ECE 148 **Signal Processing Applications** **Spring 2020**

Name: ______________________________

Assignment 4: Fourier Series Expansion

Due: Tuesday, May 12

1. ______________/20

2. ______________/20

3. ______________/20

Total: ______________/60

1. (a) Show the basis functions $\{exp(jn\omega_0 t)\}$ of Fourier series expansion are mutually orthogonal with the definition of the inner product

$$< f(t), g(t) > \;=\; \frac{1}{T}\int_0^T f(t)\, g^*(t)\, dt$$

(b) Extend the analysis for the basis functions $\{exp(jn\theta)\}$ of *DTFT*.

2. Use your 7-digit perm number to produce a 7-point sequence $\{F_n\}$, where $n=0,1,\ldots,6$.

   (a) Use $\{F_n\}$ as the Fourier series coefficients to formulate and plot the periodic function $f(t)$ for the interval $(0, T)$.

   (b) Apply *DTFT* onto the sequence $\{F_n\}$. Formulate and plot the *DTFT* spectrum for the interval $(0, 2\pi)$.

   (c) Summarize your observations based on the results from Parts (a) and (b), and explain why so.

3. (a) Consider a real periodic signal, with period T. The signal has 6 harmonics, for $n=0,1,\ldots,5$.

$$f(t) \;=\; \sum_{n=0}^{5} a_n \cos(n\omega_0 t + \theta_n)$$

Then we take 16 uniform samples within one period to form a short 16-point sequence $\{f(m)\}$. Subsequently, we take a 16-point *DFT* of the sequence

$$F(k) \;=\; DFT\,\{f(m)\}$$

Identify and list the 16-point *DFT* spectrum $F(k)$ in terms of a_n and θ_n.

(b) Repeat the exercise with the periodic function $g(t)$

$$g(t) \;=\; \sum_{n=1}^{5} b_n \sin(n\omega_0 t + \varphi_n)$$