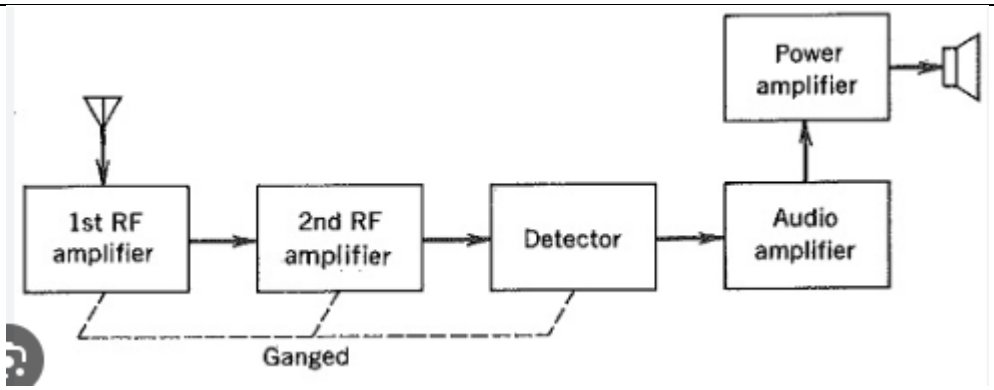
SIES Graduate School of Technology (Autonomous) NAAC A+ (Affiliated to University of Mumbai)	***End Semester Examination (R-24) FH 202 Answer Key with marking scheme***
Branch: EXTC	Course: PCE
Year/ Semester: SE/IV	Course code: ETC 402
Time: 03 hours	Marks: 80

Q. 1	Attempt any FOUR. (All questions carry equal marks)
A.	List all types 1 mark Explain any 4 types in detail 4 marks
B.	

Parameter	**AM-DSBFC (Amplitude Modulation – Double Sideband Full Carrier)**	**AM-DSBSC (Amplitude Modulation – Double Sideband Suppressed Carrier)**
Carrier	Carrier is **transmitted fully**	Carrier is **suppressed (not transmitted)**
Power Efficiency	**Low** (most power wasted in carrier)	**High** (power used only for sidebands)
Bandwidth	Same as DSBSC (**2fm**)	Same (**2fm**)
Transmission Power	High	Lower than DSBFC
Information Content	Carrier carries **no information**	Only sidebands carry information
Generation	Simple (using standard AM modulator)	More complex (balanced modulator required)
Demodulation	**Easy** (envelope detector can be used)	**Difficult** (requires coherent detection)
Receiver Complexity	Simple	Complex
Efficiency	Maximum efficiency ≈ **33%**	Efficiency up to **100%**
Applications	Radio broadcasting (AM radio)	Telecommunication systems, suppressed carrier systems

Each correct and significant difference carry 0.5 marks

C.	Given, the amplitude of modulating signal, $A_m = 5V$ Frequency of modulating signal, $f_m = 2KHz$ Frequency sensitivity, $k_f = 40Hz/volt$ We know the formula for Frequency deviation as $$\Delta f = k_f A_m$$ Substitute k_f and A_m values in the above formula. $$\Delta f = 40 \times 5 = 200Hz$$ Therefore, **frequency deviation**, Δf is $200Hz$ The formula for modulation index is $$\beta = \frac{\Delta f}{f_m}$$ Substitute Δf and f_m values in the above formula. $$\beta = \frac{200}{2 \times 1000} = 0.1$$ Here, the value of **modulation index**, β is 0.1, which is less than one. Hence, it is Narrow Band FM. The formula for Bandwidth of Narrow Band FM is the same as that of AM wave. $$BW = 2f_m$$ Substitute f_m value in the above formula. $$BW = 2 \times 2K = 4KHz$$ Therefore, the **bandwidth** of Narrow Band FM wave is $4KHz$.
D.	List of reasons: Reduction in antenna height Efficient radiation of signal Avoid mixing of different signals (interference) Increase communication range Multiplexing of signals (FDM) Better signal-to-noise ratio Shift signal to high frequency band for transmission Enables long-distance communication Reduces effect of noise and distortion Efficient use of available bandwidth In detail explanation any 5 reasons in detail : each one carry 1 Mark
E.	Block diagram 2Marks Explanation: 3 Marks

