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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Information and Communication Technology
ThirdYear- Semester II Examination – Oct./Nov. 2017

ICT 3304 – EMBEDDED SYSTEMS

Time:Three(3) hours

Instructions

1. Answer all questions.
2. If you are unclear about any question, make assumptions and clearly mention the assumptions.
3. There are four (04) questions in this question paper.

1. Answer all sections

   a) "Embedded systems are a form of standalone computer. They have a computer buried inside, but the user doesn't perceive them as computers." As a student who followed a lecture series on embedded systems, how do you support the above statements? **(12 marks)**

   b) Representing negative numbers in a processor is not straight-forward. Two's compliment is one method which represents negative numbers in a processor based system. Explain with required examples how two's complement can be used to represent negative numbers. **(13 marks)**

2. Answer all sub sections

   a) Below figure is an excerpt from the instruction set of a microcontroller.

CPU Operation	Code (Binary)	Code (Hex)
Multiply register R3 with register R2 and write the result to registers R1(MSB) and R0(LSB)	1001.1100.0011.0010	9C32

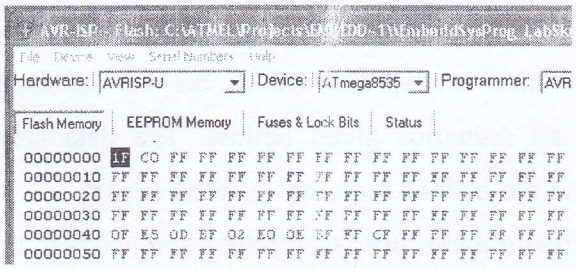
Draw necessary diagrams and explain with examples, the execution of above command in the processor. **(12 marks)**

   b) Consider the following code sample.

```
        .org 0          ;Here on Reset / Power up
        rjmp INIT
        .org 0x020      ;Code base address
INIT:
        LDI TEMP,LOW(RAMEND) ;Set Stack Pointer
        OUT SPL,TEMP
        LDI TEMP,HIGH(RAMEND)
        OUT SPH,TEMP
MAIN:
        rjmp MAIN       ;repeat
```

Actual instruction is RJMP 0x020 (The .org 0x020 directive places the 'INIT' label at program address 0x020)

After programming the above code base, the initial two bytes of the hex file appeared as indicated below. How do you explain the first two bytes being 1F and C0? **(13 marks)**



3. Answer all sections.

   a) Describe following assembly instructions with necessary clear examples.

      i. ADD
      ii. LDI
      iii. BREQ
      iv. CP
      v. AND
      vi. IN
      vii. OUT
      viii. INC
      ix. CLR
      x. RJMP **(10 marks)**

   b) Water Landslides are happening often in various parts of the country now. Landslides not only affect the social life of the families in the area but mostly erode the soil and make it not suitable for vegetation. Research is being carried out worldwide to build early warning systems for landslides. As a student who studied the fundamentals of embedded systems and an undergraduate from a reputed national university, how do you solve this problem using your knowledge on embedded systems and smart systems? Draw architecture diagrams and please mention any assumptions you are making. **(15 marks)**

4. Answer all sections.

a) As a student who knows the fundamentals of IoT, you have been asked to automate the following scenarios in expressways in Sri Lanka. Design IoT architectures separately for all scenarios given bellow. The data sensed, the conditions, the controllers and the actions required for each scenario needs to be clearly mentioned. You are free to make any assumptions and needs to be clearly mentioned.

Scenario 1

In the current expressway ticketing system, a ticket is issued at the entrance and it'll be collected at the exit manually and charge the vehicle depending on the vehicle type and the distance, making long queues at entrances and exits. You are requested to automate this by capturing and identifying the vehicle registration number at the entrance and the exit using image processing techniques. The toll will have to be calculated and withdraw directly form the vehicle owners bank account at the exit. If the vehicle was entered to the highway between 9:00p.m. to 6.00a.m., Rs.50 will have to be deducted from the toll. You may assume that the web service is available to withdraw the toll directly form the owners bank account once the vehicle number and the amount are provided.

(7 marks)

Scenario 2

It has been identified that the driving in high speed (100Kmh) in the expressway, during the rainy period, was the reason for many accidents reported. Therefore, authorities need to replace printed speed limits sign boards with digital boards, enabling the changing of speed limits automatically, by a central computer as follows;

No rain with dry road = 100Kmh
Less rain and/or wet road = 80Kmh
Heavy rain = 60Kmh

You are requested to automate this process. You may assume that in every 5Km, there are rain and water sensors installed in the expressway. **(7 marks)**

Scenario 3

Authorities are required to identify and charge over speeding drivers, in the expressways. In this regards, speed detectors and cameras have already been installed. The requirement is that when the vehicle is detected, it needs to be notified to the authorities as well as the owner of the vehicle. You are free to make any assumptions and they need to be clearly mentioned. **(7 marks)**

b) In the Colombo - Katunayaka Expressway, an Electronic Toll Collection (ETC) system have been installed to eliminate the delay. The ETC determines whether the vehicles have been enrolled in the system and then electronically deducts the toll from the registered owners' account automatically and opens the gateswithout requiring them to stop. By introducing this system to other expressways, it is expected to reduce the installation cost of ETC, by using the same general purpose computers which are currently used for manual toll collection without using dedicated computers. Do you agree or not with this suggestion? Give reasons. Hint: consider about real time systems.

(4 marks)

END