(परीक्षार्थी द्वारा भरा जाए)

(To be filled by the Candidate)

Second Periodical Test, January-April/May, 2021

परीक्षा का नाम **(Name of Examination)**...... 2nd periodical 6th sem

अनुक्रमांक अंकों में**(In figures)** 1813031

अनुक्रमांक(शब्दो में)**(Roll No. in Words)** ...... Eighteen lakh thirteen thousand thirty one

नामांकन संख्या **(Enrollment No.)** 2018/2056

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विषय**(Subject)**...... ECE

प्रश्न पत्र कोड सहित **(Paper withCode)** ...... Digital Comm. ECE304

परीक्षा दिवस और दिनांक **(Day and Date of Examination)** ...... 26.03.21 and Friday

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Question	1	2	3	4	5	6
Write NA for questions not attempted			NA	NA		NA

Signature of the Student

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Digital Electronics

Q.1(a) Given,
let the signal frequency is f_m KHz

Step Size, $\Delta < A_m \omega_m T_s$

$$\Rightarrow A_m > \frac{\Delta}{\omega_m T_s}$$

$$\because \omega_m = 2 f_m \pi$$

$$A_m > \frac{\Delta}{2\pi f_m T_s}$$

for slop overload will not occur if

$$\boxed{A_m \leq \frac{\Delta}{2\pi f_m T_s}}$$

$f_m = 3\,KHz$

$\therefore$ Nyquist rate $= 2 f_m = 2 \times 3 = 6\,KHz$

$\therefore f_s = 5 \times$ nyquist rate $= 5 \times 6 = 30\,KHz$

Sampling interval, $T_s = \frac{1}{f_s} = \frac{1}{30 \times 10^3} = 3.33 \times 10^{-5}\,s$

Step size, $\Delta = 250\,mV = 250 \times 10^{-3}\,V = 0.25\,V$

$f_m = 2\,KHz = 2 \times 10^3\,Hz$

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$$\therefore A_m \le \frac{0.25}{2\times 3.14\times 2\times 10^3\times 3.33\times 10^{-5}}$$

$$\Rightarrow A_m \le 0.598$$

$\boxed{A_m = 0.6V}$ Maximum Amplitude

(8) Given

$f_m = 1KHz$

$f_s = 32 KHz$

$BW = f_m = 4KHz$

Given that there is no slope overload. The output signal to noise ratio in DM system is expressed as

$$(SNR)_o = \frac{3 f_s^3}{8\pi^2 f_m^2 f_M}$$

$$= \frac{3\times(32\times 10^3)^3}{8\times(3.14)^2\times(1\times 10^3)^2\times(4\times 10^3)}$$

$$= \frac{98304\times 10^9}{315.5072\times 10^9}$$

$$= 311.575$$

$$= 10\log_{10}(311.575)\,dB$$

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∴ Output SNR → $\boxed{(SNR)_o = 24.94\,dB}$

Derivation of the used formula

To avoid the slope overload distortion,

$$A \le \frac{\Delta}{\omega_m T_s} = \frac{\Delta}{2\pi}\left(\frac{f_s}{f_m}\right) \longrightarrow (i)$$

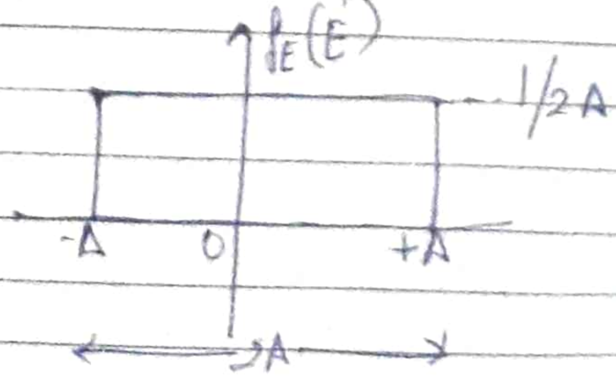
Max. value of the output signal power is expressed as:

$$P_{max} = \left(\frac{A}{\sqrt{2}}\right)^2 = \frac{A^2}{2} = \frac{\Delta^2 f_s^2}{8\pi f_m^2} \longrightarrow (ii)$$

$$E_{max} = \pm A$$

$$PDF = f_\epsilon(E) = \begin{cases} \frac{1}{2\Delta}, & \text{for } -\Delta \le f_\epsilon(E) \le +\Delta \\ 0, & \text{otherwise} \end{cases}$$

