ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION
DURATION: 3 HOURS

WINTER SEMESTER, 2021-2022
FULL MARKS: 150

SWE 4701: Software Metrics and Process

Programmable calculators are not allowed. Do not write anything on the question paper.
Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

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1. a) Consider the following items: 6+3
    (CO1)
    (PO1)

    - Defect detection efficiency
    - Size of test code
    - Test coverage
    - Requirements reliability
    - Time for implementation
    - System spoilage
    - Developer productivity
    - Module stability
    - Fault count
    - System uptime

    i. Which of the items above belong to Direct and Derived measures.
    ii. Write the formula to compute Test coverage and System spoilage for a software.

    b) CTO of NinjaTech Software Ltd wants to perform Integration testing, UI testing, and Penetration testing in his/her company. S/he hired some experienced (average 4 years) testers to perform these testing. Before implementing these testing methods the CTO wants to know the effectiveness of these testing by conducting a formal experiment. 8
    (CO4)
    (PO3)

    Develop the factorial design of the experiment by considering Crossing and Nesting of factors.

    c) What is Retrospective study? Briefly discuss different types of threats to validity in Empirical Study. 8
    (CO4)
    (PO1)

2. a) What is Goal Question Indicator Metrics (GQIM) Framework? Briefly describe each steps to apply the framework. 12
    (CO3)
    (PO1)

    b) An Inventory System has 6 screens, 2 reports, and 1 external component. It uses 6 data tables to perform its functionality. Table 1 contains the number of views for screens and reports. 6+2
    (CO4)
    (PO2)

    Table 1: Inventory System Data for Question 2.b)

Screens	Number of views	Screens	Number of views	**Reports**	Number of views
1st Screen	2	2nd Screen	5	1st Report	1
3rd Screen	8	4th Screen	1	1st Report	3
5th Screen	3	6th Screen	6		

    If High experienced developers with the productivity value 25 are used to build the system:
    i. Estimate the effort to build the system by calculating Object Point.
    ii. Estimate the effort to build the system if 22% of the system can be reused.

c) How to use Use-Cases of a software to measure Use Case Point?

5
(CO2)
(PO1)

3. a) Why Object Oriented metrics are different from the conventional software metrics?

7
(CO1)
(PO1)

b) "*A good design should exhibit high cohesion and low coupling.*" design a Class Diagram to discuss this assertion in terms of the metrics *Coupling Between Object (CBO)* and *Lack of Cohesion Measure (LCOM)*.

8
(CO2)
(PO2)

c) Figure 1 represents a Component-based System (CBS) design where A, B, and C are three components and 1-9 are elements of those components.
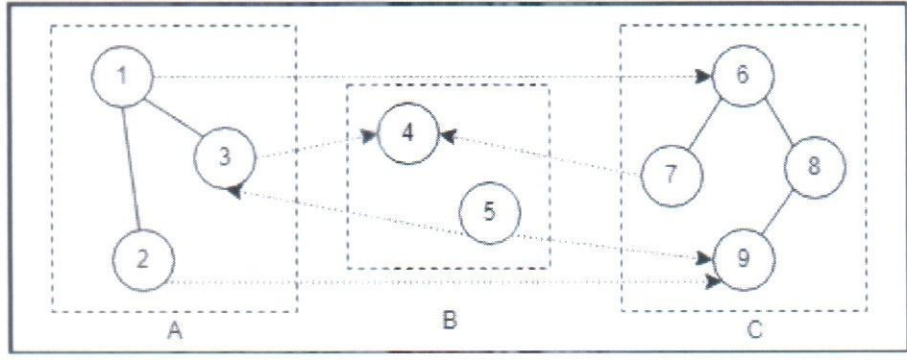
5+5
(CO2)
(PO2)

Figure 1: Component-based Software Design

   i. Calculate the *Cohesion* of each of the components and the overall system.

   ii. Calculate the "Instability" of the three packages A, B, and C where each of the constituent "elements" (for example, 1, 2, etc.) represent "classes" within the packages and the "directed edges" represent the corresponding "relationship" among the classes following Object Oriented Programming (OOP).

