

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

SUMMER EXAMINATIONS 2000

**MASTERS OF INFORMATION TECHNOLOGY
and MASTERS OF ENGINEERING SCIENCE**

CT503. SOFTWARE ENGINEERING

Prof. D. Bell
Dr. G. Lyons

(Time allowed: 3 hours)
Answer **four** questions in all.
All questions carry equal marks.

1. (a) For the Elevator Controller described in the following narrative, construct Environmental and Behavioural models using DFDs.
- (b) Using the Ward and Mellor extension to the DFD technique, illustrate how *control* is modelled on a data flow diagram.
- (c) Construct an annotated State-transition Diagram (STD) to describe the operation of the Elevator Controller.

FREEFALL Elevator Control System

The FREEFALL elevator controller is designed to control several lifts (up to N) in an elevator lobby of a large hotel building.

Each elevator has a control panel with a set of M buttons, one for each floor. These illuminate when pressed and cause the elevator to visit the corresponding floor. The illumination is cancelled when the corresponding floor is visited by the elevator.

Each floor, except the ground floor and top floor, has two buttons, one to request an up-elevator and one to request a down-elevator. These buttons illuminate when pressed. The illumination is cancelled when an elevator visits the floor and then moves in the desired direction.

When an elevator has no requests, it remains at its current floor with its doors closed.

When an Elevator Request or Floor Request signal is received by the FREEFALL system, the Travel Distance is calculated and drive motors activated. As the elevator approaches the target floor, or an intermediate stop, the drive motors are progressively "braked" until the elevator comes to a stop at its correct destination.

Apart from the normal passenger interface to the Elevator Controller, an Operator Override switch allows authorised personnel (holding a security key) to disable normal operation, for the purposes of maintenance and emergency situations.

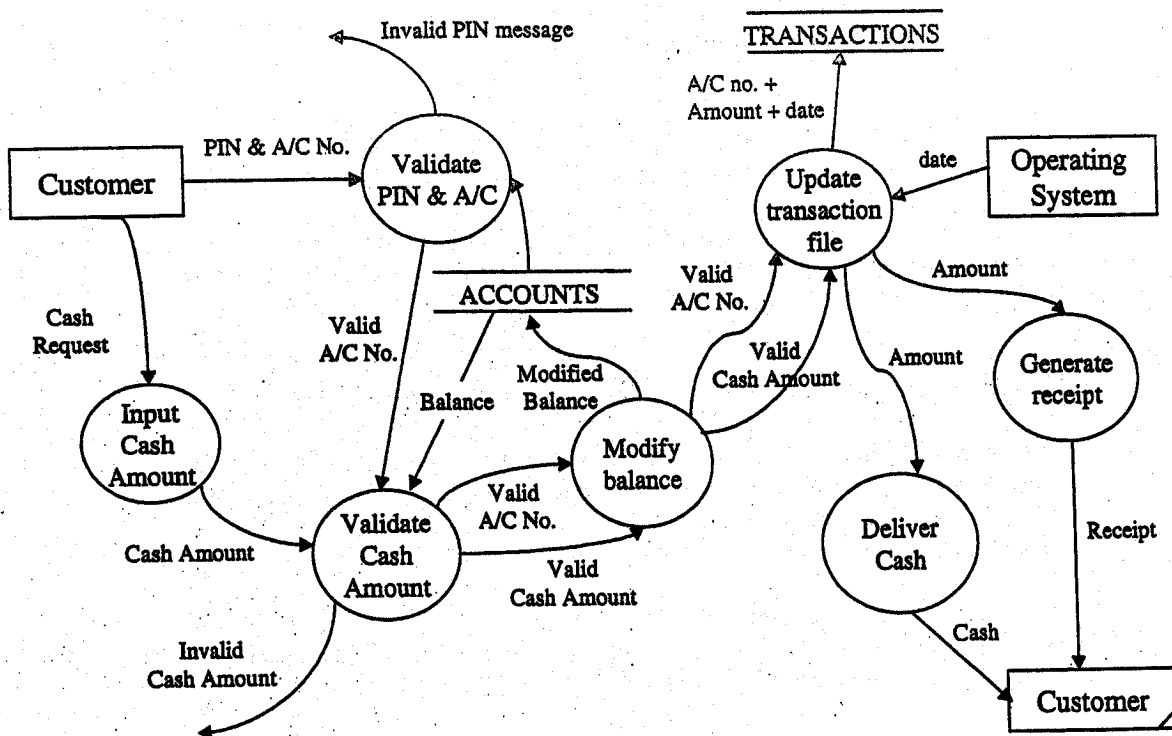
2. (a) For the Automobile Service Management System described in the following narrative, construct and refine an ER model of the data, showing all relevant cardinalities.