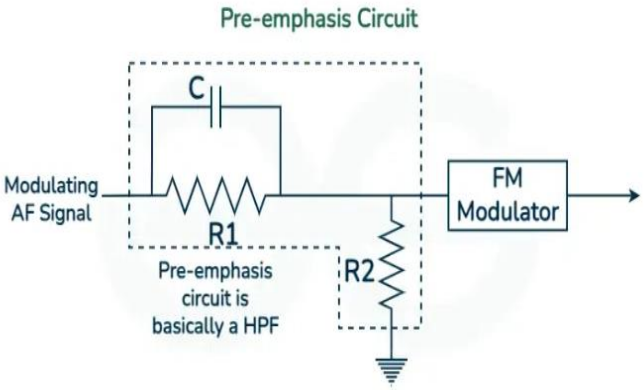


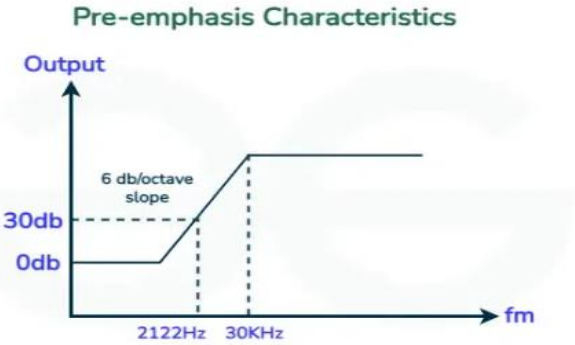
F.

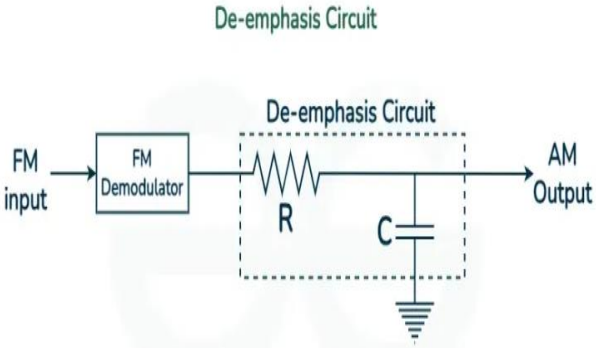
Parameter	TDM (Time Division Multiplexing)	FDM (Frequency Division Multiplexing)
Basic Principle	Signals are separated in **time slots**	Signals are separated by **frequency bands**
Transmission	Users transmit one after another in time	All users transmit **simultaneously**
Bandwidth Usage	Uses full bandwidth for a short time	Bandwidth is divided into smaller bands
Signal Type	Mainly used for **digital signals**	Mainly used for **analog signals**
Synchronization	Requires strict **time synchronization**	No time synchronization required
Guard Requirement	No guard bands required	Requires **guard bands** to avoid overlap
Complexity	Simpler implementation	More complex due to filtering
Interference	Less interference	Possible **adjacent channel interference**
Efficiency	High for digital data	Lower due to guard bands
Examples	PCM systems, digital telephony	Radio broadcasting, TV transmission

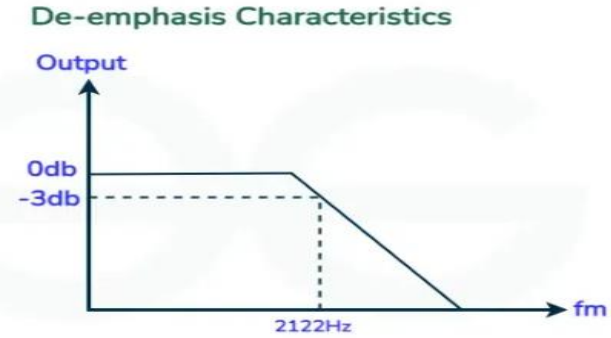
Q.2 Attempt any FOUR. (All questions carry equal marks)

A.

