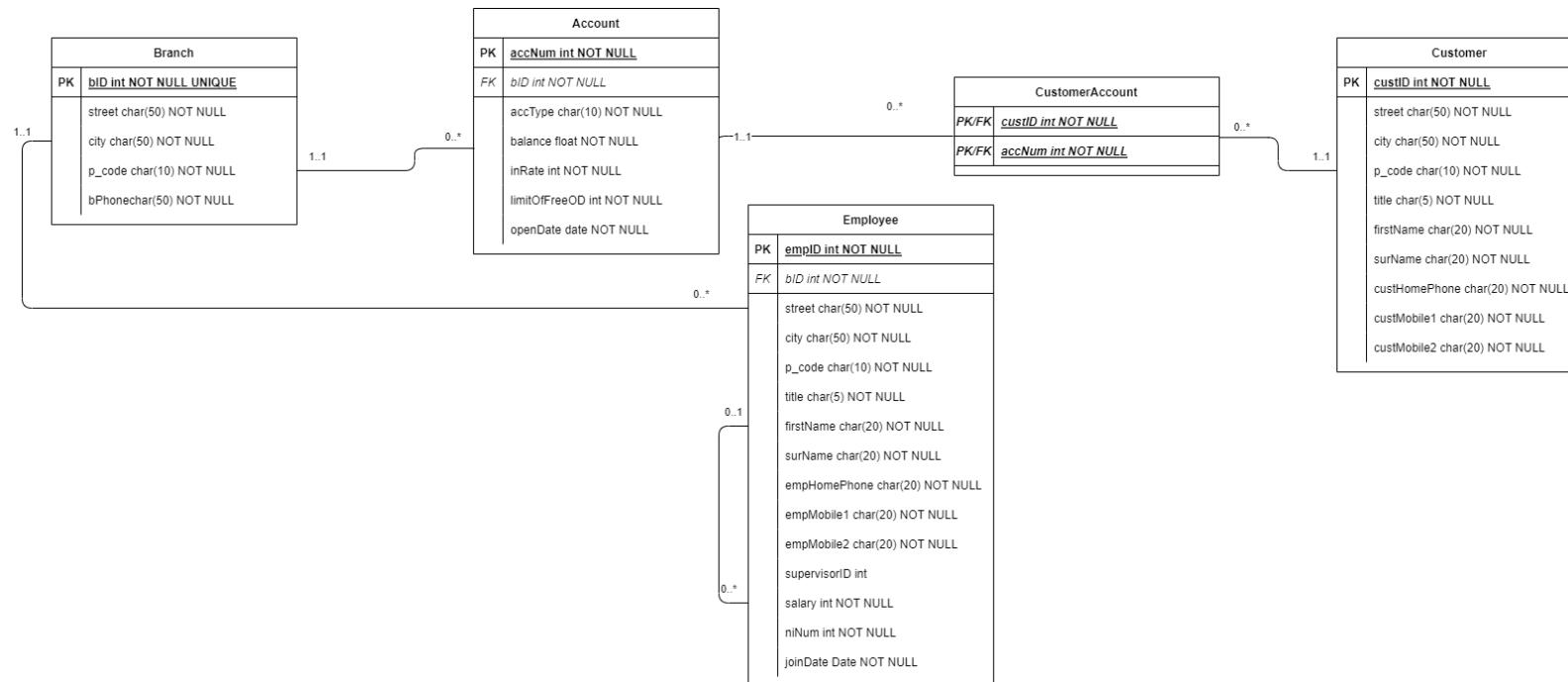**Edinburgh Napier**
UNIVERSITY

SET09107: Advanced Database Systems
2022/23 Coursework

(*Report Template*)

Name: Mansour Sami
Matriculation Number: 40617066

Task 1: Draw an ER diagram corresponding to the relational database schema and the scenario. (**5 marks**)

Branch	
PK	bID int NOT NULL UNIQUE
	street char(50) NOT NULL
	city char(50) NOT NULL
	p_code char(10) NOT NULL
	bPhonechar(50) NOT NULL

Account	
PK	accNum int NOT NULL
FK	bID int NOT NULL
	accType char(10) NOT NULL
	balance float NOT NULL
	inRate int NOT NULL
	limitOfFreeOD int NOT NULL
	openDate date NOT NULL

CustomerAccount	
PK/FK	custID int NOT NULL
PK/FK	accNum int NOT NULL

Customer	
PK	custID int NOT NULL
	street char(50) NOT NULL
	city char(50) NOT NULL
	p_code char(10) NOT NULL
	title char(5) NOT NULL
	firstName char(20) NOT NULL
	surName char(20) NOT NULL
	custHomePhone char(20) NOT NULL
	custMobile1 char(20) NOT NULL
	custMobile2 char(20) NOT NULL

Employee	
PK	empID int NOT NULL
FK	bID int NOT NULL
	street char(50) NOT NULL
	city char(50) NOT NULL
	p_code char(10) NOT NULL
	title char(5) NOT NULL
	firstName char(20) NOT NULL
	surName char(20) NOT NULL
	empHomePhone char(20) NOT NULL
	empMobile1 char(20) NOT NULL
	empMobile2 char(20) NOT NULL
	supervisorID int
	salary int NOT NULL
	niNum int NOT NULL
	joinDate Date NOT NULL

Task 2: Re-design the database to capture more of the semantics of the application making use of object-relational features as extensively as possible while still retaining the semantics of the application. Provide a **critical** discussion on the rationale for your object-relational design justifying the design you adopted with reasons. The discussion should include alternative possible object-relational representations you considered and why they were rejected (only include those if you think they demonstrate a deeper understanding of the problem involved). (**40 marks**)

In designing the database schema, the first step was to simplify the types as much as possible and reuse them where feasible. This led to the creation of the Person type, which comprises three other types: Address, Phone, and Name. However, an alternative was considered, which was to combine all the values into one class. While this approach would have made data access easier, it would have made the database schema disorganized and untidy. Moreover, in practice, the design is to create the Person class with three different classes, namely Name, Phone, and Address. The reason for not creating any more classes is that they cannot be used in at least two different subclasses.

