Advanced Databases
ADDB6311
MODULE OUTLINE 2024
(First Edition: 2018)

The Independent Institute of Education (Pty) Ltd is registered with the Department of Higher Education and Training as a private higher education institution under the Higher Education Act, 1997 (reg. no. 2007/HE07/002). Company registration number: 1987/004754/07.

Table of Contents

Introduction

Welcome to the Advanced Databases module. This module covers database implementation and management using Oracle Express™. You will gain enormously from this module, as skills in database design are often neglected in programming courses. Ninety percent of most business applications have a database working in the background. If you never become involved in database administration, design, and/or database development, it can lead to a real loss in development in the IT world.

After you have completed this module, you should be proficient in going into any small to medium business (or a business unit of a large corporate), analysing the data needs of the business, and, thereafter, designing, building, and implementing a database using any Database Management System (DBMS) software specified. The skills learned in Oracle XE™ are easily transferable to Access, SQL Server, etc. The emphasis of the module is to develop strong skills in Oracle. Oracle skills are one of the most sought-after skills for programmers.

This is a practical module and is best learnt by “doing”. Questions and exercises are provided at the end of each learning unit. If you need more exercises, please feel free to refer to the module manual prescribed in the bibliography section. These texts also have many examples.

The module has nine learning units. You will need to gain adequate experience in the field to supplement the examples given in the module manual. Your lecturer will provide different approaches and examples for the different concepts.

Using this Module Outline

This module outline has been developed to **support your learning**. Please note that the content of this module is on Learn as well as in the prescribed material. You will not succeed in this module if you focus on this document alone.

- This document does not reflect all the content on Learn, the links to different resources, nor the specific instructions for the group and individual activities.
- Your lecturer will decide when activities are available/open for submission and when these submissions or contributions are due. Ensure that you take note of announcements made during lectures and/or posted within Learn in this regard.

Module Resources	
Prescribed Material (PM) for this Module	IIE Manual
Recommended Readings, Digital, and Web Resources	Please note that several additional resources and links to resources are provided throughout this module on the Learn platform. You are encouraged to engage with these as they will assist you in mastering the various objectives of this module. They may also be useful resources for completing any assignments. You will not, however, be assessed under examination conditions on any additional or recommended reading material. • Oracle Tutorial - Learn Oracle Database from Scratch | OracleTutorial.com. • Cengage Learning. 2012. *Database Principles. Fundamentals of Design, Implementation, and Management. Cengage Learning*. • Thomson Learning. 2014. *Database Systems, Design, Implementation and Management*. International Student Edition. Canada: Thomson Learning. •
Software required	Oracle Database Express Edition (Latest version)
Software Licence requirements	https://www.oracle.com/za/database/technologies/xe-downloads.html
System Requirements	https://www.oracle.com/za/database/technologies/xe-downloads.html
Lab minimum requirements	https://www.oracle.com/za/database/technologies/xe-downloads.html
Lab configuration settings	Run on Host Computer – Standalone Machine
Module Overview	You will find an overview of this module on Learn under the *Module Information* link in the Course Menu.
Assessments	Find more information on this module's assessments in this document and on the Student Portal.

This Module on Learn

Learn is an online space, designed to support and maximise your learning in an active manner. Its main purpose is to guide and pace you through the module. In addition to the information provided in this document, you will find the following when you access Learn:

- A list of prescribed material;
- A variety of additional online resources (articles, videos, audio, interactive graphics, etc.) in each learning unit that will further help to explain theoretical concepts;
- Critical questions to guide you through the module's objectives;
- Collaborative and individual activities (all of which are gradable) with time-on-task estimates to assist you in managing your time around these;
- Revision questions, or references to revision questions, after each learning unit.

Kindly note:

- Unless you are completing this as a distance module, Learn does not replace your contact time with your lecturers and/or tutors.
- ADDB6311 is a Learn module, and as such, you are required to engage extensively with the content on the Learn platform. Effective use of this tool will provide you with opportunities to discuss, debate, and consolidate your understanding of the content presented in this module.
- You are expected to work through the learning units on Learn in your own time – especially before class. Any contact sessions will therefore be used to raise and address any questions or interesting points with your lecturer, and not to cover every aspect of this module.
- Your lecturer will communicate submission dates for specific activities in class and/or on Learn.

