**Q.2a.** List and define the three main characteristics of embedded systems that distinguish such systems from other computing systems. Draw and explain the simplified revenue model for computing revenue loss from delayed entry of the embedded product to market.

Answer: Some common characteristics of embedded systems:

- Single-functioned
    - Executes a single program, repeatedly
- Tightly-constrained
    - Low cost, low power, small, fast, etc.
- Reactive and real-time
    - Continually reacts to changes in the system's environment
    - Must compute certain results in real-time without delay

Losses due to delayed market entry:
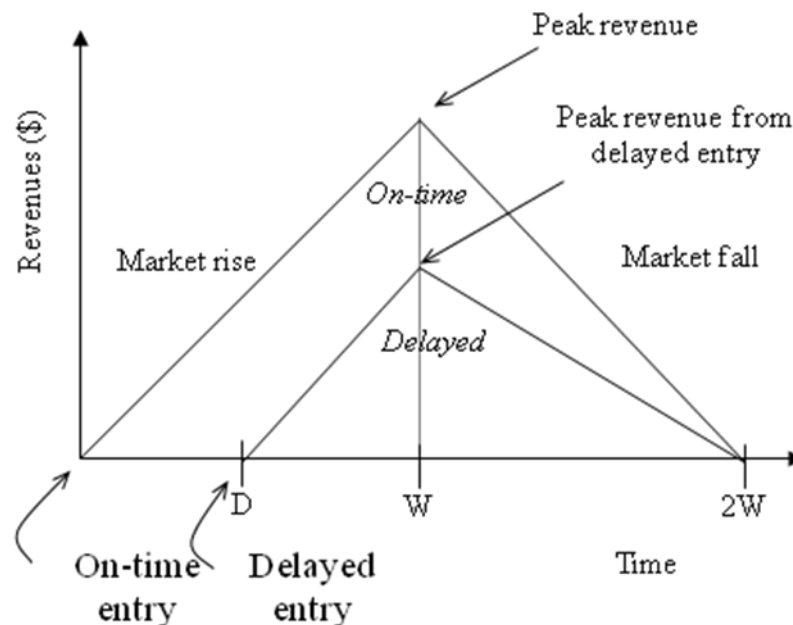
- Simplified revenue model
    - Product life = 2W, peak at W
    - Time of market entry defines a triangle, representing market penetration
    - Triangle area equals revenue
- Loss
    - The difference between the on-time and delayed triangle area

b. What is a "Market Window" and why is it so important for products to reach the market early in this window?

Answer: Page No. 6, 7 of Textbook 1.

Q.3 a. Compare the following

i) Superscalar and VLIW architectures
ii) Princeton and Harvard
Answer:

- Superscalar
  - Scalar: non-vector operations
  - Fetches instructions in batches, executes as many as possible
    - May require extensive hardware to detect independent instructions
- VLIW: each word in memory has multiple independent instructions
  - Relies on the compiler to detect and schedule instructions
  - Currently growing in popularity

  ii. Princeton and Harvard

- Princeton
  - Fewer memory wires
- Harvard
  - Simultaneous program and data memory access
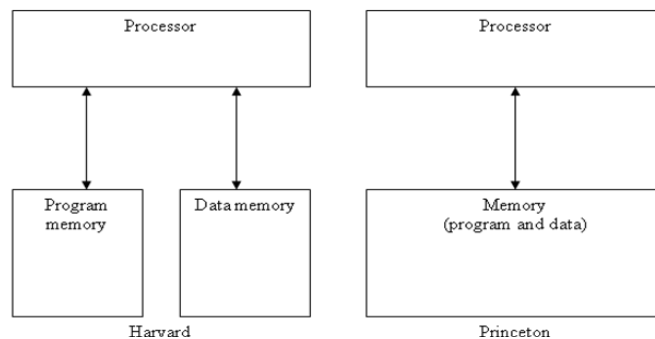
**b.** Explain the main features of Timers, Counters and Watchdog Timers.

Answer:
- Timer: measures time intervals
  - To generate timed output events
    - e.g., hold traffic light green for 10 s
  - To measure input events
  e.g., measure a car's speed

- Counter: like a timer, but counts pulses on a general input signal rather than clock
    - e.g., count cars passing over a sensor
    - Can often configure device as either a timer or counter
    -
- Watchdog timer
    - Must reset timer every X time unit, else timer generates a signal
    - Common use: detect failure, self-reset
    - Another use: timeouts
    - e.g., ATM machine

Q.4 a. Explain how a PC communicates serially with an embedded device. Describe transmission protocol used by the two UARTs.

