Dordt University Engineering Department
EGR 304, Embedded Microprocessor Systems— Test 1, February 21, 2020.
Open notes, an Internet-connected computer is recommended.

1. What is meant by the phrase, *embedded system*? How is that different from a *system-on-a-chip*?
(25 points)

Both an embedded system and a system-on-a-chip are a combination of a CPU, memory, and I/O ports on one integrated circuit. An embedded system is a device that has a dedicated purpose, is not usually thought of as a computer, and does not recieve software updates or the installation of programs by the user ("apps"). Examples of embedded systems would be a digital thermostat, a remote controller for a TV, a garage door opener's radio reciever, etc. This is in contrast to a smartphone or tablet computer, the quintessential examples of a system-on-a-chip. An embedded system is optimized for one purpose. An SoC is optimized for flexibility.

2. Describe how version control software helps teams of software writers work together. Specifically, why is it better than simply e-mailing files back and forth among the team as needed?. (25 Points)

Version control rigorously enforces documentation of software updates in such a way that several people can be working in the same file at the same time and any resulting conflicts will be found and resolved automatically to the extent possible, and any need for manual resolution of conflicts will not be accidentally overlooked. Version control software does this for all file formats — code, text documentation, drawings, photos, ... any file. The version control software also keeps an accurate history of updates and the addition of new content to the project so that if needed, any older version can be recovered.

3. The certain GPIO pin of a Raspberry Pi evaluation board, when configured as an output, can source or sink no more than a current magnitude of 2 mA. Assuming the GPIO pin is correctly configured as an output, **draw a schematic showing how to control the LED from the output pin**.

   The Raspberry Pi uses 3.3 V logic meaning that. . .
    a logic-0 will be somewhere between 0 V and 0.6 V and. . .
    a logic-1 will be somewhere between 2.3 V and 3.3 V.

   The LED will draw power from the 3.3 V power supply (which you may assume is exactly 3.3 V. The LED has a forward voltage drop of 1.2 V while it is on and requires 10 mA to illuminate.

   You may assume that the 3.3 V power supply, ground, and the GPIO pin can all be conveniently connected to your circuit. You may also assume that any resistors you might want and a TN0606N transistor are available in addition to the LED. The TN0606N transistor is an n–channel enhancement field-effect transistor with a threshold voltage assured to be between 0.6 V and 2.0 V. If the voltage from gate-to-source is less than the threshold you can assume it is "off" and if the voltage is greater than the threshold by at least 0.3 V you can assume the resistance from drain to source is less than 0.1 ohm.   (25 points)

$$R_D = \frac{V_{DD} - V_{LED}}{I_{LED}} - R_{ON} = \frac{(3.3\,V) - (1.2\,V)}{10\,mA} - (0.1\,\Omega)$$

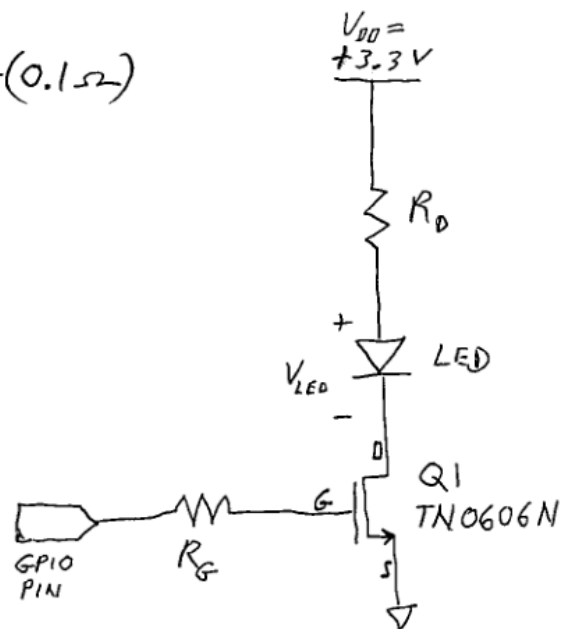$$\boxed{R_D = 209.9\,\Omega}$$

ANY ANSWER OF $R_D \cong 210\,\Omega$ IS ACCEPTABLE

R_G IS OPTIONAL, USED TO PROTECT THE GPIO PIN IN CASE Q_1 FAILS WITH A SHORT FROM DRAIN TO GATE.

ALMOST ANY RESISTANCE ABOVE

$$R_G = \frac{V_{DD}}{|I_{PIN-MAX}|} = \frac{(3.3V)}{(2\,mA)} = 1.65\,k\Omega$$

$R_G = 2.2\,k\Omega$ IS CONVENTIONAL FOR RASPBERRY–PI

$V_{DD} = +3.3\,V$

R_D

V_{LED} LED

GPIO PIN R_G $Q1$ TN0606N

4. A single spring-loaded pushbutton needs to be connected to a GPIO pin on an Arduino Uno. When the button is pressed down a counter should advance by one count, so that in effect, the number of times the button is pressed is counted from the moment the program starts running. (The count should advance when the button is pressed down, not when it is released.)   (25 points)

    a.) Draw a schematic to show how to connect the button to pin of the Arduino Uno.
    b.) Describe how you would like the pin configured. (Words will do, no code needed.)
    c.) How will you assure that the count advances predictably and never more than once per press?

a)

+5V

GPIO
PIN

OTHER CURRECT
SOLUTIONS ARE POSSIBLE
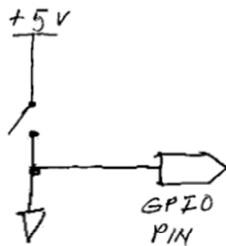
b) THE PIN SHOULD BE CONFIGURED AS AN INPUT WITH A PULL-UP RESISTOR. WHEN THE SWITCH IS OPEN READING THE SWITCH WILL YIELD LOGIC-1.

c) THIS SWITCH WILL NEED TO BE DEBOUNCED. THIS COULD BE DONE IN SOFTWARE. IF A TRANSITION FROM LOGIC-1 TO LOGIC-0 IS OBSERVED, COUNT THE TRANSITION BUT THEN WAIT 30ms BEFORE DOING ANYTHING ELSE TO GIVE THE SWITCH TIME TO STOP BOUNCING. SIMILARLY, IF A LOGIC-0 TO LOGIC-1 IS OBSERVED (DON'T COUNT) WAIT 30ms.