Icons Used in this Document and on Learn

The following icons are used in all your modules on Learn:

Icon	Description
	A list of what you should be able to do after working through the learning unit.
	Specific references to sections in the prescribed work.
	Questions to help you recognise or think about theoretical concepts to be covered.
	Sections where you get to grapple with the content/ theory. This is mainly presented in the form of questions which focus your attention and are aimed at helping you to understand the content better. You will be presented with online resources to work through (in addition to the textbook or manual references) and find some of the answers to the questions posed.
	Opportunities to make connections between different chunks of theory in the module or to real life.
	Real life or world of work information or examples of application of theory, using online resources for self-exploration.

REMEMBER:

You need to log onto Learn to:

- Access online resources such as articles, interactive graphics, explanations, video clips, etc. which will assist you in mastering the content; and
- View instructions and submit or post your contributions to individual or group activities which are managed and tracked on Learn.

Module Purpose	
The purpose of this module is to advance and develop your applied skills in database design and implementation within a commercial database management system.	
Module Outcomes	
MO1	Demonstrate the ability to create, manipulate, and control database objects using SQL queries and control structures.
MO2	Describe procedural structured query language (PL/SQL) and manipulate data using PL/SQL coding language.
MO3	Define and apply exception handling techniques.
MO4	Create and use PL/SQL subprograms to extend PL/SQL functionality.
MO5	Demonstrate the ability to interface databases with an organisation's platform.
MO6	Apply database security principles within a given organisation's database setup.

Assessments

Integrated Curriculum Engagement (ICE)	
Minimum number of ICE activities to complete	4
Weighting towards the final module mark	10%

Assignments	Practical Assignment 1	Practical Assignment 2
Weighting	25%	30%
Duration	Approximately 10 hours	Approximately 15 hours
Write/ Submit after	LU 4	LU 9
Learning Units covered	LU1 To LU4	LU1 To LU7
Period	Period 3	Period 5
Open/ closed book	Open book.	Open book.
Resources required	Oracle Database Express Edition (XE)™ Prescribed Textbook	Oracle Database Express Edition (XE)™ Prescribed Textbook

Summative	Practicum
Weighting	35%
Duration	8 hours
Total marks	100
Open/Closed book	Open book
Resources required	Oracle Database Express Edition (XE)™ Prescribed Textbook
Learning Units covered	All

Assessment Preparation Guidelines		
	Format of the Assessment *(The Focus/ Approach/ Objectives)*	Preparation Hints *(How to Prepare, Resources to Use, etc.)*
Practical Assignment 1	The Practical Assignment will be focused on all the skills acquired from LU1–LU4. Questions will be practical based using SQL*Plus and SQL Developer in Oracle Database Express Edition (XE)™	To prepare effectively for this test, you can include the following in your preparation: • Ensure that you work through all the review questions in the LUs tested. • Check if you are confident that you can answer questions relating to all of the learning objectives for the LUs tested. • Work through mock assessments. • Ensure that you understand how to create and insert into tables. In other words, how to populate tables using SQL Developer or SQL*Plus. • Make certain that you can create views to display fields from a table. • Make sure that you know how to create a PL/SQL query to display information and write up iterative control statements. • Design SQL queries using SQL*Plus and SQL Developer. • Revise using past test papers.

Practical Assignment 2	This assignment will challenge you to do some problem-solving and research on the material covered in LU1–LU7. Pay special attention in class as each skill acquired is vital to your foundation of programming using Oracle Database Express Edition (XE)™	In your preparation for Assignment 1, pay special attention to all the skills acquired from LU1–LU7. Pay attention to: • PL/SQL variables; • Identifying errors from given code; • Using database control structures, cursors, and loops.; • SQL queries; • Creating database objects; • implementing exception handling. It is recommended that you look at Oracle examples when working on your assignment. • NOTE: Even though you should look at other examples of Oracle code, you may NOT copy the code directly from a source without referencing it correctly.

Assessment Preparation Guidelines		
	Format of the Assessment *(The Focus/ Approach/ Objectives)*	Preparation Hints *(How to Prepare, Resources to Use, etc.)*
Practicum	The Practicum will be focused on all the skills acquired. Questions will be both theory- and practical-based, and will consist of a variety of formats, such as short questions, paragraph questions, but mostly query creation in Oracle Database Express Edition (XE)™using SQL*Plus and SQL Developer.	To prepare effectively for this exam, you can include the following in your preparation: • Ensure that you work through all the review questions in the LUs tested. • Ensure you are confident to discuss key theoretical concepts. • Check if you are confident that you can answer questions relating to all of the learning objectives for the LUs tested. • Check you are confident with executing SQL queries to create a database schema using SQL*Plus and SQL Developer. • Design SQL queries using SQL*Plus and SQL Developer. • Create PL/SQL queries using simple cursors, selection, and iterative control statements. • Create views to display data. • Design procedures that receive one or multiple parameters. • Design functions that receive one or multiple parameters. • Create triggers to execute depending on the situation.