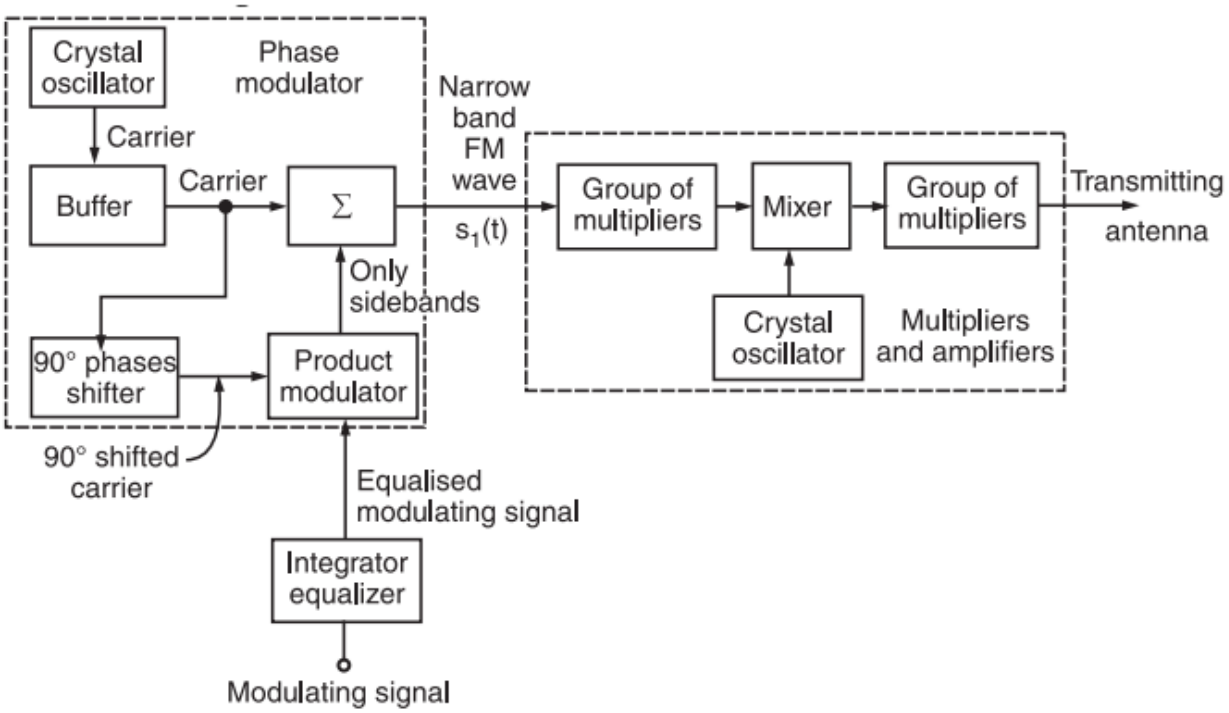
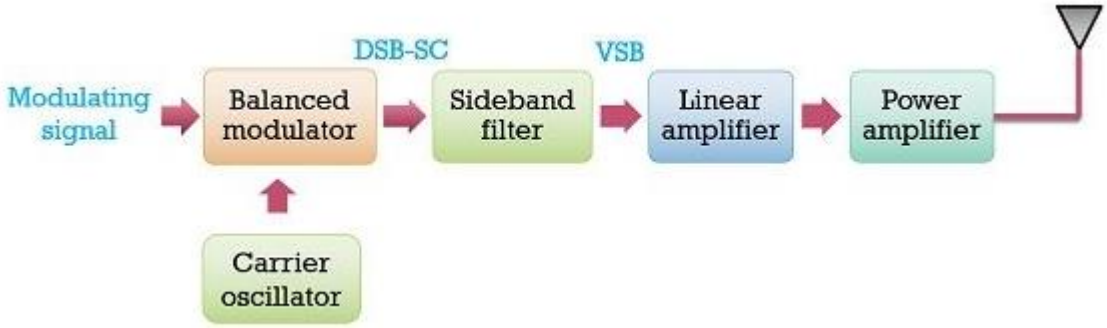


