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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*(A constituent unit of MAHE, Manipal)*

**SIXTH SEMESTER B.Tech. (E & C) DEGREE END SEMESTER EXAMINATION**
**APRIL 2018**
**SUBJECT: ADVANCED DIGITAL SIGNAL PROCESSING (ECE - 4005)**

**TIME: 3 HOURS** **MAX. MARKS: 50**

**Instructions to candidates**

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Suppose that an analog signal is given as $x(t)=5\cos(2\pi.2000t)+ 3\cos(2\pi.3000t)$, for $t \geq 0$ and is sampled at the rate of 8,000 Hz. (a) Sketch the spectrum of the original signal. (b) Sketch the spectrum of the sampled signal up to 20 kHz. (c) Sketch the recovered analog signal spectrum if an ideal lowpass filter with a cut off frequency of 4 kHz is used to filter the sampled signal ($y(n)=x(n)$ in this case) to recover the original signal.

1B. Let $x(t)$ be the modulating signal, $\cos(2\pi f_c t+\varphi)$ be the carrier and $x(t).\cos(2\pi f_c t+\varphi)$ represents the carrier modulation output. State and prove the modulation theorem.

1C. Write down the time domain and transformed domain expression for downsampler.

**(5+3+2)**

2A. (i) When do we prefer multistage scheme for decimation to single-stage scheme? Explain.
(ii) A signal at 2048 Hz is decimated by 32 to get 64 Hz. The input signal is band limited to 30 Hz. The components from 30 Hz to 32 Hz should be protected from aliasing. The decimation filter can have passband deviation (max) of 0.01 dB and should have minimum attenuation of 80 dB. Design the filter for the given specifications. Also, find the individual filter specifications for multistage scheme with $4\times4\times2$ configuration.

2B. Discuss the basic idea of adaptive filtering.

2C. Illustrate interpolated FIR technique with necessary diagrams.

**(5+3+2)**

3A. What is filter bank? Discuss the polyphase implementation of a uniform filter bank.

3B. Derive Wiener-Hopf equation.

3C. (i) For the signal $f = (2, 2, 4, 6, 8, 8, 12, 10)$, find the second level *Haar* transforms. (ii) Given the *Haar* transformed signal $(2.828, -1.141, 3.423, -1.141 \mid 0, 1.141, 0, 1.141)$, fine the original signal that corresponds to them.

**(5+3+2)**

4A. Draw and discuss the block diagram realization of homomorphic system for convolution. Also, represent the system in canonic form.

4B. Given a quadratic MSE function for the Wiener filter: $J=40-20w+10w^2$. Use the steepest descent method with an initial guess as $w_0=0$ and $\mu=0.04$ to find the optimal solution for $w$ and determine $J_{min}$ by iterating three times.

4C. What is short-time Fourier transform (STFT)? Draw the filter bank structure for STFT.

**(5+3+2)**

5A. (i) What is cepstrum? Discuss real and complex cepstrum. (ii) Define: (a) Lifter (b) Quefrency.

5B. Describe the adaptive filter for system modelling with a neat diagram.

5C. Explain homomorphic processing of speech signal.

**(5+3+2)**