EC 2403 -RF & MICROWAVE ENGINEERING
BRANCH/YEAR/: ECE/IV

UNIT – 4
MICROWAVE GENERATION

PART A

1. What are the high frequency effects in conventional tubes?

The high frequency effects in conventional tubes are

i) Circuit reactance
   a)Inter electrode capacitance
   b) Lead inductance
ii) Transit time effect
iii) Cathode emission
iv) Plate heat dissipation area
v) Power loss due to skin effect, radiation and dielectric loss.

2. What are the assumptions for calculation of RF power in Reflex Klystron?

i) Cavity grids and repeller are plane parallel and very large in extent.
ii) No RF field is excited in repeller space
iii) Electrons are not intercepted by the cavity anode grid.
iv) No debunching takes place in repeller space.
v) The cavity RF gap voltage amplitude V, is small compared to the dc beam voltage VO

3. What is the condition for oscillation in Reflex klystron ?

The necessary condition for oscillation is that the magnitude of the negative real part of the electronic admittance should not be less than the total conductance of the cavity circuit

i.e. _-Ge__G. Where 1 G=Gc + Gb +G1 = ------ Rsh

Rsh _ effective shunt resistance

Gc _ copper losses of cavity Gb
_ beam loading conductance G1
_ load conductance

4. Give the drawbacks of klystron amplifiers.

1. As the oscillator frequency changes then resonator frequency also changes and the feedback path phase shift must be readjusted for a positive feedback.

2. The multicavity klystron amplifiers suffer from the noise caused because bunching is never complete and electrons arrive at random at catcher cavity. Hence it is not used in receivers.

5. What is the effect of transit time?

There are two effects.

1) At low frequencies, the grid and anode signals are no longer 180O out of phase, thus causing design problems with feedback in oscillators.

2) The grid begins to take power from the driving source and the power is absorbed even when the grid is negatively biased.

6. What are the applications of reflex klystron?

1) Signal source in MW generator
2) Local oscillators in receivers
3) It is used in FM oscillator in low power MW links.
4) In parametric amplifier as pump source.

7. What is the purpose of slow wave structures used in TWT amplifiers?

Slow wave structures are special circuits that are used in microwave tubes to reduce wave velocity in a certain direction so that the electron beam and the signal wave can interact. In TWT, since the beam can be accelerated only to velocities that are about a fraction of the velocity of light, slow wave structures are used.

8. How are spurious oscillations generated in TWT amplifier? State the method to suppress it.

In a TWT, adjacent turns of the helix are so close to each other and hence oscillations are likely to occur. To prevent these spurious signals some form of attenuator is placed near the input end of the tube which absorb the oscillations.

9. State the applications of TWT.

1) Low power, low noise TWT‟s used in radar and microwave receivers
2) Laboratory instruments
3) Drivers for more powerful tubes
4) Medium and high power CWTWT‟S are used for communication and radar.

10. How the klystron amplifier can act as klystron oscillator? What are the applications of klystron amplifier?

When the klystron amplifier is given a positive feedback such that the overall phase shift becomes zero 360° and __Av _= I then klystron amplifier acts as an oscillator.

Applications:

(1) UHF TV Transmitters
(2) Long ranger radar
(3) Linear particle accelerator
(4) Troposcatter links
(5) Earth station transmitter.

11. Define phase focusing effect.

The bunching of electrons in known as “Phase focusing effect” This effect is important because without it, favored electrons will fall behind the phase change of electric field across the gaps. Such electrons are retarded at each interaction with the R.F field in magnetron.

12. What do you mean by O-type tubes? Name some O-type tubes.

In O – type tube a magnetic field whose axis coincides with that electron beam is used to hold the beam together as it travels the length of the tube. It is also called as linear beam tube.

i) Helix Traveling wave tube
ii) Coupled cavity TWT

iii) Forward wave amplifier
iv) Backward wave amplifier
v) Backward wave oscillator

13. Define Transit time in Reflex klystron.
The time taken by the electron to travel into the repeller space and back to the gap. T =n + ¾

14. Write the parameters on which bunching depend on?
i) Drift space should be properly adjusted.
ii) D.C anode voltage
iii) Signal amplitude should be such that proper bunching takes place.

15. Compare TWTA Klystron amplifier

S.no	Klystron amplifier	TWTA
1	Linear beam or „O‟ type device.	Linear beam or „O‟ type device
2	Uses cavities for input and Output circuits.	Use non resonant wave circuit.
3	Narrow band device due to resonant cavities.	Wide band device because use of Non-resonant wave circuit.

16. Give the performance Specification of Reflex klystron?
Frequency range: 2- 200 GHz
Band width: + 30 MHz for _ VR = + 10
V Power output: 10 mw – 2.5W
Efficiency: 20 to 30%

17. What is CFA? State the applications of CFA.
CFA _Cross Field Amplifier

CFA is a microwave power amplifier. It is a cross between TWT and magnetron in its operation. i.e., it has a magnetron structure to provide an interaction between crossed dc electric and magnetic fields on one hand and an RF field on the other hand. It also uses a slow wave structure as in TWT to provide a continuous interaction between the electron beam and a moving RF field.

Applications:
(1) Radar system
(2) Electronic counter measure.

18. State the characteristics of magnetron and of 2-cavity klystron amplifier.
Magnetron:
Operating frequencies _ 70 GH z
Output power _ 40 MW
Efficiency _ 40 to 70%
2-cavity klystron:

Efficiency _ 40%
Power output _ average power _> 500 KW
Pulsed power _> 30 MW
Power gain _ about 30 db.