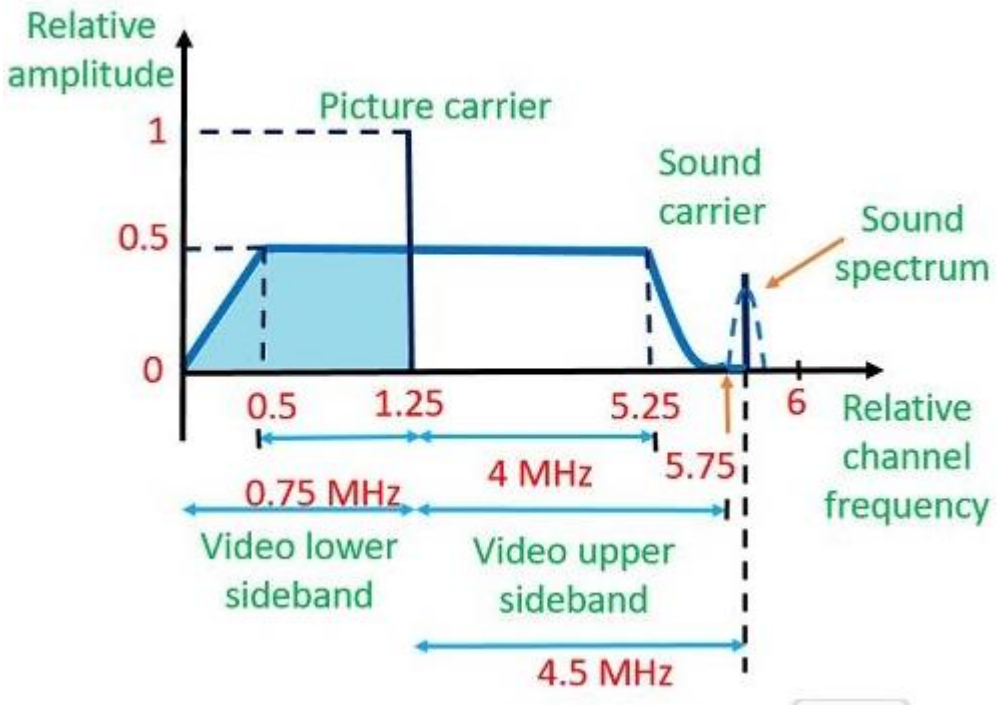






Pre-emphasis and De-emphasis Block diagram and Graph: 6 Marks
Explanation : 4 Marks

B.	 Block diagram 3 Marks Working principal: 2 Marks Explanation of Block diagram along with frequency marking at significant blocks: 5 Marks
C.	Derivation 6 marks Waveform 2 marks Frequency spectrum 2 Marks
D.	Sampling Theorem statement 2 Marks Derivation with low pass filter 6 Marks Waveform 2 Marks
E.	

	 Block diagram 2 Marks Frequency spectrum 2 Marks Explanation 6 Marks Application: 1 Mark	
F.	Explanation of AWGN : 6 marks C=Blog2(1+SNR)	

Step 1: Convert SNR from dB to linear scale

$$\text{SNR}_{linear} = 10^{\frac{20}{10}} = 10^2 = 100$$

Step 2: Substitute values into formula

$$C = 3 \times 10^6 \cdot \log_2(1 + 100)$$

$$C = 3 \times 10^6 \cdot \log_2(101)$$

Step 3: Calculate log value

$$\log_2(101) \approx 6.658$$

Step 4: Final Answer

$$C = 3 \times 10^6 \times 6.658$$

$$C \approx 19.97 \times 10^6 \text{ bits/sec}$$

Each step : 1 Mark

Q.3	Attempt any FOUR. (All questions carry equal marks)
A.	Signal to noise ratio Definition 1 mark Signal to noise ratio Formula 1 mark Noise Figure Definition 1 Mark Noise Figure Formula 1 Mark Example: Solution 1 Mark