Answer:
- UART: Universal Asynchronous Receiver Transmitter
    - Takes parallel data and transmits serially
    - Receives serial data and converts to parallel
- Parity: extra bit for simple error checking
- Start bit, stop bit
- Baud rate
    - Signal changes per second
   - Bit rate usually higher
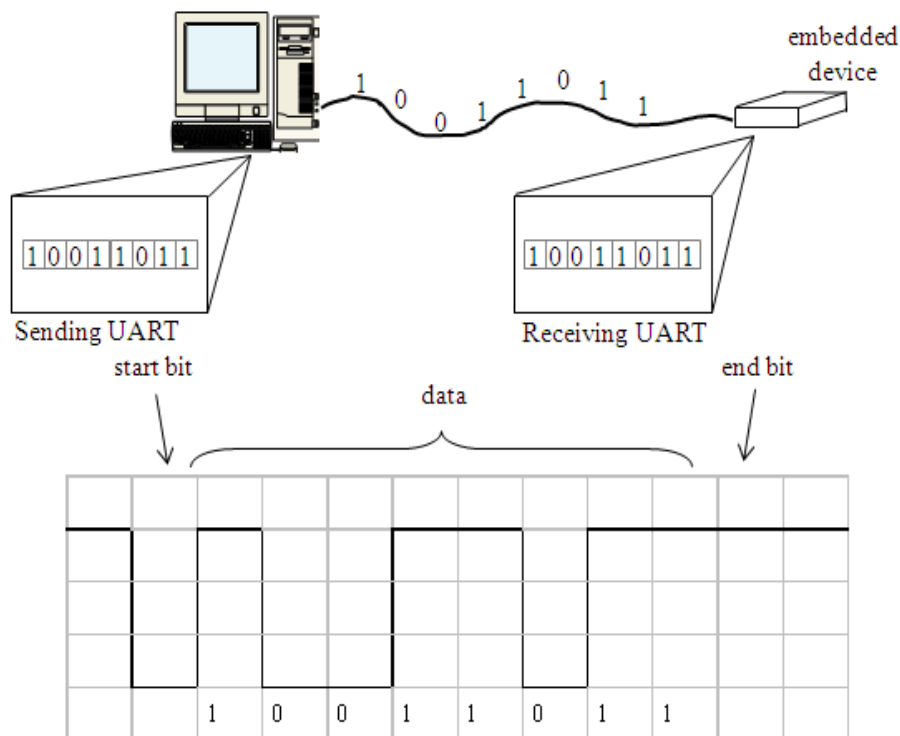
b. Draw the internal view of an 8 x 4 ROM and explain the ROM main features.

Answer:
- Nonvolatile memory
- Can be read from but not written to, by a processor in an embedded system
- Traditionally written to, "programmed", before inserting to embedded system
- Uses
  - Store software program for general-purpose processor
    - Program instructions can be one or more ROM words
  - Store constant data needed by system
  - Implement combinational circuit

Internal view
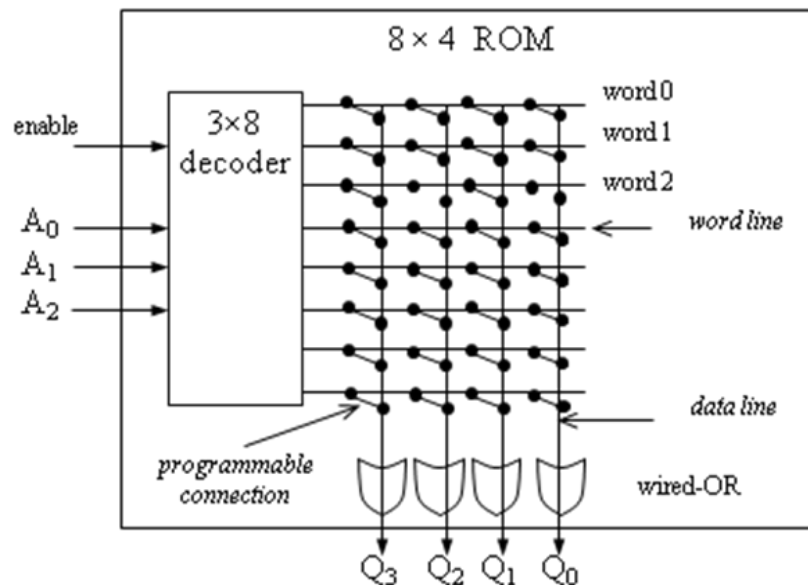
Q.5 a. Compare Fixed and Vectored interrupts.

Answer: Fixed interrupt
- Address built into microprocessor, cannot be changed
- Either ISR stored at address or a jump to actual ISR stored if not enough bytes available

Vectored interrupt
- Peripheral must provide the address
- Common when microprocessor has multiple peripherals connected by a system bus

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b. Interface 8k of data and 32k of program code memory to an 8051 micro controller. Explain how a memory read operation performs.