4. a) What is tree impurity? Calculate tree impurity for module C in Figure 1.

6
(CO2)
(PO1)

b) Consider the novel Structural Complexity measure as proposed in Equations 1, and 2. Equation 1 computes the *complexity of a module* and Equation 2 computes the *total complexity* of the system. What properties of Structural Complexity do the proposed measure satisfy?

8
(CO2)
(PO2)

$$C_{new} = length_m \times (fanin_m - 0.5 fanout_m) \tag{1}$$

$$C_{newSyst} = \sum_{i=1}^{n} length_i \times \left(\sum_{i=1}^{n} fanin_i - 0.5 \sum_{i=1}^{n} fanout_i \right) \tag{2}$$

c) What is the trade-off between *Cyclomatic Complexity* and *Data Structure Complexity*?

5
(CO1)
(PO1)

d) What is *Usability*? How can we compute the *usability* of a mobile application?

6
(CO1)
(PO1)

5. a) Figure 2 represents a software lifetime, where the X-axis denotes time in "hour" and the Y-axis denotes the operation state of the software based on the following values:

5+4
(CO2)
(PO2)

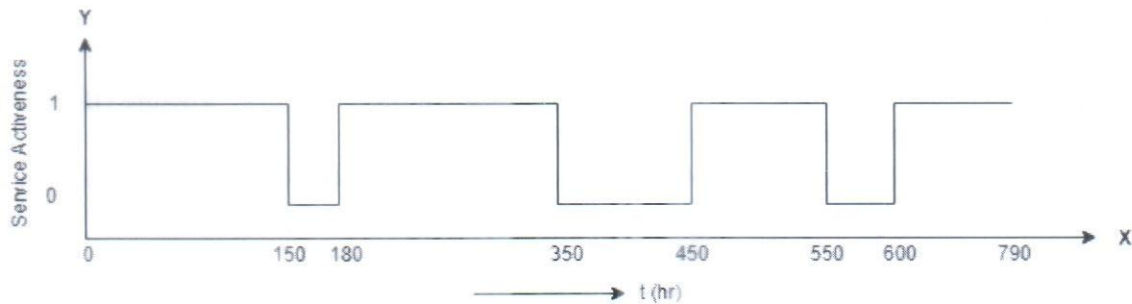   • 1 - Operating normally

   • 0 - Under repair

Figure 2: A software lifetime.

i. Calculate the *Availability* of the software in Figure 2, and interpret the result while the availability requirement is 82%.

ii. Measure *Mean Time To Repair* (MTTR) of the software in Figure 2. If repair time requirement is at most 65 hours, interpret the obtained result.

b) What is *Reliability Model*? Explain *Bathtub Curve* for software reliability with figure.

6
(CO1)
(PO1)

c) A software company develops software components. In a normal condition, a component operates 900 hours without encountering any failure. In a study, 8 components were tested and it was found that 4 components failed at 450, 550, 700, 300 hours.

5+5
(CO2)
(PO2)

i. If components failure rate is constant and follows the exponential distribution, what is the reliability of the component at 750 hours? Interpret the obtained result.

ii. If components failure rate follows the Weibull distribution with a shape parameter is 2, what is the reliability of the component at 800 hours? Interpret the obtained result.