The Job type includes the Position and Salary attributes, with the Position attribute being unique and used to reference the job from the employee table. An alternative approach would be to include both the Position and Salary attributes directly in the Employee class, but this would have increased the amount of data saved in the database. The Branch type includes the bID, Address type, and phone number as a varchar2. The Account type saves the account information in its table, with the bID used as a reference to the rows of the Branch table. The Customer type uses the Person type as the superclass, with CustID as the primary key, and niNum as a unique identifier to prevent duplicate values.

The Employee type is a subclass of Person, with supervisorID, E_Job, and bID as references to the Employee, Job, and Branch tables, respectively. The customer account serves to establish a many-to-many relationship between Accounts and Customers, achieved using custID as a reference to the Customer and accNum as a reference to the Account.

The rationale for using object-relational features in the design is to create a more structured and organized database schema. Alternative possible object-relational representations were considered, including using inheritance and subtypes, but these were rejected as they would have made the database schema more complex and harder to manage. The use of object types and nested tables provides a more straightforward and efficient way to manage the database schema while still capturing the semantics of the application.

Task 3: Implement the database according to your design at task 2 and populate the tables with test data, 15 rows at least for each table. The data you inserted should be sufficient to demonstrate your object-relational design decisions and unambiguously answer the queries below. All SQL statements for creating and populating the database should be included. (**10 marks**)

Job

Position	Salary_Max	Salary_Min
Head	42000	87000
Manager	28000	57000
Project Leader	27000	97000
Accountant	24000	60000
Cashier	15000	33000

Branch

bID	Street	City	Postcode	B_Phone
901	Market	Edinburgh	EH1 5AB	01311235560
908	Bridge	Glasgow	G18 1QQ	01413214556
426	Morningside Rd	Edinburgh	EH10 5QF	03457213141
9	Clifton Pl	Glasgow	G3 7JU	03457242424
236	Pollokshields	Glasgow	G41 2NL	03457273141
158	Fenwick Rd	Glasgow	G46 6XB	03457242474
185	Baker St	London	NW1 6XB	03456021997
90	Paul St	London	EC2A 4NE	02039620108
1	Pound Way	Oxford	OX4 3XS	03456025997
5	Queen St	Oxford	OX1 1EJ	03450808500
130	High St	Cheltenham	GL50 1EW	03454021997
4	Westgate St	Gloucester	GL1 2NW	03457203040
3	Wharfside Street	Birmingham	B1 1RD	03330048048
762	Brindley Pl	Birmingham	B1 2HP	01214078000

84	High St	Birmingham	B4 7TE	03457345345
120	Colmore Row	Birmingham	B3 3BA	03457212212
109	Roman Rd	Glasgow	G61 2SP	03457213131

Account

AccNum	AccType	Balance	bID	InRate	LimitOfFreeOD	OpenDate
1001	current	800	901	0.005	800	01-MAY-16
1010	savings	3000	901	0.02		08-MAR-15
8002	current	200	908	0.005	100	05-MAY-12
9011	current	700000	901	1.3	122	02-AUG-10
9012	current	800000	901	0.85	171	05-DEC-16
9013	current	400000	901	0.0082	51	04-DEC-12
9081	current	50000	908	1.2	53	27-AUG-21
9082	current	300000	908	2	199	07-OCT-10
9083	current	700000	908	1.2	62	19-MAR-17
4261	current	600000	426	1.6	113	27-AUG-16
4262	current	500000	426	0.31	121	20-JUN-19
4263	current	800000	426	1.4	95	07-JUL-14
91	current	300000	9	0.94	182	15-MAY-12
92	current	800000	9	1.9	129	30-DEC-20
93	current	400000	9	0.13	143	08-DEC-10
2361	current	900000	236	1.7	78	07-JUL-15
2362	current	700000	236	1.6	134	15-FEB-18
2363	current	500000	236	1.8	89	09-MAY-14
1581	current	600000	158	0.56	136	15-MAY-13
1582	current	700000	158	0.62	62	01-JAN-13
1583	current	90000	158	1.8	186	25-AUG-14
1851	current	900000	185	1	144	06-APR-11
1852	current	600000	185	1.4	190	01-SEP-11
1853	current	700000	185	1.2	103	15-JAN-17
901	current	900000	90	0.065	152	07-JAN-13
902	current	600000	90	1.1	116	22-AUG-13
903	current	800000	90	0.91	62	30-JUL-21
11	current	300000	1	1.2	114	27-JUN-16
12	current	1000000	1	1	128	25-DEC-16
13	current	400000	1	1.6	163	26-FEB-21
51	current	500000	5	0.99	181	11-FEB-15
52	current	500000	5	1.2	124	07-OCT-11
53	current	300000	5	0.51	127	16-OCT-16
1301	current	900000	130	1	87	23-DEC-13
1302	current	400000	130	2	139	05-DEC-20
1303	current	100000	130	0.11	150	06-APR-12
41	current	200000	4	0.91	110	18-DEC-17
42	current	400000	4	0.21	144	07-MAR-10