Answer:
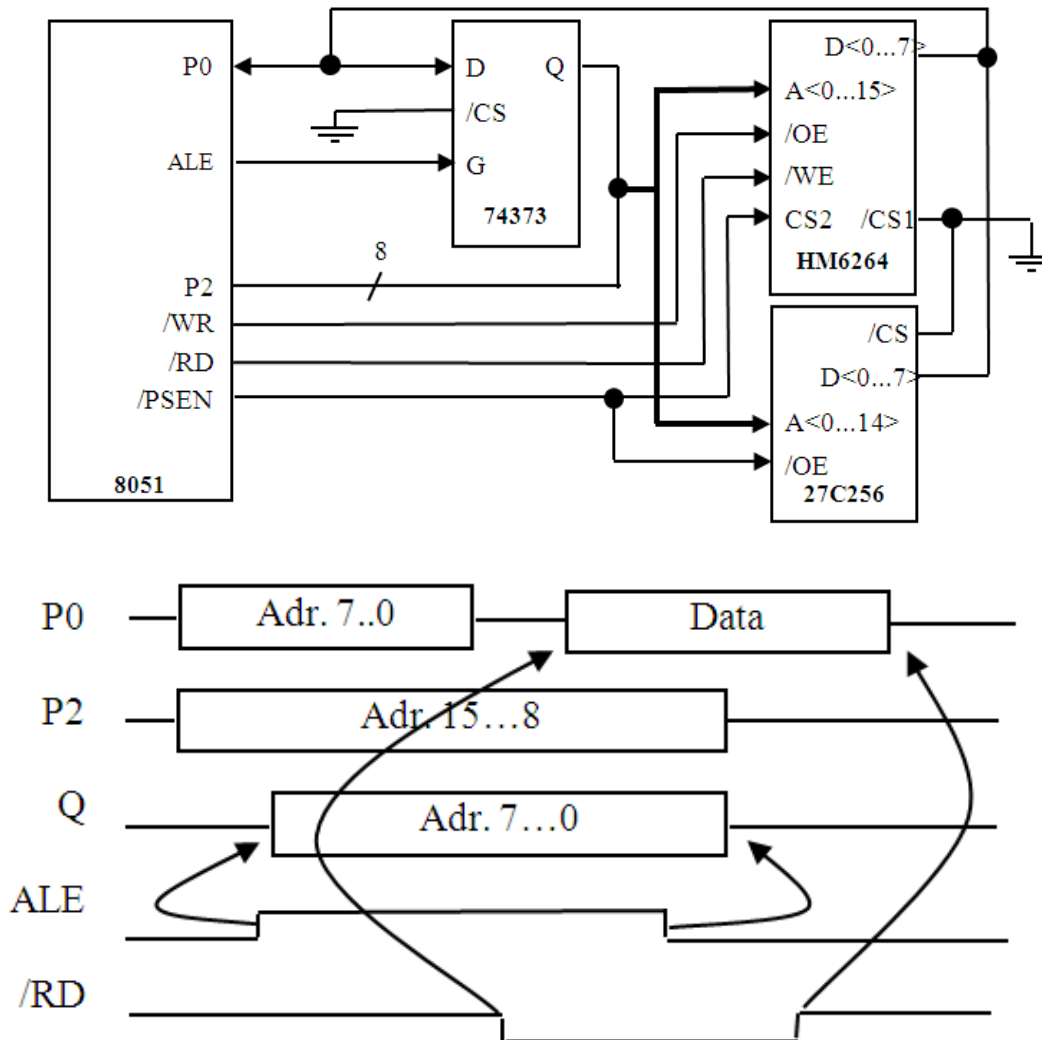
- Interfacing an 8051 to external memory
  - Ports P0 and P2 support port-based I/O when 8051 internal memory being used
  - Those ports serve as data/address buses when external memory is being used
  - 16-bit address and 8-bit data are time multiplexed; low 8-bits of address must therefore be latched with aid of ALE signal

Q.6 a. Explain different addressing modes used to indicate the data's location in assembly language programming.

Answer: Page No. 63 of Textbook 1.

    b. Explain the concepts of scheduler in RTOS in detail with example.
Answer: Page No. 160 –164 of Textbook 2.

Q.7 a.   Explain Shared Data Problems and Re-entrant functions in RTOS.

Answer: Page No. 167 – 169 of Textbook 2.

Q.8 a. Describe the architecture of basic DRAM and also explain advanced DRAM with suitable diagrams.

Answer: Page No. 130-134 of Textbook 1.

b. With the help of an example and diagram define heartbeat timer in detail.

Answer: Page No: 206-207 (Article 7.2- Timer Functions) of Text Book II-An Embedded Software Primer by David E. Simon.

Q.9 a. List the advantages and disadvantages of using a large number of tasks.

Answer: Page No. 222 of Textbook 2.

b. How messages passed through the RTOS in Telegraph operation and how it deals with an interrupt routine.

Answer: Page No: 237-238 (Article 8.2- Principles) of Text Book II-An Embedded Software Primer by David E. Simon.

TEXTBOOK:
1. Embedded System Design, A Unified Hardware/Software Introduction, Frank Vahid /Tony Givargis, 2006 reprint, Jhon Wiley student Edition
2. An Embedded Software Primer by David E. Simon, Fourth Impression 2007, Pearson Education