6. a) Consider the main function of Listing 1 and answer question 6.a. The code checks whether a given number is prime or not. [Use appendices if necessary]

7+6
+3+6
+3
(CO2)
(PO2)

Listing 1: Code Snippet for Question 6.a

```
1  #include <stdio.h>
2  int main() {
3    int n, i, flag = 0;
4    printf("Enter a positive integer: ");
5    scanf("%d", &n);
6
7    if (n == 0 || n == 1) flag = 1;
8    for (i = 2; i <= n / 2; ++i) {
9      if (n % i == 0) {
10        flag = 1;
11        break;
12      }
13    }
14
15    if (flag == 0)
16      printf("%d is a prime number.", n);
17    else printf("%d is not a prime number.", n);
18
19    return 0;
20 }
```

i. Design a control flowgraph
ii. Draw decomposition tree and calculate depth of Nesting.
iii. Consider a D-structured graph only allows $\{P_1, D_0, D_1\}$ as Basic Control Structure (BCS). Justify whether the program is D-structured program or not.
iv. Calculate the minimum number of test cases required for statement coverage by considering the decomposition tree.
v. Identify independent paths to cover all the branches of the flowgraph.

Appendices

Sequencing Function

Test Strategy	$F_1; ....F_n$
All-path coverage	$\prod_{i=1}^{n} \mu(F_i)$
Branch coverage	$max(\mu(F_1), ..., \mu(F_n))$
Statement coverage	$max(\mu(F_1), ..., \mu(F_n))$

Nesting Function

Test Strategy	$D_1(F_1, F_2)$	$C_n(F_1, ..., F_n)$	$D_0(F)$	$D_2(F)$
All-path coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^{n} \mu(F_i)$	$\mu(F) + 1$	-
Branch coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^{n} \mu(F_i)$	$\mu(F) + 1$	1
Statement coverage	$\mu(F_1) + \mu(F_2)$	$\sum_{i=1}^{n} \mu(F_i)$	$\mu(F)$	1

Test Strategy	$D_3(F)$	$D_4(F_1, F_2)$	$L_2(F_1, F_2)$
All-path coverage	-	-	-
Branch coverage	1	1	2
Statement coverage	1	1	1

Measurement Values for Primes

Test Strategy	P_1	D_0	D_1	C_n	D_2	D_3	D_4	L_2
All-path coverage	1	2	2	n	-	-	-	-
Branch coverage	1	2	2	n	1	1	1	2
Statement coverage	1	1	2	n	1	1	1	1

Complexity of Screen and Report views' for Object Point

Screen number of views	Report number of views	Number and source of data tables		
		Total < 4, < 2 servers, < 2 clients	Total < 8, 2-3 servers, 3-5 clients	Total 8+, > 3 servers, > 5 clients
< 3	0-1	Simple	Simple	Medium
3-7	2-3	Simple	Medium	Difficult
8+	4+	Medium	Difficult	Difficult

Complexity Score for Object Point

Object Type	Simple	Medium	Difficult
Screen	1	2	3
Report	2	5	8
3GL component	-	-	10

08 December 2022

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DURATION: 3 HOURS

FULL MARKS: 150

SWE 4739: Embedded Software Development

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

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1. a) What is an Embedded Software? What are the development tools and software components that are used in developing Embedded Software?

   7
   (CO1)
   (PO1)

   b) Explain the design challenges of an Embedded System. How are these challenges different from a Desktop application?

   8
   (CO2)
   (PO1)

   c) Discuss the characteristics of an Embedded Software. What are the differences between an Embedded Software and an Embedded System?

   7+3
   (CO2)
   (PO1)

2. a) It is common to use a microprocessor or a microcontroller to develop an Embedded System. What factors do you consider to choose a microprocessor or a microcontroller?

   5
   (CO1)
   (PO1)

   b) Explain in detail the hypothetical design flow of an Embedded System. Briefly discuss Gajski's Y chart iterative design flow with an example.

   10
   (CO2)
   (PO1)

   c) Processors can be varied into three to develop Embedded Software in their customization of the problem. Discuss their pros and cons with an example.

   10
   (CO2)
   (PO1)

3. a) How do the linker and the loader work? Write five differences between the Linker and the Loader.

   5+5
   (CO2)
   (PO1)

   b) Design a combinational circuit using Read Only Memory (ROM) that takes 3-bit numbers as inputs and generates an output binary number equal to the square of the input number.