Module Pacer			
Code	Programme	Contact Sessions	Credits
ADDB6311	DIS3	48 Lab	15
Learning Unit 1	Fundamentals of Databases		

Overview:

In this first learning unit, we will review basic database concepts, look at the fundamentals of databases, and how Oracle Database™ can provide a flexible, easy interface to manage large volumes of data.

The learning unit starts with a look at different database models and tiered architecture. Relational database management systems and database environments are explored. We will also discuss data warehousing, distinguish between the different types of RDBMS applications, and analyse the advantages of using Oracle Database Express Edition. A comparison of various programme categories.

<table>
<tr><th colspan="3">Learning Unit 1: Theme Breakdown</th></tr>
<tr><td>Sessions:
1-6</td><td>Theme1: Database Concepts</td><td>Prescribed Material (PM)</td></tr>
<tr><td rowspan="3">Related Outcomes:
MO001</td><td>• Discuss the different database models;
• Describe tiered architecture to manage data more effectively;
• Discuss relational database management systems.
• compare different types of RDBMS applications;
• Discuss data warehousing;</td><td>Manual LU1</td></tr>
<tr><td>Theme2: Using SQL Commands to work with data ™</td><td>Prescribed Material (PM)</td></tr>
<tr><td>• Distinguish between SQL*Plus and SQL Developer;
• Explain how SQL*Plus can submit SQL statements and PL/SQL blocks for execution;
• Discuss how the Oracle SQL developer can improve productivity;
• Discuss the various data types available;
• Formulate and use different DDL and DML SQL statements.
• Construct and explain how and why to use:
o Aliases;
o Set Operators;
o Subqueries;
o Joins.
• Compare the various functions supported by the GROUP BY function;
• Discuss the purpose of DCL SQL statements:
o COMMIT;
o ROLLBACK;
o SAVEPOINT.</td><td>Manual LU1</td></tr>
</table>

Learning Unit 2	Administering a Database

Overview:

In this learning unit, we will explore the administration of databases. You will learn to manage and monitor database components and processes. The learning unit covers statements needed to create a database in a specific user environment. Various database administrative tasks and administrative privileges in Oracle DBA are discussed. Important topics such as managing memory spaces and Oracle database server processes are also explored. Critical steps to manage and enhance data storage are outlined.

The learning unit starts with the formulation of database statements and explains the purpose of the database configuration assistant. The various database administrator tasks are examined, as are the privileges that are available to perform database operations. A distinction between manual and automatic memory management is made, and finally, there is a discussion on how to manage database processes effectively.

<table>
<tr><th colspan="3">Learning Unit 2: Theme Breakdown</th></tr>
<tr><td>Sessions:
7-8</td><td>Theme1: Database Creation and Memory Management</td><td>Prescribed Material (PM)</td></tr>
<tr><td rowspan="2">Related Outcomes:
MO001
MO002
MO003
MO004</td><td>• Explain how to create a database;
• Explain the database configuration assistant (DBCA);
• Describe the various administrator tasks and privileges to perform database operations.
• Describe the initialisation parameters to accomplish automatic memory management;
• Compare various methods associated with manual memory management;
• Describe how to manage database memory;</td><td>Manual LU 2</td></tr>
<tr><td>Theme2: Database Administration ™</td><td>Prescribed Material (PM)</td></tr>
<tr><td></td><td>• Compare the types of database server processes;
• Describe how to manage processes effectively;
• Explain how to use table spaces to optimise table storage space;
• Explain predefined and administrative user accounts;
• Explain how to assign and revoke user privileges.</td><td>Manual LU 2</td></tr>
</table>

Learning Unit 3	Creating Other Database Objects

Overview:

In this learning unit, we will explore various database objects, such as indexes, sequences, views, and synonyms. Oracle provides these features to enhance the manageability of a database. You will also learn how to handle the increasing number of users accessing databases at once.

At the start of the learning unit, you will learn to create firstly indexes to facilitate faster retrieval of data and secondly sequences to ensure that every row in a table is unique. After this, you will learn to create and use views to partition data in a table, both vertically and horizontally. We will conclude the learning unit with an introduction to synonyms, used to shorten long and cumbersome object names.