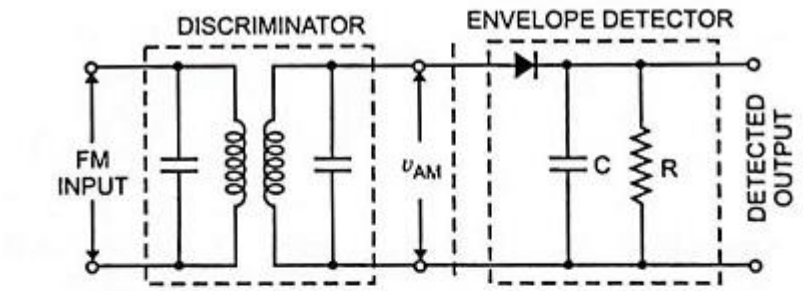
SNR (linear):

$$\text{SNR} = \frac{S}{N} = \frac{10}{1} = 10$$

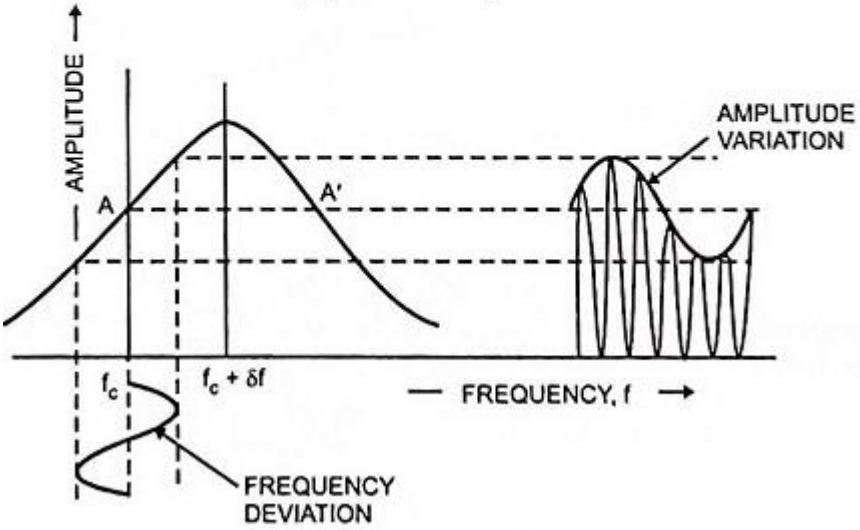
SNR in dB:

$$SNR_{dB} = 10\log_{10}(10) = 10\,dB$$

B.