   15
   (CO2)
   (PO2)

4. You are given a pseudocode that calculates the Greatest Common Divisor (GCD) of two numbers shown in Figure 1.

   a) Design a single-purpose processor with the following requirements:
      i. Finite State Machine with Data (FSMD)
      ii. Datapath
      iii. FSM controller

   3×5
   (CO3)
   (PO3)

```
int x, y;
while(1){
    while(!go_in);
    x = x_in;
    y = y_in;
    while(x!=y){
        if(x<y)
            y = y - x;
        else
            x = x - y;
    }
    d_out = x;
}
```

Figure 1: GCD of two numbers for Question 4.

b) Optimize the implementation shown in Figure 1, and based on the modified code snippet, update the requirements mentioned in Question (4.a).

2+8
(CO3)
(PO3)

5. Assume an Embedded System where two voltage sources (15V and 10V) and one microprocessor are attached. The microprocessor can use one of the voltage sources at a given time. For a specific task, the distributions of time and cost of energy over the number of cycles are given in Figure 2. **Specification of the task**: a basic home intruder detection system that consists of a PIR sensor, a Buzzer, and a red LED bulb. Whenever there is a movement of the given area that PIR is covered, the Buzzer will sound and the bulb will start blinking.

(a) Cycle time

(b) Energy per cycle
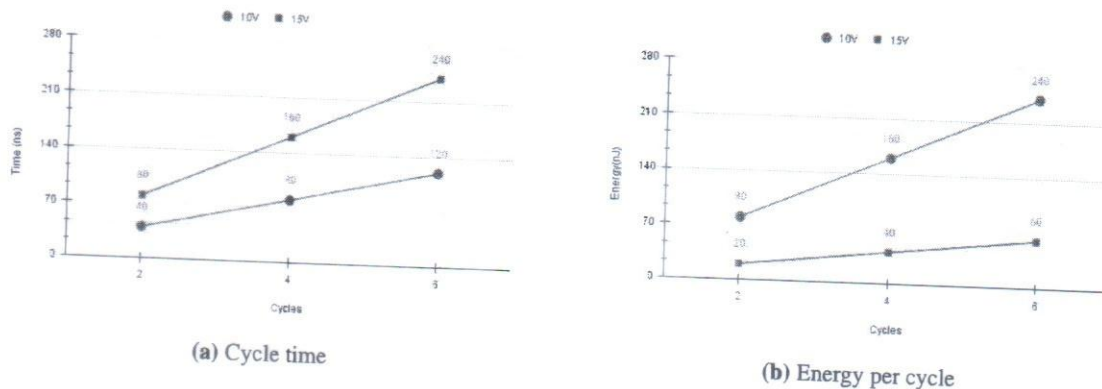
Figure 2: Distribution of time and energy over cycles.

a) Analyze the above specification and write the *setup()* and *loop()* functions for Arduino.

5
(CO1)
(PO1)

b) According to the above scenario, find the optimal combination where a task needs to execute 10^9 cycles within 25 seconds. To find the optimal combination, you can split the total time into 5 intervals.

10
(CO2)
(PO1)

c) What are the things you consider for optimization? Explain with examples considering both hardware and software.

10
(CO2)
(PO1)

6. Consider the following scheduling problem consisting of three tasks (assume that all tasks arrive at time 0). Here, Rate Monotonic Scheduling (RMS) and Earliest Deadline First (EDF) are applied to measure the performance of the scheduling problem.

Table 1: Data for Question 6.

Task	Period	Deadline	Execution Time (s)
A	10	10	4
B	15	15	4
C	18	18	6

a) From an implementation perspective, what are the advantages/disadvantages of an RMS vs. an EDF scheduler?

5
(CO1)
(PO1)

b) Compare the performance of RMS and EDF on the above task sets.