PDF of quantization



The mean square value of the variance of the quantization noise is given by,

$$\overline{\varepsilon^2} = \int_{-\Delta}^{\Delta} \varepsilon^2 f_\varepsilon(\varepsilon)\,d\varepsilon = \int_{-\Delta}^{\Delta} \varepsilon^2 \frac{1}{2\Delta}\,d\varepsilon$$

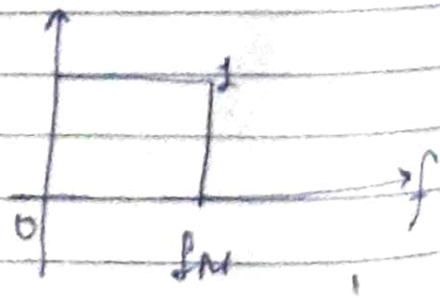
$$= \frac{1}{2\Delta}\left[\frac{\varepsilon^3}{3}\right]_{-\Delta}^{\Delta}$$

$$\therefore \varepsilon^2 = \frac{1}{2\Delta}\left[\frac{\Delta^3}{3} + \frac{\Delta^3}{3}\right] = \frac{\Delta^3}{3} \quad \text{(iii)}$$

$$N = \frac{\overline{\varepsilon^2}}{1} = \frac{\Delta^3}{3} \quad \text{(iv)}$$

input $\longrightarrow$ [LPF] $\longrightarrow$ output.

$f_M \geq f_m$ and $f << f_s$



N_q is the distributed uniformly over the frequency band upto f_s, the output quantization noise power within the B.W. is given by f_N.

$$N_q' = \frac{\Delta^2}{3} \times \frac{f_M}{f_s} \quad \text{(v)}$$

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from eq^n (ii) & (iv) in (V), we get.

$$\left(\frac{S}{N_q}\right)_0 = \frac{P_{max}}{N_q'} = \frac{3 f_s^3}{8 a^2 f_m^2 f_M}$$

$$= \left(\frac{S}{N_1}\right)_0 = \boxed{\frac{3 f_s^3}{8 a^2 f_m^2 f_m}}$$

Ques2.

Given

(B) Bandwidth = 3.5 KHz
(r) Transmission Rate = 50 Kbps
= 50×10^3 bits/sec.

Peak to Peak Voltage = 4V
RMS Value = 0.2V

Since the message signal has a peak to peak voltage of 4V i.e, peak voltage of 2V and RMS value of 0.2V, it is not sinusoidal signal.

∴ The general expression for SNR will be used which is applicable to all message signals.

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i.e, $SNR = 3S(2^{2n})$ —— (1)

where,

S = Average power of normalized message signal

n = No of bits used for representing each sample value.

our message signal is not normalized so that $|x(t)| \leq 1$, its average power after normalization will be

$$S = \frac{\text{Average power of given } x(t)}{\text{Peak to Peak Voltage}}$$

RMS value = 0.2V ∴

Average power $(0.2)^2 = 0.04W$

Substituting the values

$$S = \frac{0.04}{4} = 0.01$$

S = 0.01.

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Bandwidth is given as 3.5 KHz

Niquist Rate for 3.5 KHz bandwidth.

$$\therefore f_s = 2 \times BW$$

$$f(s) = 2 \times 3.5 \times 1000\,Hz$$

$$f(s) = 7 \times 10^3\,Hz$$

To maximize n we take the minimum value of f_s,

$$f_s \times n_{max} = r$$

Substituting the values of f_s and r.

$$7 \times 10^3 \times n_{max} = 50 \times 10^3$$

$$n_{max} = \frac{50 \times 10^3}{7 \times 10^3}$$

$$n_{max} = 7.142$$

$$\text{i.e., } n_{max} = 7$$

Substituting the value of S, n in (1)

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(8)

$$SNR = 3S(2^{2n})$$

$$SNR = 3(0.01)(2^{2\times 7})$$

$$SNR = (0.03)(2^{14})$$

$$SNR = 0.03 \times 16384$$

$$\boxed{SNR = 491.52}$$

or,

$$SNR = 10\log_{10} 491.52$$

$$SNR = 10(2.6915)$$

$$\boxed{SNR = 26.915\ dB}$$

Max signal to Noise Ratio that can be obtained by the system is 491.52 or 26.915 dB.