Learning Unit 3: Theme Breakdown		
Sessions: 9 -10	Theme1: Creating Database Objects	Prescribed Material (PM)
Related Outcomes: MO001	• Create indexes; • Apply sequences to a table; • Write a CREATE VIEW statement; • Create and use synonyms. • Evaluate the importance of objects in managing the database.	Manual LU3

Learning Unit 4	Getting Started with PL/SQL programming

Overview:

In this learning unit, you will learn to create PL/SQL blocks that can be used or shared by multiple forms, reports, and data management applications.

The learning unit starts by examining PL/SQL basics and development environments such as SQL*Plus and SQL Developer. You will also learn how to write a simple PL/SQL programme block and produce output messages.

Learning Unit 4: Theme Breakdown		
Sessions: 11–20	Theme1: Formulating PL/SQL Statements	Prescribed Material (PM)
Related Outcomes: MO004	• Compare the features of PL/SQL; • Compare the components of the PL/SQL environment; • Distinguish between the types of PL/SQL blocks; • Explain how to output messages using PL/SQL. • Construct PL/SQL blocks; • Design PL/SQL queries that use Variables; • Design PL/SQL queries with constants;	Manual LU4
Related Outcomes: MO004	Theme 2: Managing Data with Cursors	Prescribed Material (PM)

	• Construct a PL/SQL query with a cursor;
	• Explain how to manage data using cursors;
	• Motivate how and why to use:
	  ○ The implicit cursor attributes;
	  ○ The explicit cursor attributes.
	• Explain how to use the following clauses:
	  ○ FOR UPDATE;
	  ○ CURRENT OF.
	• Create PL/SQL queries that use cursor variables;
	• Explain how to retrieve data using the cursor with looping mechanisms.
		Manual LU 4

FORMATIVE ASSESSMENT 1		

Learning Unit 5	Using Variables and Lexical Units

Overview:

PL/SQL variables are used in a programme/ query to structure it and perform data operations. Using these variables will allow communication between various blocks in a programme and take your skill to the next level.

The learning unit starts by introducing predefined, scalar, and large object data types that are used to declare PL/SQL variables and will be used in PL/SQL statements. PL/SQL lexical units are explored in the second theme.

<table>
<tr><th colspan="3">Learning Unit 5: Theme Breakdown</th></tr>
<tr><td rowspan="2">Sessions:
21 - 24

Related Outcomes:
MO004
MO005</td><td>Theme1: Using Variables and Data Types</td><td>Prescribed Material (PM)</td></tr>
<tr><td>• Compare the predefined data types;
• Discuss the scalar data types;
• Differentiate between the different types of large objects;
• Justify the use of user-defined PL/SQL subtypes;
• Create and use:
o PL/SQL variables; and
o PL/SQL constants.</td><td>Manual LU 5</td></tr>
<tr><td></td><td>Theme 2: Lexical Units</td><td>Prescribed Material (PM)</td></tr>
<tr><td></td><td>• Distinguish between the different lexical units;
• Outline/summarise the PL/SQL character sets;
• Discuss delimiters;
• Explain what an identifier is;
• Justify why comments are added to promote readability and understanding;
• Compare the different literal types;
• Explain the purpose of the:
o %TYPE attribute;
o %ROWTYPE attribute.
• Create and use PL/SQL lexical units.</td><td></td></tr>
</table>

Learning Unit 6	Using Control Structures

Overview:

Using control structures in PL/SQL assists in the branching of a program sequence. Control structures also help in incorporating a decision-making approach to programming.

The learning unit starts with exploring various control structures. Next, you will be introduced to alternating execution logic in your code. Finally, you will use control-flow statements to control the sequential flow of your instructions.

Learning Unit 6 Theme Breakdown		
Sessions: 25 - 28	Theme1: PL/SQL Operators and Expressions	Prescribed Material (PM)
Related Outcomes: MO001 MO004 MO005	• Identify applicable/ suitable arithmetic operators used to perform expressions; • Evaluate comparison operators to compare expressions or values; • Explain how to combine two string expressions into one expression; • Compare the three logical operators used in PL/SQL; • Explain operator precedence; • Create and use expressions; • Contrast the types of Boolean expressions supported in procedural statements;	Manual LU 6
	Theme 2: Using Conditional and Iterative Statements	Prescribed Material (PM)
	• Compare and formulate the three basic control structures; • Identify the types of IF statements used to control the execution of statements; • Create and use CASE statements; • Compare the three types of LOOP statements used in PL/SQL statements; • Compare and use the two types of EXIT statements; • Use the two forms of CONTINUE statements;	Manual LU 6

Learning Unit 7	Handling PL/SQL Exceptions

Overview:

The focus of this learning unit is dealing with database programming errors. You will learn to declare, raise, and handle exceptions. We will start by investigating the scope and advantages of exception handling as a mechanism to deal with runtime errors. You will also learn to handle user-defined exceptions that must be declared and raised explicitly, using either a procedure or a raise statement.

