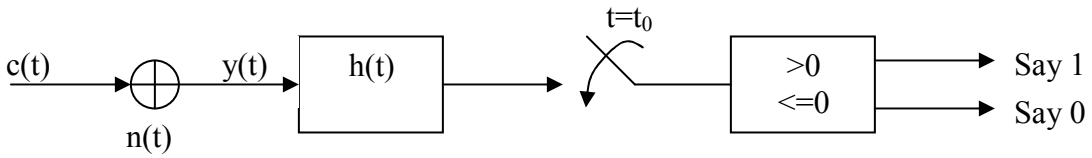
Computer Engineering

The transmitted signal in a communication system is given by

$$c(t) = \begin{cases} s(t) & \text{if } 1 \text{ is being sent} \\ -s(t) & \text{if } 0 \text{ is being sent} \end{cases}$$

where *s(t)* is a single square pulse of amplitude *A* and width *T*. The signal at the receiver is corrupted by additive white gaussian noise with power spectral density $N_0/2$. The received signal *y(t) = c(t) + n(t)* is then processed as shown below,



where *h(t)* is a single square pulse of amplitude 1 and width *T*.

(a) Find the signal contribution at the output of the filter as a function of time, given that 1 is being sent.
(b) Find the sampling time t_0 so as to maximize the magnitude of the signal contribution to the sample.
(c) Find the mean and variance of the noise contribution to the sample.
(d) Find the probability of error.

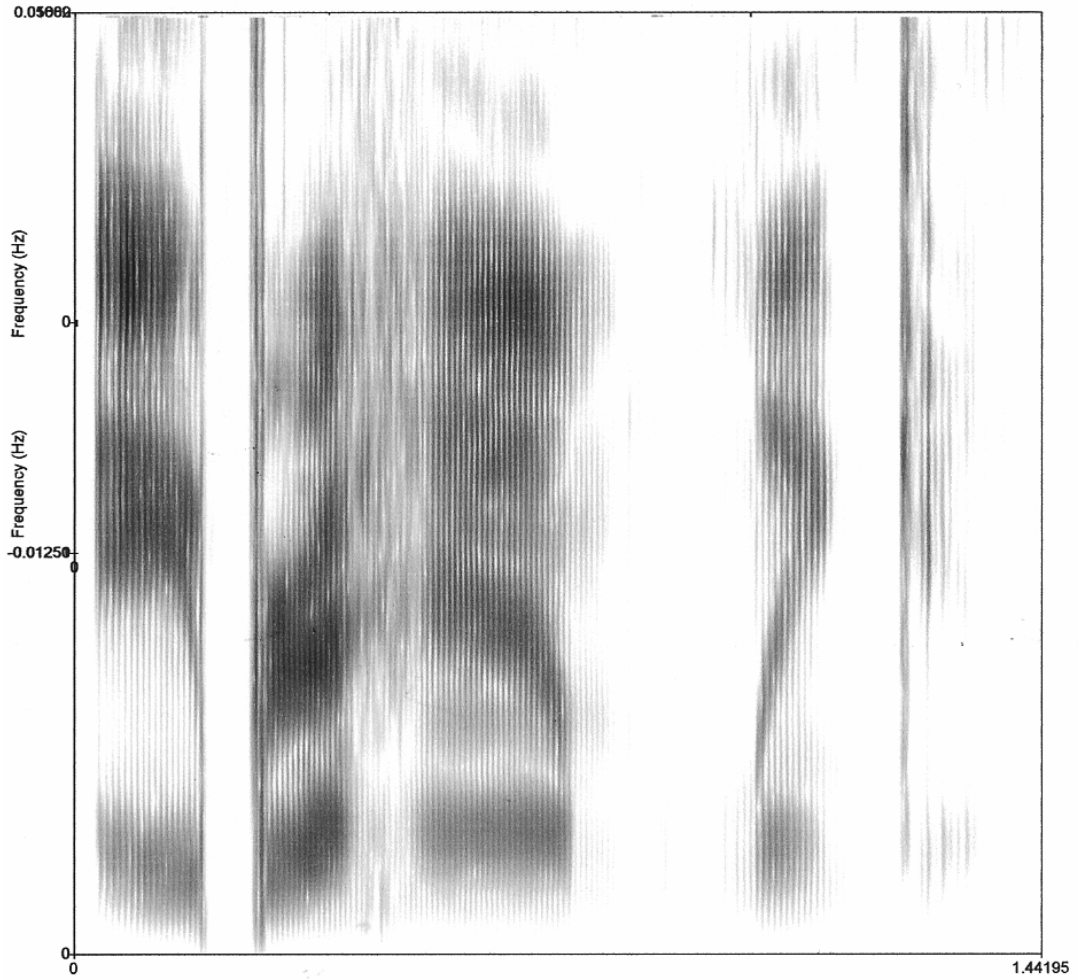
Mechanical Engineering

Consider finding the response of a single degree-of-freedom damped spring-mass system to a pulse of force that takes the form of a half sine wave of arbitrary duration, with the system at rest prior to the force application. (Hint: the basic approach is to find the response to a sine wave of force, and then to use superposition of a similar solution that was offset in time.)

a) Show the forcing functions as a function of time, and show how they can be added together to get a half sine-wave force pulse.
b) In general, the solution to the differential equation representing the response is made up of a homogeneous solution (the transient solution in a vibration problem) and a particular integral (the steady state solution in a vibration problem). Is it necessary to consider both of these parts of the solution here? Why or why not?
c) Write down the solution for displacement resulting from the sine wave force application.
d) Explain and outline how to obtain any unknown constants in the solution.
e) From the above, write down the solution for the response of the 2nd system offset in time by a value of t_0.

Linguistics

Which American President's name is painted in the spectrogram below? Identify the name and mark out the individual segments.



Psychology

Define and discuss the ecological self and the existential self in the context of dynamic systems theory. When do these "selfs" emerge and what role do they play in infant development?

Economics

Throughout this question, assume that the firm's production function exhibits increasing returns to scale. Also assume that the firm is a monopolist.

(a) Sketch a situation in which, in the long run, the monopolist would rather shut down than produce. Using your graph, explain why the monopolist is better off not producing.
(b) Sketch a situation in which, in the long run, the monopolist would rather produce than shut down. Using your graph, explain why the monopolist is better off producing. Show the area of consumer surplus on your graph.
(c) Just like in part (b), sketch a situation in which, in the long run, the monopolist would rather produce than shut down. If the monopolist is producing some quantity 'Q1' (where Q1 could be any positive number), define 'social surplus' as being the total area between the demand curve and the marginal cost curve, from a quantity of zero to a quantity of Q1. Areas where the demand curve is higher than the marginal cost curve count as positive areas of social surplus; areas where the demand curve is lower than the marginal cost curve count as negative areas of social surplus. Let 'Q2' be the quantity which results in the maximum social surplus. Locate Q2 on your graph and explain your answer briefly.
(d) Is the market-clearing price at Q2 greater than, equal to, or less than the marginal cost of producing Q2, or can you tell?
(e) Suppose the government wanted to force the monopolist to produce Q2, so it passed a law saying that the monopolist had to produce Q2 or go out of business. What would happen: would the monopolist produce Q2 or would he go out of business?