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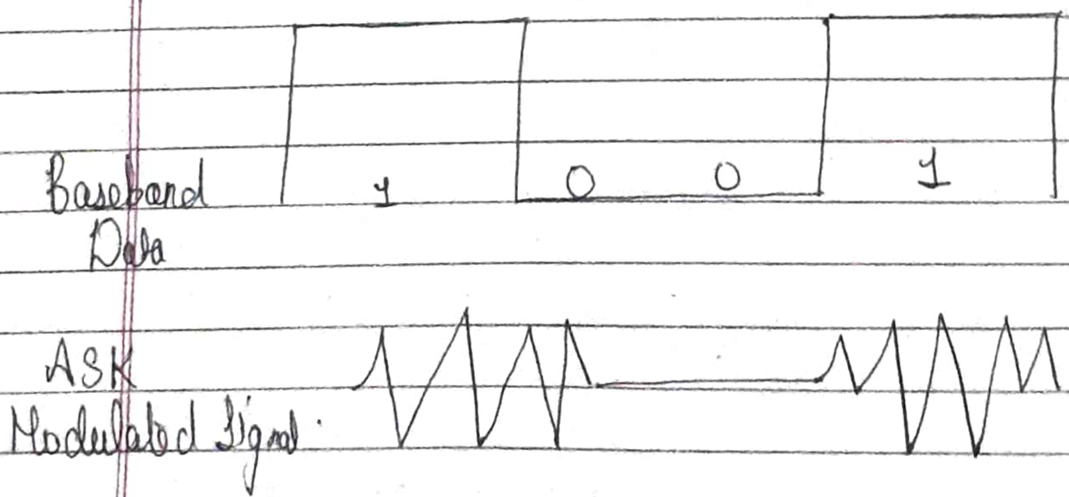
Ques 5

Ans Concept of Non-Coherent Binary Amplitude Shift Keying (ASK)

ASK is a type of Amplitude Modulation which represents the binary data in the form of variations in the amplitude of a signal.

Any modulated signal has a high frequency carrier. The binary signal when ASK modulated gives a zero value for low input while it gives the carrier output for high input.

The following figures represent ASK modulated waveform along with its input



In the binary ASK case, transmitted signal

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$$s(t) = \sqrt{2 P_s} \cos(2\pi f_c t)$$

Binary ASK Signal can also be demodulated non-coherently using envelope detector. This greatly simplified design consideration required in synchronous detection. Non-Coherent detection Schemes do not require a phase coherent local oscillator. This method involves some form of rectification and low pass filtering at the receiver. The Block diagram of non-coherent receiver for ASK signal has been shown.

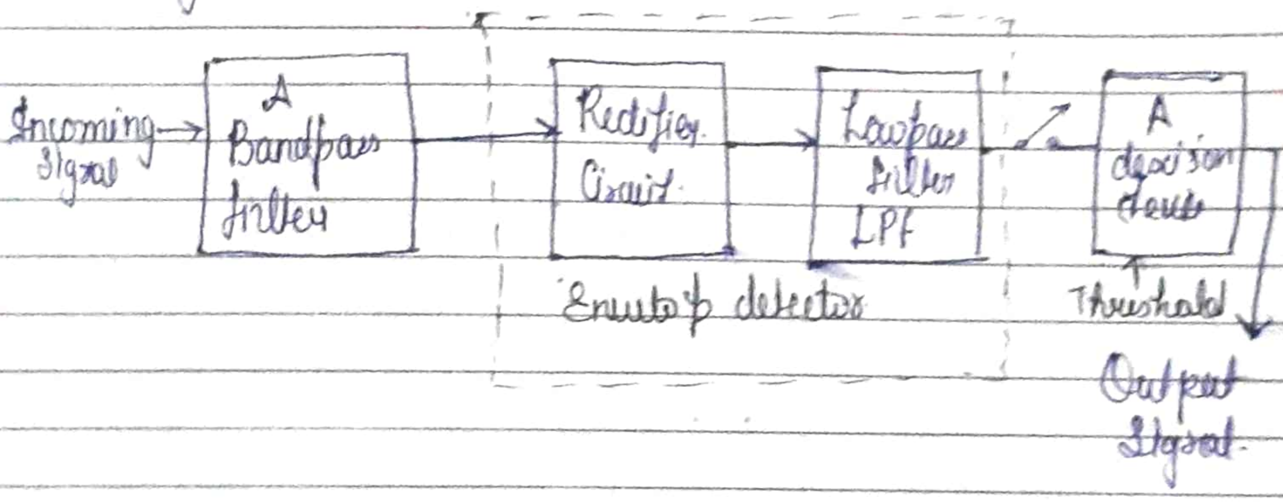
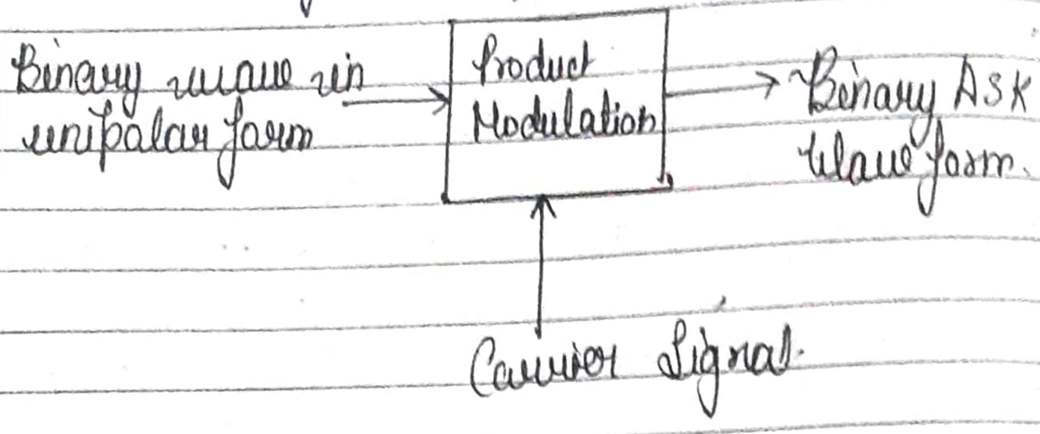


