EE 3755,

Homework # 7

Question 1: Provide some advantages of microprogram-based controllers over hardwired ones.

Answer:

(a) Microprogram-based controllers are easy to design and implement.

(b) They are cost-effective especially when implementing large controllers; (hundreds/thousands of steps).

(c) They provide ability to correct design errors.

(d) They provide ability to modify instruction set architecture.

(e) Part of the control ROM can be used to store useful functions (like trigonometric functions, fixed or floating point multiplication/division etc..) which can be looked-up instead of using the ALU of the computer to compute them.

Question 2: Provide one disadvantage of microprogrsm-based controllers over hardwired ones

Answer: Microprogrsm-based controllers are slower then hardwired ones.

Question 3: The microprogrsm-based controller presented in the respective handout was not the fastest possible one. Explain why this is true. Also, provide guidelines for designing the fastest possible microprogrsm-based controllers.

Answer: The microprogrsm-based computer presented in the respective handout had two different types of microinstructions: a transfer and a branch microinstruction. Therefore, if a control step of the computer had both transfer and brench responsibilities, it could not be microcoded with one microinstruction.

Moreover, steps that required double target selection and/or conditional connections or transfers could not be microcoded with one microinstruction. This is due to the fact that the microinstructions were designed in a way such that only unconditional BUS-connections were allowed (see pages 8, 9 of the handout entitled "Microprogram-based controllers", for example) and also only single (not multiple) unconditional (not conditional) target selections were allowed; (see page 10 of respective handout). Also, the microprogram-based controller relied on the 4-step microsequencer of page 15 of the respective handout. This microsequencer dictates that the time required for fetching, decoding and executing each microinstruction is three clock periods.

Putting the entire picture together, for the example presented in the respective handout, each AHPL control step

of the computer could require more than one microinstruction for its microcoding while each such microinstruction requires three clock periods for its execution. Therefore, each AHPL control step requires three or more clock periods for its execution.

Some guidelines for designing the fastest possible microprogram-based controller follow:

(1). Intergrate the transfer and branch microinstructions into one longer microinstruction, responsible for both transfering and branching.

(2). Design the transfer part of the microinstruction in a way such that conditional BUS-connections as well as multiple and conditional target-selections are allowed.

The implication of guidelines 1 and 2 will be that each AHPL control step of the computer can now be microcoded with one microinstruction.

[3] Modify the microsequencer to become a 1-step sequencer so that now each microinstruction can be executed in one clock period.

Therefore, the overall implication will be that now each AHPL control step of the computer will require <u>one</u> clock period for its execution.