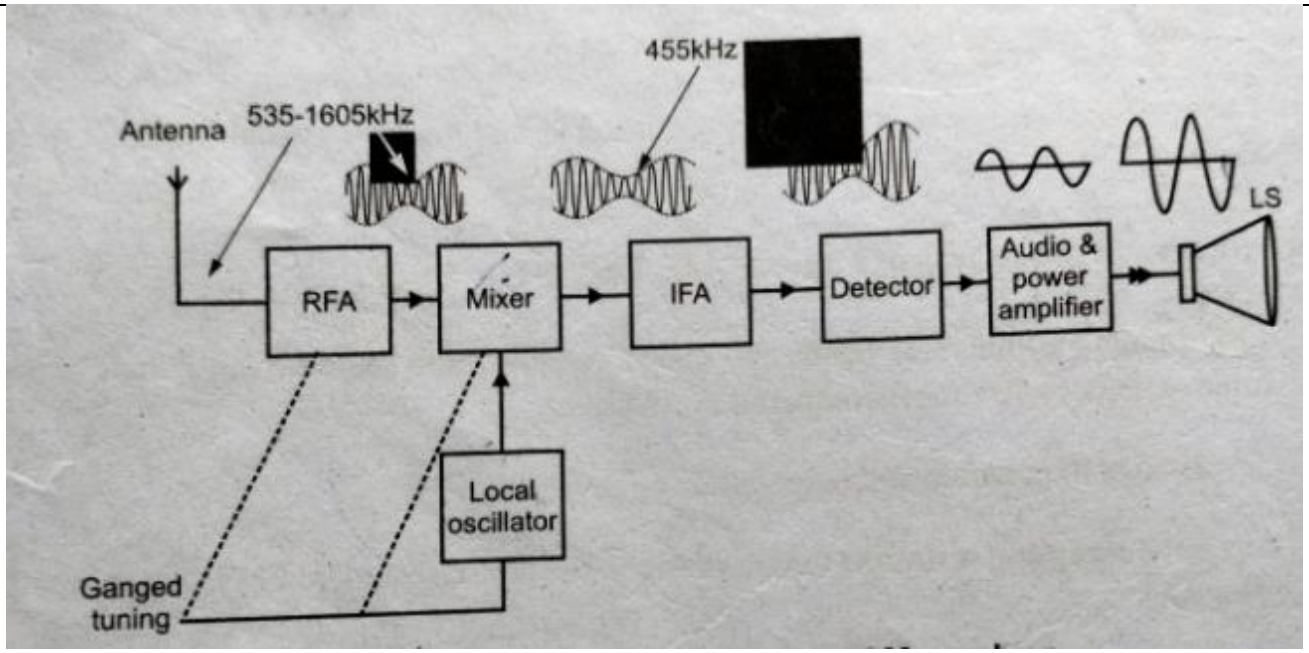
(a) Circuit Diagram



(b) Characteristic Curve

Circuit Diagram: 2 Marks
Explanation 6 Marks
Characteristic curve : 2 marks

C.



Block diagram 2 marks

	Explanation 3 Marks	
D.	Given, the equation of modulating signal as $$m(t) = 10\cos(2\pi \times 10^3 t)$$ We know the standard equation of modulating signal as $$m(t) = A_m \cos(2\pi f_m t)$$ By comparing the above two equations, we will get Amplitude of modulating signal as $A_m = 10volts$ and Frequency of modulating signal as $$f_m = 10^3 Hz = 1KHz$$ Given, the equation of carrier signal is $$c(t) = 50\cos(2\pi \times 10^5 t)$$ The standard equation of carrier signal is $$c(t) = A_c \cos(2\pi f_c t)$$ By comparing these two equations, we will get Amplitude of carrier signal as $A_c = 50volts$ and Frequency of carrier signal as $f_c = 10^5 Hz = 100KHz$ We know the formula for modulation index as $$\mu = \frac{A_m}{A_c}$$	

Substitute, A_m and A_c values in the above formula.

$$\mu = \frac{10}{50} = 0.2$$

Therefore, the value of **modulation index is 0.2** and percentage of modulation is 20%.

The formula for Carrier power, $P_c =$ is

$$P_c = \frac{{A_c}^2}{2R}$$

Assume $R = 1\Omega$ and substitute A_c value in the above formula.

$$P_c = \frac{(50)^2}{2\,(1)} = 1250W$$

Therefore, the **Carrier power**, P_c is **1250 watts**.

We know the formula for **power** required for **transmitting AM** wave is

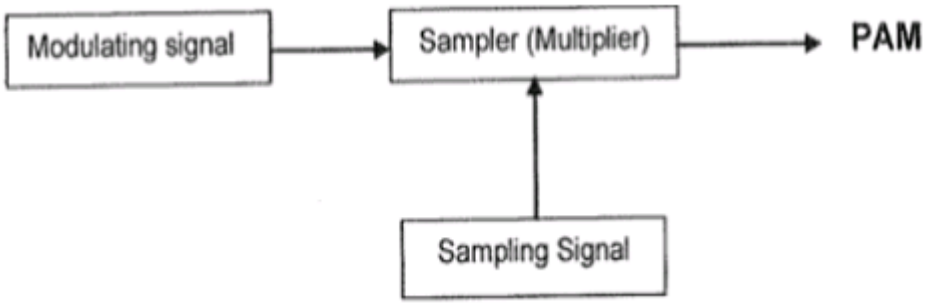
$$\Rightarrow P_t = P_c\left(1 + \frac{\mu^2}{2}\right)$$