fig:- Non-Coherent ASK Detector

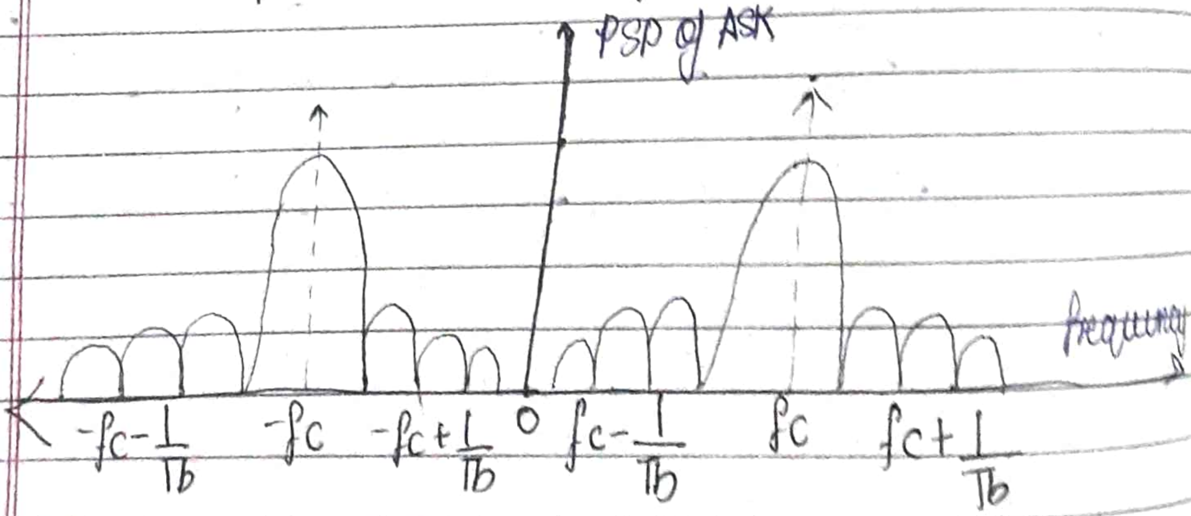
Mathematical Representation

ASK is also known as ON-OFF keying (OOK). Since in this modulation technique the carrier wave is switched ON or OFF based on the input binary sequence.

Generation of ASK Signal:-



Power Spectral density of ASK Signal:-



If the carrier wave is given as,

$$s(t) = A\cos(2\pi fct)$$

Here A is peak value of the sinusoidal carrier wave.

For a standard 1 Ω load resistor, the power dissipated would be

$$\therefore P = \frac{V_{rms}^2}{R} = \left(\frac{V_{max}}{\sqrt{2}}\right)^2 / 1 = \left(\frac{A}{\sqrt{2}}\right)^2 = \frac{A^2}{2}$$

$$\Rightarrow P = \frac{A^2}{2}$$

$$A = \sqrt{2P}$$

Mathematically ASK waveform may be expressed as :

$$S(t) = \begin{cases} \sqrt{2P_s}\cos(2\pi f_c t); & \text{when 1 is to be transmitted} \\ 0 \quad \text{(i.e no signal is transmitted)}; & \text{when 0 is to be transmitted} \end{cases}$$