43	current	500000	4	1.1	112	20-JUL-15
31	current	200000	3	1.9	112	10-MAY-11
32	current	700000	3	1.2	171	09-NOV-10
33	current	100000	3	1.4	107	13-AUG-11
7621	current	500000	762	0.23	55	09-FEB-14
7622	current	900000	762	0.84	51	15-APR-16
7623	current	1000000	762	0.55	72	10-FEB-19
841	current	700000	84	0.23	192	03-FEB-22
842	current	800000	84	1.9	112	04-DEC-20
843	current	500000	84	1.3	186	20-AUG-10
1201	current	600000	120	0.8	95	06-OCT-10
1202	current	700000	120	0.086	189	14-MAR-13
1203	current	600000	120	0.86	125	14-MAY-19
1091	current	500000	109	1.3	69	13-NOV-13
1092	current	800000	109	1.1	55	09-MAR-16
1093	current	50000	109	0.72	186	07-SEP-21
90115	savings	500000	901	0.43		16-JAN-12
90125	savings	600000	901	0.68		03-JAN-04
90135	savings	400000	901	0.15		03-AUG-06
90815	savings	300000	908	1.5		08-JAN-12
90825	savings	500000	908	1.9		21-JAN-14
90835	savings	500000	908	1.4		05-OCT-09
42615	savings	200000	426	0.49		30-DEC-14
42625	savings	80000	426	0.63		08-MAY-17
42635	savings	500000	426	0.89		23-DEC-14
915	savings	500000	9	0.047		19-DEC-21
925	savings	600000	9	0.17		04-NOV-18
935	savings	500000	9	1.6		15-APR-14
23615	savings	300000	236	0.61		09-SEP-01
23625	savings	90000	236	1.5		26-MAY-18
23635	savings	900000	236	2		08-APR-05
15815	savings	500000	158	0.0013		15-FEB-13
15825	savings	200000	158	0.52		19-JUL-12
15835	savings	800000	158	0.88		16-MAY-03
18515	savings	200000	185	0.014		27-FEB-05
18525	savings	100000	185	0.16		14-APR-15
18535	savings	100000	185	1.9		26-MAY-08
9015	savings	100000	90	1.6		31-AUG-03
9025	savings	700000	90	1.6		25-OCT-12
9035	savings	200000	90	1.2		07-JUL-05
115	savings	900000	1	0.26		19-NOV-10
125	savings	300000	1	1.3		31-MAY-05
135	savings	200000	1	1.4		07-MAY-07
515	savings	90000	5	0.6		14-MAY-16
525	savings	40000	5	1.5		22-SEP-10
535	savings	300000	5	1.2		17-FEB-02
13015	savings	400000	130	0.85		03-DEC-20
13025	savings	1000000	130	0.46		06-DEC-05

13035	savings	800000	130	1.2		23-JAN-13
415	savings	800000	4	1.5		27-DEC-17
425	savings	10000	4	0.17		04-MAY-14
435	savings	400000	4	0.23		11-FEB-09
315	savings	500000	3	0.71		02-JUL-01
325	savings	400000	3	0.43		01-JUL-16
335	savings	800000	3	0.26		28-OCT-08
76215	savings	300000	762	0.82		22-FEB-16
76225	savings	500000	762	0.23		10-FEB-09
76235	savings	500000	762	0.33		12-DEC-04
8415	savings	30000	84	1.3		12-AUG-19
8425	savings	10000	84	0.24		26-JUL-16
8435	savings	900000	84	0.4		07-JAN-09
12015	savings	100000	120	0.94		03-MAY-18
12025	savings	500000	120	1.1		07-AUG-09
12035	savings	800000	120	1.3		30-MAR-02
10915	savings	300000	109	0.52		31-AUG-18
10925	savings	1000000	109	0.4		27-NOV-12
10935	savings	1000000	109	0.47		20-OCT-14

Employee

Street	City	postcode	title	Firstname	surname	Home phone	Mobile	NiNum	EmpID	Supervisor	Position	bID	JoinDate	Salary
Colinton	Edinburgh	EH105TT	Mrs.	Alison	Smith	01312125555	('07705623443', '07907812345')	NI001	101		Head	901	01-FEB-05	50000
New	Edinburgh	EH24AB	Mr.	John	William	01312031990	('07902314551', '07701234567')	NI010	105	101	Manager	901	04-MAR-07	40000
Old	Edinburgh	EH94BB	Mr.	Mark	Slack	01312102211		NI120	108	105	Accountant	901	01-FEB-15	30000
Ardwell Road	Glasgow	G52 1PR	Mr.	John	Johnson	01362031990	('07902323551', '07706454567')	NI010	115	101	Manager	901	14-MAR-07	50800
123 Main St	Anytown	12345	Mr.	John	Doe	555-1234	('555-5678', '555-9012')	AB123456C	001		Head	1	19-MAR-23	62200
456 Elm St	Otherville	67890	Ms.	Jane	Smith	555-5678	('555-1234', '555-9012')	CD456789A	002	001	Manager	1	19-MAR-23	53300
789 Oak St	Anycity	13579	Dr.	Bob	Johnson	555-9012	('555-1234', '555-5678')	EF789012B	003	001	Project Leader	1	19-MAR-23	91500
123 Main St	Los Angeles	90001	Mr.	John	Doe	555-1234	('555-5678', '555-9012')	AB123456C	004	002	Accountant	1	19-MAR-23	36900