Automobile Service Management System

The Service Management System (ASMS) is used to keep track of all automobile services performed by the garage, including details of labour and parts used, so that correct invoices may be generated and an up-to-date service log provided to the automobile owners. Details

stored include: customer name, address, home & work telephone numbers, and credit status; car reg. no., make, model, mileage and warranty status. For each service, a work order is created and assigned a unique WO number. Details on the date-of-service, short description of work performed, number of labour hours needed, and mechanic assigned to the job (including the hourly rate for billing purposes) are also maintained. Finally, information on the parts used (part number, type, quantity, unit costs and description) during the service are recorded. These data allow the garage to invoice the customer with a correct amount, which includes details of parts and labour used in the service. Invoices are also dated and contain a short description of the work performed.

- (b) Use relational notation to describe each of the main entities, attributes and primary keys of the data contained in the Service Management System. Then, convert the un-normalised relations into 3NF. Describe each step of the normalisation process, stating your assumptions and identifying functional dependencies in the data.
3. (a) *Modularity* is the cornerstone of good program architecture. Describe how the design principles of *coupling* and *cohesion* contribute to software modularity.
- (b) Identify, and illustrate with examples, the five levels of *coupling* commonly found in program design.
- (c) The following data flow diagram describes the Cash Withdrawal module of an Automated Teller Machine. Convert the DFD into a fully annotated structure chart, by using Transform Analysis. Refine your first-cut structure chart as necessary, applying coupling and cohesion criteria. Give design reasons for any changes made.



4. (a) Describe the role of Function Point Analysis in software estimation. Briefly illustrate how Function Points are calculated using either Albrecht's method or the FPII approach.
- (b) Describe and illustrate the technique of *basis path testing*? What part does *basis path testing* play in a testing strategy described by the V-model ?
- (c) Analyse the following piece of procedural logic. Based on this module specification:
- Draw a flow graph
 - Show the number of regions in the graph
 - Calculate, using 3 methods, $V(G)$
 - List each independent path through the code
 - Estimate the upper bound number of tests required to ensure maximum branch coverage.

```

DO WHILE (X < Y)
    Procedure A1
    IF (P AND Q) THEN
        Procedure A2
    ELSE IF (R AND S) THEN
        Procedure A3
    ELSE IF (T) THEN
        Procedure A4
    ELSE
        Procedure A5
    END IF
END DO

```

5. For the "Survivor Takes All" computer game described in the following narrative, develop an object-oriented class model, identifying all classes, associations (including inheritance), attributes and operations.

