King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE370: Communications Engineering I (101)
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Quiz 4: Frequency Modulation

Serial # 0
-1 for not writing your serial number

Name: KEY

1 **1) Choose the correct answer:**
The modulating frequency in frequency modulation is increased from 10 kHz to 20 kHz. The bandwidth is :
a) doubled **b)** halved **(c)** increased by 20 kHz **d)** increased tremendously **e)** not affected

1 **2) What is the main disadvantage with direct method of frequency modulation?**

Frequency instability.

1 **3) What are the main two blocks in a band-pass limiter?**

hard limiter + Bandpass filter

4) A single-tone FM signal is given by $\varphi_{FM}(t) = 10\cos(16\pi \times 10^6 t + 20\sin(2\pi \times 10^3 t))$

4 a) Find the modulation index and estimate the bandwidth of the signal.

$B = 1\,KHz$

$\omega_i = 16\pi \times 10^6 + 4\pi \times 10^4 \cos(2\pi \times 10^3 t)$

$f_i = 8 \times 10^6 + 2 \times 10^4 \cos(2\pi \times 10^3 t)$

Bandwidth $= 2(\Delta f + B) = \boxed{42\,KHz}$

$\Delta f_{max} = 20\,KHz$

$\beta = \frac{\Delta f}{B} = \frac{20k}{1k} = \boxed{20}$

3 b) if $k_f = 10/\pi$ kHz/V, what is the message $m(t)$. Hint: check the units for k_f

$\frac{10}{\pi} k_f \cdot 2\pi \equiv K_f = 20\,K\,rad/V$

$\varphi_{FM}(t) = 10\cos(16\pi \times 10^6 t + 20\sin(2\pi \times 10^3 t))$

Compare with $\varphi_{FM}(t) = A\cos(\omega_c t + k_f a(t))$

$20\sin(2\pi \times 10^3 t) = 20k\,a(t)$ differentiate both sides

$\Rightarrow m(t) = \frac{2\pi \times 10^3}{10^3}\cos(2\pi \times 10^3 t) = \boxed{2\pi\cos(2\pi \times 10^3)}\,V$

Good Luck, **Dr. Ali Muqaibel**