456 Oak Ave	New York	10001	Ms.	Jane	Smith	555-5678	('555-1234', '555-9012')	DE456789F	005	003	Cashier	1	19-MAR-23	26000
456 Main St	Los Angeles	90001	Mr.	John	Doe	555-5678	('555-9012')	AB123456C	EMP001		Head	3	01-JAN-22	74000
789 Main St	Los Angeles	90001	Ms.	Jane	Smith	555-2345	('555-6789')	CD123456E	EMP002	EMP001	Manager	3	02-JAN-22	53400
101 Main St	Los Angeles	90001	Mr.	Bob	Johnson	555-3456	('555-7890')	EF123456G	EMP003	EMP001	Project Leader	3	03-JAN-22	72000
111 Main St	Los Angeles	90001	Ms.	Emily	Davis	555-4567	('555-8901')	GH123456H	EMP004	EMP001	Accountant	3	04-JAN-22	44500
456 Oak St	New York	10001	Ms.	Jane	Smith	555-5678	('555-9012', '555-3456')	CD456789E	emp005		Head	4	01-JAN-00	47000
789 Elm St	San Francisco	94101	Mr.	David	Lee	555-9012	('555-3456', '555-7890')	EF789012G	emp006	emp005	Manager	4	01-JAN-00	35400
321 Pine St	Chicago	60601	Ms.	Emily	Nguyen	555-3456	('555-7890', '555-1234')	GH234567I	emp007	emp005	Manager	4	01-JAN-00	49500
654 Cedar St	Boston	02101	Mr.	Daniel	Chen	555-7890	('555-1234', '555-5678')	IJ345678K	emp008	emp006	Project Leader	4	01-JAN-00	57600
987 Maple St	Seattle	98101	Ms.	Catherine	Chung	555-1234	('555-5678', '555-9012')	KL456789M	emp009	emp007	Accountant	4	01-JAN-00	53900
741 Birch St	Houston	77001	Mr.	William	Huang	555-5678	('555-9012', '555-3456')	MN567890O	emp010	emp007	Accountant	4	01-JAN-00	45200
852 Spruce St	Miami	33101	Ms.	Isabella	Kim	555-9012	('555-3456', '555-7890')	OP678901Q	emp011	emp007	Accountant	4	01-JAN-00	50600
963 Pine St	Dallas	75201	Mr.	Samuel	Choi	555-3456	('555-7890', '555-1234')	QR789012S	emp012	emp007	Accountant	4	01-JAN-00	34900
159 Cedar St	Washington D.C.	20001	Ms.	Olivia	Park	555-7890	('555-1234', '555-5678')	ST234567U	emp013	emp007	Accountant	4	01-JAN-00	40900
753 Oak St	Philadelphia	19101	Mr.	Ethan	Wong	555-1234	('555-5678', '555-9012')	UV345678W	emp014	emp007	Accountant	4	01-JAN-00	29000
456 Pine St	Los Angeles	90001	Ms.	Avery	Ng	555-5678	('555-9012', '555-3456')	WX456789Y	emp015	emp007	Accountant	4	01-JAN-00	44800
456 Elm St	New York	10001	Ms.	Alice	Smith	555-5678	('555-1234', '555-9012')	CD234567D	emp016	emp007	Accountant	4	01-JAN-00	29300
12 Main Street	Napier	4110	Mr.	John	Smith	0271234567	('0212345678')	NI123456A	emp17		Head	5	01-JAN-00	62900
14 Main Street	Napier	4110	Ms.	Jane	Doe	0272345678	('0213456789')	NI123457B	emp18	emp17	Manager	5	01-JAN-00	52400
16 Main Street	Napier	4110	Mr.	Jack	Johnson	0273456789	('0214567890')	NI123458C	emp19	emp17	Manager	5	01-JAN-00	33100
18 Main Street	Napier	4110	Ms.	Sarah	Lee	0274567890	('0215678901')	NI123459D	emp20	emp18	Project Leader	5	01-JAN-00	60500
20 Main Street	Napier	4110	Mr.	William	Ng	0275678901	('0216789012')	NI123460E	emp21	emp18	Accountant	5	01-JAN-00	55500
22 Main Street	Napier	4110	Ms.	Emily	Wong	0276789012	('0217890123')	NI123461F	emp22	emp19	Cashier	5	01-JAN-00	24700

24 Main Street	Napier	4110	Mr.	David	Chen	0277890123	('0218901234')	NI123462G	emp23	emp19	Cashier	5	01-JAN-00	32400
12 Main Street	Napier	4110	Ms.	Samantha	Smith	0271234567	('0212345678')	NI123456A	emp24		Head	9	01-JAN-00	61000
14 Main Street	Napier	4110	Mr.	John	Doe	0272345678	('0213456789')	NI123457B	emp25	emp24	Manager	9	01-JAN-00	44700
16 Main Street	Napier	4110	Mr.	Adam	Johnson	0273456789	('0214567890')	NI123458C	emp26	emp25	Accountant	9	01-JAN-00	42900
18 Main Street	Napier	4110	Ms.	Emily	Lee	0274567890	('0215678901')	NI123459D	emp27	emp25	Cashier	9	01-JAN-00	21700
24 Main Street	Napier	4110	Ms.	Rachel	Nguyen	0278765432	('0219876543')	NI123460E	emp31	emp25	Project Leader	5	01-JAN-00	86200
26 Main Street	Napier	4110	Ms.	Catherine	Wang	0277654321	('0218765432')	NI123461F	emp32	emp31	Cashier	5	01-JAN-00	28600
28 Main Street	Napier	4110	Mr.	Tom	Lee	0276543217	('0217654321')	NI123462G	emp33	emp31	Cashier	5	01-JAN-00	21200
30 Main Street	Napier	4110	Ms.	Emily	Tan	0275432176	('0216543217')	NI123463H	emp34	emp31	Cashier	5	01-JAN-00	27300
20 Main Street	Napier	4110	Ms.	Olivia	Brown	0275678901	('0216789012')	NI123463H	emp35	emp31	Cashier	5	01-JAN-00	15700
22 Main Street	Napier	4110	Mr.	Ethan	Johnson	0276789012	('0217890123')	NI123464J	emp36	emp31	Cashier	5	01-JAN-00	30300
24 Main Street	Napier	4110	Ms.	Isabella	Davis	0277890123	('0218901234')	NI123465K	emp37	emp31	Cashier	5	01-JAN-00	31600
28 Queen Street	Napier	4110	Mrs.	Maria	Garcia	0277890123	('0218901234')	NI678912A	emp38		Head	84	01-JAN-12	50100
30 Queen Street	Napier	4110	Mr.	David	Lee	0278901234	('0219012345')	NI678913B	emp39	emp38	Project Leader	84	01-JAN-12	68400
32 Queen Street	Napier	4110	Ms.	Emily	Wang	0279012345	('0210123456')	NI678914C	emp40	emp38	Project Leader	84	01-JAN-12	40300
34 Queen Street	Napier	4110	Mr.	Daniel	Kim	0270123456	('0211234567')	NI678915D	emp41	emp38	Project Leader	84	01-JAN-12	57400
20 Main Street	Napier	4110	Ms.	Samantha	Jones	0275678901	('0216789012')	NI123462G	emp42	emp38	Cashier	84	01-JAN-12	25900
22 Main Street	Napier	4110	Mr.	Peter	Chen	0276789012	('0217890123')	NI123463H	emp43	emp38	Cashier	84	01-JAN-12	25200
24 Main Street	Napier	4110	Ms.	Julia	Wang	0277890123	('0218901234')	NI123464I	emp44	emp38	Cashier	84	01-JAN-12	32400
10 Marine Parade	Napier	4110	Mr.	Adam	Smith	0271234567	('0212345678')	NI123456A	emp45		Head	90	01-JAN-18	59800
12 Marine Parade	Glasgow	4110	Ms.	Emma	Jones	0272345678	('0213456789')	NI123457B	emp46	emp45	Manager	90	01-JAN-18	29700
14 Marine Parade	Napier	4110	Mr.	William	Brown	0273456789	('0214567890')	NI123458C	emp47	emp45	Manager	90	01-JAN-18	41500
10 High Street	Glasgow	G1 1LE	Mr.	David	On	01412345678	('07712345678')	GL123456D	emp48	emp47	Accountant	90	01-JAN-18	58500