SURVIVOR TAKES-ALL Computer Game

This "construction and combat" game allows the player to build civilisations from a selection of different tribes, and then enact battle scenes amongst war-making peoples. A number of different "tribes" are available, including (but not exclusively): the Goths, the Turks, the Celts, the Vikings. Each tribe is populated by different types of Individual, including: Villagers, Monks and Raiders. All of these have a name, age, and strength index. In turn, there are different types of Villager, depending upon their Status/Rank, Sex, and Home Location, as well as their function in life: Farmer, Builder, and Miner. The Monks are divided according to their function alone: Gardner, Preacher or Healer – and are otherwise described by common features, such as name, age and order; all monks perform some common functions, such as praying. Raiders are either Cavalry, Navy or Foot-Soldiers and are described by Brigade Name, in addition to the generic Individual characteristics. Foot-Soldiers are further divided into Archers and Artillery. As is obvious from their names, the Raiders are also differentiated according to function – for instance Archers can Shoot Arrows and Cross-bows, while Cavalry raiders Ride Horses, Charge with Spears and Attack with Swords. Some details are left up to your own (i.e. the exam candidate's) imagination and additional attributes or operations may be added, at your discretion.

Apart from the Individuals described, the game also provides various objects that are normally found useful in building a civilisation, such as: Houses, Churches, Castles and Siege Works, all constructed by Builders from Wood and Stone. Farmers work in Fields of different Crop Type (including: Oats, Vegetables and Hay). Monks live in Monasteries and do not venture out into the dangerous world. However, this does not guarantee protection, as the troublesome Raiders are inclined to Attack various constructions, including Monasteries, Houses, etc. and Individuals. Raiders also attack each other, that is, they attack Raiders from other tribes, not their own people.

6. (a) Describe how a *Business Process* view of an organisation differs in terms of structure, emphasis and systems support from a more traditional model of business organisation. What is meant by the term *Core Business Process* and how do we distinguish these from the many other "processes" present in an enterprise? What is the central objective of Business Process Re-engineering (BPR) and how does this differ from earlier attempts at performance improvement, such as Total Quality Management, Scientific Management, etc.?
- (b) From an IT viewpoint, what difficulties are encountered in migrating from a Functional to a Process based enterprise, and how might these be overcome in practice? Briefly outline the role of IT in *Business Process Re-engineering* and identify the relevant types of tools and technology deployed.
- (c) What elements of Software Engineering analysis are useful in the modelling and implementation of Business Processes? In particular, how can Event Partitioning help to isolate and map core business processes? Describe the IDEF₀ technique used in business process modelling and illustrate its application.
7. (a) Following an extensive review of your company's business processes, the Board has given its approval for a Feasibility Study to examine the viability of replacing all legacy systems with new process based IT infrastructure. The Proposed System has an Annual Lease Cost of £20,000, while the Current System has a Variable Lease Cost. All of the costs associated with the Current and Proposed systems are presented in the following table, for the 4-year period over which the feasibility is being examined.

Year	Proposed System Costs (£)	Current System Costs (£)
Year 0		
System lease	20,000	11,500
Salaries	30,000	50,000
Overheads	4,000	3,000
Development	30,000	
Year 1		
System lease	20,000	10,500
Salaries	33,000	55,000
Overheads	4,400	3,300
Development	12,000	
Year 2		
System lease	20,000	10,500
Salaries	36,000	60,000
Overheads	4,900	3,600
Development		
Year 3		
System lease	20,000	10,500
Salaries	39,000	60,000
Overheads	5,500	4,000
Development		

Using break-even analysis, determine the year in which the Proposed System would break even.

Applying a discount rate of 12% to the analysis, evaluate the financial viability of the Proposed System relative to the option of retaining the Current System. Identify any assumptions and/or formulae used in your analysis.

- (b) As part of the development of the Proposed System, the analysts have constructed the following table to describe the timing and interdependencies of the tasks involved.

Activity Description	Task	Must Follow	Expected Time (Days)
Develop DFDs	P	None	9
Construct decision tables	Q	P	12
Revise specification	R	Q	3
Document project	S	R, Z	7
Organise data dictionary	T	P	11
Produce prototype	X	None	8
Revise prototype	Y	X	14
Design database	Z	T, Y	5

- (i) Draw a Gantt chart for the development phase shown.
- (ii) Draw a PERT chart for the development phase and determine the critical path.