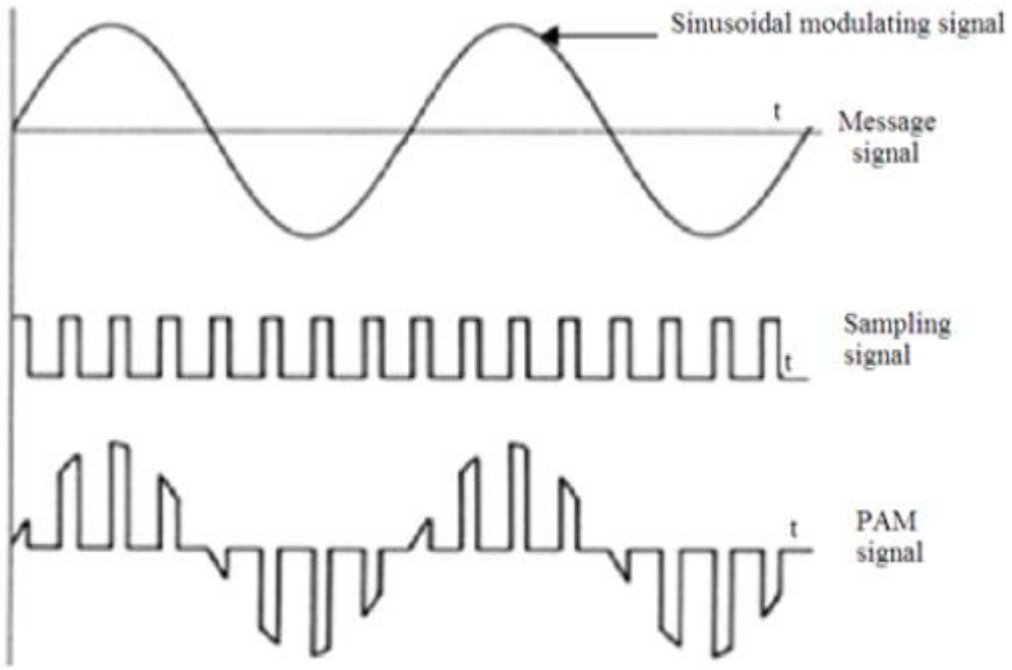
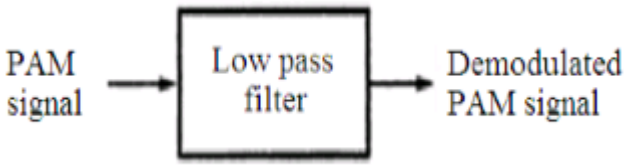
Substitute P_c and μ values in the above formula.

$$P_t = 1250\left(1 + \frac{(0.2)^2}{2}\right) = 1275W$$

Therefore, the **power required for transmitting AM** wave is **1275 watts**.

E.



	 Generation: 3 Marks Detection : 2 Marks 	
F.	Fourier transform : 2 Marks PSD calculation: 2 Marks PSD representation 1 Mark	

***Note:**

1. Read the instruction carefully mentioned in your appointment letter.
2. Provide detail solution with marking scheme as this solution needs to be displayed on website before open house.
3. All paper setters need to rename the question paper file as "Class_Branch_Sem_CourseCode_QPset no." (e.g.ME_IS_II_MEISC201_QP1) and solution key as "Class_Branch_Sem_CourseCode_SKset no."(e.g. ME_IS_II_MEISC201_SK1).
4. Kindly remove this note (mentioned in Red text) from the final copy before submitting your Solution key.