123 Main Street	Napier	4110	Mrs.	King	Brown	0271111111	('0211111111')	NI123456A	emp49		Head	109	01-JAN-18	71500
125 Main Street	Napier	4110	Mr.	John	Smith	0272222222	('0212222222')	NI123457B	emp50	emp49	Manager	109	01-JAN-18	35500
10 Main Street	Napier	4110	Mr.	David	Brown	0271234567	('0212345678')	NZ654321D	emp51	emp50	Project Leader	109	01-JAN-18	55600
12 Main Street	Napier	4110	Ms.	Emily	Davis	0272345678	('0213456789')	NZ654322E	emp52	emp50	Cashier	109	01-JAN-18	26800
14 Main Street	Napier	4110	Mr.	Daniel	Taylor	0273456789	('0214567890')	NZ654323F	emp53	emp50	Cashier	109	01-JAN-18	32000
22 Main Street	Napier	4110	Mr.	David	Taylor	0275678901	('0216789012')	NZ123456A	emp54		Head	120	01-JAN-18	48100
24 Main Street	Napier	4110	Mr.	John	Smith	0276789012	('0217890123')	NZ123457B	emp55	emp54	Manager	120	01-JAN-18	55500
Toronto	M5H 2N2	Canada	Mr.	Daniel	Lee	4165556789	('6475556789', '4375556789')	CA123	emp56	emp54	Accountant	120	01-JAN-18	44100
10 Marine Parade	Napier	4110	Ms.	Emily	Wilson	0273456789	('0214567890')	NW234567A	emp57		Head	130	01-JAN-20	83000
12 Marine Parade	Napier	4110	Mr.	Jacob	Anderson	0274567890	('0215678901')	NW234568B	emp58	emp57	Manager	130	01-JAN-20	31500
Toronto	M5H 2N2	Canada	Mr.	Daniel	Lee	4165556789	('6475556789', '4375556789')	CA123	emp59	emp57	Accountant	130	01-JAN-20	59800
22 George Street	Sydney	2000	Ms	Isabella	Brown	0298765432	('0410123456', '0420123456', '0430123456', '0440123456', '0450123456', '0460123456')	AU1234	emp60		Head	158	01-JAN-22	54200
22 George Street	Sydney	2000	Ms	Emma	Garcia	0498765432	('0410111111', '0420222222', '0430333333', '0440444444')	AU1235	emp61	emp60	Manager	158	01-JAN-22	42600
22 George Street	Sydney	2000	Mr.	David	Jones	0398765432	('0410777777', '0420888888', '0430999999')	AU1236	emp62	emp60	Accountant	158	01-JAN-22	37600
1 Napier Street	Napier	4110	Mr.	John	Smith	068759432	('0210987654', '0220987654', '0230987654')	NZ123	emp63		Head	185	01-JAN-22	86600
Paris	75008	France	Mr	Jean	Dupont	0147202020	('0620202020')	FR123	emp64	emp63	Manager	185	01-JAN-22	54600
3 Napier Street	Napier	4110	Ms.	Olivia	Wilson	068234567	('0213456789', '0223456789', '0233456789')	NZ345	emp65	emp63	Accountant	185	01-JAN-22	35100
50 Emerson Street	Napier	4110	Mr.	John	Smith	06-123-4567	('021-123-4567', '027-123-4567')	NZ5678	emp66		Head	236	01-JAN-22	76600

10 Herschell Street	Napier	4110	Ms	Samantha	Williams	06-234-5678	('021-234-5678', '027-234-5678')	NZ6789	emp67	emp66	Manager	236	01-JAN-22	46300
25 Tennyson Street	Napier	4110	Mr.	David	Johnson	06-345-6789	('021-345-6789', '027-345-6789')	NZ7890	emp68	emp66	Accountant	236	01-JAN-22	34400
19 Shakespeare Road	Napier	4110	Mr.	William	Smith	068743218	('027843219', '027643218', '027943217')	NZ1234	emp69		Head	426	01-JAN-22	65000
31 Dalton Street	Napier	4110	Ms	Olivia	Johnson	068556789	('027845678', '027645679', '027945678')	NZ2345	emp70	emp69	Manager	426	01-JAN-22	33100
6 Main Street	Cork	T23 XY12	Mr	Patrick	O\Leary	0217777777	('0861234567')	EI4567	emp71	emp70	Accountant	426	01-JAN-22	45200
56 Carlyle Street	Napier	4110	Mr.	Lucas	Brown	068987654	('027843215', '027643214', '027943213')	NZ4567	emp72	emp69	Cashier	426	01-JAN-22	21600
42 Elm Street	Napier	4110	Ms	Olivia	Jones	06-843-8572	('027-123-4567', '021-234-5678')	NZ1290	emp73		Head	762	01-JAN-23	61300
55 High Street	Napier	4110	Mr	Ethan	Wang	06-843-3456	('021-345-6789', '027-456-7890')	NZ1289	emp74	emp73	Manager	762	01-JAN-23	47300
33 Main Road	Napier	4112	Ms	Sophia	Lee	06-842-1234	('021-987-6543', '027-876-5432')	NZ1288	emp75	emp73	Accountant	762	01-JAN-23	30100
21 Broadway	Napier	4110	Mr	William	Smith	06-845-6789	('027-765-4321', '021-654-3210')	NZ1287	emp76	emp73	Cashier	762	01-JAN-23	23600
456 High St	Napier	4110	Ms	Samantha	Jones	06-765-4321	('021-012-3456', '021-112-3456')	NZ1234	801		Head	908	01-JAN-23	64100
5 George Square	Toronto	M5H 2N2	Mr	Jacob	Lee	4165556789	('6475556789', '4375556789', '9055556789')	CA14	emp78	801	Manager	908	01-JAN-23	38300
567 King St	Napier	4110	Ms	Emily	Wilson	06-444-4444	('021-432-3456', '021-532-3456')	NZ9101	emp79	emp78	Accountant	908	01-JAN-23	30900
234 Elm St	Napier	4110	Mr	Thomas	Nguyen	06-222-2222	('021-632-3456', '021-732-3456')	NZ1112	emp80	emp78	Cashier	908	01-JAN-23	17900
Adam	Edinburgh	EH16EA	Mr	Jack	Smith	01311112223	('0781209890')	NI810	804	801	Project Leader	908	05-FEB-12	35000
Colinton	Edinburgh	EH105TT	Mrs.	Alison	Smith	01312125555	('07705623443', '07907812345')	NI001	101		Head	901	01-FEB-05	50000

