Birla Institute of Technology and Science, Pilani
ECE/EEE F311 Communication Systems
First Semester 2023-2024 (09-10-2023)
Mid-Semester Test (Closed Book)

Maximum Marks: 75 **Duration: 90 minutes**

- **There are four questions. All questions are compulsory.**
- **Put important steps and final answer in a rectangular box.**
- **Answer all the parts of a question at the same place.**
- **A formula sheet consisting of FT, FS, and trigonometric identities is provided.**

Q1. (a) Find the power efficiency and modulation index for an AM signal $x(t) = \cos 220\pi t + 4\cos 200\pi t + \cos 180\pi t$. [**4 Marks**]

(b) A message signal $m(t)$ with a bandwidth 10 Hz and average power 2 Watts amplitude modulates a carrier signal $\cos(200\pi t)$. Find the average transmit power and the bandwidth for both DSB-SC and LSSB modulated signals. [**4 Marks**]

(c) Find the Hilbert transform of $sinc(20\pi t)$. [**4 Marks**]

(d) Draw a block diagram of an FM demodulator. [**4 Marks**]

(e) Find the autocorrelation function $R_m(\tau)$ for the signal $m(t) = e^{-t}u(t)$. [**4 Marks**]

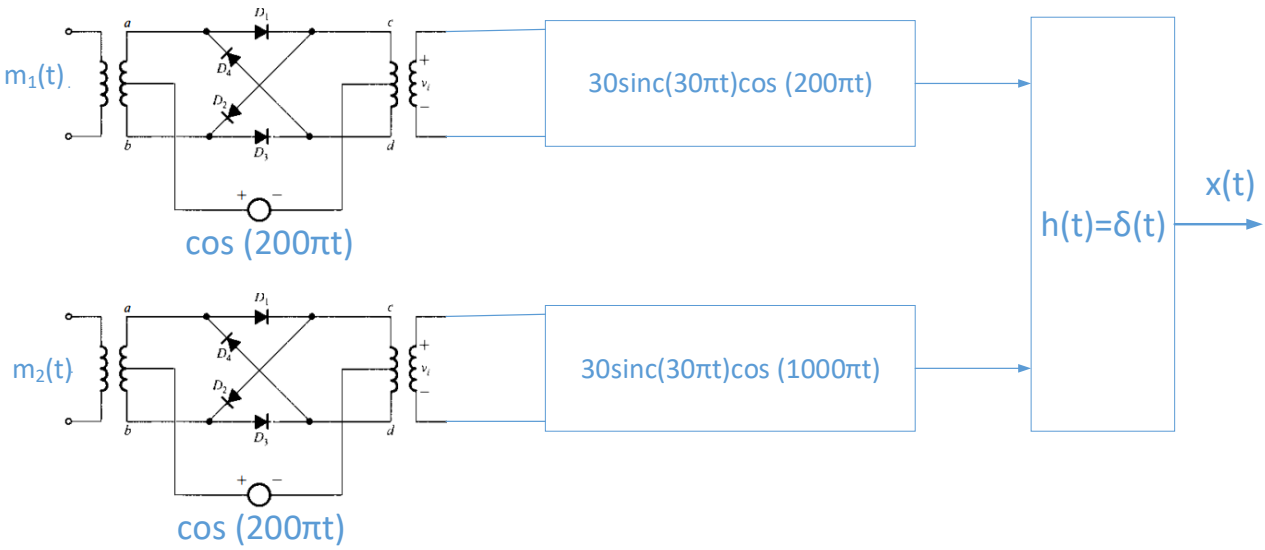
Q2. A message signal $m(t)$ of bandwidth B Hz phase modulates a carrier $c(t) = A\cos(2\pi f_c t)$ with a phase deviation constant k_p rad/volt. The PM modulated signal $x(t)$ is passed through a bandpass filter having a center frequency f_c Hz and bandwidth $4B$ Hz.

(a) Find the time-domain signal $y(t)$ at the output of the bandpass filter. [**12 Marks**]

(b) Assuming $m(t) = 100sinc(100\pi t)$, $c(t) = 10\cos(2000\pi t)$, and $k_p = 2$ rad/volt, sketch the magnitude spectrum $|Y(f)|$ (in the positive frequency axis only). [**8 Marks**]

Q3. (a) Two message signals $m_1(t)$ and $m_2(t)$ each of bandwidth 10 Hz amplitude modulates a carrier signal using the balanced ring modulator, as shown in the figure. Find the signal $x(t)$ at the output of the channel. [**8 Marks**]

(b) From part (a), design a superhetrodyne receiver for the received signal $x(t)$. Provide the specifications of each block to detect the message signal $m_1(t)$. Also find signals at the output of each block. Assume that the message signal $m_1(t)$ has both positive and negative amplitude values. Take IF frequency as 200 Hz. [**12 Marks**]



Q4. The frequency spectrum $M(f)$ of a message signal $m(t)$ is given in the figure. The message signal $m(t)$ amplitude modulates a carrier $\cos(20\pi t)$. Find the time-domain expression for the USSB modulated signal. [**15 Marks**]