<table>
<tr><th colspan="3">Learning Unit 7: Theme Breakdown</th></tr>
<tr><td>Sessions:
29 - 34</td><td>Theme1: PL/SQL Exception Handling</td><td>Prescribed Material (PM)</td></tr>
<tr><td rowspan="2">Related Outcomes:
MO003</td><td rowspan="2">• Explain how to deal with exceptions;
• Explain the rules for declaring exceptions;
• Discuss the advantages of exceptions;
• Justify the use of pre-defined system exceptions;
• Explain how to handle user-defined exceptions;
• Describe how to deal with unhandled exceptions.
• Create PL/SQL blocks with exception handling.</td><td rowspan="2">Manual LU 7</td></tr>
<tr><td></td></tr>
<tr><td colspan="3">75% of ICE Tasks to be completed by this point.
FORMATIVE ASSESSMENT 2</td></tr>
</table>

Learning Unit 8	Creating PL/SQL Subprograms

Overview:

There will be situations where you will want to store a particular set of database code and repeatedly execute it or divide large, complex PL/SQL programmes into multiple subprogrammes in order to increase programming efficiency. You can achieve this by creating subprograms. We start this learning unit with a look at PL/SQL subprograms, stored procedures, and return statements. We will compare procedures and different types of functions and also investigate implicit and explicit conversions, overloading, the NOCOPY hint, and finally the deterministic clause.

<table>
<tr><th colspan="3">Learning Unit 8: Theme Breakdown</th></tr>
<tr><td rowspan="5">Sessions:
35–41

Related Outcomes:
MO004</td><td>Theme1: Using Subprograms</td><td>Prescribed Material (PM)</td></tr>
<tr><td>• Describe the parts of a subprogramme;
• Compare the benefits and uses of subprograms;
• Compare anonymous blocks to subprograms;</td><td>Manual LU 8</td></tr>
<tr><td>Theme 2: Stored Procedures and Stored Functions</td><td>Prescribed Material (PM)</td></tr>
<tr><td>• Create and use:
o Stored procedures;
o Return statements.
• Compare functions and procedures;
• Create and use stored and user-defined functions;
• Compare the different categories of built-in functions;
• Compare implicit and explicit conversions;
• Explain what overloading is;
• Compare the different subprogram parameter modes;
• Discuss the NOCOPY hint;
o Describe the function of the DETERMINISTIC clause.</td><td></td></tr>
<tr><td>Theme 3: Formulating Triggers</td><td>Prescribed Material (PM)</td></tr>
<tr><td></td><td>• Create and execute simple triggers;
• Compare the different:
o Trigger categories;
o Trigger states.
• Create and use compound triggers;
• Distinguish between the various compound timing points;
• Explain trigger execution;</td><td>Manual LU8</td></tr>
</table>

Learning Unit 9	Advanced Interface Methods and Security

Overview:

This learning unit also explores PL/SQL subprograms that invoke external class methods. You will also discover how external C routines and Java code can be implemented into your PL/SQL programs. External procedures and the benefits of using these external procedures are also discussed. You will also learn how to interface the Oracle Database with business applications.

In the last section of the learning unit, you will explore and apply the important concepts of database security.

<table>
<tr><th colspan="3">Learning Unit 9: Theme Breakdown</th></tr>
<tr><td rowspan="2">Sessions:
42-48</td><td>Theme1: Using Advanced Interface Methods</td><td>Prescribed Material (PM)</td></tr>
<tr><td rowspan="2">Related Outcomes:
MO004
MO005</td><td>• Describe external procedures;
• Discuss the benefits of external procedures;
• Explain how to execute external C programmes from PL/SQL;
• Execute Java programmes from PL/SQL.
• Create and interface the database to an organisational platform.
• Create and use packages;</td><td>Manual LU9</td></tr>
<tr><td>Related Outcomes:
MO006</td><td>Theme2: Ensuring Database Security</td><td>Prescribed Material (PM)</td></tr>
<tr><td></td><td>• Describe the importance of database security;
• Discuss the common threats and challenges to databases;
• Explore the best practices in database security;
• Describe various data protection tools and platforms.</td><td>Manual LU9</td></tr>
</table>