Customer

Street	City	Postcode	Title	First name	Surname	Home number	Mobile number		
Adam	Edinburgh	EH1 6EA	Mr	Jack	Smith	01311112223	('0781209890', '0771234567')	NI810	1002
Adam	Edinburgh	EH1 6EA	Ms	Anna	Smith	01311112223	('0770111222')	NI010	1003
New	Edinburgh	EH2 8XN	Mr	Liam	Bain	01314425567		NI034	1098
10 Park Street	Belfast	BT7 2ED	Mr	John	Doe	02890222222	('07912345678', '07787654321')	NI1234	1004
1 Main Street	Dublin	D01 AB2C	Ms	Mary	Murphy	016789012	('0831234567', '0760123456')	EI9876	1005
22 George Street	Glasgow	G1 1QB	Mr	David	Brown	01411234567	('07898765432', '07987654321')	SI6789	1006
123 Main Street	Cork	T12 XY1Z	Ms	Sarah	Jones	0215555555		EI1234	1007
456 Queen Street	Belfast	BT3 9DS	Mr	Michael	O\Neill	02812345678		NI9876	1008
23 Rose Street	Edinburgh	EH2 2PR	Ms	Elizabeth	Taylor	01315555555	('07776543210', '0760765432')	NI4321	1009
4 High Street	Dublin	D02 XY34	Mr	Daniel	Murphy	015555555	('0851234567', '0867654321')	EI5678	1010
5 George Square	Glasgow	G2 1DY	Ms	Fiona	McDonald	01412223344		SI3456	1011
6 Main Street	Cork	T23 XY12	Mr	Patrick	O\Leary	0217777777	('0861234567', '0760888777')	EI4567	1012
London	SE1 2SW	UK	Ms	Sophie	Green	02071234567	('07771234567', '07981234567', '0760987654')	GB123	2034
New York	10001	USA	Mrs	Elizabeth	Brown	2125550123	('9175550123')	US123	4321
Paris	75008	France	Mr	Jean	Dupont	0147202020	('0620202020', '0760111222')	FR123	5687
Berlin	10117	Germany	Ms	Maria	Schmidt	03012345678	('01761234567', '01781234567', '0760123456')	DE123	9867
Dublin	D02 DY26	Ireland	Mr	David	Murphy	014567890	('0851234567')	IE123	2345
Sydney	2000	Australia	Ms	Emily	Chen	0298765432	('0410123456', '0760567890')	AU123	8754
Toronto	M5H 2N2	Canada	Mr	Daniel	Lee	4165556789	('6475556789', '4375556789', '0760998877')	CA123	1289
Tokyo	100-0005	Japan	Ms	Yuka	Ito	0367523412	('08012345678')	JP123	4567
Rio de Janeiro	22250-040	Brazil	Mr	Luiz	Santos	2122334455	('21999887766', '0760456789')	BR123	3421
Cape Town	8001	South Africa	Ms	Nomonde	Mbele	0211234567		ZA123	6532
123 Main Street	New York	10001	Mr	William	Johnson	2125555555	('9175555555', '6465555555', '7185555555', '2125554444', '2125553333', '0760223344')	US1234	2001
456 Queen Street	London	SE1 2SW	Ms	Olivia	Smith	02071234567	('07771234567', '07981234567', '07761234567', '07871234567')	GB1234	2002
1 Main Street	Paris	75008	Mr	Thomas	Martin	0147202020	('0620202020', '0620202021', '0620202022', '0760889900')	FR1234	2003
22 George Street	Sydney	2000	Ms	Isabella	Brown	0298765432	('0410123456', '0420123456', '0430123456', '0440123456', '0450123456', '0460123456')	AU1234	2004
5 George Square	Toronto	M5H 2N2	Mr	Jacob	Lee	4165556789	('6475556789', '4375556789', '9055556789')	CA1234	2005

Customer Account

CustID	AccNum
1002	1001
1002	1010
1003	1010
1098	8002
1004	90115
1004	925
1004	23635
1004	76215
1004	8435
1005	10915
1006	42615
1006	42635
1006	915
1006	8425
1007	315
1008	18525
1008	13015
1010	15835
1010	13025
1010	12025
1011	335
1012	90125
1012	90135
1012	9025
1012	10925
1012	10935
2034	15825
5687	90825
5687	18515
5687	515
5687	13035
5687	435
5687	12015
9867	135
2345	12035
8754	23615
8754	415
4567	23625
3421	525
6532	42625
6532	9035
6532	425
6532	8415
2001	90835
2001	935
2001	15815
2001	76235

2003	90815
2004	9015
2004	115
2004	325
2005	18535
2005	125
2005	535
2005	76225
5687	51
2005	1301
1010	1301
5687	9081
1005	9081
2004	9081
1004	53
1005	9013
1005	9083
1005	1581
1005	1583
1005	51
1005	1301
1007	9081
1007	91
1007	903
1007	32
1008	
1008	4261
1008	4262
1008	93
1008	842
1008	1203
1010	2363
1010	901
1010	12
1010	1302
1010	1303
1010	1202
1011	92
1011	41
1011	7623
2034	52
5687	1853
9867	843
9867	1093
2345	1851
2345	902
2345	42
2345	1092

Edinburgh Napier
UNIVERSITY

4567	9012
4567	2361
3421	
3421	11
3421	43
3421	33
3421	1091
6532	9011
6532	2362
6532	841
2001	13
2004	1852
2004	31
2004	7622
2004	1201
2005	
2005	7621

Task 4: Provide SQL statements and answers (outputs) to the following queries on the database you re-designed and implemented. Comments are expected. Output should be formatted. Data/information displayed should be in values, not in types, e.g., John Smith, not NAME('John', 'Smith'). (**35 marks**)