20
(CO3)
(PO2)

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HUM 4747: Legal Issues and Cyber Law

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Answer **all 6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

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1. a) Imagine while working on your final thesis in IUT, you come up with an innovative product that has potential for business both in Bangladesh and abroad. To protect your product from being copied by big corporates, you need to have a patent of your product. `8 (CO3) (PO6)`

   i. Briefly outline the procedure that you need to follow to have a patent in Bangladesh. Also explain the administrative remedies you will get after getting the patent.

   ii. Is it possible to have the patent for your product that works for the other region of the world? State the reasons behind your answer. `5 (CO1) (PO8)`

   b) Briefly explain the different steps in applying and getting a patent under PCT, with the help of the overview and timeline diagram. `12 (CO1) (PO6)`

2. a) Suppose you recently joined a company and you heard your colleagues talking about how the company monitors and tracks employees' activities in the workplace. `7 (CO2) (PO6)`

   i. What do you understand about workplace privacy? Explain the privacy issues that can arise when you are in the workplace.

   ii. Name 3 tools employers normally use to monitor and track employees. What are the most common reasons employers want to monitor employees' workplace activity? `6 (CO1) (PO2)`

   b) To safeguard business resources and potential business loss, we can make use of Patent, Trademark, Copyright, NDA, etc. Briefly compare Patent, Trademark, Copyright and NDA with the context in which they are deployed. `12 (CO1) (PO2)`

3. a) Digital forensic is an important aspect when presenting a cyber-crime to the court of law. Suppose a cybersecurity attack took place in Bangladesh Bank. Thirty-five fraudulent instructions were issued by security hackers via the SWIFT network to illegally transfer close to US$2 billion from the Federal Reserve Bank of New York account belonging to Bangladesh Bank. Assume that you are a famous Information Security specialist and Bangladesh Bank contacted you to conduct an investigation to support the law team regarding the above mentioned incident. `18 (CO3) (PO2)`
   Briefly explain the steps and activities you will take to support the law team in the above context.

   b) What is 'steganography' and how is it related to digital forensic? What is the difference between 'steganography' and 'cryptography'? `7 (CO2) (PO4)`

4. a) What do you understand by cybercrime and cybersecurity? Briefly explain the different cybersecurity control types with examples. `10 (CO1) (PO1)`

b) What are the main human factors in cybersecurity? *"Cybersecurity is not a purely technical problem for the technical team. People are more likely to create cybersecurity failures than technology is."* Do you agree with this statement? Explain the reasons behind your answer from the perspectives of human factors in cybersecurity.   15 (CO2) (PO6)

5. a) In the modern world, use of electronic documents is getting increasingly popular. Sometimes, to secure the documents, digital signatures are used.   8 (CO1) (PO1)

     i. What do you understand by "E-contract" and "digital signature"? What are the differences between them?

     ii. Explain the role of CA in the digital signature deployment process.   8 (CO1) (PO1)

b) Several guidelines have been provided over time for passing any act pertaining to ICT and Cyberspace in Bangladesh with a specific context. According to the Cyber Security Guideline from 11 March, 2014, briefly explain the national priorities on any national cybersecurity strategy should have? What actions are necessary to maintain the 2nd priority?   9 (CO4) (PO2)

6. a) As part of regulatory or compliance controls, Cyber Law comes into existence and we expect cyber law helps in controlling cybercrime. Digital Security Act, 2018 is the most prominent law in Bangladesh to protect the cyberspace.   8 (CO1) (PO6)

     i. Briefly explain the role of Digital Security Agency and National Digital Security Council to protect our cyberspace as per the law.

     ii. What is the difference between digital/electronic forgery and fraud? What are the existing laws as per the DSA 2018 to protect from the two mentioned crimes?   8 (CO2) (PO2)

b) As per ICT Act 2006, how can electronic records and electronic signatures be used in government and its agencies? Also state the rules regarding securing electronic records and digital signature as per this act.   9 (CO1) (PO6)