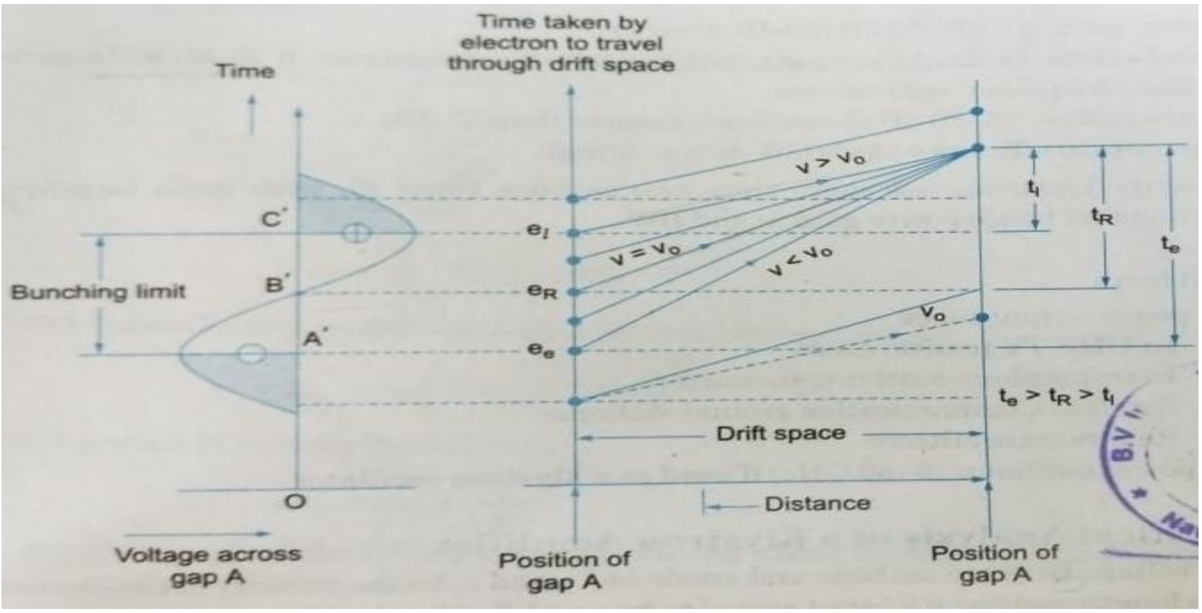
Subject Name: Microwave and RADAR **Subject Code: 22535**

Model Answer

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**Describe the bunching process of two cavity klystron with help of Apple gate diagram and state its two applications.**	**6M**
	Ans:	 **Working/Operation:** • The RF signal to be amplified is used for exciting the input buncher cavity thereby developing an alternating voltage of signal frequency across gap A. • Consider the effect of this gap voltage on the electron beam passing through gap A by means of an Applegate diagram. At point B on the input RF cycle, the alternating voltage is zero and going positive. • At this instant, the EF across the gap A is zero and an electron which passes through	**For constructional diagram & working** **1.5 M each** **2M for apple gate diagram** **1M for any 2 applications**

		the gap A at this instant is unaffected by the RF signal. • Let us consider this electron be called the reference electron e_R which travels with unchanged velocity $v_0 = \sqrt{\frac{2eV}{m}}$ where V is the anode to cathode voltage. • At point C of the input RF cycle, an electron which leaves the gap A later than the reference electron called the late electron e_l is subjected to maximum positive RF voltage and hence travels towards gap B with an increased velocity ($v>v_0$) and this electron tries to overtake the reference electron e_R. • Similarly an early electron e_e that passes the gap A slightly before the reference electron e_R is subjected to a maximum negative voltage field. Hence, this early electron is decelerated and travels with a reduced velocity. This electron falls back and the reference electron catches up with the early electron. • Therefore, the velocity of electron varies in accordance with the input RF voltage resulting in velocity modulation of the electron beam. As a result of these actions, the electrons in the bunching limit (between A and C) gradually bunch together as they travel down the drift space from gap A to gap B and excite oscillations in the output cavity (catcher). • The density of electrons passing gap B vary cyclically with time i.e. the electron beam contains an ac current and is current modulated. • The drift space coverts the velocity modulation into current modulation • Bunching occurs only once per cycle, centered on the reference electron.  	

or



Applications:

1. As power output tubes in – UHF TV transmitters,
2. Troposphere scatter transmitters,
3. Satellite communication ground station,
4. Radar transmitters.
5. As power oscillators (5-50 GHz) if used as an oscillator.

	b)	**Calculate the maximum range of guided missile tracking RADAR operate at 5GHz with 1M Watt peak power output. If the antenna diameter is 3m and the receiver has a bandwidth of 2MHz with 10 dB noise figure. The target cross – section is 2 m^{2}.**	**6M**

	Ans:	Given : $P_t = 1mW = 1\times10^{6}\,W$ $\sigma = 2m^2$ $B = 2MHz = 2\times10^6 Hz$ $D = 3m$ $F(dB) = 10dB$ $\therefore F = antilog_{10}\left(\frac{10}{10}\right) = 10$ $f = 5GHz = 5\times10^9 Hz$ $\lambda = \frac{c}{f} = \frac{3\times10^8}{5\times10^9}\,m$ $= 0.06\,m$ $R_{max} = 48\left[\frac{P_t D^4 \sigma}{B\lambda^2 (F-1)}\right]^{1/4} km$ $= 48\left[\frac{1\times10^6\times3^4\times2^2}{2\times10^6\times(0.06)^2\times(10-1)}\right]^{1/4}$ $= 48\left[\frac{1\times10^6\times3^4\times2}{2\times10^6\times(0.06)^2\times9}\right]^{1/4} km$ $= 48\,[2500]^{1/4}\,km$ $= 48\times7.07106\,km$ $= 339.41\,km.$	**2 M for formula** **2M cal.** **2 M for final ans.**

WINTER-19 EXAMINATION

Subject Name: Microwave and RADAR **Subject Code: 22535**

Model Answer

	c)	**Explain blind speed of RADAR. Write step by step procedure to calculate blind speed.**	**6M**
	Ans:	**Blind speed of RADAR:**	**3M**

The radar blind speed is the speed at which the target will not be visible to the radar. This speed can be calculated based on the frequency/wavelength of the wave and the Pulse Repetition Time.

FORMULA

$$v = \frac{\lambda}{2 * \mathrm{PRT}}$$

Where,

f = frequency of operation

PRT = pulse repetition time

v = radar blind speed

If the Doppler frequency produced by a moving target is exactly the same as PRF, then sampling occurs at the same point in each cycle. With blind speed moving targets are suppressed by an MTI system-like ground clutters.

Procedure to calculate blind speed: **3M**

1. The blind speeds are encountered a phase difference of exactly 2π or multiple .
2. It can thus , be seen that if a target moves a distance of half wavelength between the successive pulses, then the change in phase will be precisely 2π radians.
3. Thus , we say that

$$V_b = \frac{n\lambda}{2} = f_r$$

where,

λ = Wavelength of the transmitted signal

n = Any integer

V_b = Blind speed

f_r = Polar repetition frequency

		Consequently , the lowest two blind speeds will be 67.5km/hr and 135 km/hr for n=1 and n=2 respectively.	