Question a
SELECT e.P_Name.title || ' ' || e.P_Name.FirstName || ' ' || e.P_Name.SurName AS "Full Name"
FROM MS_Employee_Table e
WHERE
    e.P_Name.SurName LIKE '%on%' AND
    e.P_Address.City = 'Glasgow';

	Full Name
1	Mr. John Johnson
2	Ms. Emma Jones

Question b

SELECT count(1) AS "Number of savings accounts",
    deref(bID).b_address.street || ', ' || deref(bID).b_address.city || ', ' || deref(bID).b_address.PostCode AS "Address"
FROM MS_Account_Table
WHERE accType = 'savings'
GROUP BY bID;

	Number of savings accounts	Address
1	3	Queen St, Oxford, OX1 1EJ
2	3	Colmore Row, Birmingham, B3 3BA
3	3	Paul St, London, EC2A 4NE
4	3	Baker St, London, NW1 6XB
5	3	Westgate St, Gloucester, GL1 2NW
6	3	Fenwick Rd, Glasgow, G46 6XB
7	3	Pound Way, Oxford, OX4 3XS
8	3	Clifton Pl, Glasgow, G3 7JU
9	4	Market, Edinburgh, EH1 5AB
10	3	Wharfside Street, Birmingham , B1 1RD
11	3	High St, Cheltenham, GL50 1EW
12	3	Pollokshields, Glasgow, G41 2NL
13	3	Bridge, Glasgow, G18 1QQ
14	3	Morningside Rd, Edinburgh, EH10 5QF
15	3	High St, Birmingham, B4 7TE
16	3	Brindley Pl, Birmingham, B1 2HP
17	3	Roman Rd, Glasgow, G61 2SP

Question c
SELECT
    DEREF(DEREF(ca.accNum).bID).bID AS "Branch ID",
    DEREF(ca.custID).P_Name.title || ' ' || DEREF(ca.custID).P_Name.firstName || ' ' || DEREF(ca.custID).P_Name.surName AS "Full name",
    DEREF(ca.accNum).balance AS "Balance"
FROM MS_CustomerAccount_Table ca

INNER JOIN
(
  SELECT
    DEREF(DEREF(ca.accNum).bID).bID AS "Branch ID",
    MAX(DEREF(ca.accNum).balance) AS "Balance"
  FROM MS_CustomerAccount_Table ca
  GROUP BY DEREF(DEREF(ca.accNum).bID).bID
) CA2
ON
  DEREF(DEREF(ca.accNum).bID).bID = CA2."Branch ID" AND
  DEREF(ca.accNum).balance = CA2."Balance";

	Number of savings accounts	Address
1	3	Queen St, Oxford, OX1 1EJ
2	3	Colmore Row, Birmingham, B3 3BA
3	3	Paul St, London, EC2A 4NE
4	3	Baker St, London, NW1 6XB
5	3	Westgate St, Gloucester, GL1 2NW
6	3	Fenwick Rd, Glasgow, G46 6XB
7	3	Pound Way, Oxford, OX4 3XS
8	3	Clifton Pl, Glasgow, G3 7JU
9	4	Market, Edinburgh, EH1 5AB
10	3	Wharfside Street, Birmingham , B1 1RD
11	3	High St, Cheltenham, GL50 1EW
12	3	Pollokshields, Glasgow, G41 2NL
13	3	Bridge, Glasgow, G18 1QQ
14	3	Morningside Rd, Edinburgh, EH10 5QF
15	3	High St, Birmingham, B4 7TE
16	3	Brindley Pl, Birmingham, B1 2HP
17	3	Roman Rd, Glasgow, G61 2SP

Question d

SELECT
   DEREF(E.bID).bID AS "Branch that the employee works.",
   DEREF(DEREF(CA.accNum).bID).bID AS "Branch that the Account was opend."

FROM MS_Customer_Table C
INNER JOIN MS_Employee_Table E
ON C.niNum = E.niNum
INNER JOIN MS_CustomerAccount_Table CA
ON C.CustID = DEREF(CA.custID).CustID;
WHERE DEREF(DEREF(E.supervisorID).E_Job)."Position" = 'Manager';

	Branch that the employee works.	Branch that the Account was opend.
1	908	901
2	908	901
3	901	901
4	901	901
5	426	901
6	426	901
7	426	90
8	426	109
9	426	109
10	185	908
11	185	185
12	185	5
13	185	130
14	185	4
15	185	120
16	158	90
17	158	1
18	158	3
19	185	5
20	185	908
21	158	908
22	185	185
23	158	185
24	158	3
25	158	762
26	158	120

Edinburgh Napier
UNIVERSITY

Question e
SELECT
  DEREF(DEREF(ca.accNum).bID).bID AS "Branch ID",
  DEREF(ca.custID).P_Name.title || ' ' || DEREF(ca.custID).P_Name.firstName || ' ' || DEREF(ca.custID).P_Name.surName AS "Full name",
  DEREF(ca.accNum).limitOfFreeOD AS "Limit Of Free Overdraft"
FROM MS_CustomerAccount_Table ca
INNER JOIN
(
  SELECT
    DEREF(DEREF(ca.accNum).bID).bID AS "Branch ID",
    MAX(DEREF(ca.accNum).limitOfFreeOD) AS "limitOfFreeOD",
    COUNT(*) AS "Owners",
    DEREF(ca.accNum).accType
  FROM MS_CustomerAccount_Table ca
  WHERE DEREF(ca.accNum).accType = 'current'
  GROUP BY DEREF(DEREF(ca.accNum).bID).bID, DEREF(ca.accNum).accNum, DEREF(ca.accNum).accType
) CA2
ON
  DEREF(DEREF(ca.accNum).bID).bID = CA2."Branch ID"
WHERE CA2."Owners" > 1 AND DEREF(ca.accNum).limitOfFreeOD > 0;

Edinburgh Napier
UNIVERSITY

	Branch ID	Full name	Limit Of Free Overdraft
1	5	Mr Jean Dupont	181
2	5	Mr John Doe	127
3	5	Ms Mary Murphy	181
4	5	Ms Sophie Green	124
5	130	Mr Jacob Lee	87
6	130	Mr Daniel Murphy	87
7	130	Ms Mary Murphy	87
8	130	Mr Daniel Murphy	139
9	130	Mr Daniel Murphy	150
10	908	Mr Liam Bain	100
11	908	Mr Jean Dupont	53
12	908	Ms Mary Murphy	53
13	908	Ms Isabella Brown	53
14	908	Ms Mary Murphy	62
15	908	Ms Sarah Jones	53