19. What are the advantages of TWT?
1. Bandwidth is large.
2. High reliability
3. High gain
4. Constant Performance in space
5. Higher duty cycle.

20. What is meant by strapping?

The magnetron has eight or more coupled cavity resonators and hence several modes of oscillation are possible. The oscillating frequency of different modes are not same and are quite close to each other which results in mode jumping. i.e., a 3 cm _ mode oscillation which is normal for a particular magnetron 3 _ Could become a 3.05 cm------- mode oscillation. This result in 4 oscillations of reduced power at wrong frequency. To prevent this. Strapping is used. It consists of two rings of heavy gauge wire connecting alternate anode poles. It provides a phase difference 0f 2 _ radians for the modes other _-mode and thus preventing the occurrence of other modes, except the _-mode .

21. State the applications of magnetrons. why magnetron is called as cross filed device?
1) Pulse work in radar
2) Linear particle accelerators.

In cavity magnetron, there exists a radial electric field and an axial magnetic field perpendicular to each other and hence magnetron is called as a cross filed device.

22. What is BWO? State the applications of BWO.

A backward wave oscillator (BWO) is microwave cw oscillator with an enormous tuning and ever all frequency coverage range.

Applications:
(i) It can be used as signal source in instruments and transmitters.
(ii) It can be used as broad band noise sources which used to confuse enemy radar.

23. What is hull cutoff condition?

In a magnetron, the electron will just graze the anode and return towards the cathode depends on Vo and Bo . The hull cut of magnetic equation is

$$Boc = \frac{(8Vo\ m / e)^{1/2}}{b(1- a\ 2 / b2)}$$

The hull cutoff voltage equation is

$$Voc = \frac{e\ BO2\ b2\ (1- a2/ b2)}{8m}$$

If B0>BOe for given Vo.the electrons will not reach anode.

If Vo < Voc for a given Bo the electrons will not reach the anode.

24. What are the principal limitations of conventional negative grid electron tubes?

1) Electron transit time becomes a noticeable proportion at high frequencies.

2) Lumped electrical reactance and low Q resonant circuit.

25. What is frequency pulling and frequency pushing in magnetrons?

Frequency pulling is caused by changes in the load impedance reflected into the cavity resonators. Frequency pushing is due to the change in anode voltage which alters the orbital velocity of electron clouds.

26. What are the applications of High Q-oscillators and amplifier circuits? They are used in

a) Low power transmitters

b) Parametric amplifier pumps

c) Police radars and intrusion alarms.

27. What is slotted section with line carriage?

It is a microwave sectioned coaxial line connecting a coaxial E-field probe which penetrates inside a rectangular waveguide slotted section.The longitudinal slot is cut along the center of the waveguide broad walls.The probe is made to move along the slotted wall which samples the electric field propotional to probe voltage.

28. What is the main purpose of slotted section with line carriage?

1.For determination of location of voltage standing wave maxima and minima along the line. 2.Measure the VSWR and standing wave pattern.

3.Wavelength.

4.Impedence.

5.Reflection coeffient.

6.Return loss measurement.

29. What is a VSWR meter?

VSWR meter is a highly sensitive, high gain, high theta, low noise voltage amplifier tuned normally at fixed frequency of 1KHZ of which microwave signals modulated. This meter indicates calibrated VSWR reading fir any loads.

30. How will you determine the vswr and return loss in reflecto meter method?

The voltage ratio between port3 or port4 is known reflectin coefficient (T) determined we determine VSWR and return loss as

VSWR=(1+T)/(1-T)

Return loss=-20 log(T)

31. List the different types of Impedence measurement methods?

1. Slotted line method

2. Reflectometer method

3. Reactor discontructer method

32. How do you measure microwave frequency?
1. Wave meter method
2. Slotted line method
3. down conversion method

33. What is a wave meter?

It is a device used for frequency measurement in microwave. It has cylindrical cavity with a variable short circuit termination .It changes the resonant frequency of cavity by changing cavity length.

34. How the S-parameter of a microwave circuit measured?

S-parameters are conveniently measured using the decamps method which utilizes the measured value of complex input reflection coefficient under a number of a reactive terminations.

PART - B

1. With neat circuit diagrams and relevant equations, explain the velocity modulation process and bunching in a klystron amplifier?(16)

2. Explain in detail about 2-cavity klystron amplifier.(16)

3. Explain in detail about multicavity klystron amplifiers. (16)

4. Derive the equation for power output and efficiency of two cavities and four cavity klystron amplifiers. (16)

5. With neat diagrams and relevant equations, explain about helix traveling wave tube.(16)

6. With neat diagrams and relevant equations, explain about cylindrical and coaxial magnetron. (16)

7. Discuss in detail about tunable magnetron and also explain in brief regarding Ricke diagram. (16)

8. Explain in detail the measurement of VSWR through return loss measurements.(16)

9. Discuss in detail the power measurement using microwave devices.(16)

10. Write a brief note on insertion loss and attenuation measurements.(16)

11. . Explain in detail about the dielectric constant measurement of a solid using waveguide.(16)

12. Discuss in detail the impedance measurement using microwave devices.(16)

13. Derive the equation for power output and efficiency of two cavities and four cavity klystron amplifiers.
(16)\

14. . With neat diagrams and relevant equations, explain about helix traveling wave tube.(16)

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