

Study Programme	: Bachelor of Software Engineering Honours
Name of the Examination	: Final Examination
Course Code and Title	: EEI5466 Advanced Database Systems
Academic Year	: 2024/2025
Date	: 16 th August 2025
Time	: 13:30 -16:30 hrs
Duration	: 3 Hours

General Instructions

1. This examination paper has five (05) questions in four (04) pages.
2. Answer all five (05) questions.
3. This is a closed book exam, and no reference books and materials are allowed.

Consider the following scenario containing Cruise trip information to answer **Question 01 & 02**

Trip (Trno, from, to, distance, departs, arrives)

Cruise (Crid, Cname, travelRange)

Certified (Eid, Crid)

Employee (Eid, Ename, salary)

Note: The **Employee** relation includes Captains as well as other types of employees. Every Captain is certified for at least one cruise ship (otherwise, they would not qualify as a Captain), and only Captains are certified to navigate a cruise ship.

Question 1 – Database Programming - (20 Marks)

Write the following queries in **SQL**.

- a) Find the **Eid** of employees who are certified for exactly two cruise ships. (05 Marks)
- b) Find the **Eid** of employees who are certified for the largest number of cruise ships. (06 Marks)
- c) Write a trigger named "Salary_Update" to monitor salary changes in Employee table. Your trigger should insert a record to *salChanges* table for each modification of salary of employees to track the changes. Assume no primary key in *salChanges* table.

The *salChanges* table contains employee id (*Eid*), new salary (*newSalary*), and change date and time (*dateTime*). (09 Marks)

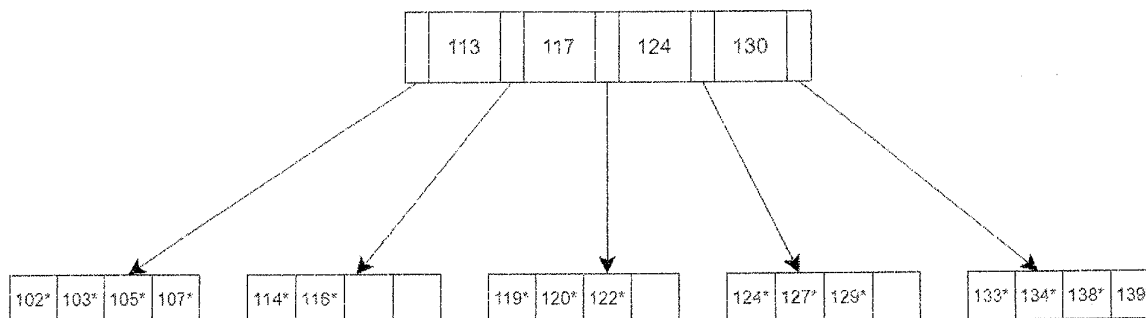
Question 2 – Relational Algebra – (20 Marks)

Write the following queries in **Relational Algebra**.

- List the name of the captain certified for a cruise ship named "Oasis". (04 Marks)
- List the *Eid* and *Ename* of all the captains whose salary is more than Rs. 150,000/=. (04 Marks)
- List the *Crid* of all cruise ships that can be used on non-stop trips from *Barcelona* to *Ibiza*.
(Hint: consider $travelRange > distance$ to identify non-stop trips) (04 Marks)
- List the *Ename* of captains who have been assigned more than three cruise ships. (04 Marks)
- List the *Eid* and *Ename* of all employees and include the cruise ship information (i.e. *Crid*) for employees who are also a captain. (04 Marks)

Question 3 – Disk, Files, Indexes & Query Processing – (20 Marks)

- Briefly describe two main techniques used in RAID. (04 Marks)
- Given the B+ Tree below:



- Redraw the B+ Tree after inserting 108*. (04 Marks)
 - Based on the updated tree from (I), redraw the B+ Tree after deleting 119* and 120*. (04 Marks)
- Using a diagram show the steps involved in query processing? Explain each step. (04 Marks)
 - Write the extended relational algebra expression that is created after the first step of query processing for the following SQL query:

```

SELECT DISTINCT S.sname
FROM S, SP
WHERE S.sno = SP.sno AND SP.pno = 'P2'
  
```

(04 Marks)

Question 4 – Object Relational Databases – (20 Marks)

Consider the following object relational database schema for recording assignments of employees to projects:

Object types:

proj_t (*pno*: *char*(6), *pname*: *varchar2*(12), *stdate*: *date*, *enddate*: *date*)

assignment_t (*project*: *ref proj_t*, *adate*: *date*, *hours*: *number*(2))

assignment_tb: *table of assignment_t*

emp_t (*eno*: *number*(8), *ename*: *varchar2*(12), *assignments*: *assignment_tb*)

Tables:

emp of *emp_t*(*eno* primary key)

nested table *assignments* store as *emp_assigntb*;

The attributes of *proj_t* are project number (*pno*), project name (*pname*), start date (*stdate*), and end date (*enddate*). The attributes of *assignment_t* include ref of *proj_t* (*project*), date on which the employee was assigned to the project (*adate*), and number of hours per week (*hours*). In the type *emp_t*, the attributes are employee number (*eno*), name (*ename*), and the set of project assignments of type *assignment_tb* which is a table of *assignment_t*. Some sample data for this database is shown below.

PROJECTS

PNO	PNAME	STDATE	ENDATE
MARS01	MARS PROBE	01-Jan-2007	31-Aug-2008
LUNA05	LUNAR LANDER	01-Jan-2006	31-Dec-2008
SPCE02	SPACE STATION	01-Jun-2006	30-Jun-2008
COME03	COMET PROBE	05-Sep-2007	31-Dec-2008

EMP

ENO	ENAME	ASSIGNMENTS		
		PROJECT	ADATE	HOURS
12347648	Carol SMART	MARS01	01-Jan-2007	10
		LUNA05	10-Jun-2007	10
		SPEC02	20-Mar-2007	15
14527845	Jim TERRIFIC	MARS01	11-Feb-2007	15
		LUNA05	12-Apr-2007	12
		SPEC02	20-Jun-2007	13

Write Oracle OBJECT SQL statement to answer the following queries. (Use columns of REF type instead of joins to link tables.)

- For each employee, get the employee number, name, and the total number of hours per week the employee is assigned to work on projects. (04 Marks)
- For each project that has employees assigned to it, find the project number, project name, and how many employees are assigned to it. (08 Marks)
- Assuming that the database contains only the given sample data, assign Carol SMART to project number COME03 for 2 hours per week from 5 September 2007. (08 Marks)

Question 5 – Transactions & Concurrency Control – (20 Marks)

- a) Briefly explain the rules in Strict 2 Phase Locking Protocol (04 Marks)
- b) Briefly explain what is a "Phantom Problem". Give an example of it. (04 Marks)
- c) Briefly explain, what a Serializable Schedule is? (04 Marks)
- d) Consider the following part of the schedule

T1	T2	T3	T4
S(A)			
R(A)			
	X(B)		
	W(B)		
S(B)			
			S(D)
			R(D)
	X(D)		
		S(C)	
		R(C)	
			X(A)

Assume that transaction T_i has higher priority than transaction T_{i+1} (i.e. transaction T_1 has higher priority than T_2 ; T_2 has higher priority than T_3 ; and T_3 has higher priority than T_4).

- II. Draw a wait-for graph for the schedule given above to detect the deadlock and briefly explain how to identify the deadlock and remove it. (04 Marks)
- III. Follow the wait-die policy to deal with deadlock and draw the above schedule again. (04 Marks)

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