Question f
SELECT
    C1."Full name", C2."Number of mobile phones"
FROM
    (
      SELECT
        C.niNum,
        C.P_Name.Title || '. '|| C.P_Name.FirstName || ' ' || C.P_Name.SurName AS "Full name"
      FROM MS_Customer_Table c, Table(C.P_Phone.Mobile) t
      WHERE COLUMN_VALUE LIKE '0760%'
) C1

INNER JOIN
    (
      SELECT

19

```
        C.niNum,
        COUNT(1) AS "Number of mobile phones"
    FROM MS_Customer_Table c, Table(C.P_Phone.Mobile) t
    WHERE t.COLUMN_VALUE NOT LIKE '362%'
    GROUP BY C.niNum
    HAVING COUNT(1) > 1
    ORDER BY "Number of mobile phones"
  ) C2
ON C1.niNum = C2.niNum;
```

	Full name	Number of mobile phones
1	Ms. Elizabeth Taylor	2
2	Ms. Emily Chen	2
3	Mr. Patrick O\Leary	2
4	Ms. Mary Murphy	2
5	Mr. Jean Dupont	2
6	Mr. Luiz Santos	2
7	Mr. Daniel Lee	3
8	Ms. Sophie Green	3
9	Ms. Maria Schmidt	3
10	Mr. Thomas Martin	4
11	Mr. William Johnson	6

Question g
```
SELECT COUNT(1) AS "Number of employees"
FROM MS_Employee_Table E
WHERE
   DEREF(E.SupervisorID).P_Name.Title = 'Mr.' AND
   DEREF(E.SupervisorID).P_Name.FirstName = 'John' AND
   DEREF(DEREF(E.SupervisorID).SupervisorID).P_Name.Title = 'Mrs.' AND
   DEREF(DEREF(E.SupervisorID).SupervisorID).P_Name.FirstName = 'King';
```

⟨⟩ Number of employees
1	3

Question h
SELECT e.P_Name.firstName || ' ' || e.P_Name.SURName AS "Employee_Name",
e.employeeStatus() AS "Employee_Status"
FROM MS_Employee_Table e;

SELECT e.P_Name.firstName || ' ' || e.P_Name.SURName AS "Employee_Name",
    NVL(e.employeeStatus(), '') AS "Employee_Status"
FROM MS_Employee_Table e
WHERE e.employeeStatus() IS NOT NULL
ORDER BY
  CASE
    WHEN e.employeeStatus() = 'gold' THEN 1
    WHEN e.employeeStatus() = 'silver' THEN 2
    WHEN e.employeeStatus() = 'bronze' THEN 3
  END;

	Employee_Name	Employee_Status
1	Emily Nguyen	gold
2	Rachel Nguyen	silver
3	Mark Slack	bronze
4	John Johnson	bronze
5	Jane Smith	bronze
6	David Lee	bronze
7	Daniel Chen	bronze
8	Catherine Chung	bronze
9	William Huang	bronze
10	Isabella Kim	bronze
11	Samuel Choi	bronze
12	Olivia Park	bronze
13	Ethan Wong	bronze
14	Avery Ng	bronze
15	Alice Smith	bronze
16	John Smith	bronze
17	Jane Doe	bronze
18	Jack Johnson	bronze
19	Sarah Lee	bronze
20	William Ng	bronze
21	Emily Wong	bronze
22	David Chen	bronze
23	Samantha Smith	bronze
24	John Doe	bronze
25	Adam Johnson	bronze
26	Emily Lee	bronze
27	Catherine Wang	bronze
28	Tom Lee	bronze
29	Emily Tan	bronze
30	Olivia Brown	bronze
31	Ethan Johnson	bronze
32	Isabella Davis	bronze
33	Maria Garcia	bronze
34	David Lee	bronze
35	Emily Wang	bronze
36	Daniel Kim	bronze
37	Samantha Jones	bronze
38	Peter Chen	bronze
39	Julia Wang	bronze
40	Adam Smith	bronze
41	Emma Jones	bronze
42	William Brown	bronze
43	David On	bronze
44	King Brown	bronze
45	John Smith	bronze
46	David Brown	bronze
47	Emily Davis	bronze
48	Daniel Taylor	bronze
49	David Taylor	bronze
50	John Smith	bronze
51	Daniel Lee	bronze
52	Jack Smith	bronze
53	Alison Smith	bronze
54	John William	bronze

Task 5.: Critically discuss the advantages and disadvantages of the object-relational model against the relational model, based on the designs and implementations for the proposed bank database. (**8 marks**)

The advantages of our design approach are:

We can store multiple phone numbers for both customers and employees using nested tables, without any limitations on the number of phone numbers. In comparison, traditional relational modeling only allows a maximum of two phone numbers.

By using references, we can minimize the need for duplicate values in our tables. For example, we only need to save job information once in the Job table, and then reference it from the Employee table. This approach makes it easier to access information and eliminates the need for join statements to retrieve related data like when we want to show the data of a branch, job, or supervisor of an employee, or when we want to see the information in the CusomerAccount table.

Using structured types makes our tables look more organized and well-designed. We can look at Branch where we used the Address type

The use of inheritances and subtypes makes our tables consistent, which can reduce confusion and errors in our work. The usage is in the Employee and Customer when we used Person type as the superclass. Like having position unique in the job, making bID primary key and b_Phone unique to not have duplicate rows or miss values. Another sample would be making accNum and accType similar to the Branch table but in the Account table. In the Customer and Employee, the niNum is unique so a person is not inserted twice. In Customer CustID and in Employee the empID is primary key.

The use of constraints ensures that we maintain data integrity and prevents false data from being inserted into our tables.

However, there are also some disadvantages to our approach:

Accessing data through nested types can be more difficult compared to relational modeling. It may also be harder to remove or modify values.

Using structured types, subtypes, and inheritances can lead to more layers in our tables, which can make it harder to navigate and access specific values.

Although using references can minimize the need for joins, it can sometimes take longer to find a specific value through a reference.