1. **a.** Explain the role which the following EIS components play within an EIS:
   - Stateless session beans
   - Stateful session beans
   - Entity beans.

   Explain which of these components have persistent data, and which components can be shared between different users (clients) of the component.

   [15 [5 each component] marks]

**b.** Define a business tier architecture for the following system.

A book wholesaler system holds data on books, orders and customers (Figure 1). There are two different categories of users: (i) customers, who can only view their own orders, and initiate or cancel orders for specific books, and (ii) staff, who can add/remove customers and books, and view and delete the orders of any customer.

For each component in your architecture identify its kind (e.g., session bean, entity bean), and for each dependency, identify if it is a read-only or an update dependency.

[20 marks]

![Class diagram of book wholesaler system](image)

**c.** What alternative business tier architectures are possible for this system? Explain in what ways your chosen architecture is better than these alternatives.

[15 marks]
2. a. (i) Explain what is meant by a web service.
   (ii) What general properties should a functionality of a system have in order to be suitable to be made available as a web service?
   [10 (5 each part) marks]

b. Explain the purpose and elements of the Router and Broker web service patterns, giving the diagrams of their typical structures.
   [20 (10 each pattern) marks]

c. Define a web service architecture for a service used by an online book retailer to fulfil customer orders: the service first requests cost and time estimates for an order of the requested number of copies of a book from a number of different suppliers. If there are suppliers able to supply the order within the customer deadline, then the order is confirmed with the supplier giving the lowest quote. Otherwise, the supplier promising the fastest delivery is chosen.
   [20 marks]
3. **a.** Explain the purpose of the *Session Facade* pattern for an EIS, and identify to which EIS tier it belongs. 

[10 marks]

**b.** Give the diagram of its typical architecture. 

[1.5 marks]

![Diagram of EIS Architecture](image)

**Figure 2: Architecture of an EIS**

**c.** Consider the case of the system shown in Figure 2. Here, presentation tier components $P_1$, $P_2$ and $P_3$ all use entity beans $E_1$ and $E_2$, and component $P_4$ uses entity beans $E_2$ and $E_3$. 

(i) Identify how this system can be improved by the use of Session Facade, and (ii) show the revised architecture. 

[25 (15 + 10) marks]
4. **a.**
   (i) Explain how state machines can be used to design the interaction between a web application and its users.
   (ii) What do states and transitions in the state machine represent in such design diagrams?
   
   [10 (5 each part) marks]

**b.**
Draw an interaction state machine diagram for an estate agency system which allows customers to register with their preferences for properties, registered users can then search for matching properties. Registered users can also login and logout from the system, and edit their preferences (when they are logged in).

[25 marks]

**c.**
Explain what is meant by *accessibility* for a web application. Give two examples of techniques for improving web application accessibility.

[15 marks]
1. [Covers topics from part 3 of the course: EIS architecture and design architectures for EIS]

   a. • Stateless session beans: these provide a service which requires no data
to be stored between invocations of the service, for example, sending an
email confirming an operation. They are potentially sharable between
users, as they store no user-specific data. They persist for a session.
• Statefull session beans: these provide a service which does require ses-
session data to be stored, for example, shopping cart operations and data.
They are not sharable between users, as they store user-specific data.
They persist for a session.
• Entity beans: these provide data and services for specific entities stored
persistently. They provide an object-oriented facade for entities. They
may persist for the duration of an application execution.

   [15 (5 each) marks]

   Figure 3: Architecture of book wholesaler system

b. This is shown in Figure 3. (6 marks for correct dependencies, 7 for session
beans, 7 for entity beans).

   [20 marks]
c. There could be session beans for each entity bean, which would reduce dependencies within the business tier, but this would also mix together operations with different authorisation levels, and different users. Each user would need instances of each session bean.

Another alternative would be a single session bean, but this would not be modular.

(5 marks for each alternative, 5 marks for justification).

[15 marks]

2. [This covers web service concepts and patterns from part 4 of the course]

a. Web services are services provided by one application, which can be used by other applications via the internet. Typical examples could be an electronic payment service, such as PayPal, or an electronic data interchange service for e-commerce.

Web services should be operations which: do not require fine-grained exchange of data; do not require highly time-critical responses; receive and return data which can be effectively transmitted across the internet.

[10 (5 + 5) marks]

b. A Router web service selects one of a number of possible services to invoke, based on rules (Figure 4).

![Figure 4: Router pattern](image)

A Broker web service invokes all of its subordinate services, according to its rules (Figure 5).

[20 (10 each) marks]

c. This could be as shown in Figure 6. The Broker pattern is appropriate for the first step, since all suppliers are polled to find their capabilities to fulfil the order, then Router is used to make a choice of one service according to the business rule.

[20 marks]
Figure 5: Broker pattern

Figure 6: Web service architecture for order system
3. [This question covers EIS design patterns from part 3 of the course]

a. This business tier pattern aims to encapsulate the details of complex interactions between business objects. A session facade for a group of business objects manages these objects and provides a simplified coarse-grain set of operations to clients.

Interaction between a client and multiple business objects may become very complex, with code for many use cases written in the same class. Instead this pattern groups related use cases together in session facades.

The elements of the pattern are:

- **Client**: client of session facade, which needs access to the business service.
- **SessionFacade**: implemented as a session bean. It manages business objects and provides a simple interface for clients.
- **BusinessObject**: can be session beans or entity beans or data.

Several related use cases can be dealt with by a single session facade – if these use cases have mainly the same business objects in common.

[10 marks]

b. This is shown in Figure 7.

![Figure 7: Architecture of session facade](image)

[15 marks]

c. The dependencies of this system can be reduced by introducing a session facade between components $P_1$, $P_2$, $P_3$ and the entity beans $E_1$ and $E_2$. This reduces the dependencies of the presentation tier on the business tier from 8 to 4, and increases the modularity of the business tier. (15 marks)

Figure 8 shows the revised architecture. (10 marks).

[25 marks]
4. [Covers web application specification techniques and issues from part 2 of the course]

a. State machines can describe the possible web pages which may be displayed to the user, as states, and the actions which may be performed on these pages, as transitions. The transitions may correspond to HTML links between pages, or the submission of a form and the return of a response (page) to the browser.

\[ 10 \text{ (5 + 5) marks} \]

b. This is shown in Figure 9. (10 marks for states, 10 for transitions, 5 for correct use of nested and initial states).

\[ 25 \text{ marks} \]

c. Accessibility means that a web interface can be used by users of differing ability—such as visually impaired, colour-blind, deaf, or senior citizen users—as effectively as by non-disabled users.

Two techniques are: (1) Ensure that colour-contrasts on a page which give important information are visible to vision-impaired users. Tools can be used to preview sites to show them as (for example) a colour-blind viewer would see them, thus helping developers avoid colour choices which would be unusable to colour-blind viewers.

(2) Provide alternative information, such as alt text for images, which enable assistive technologies such as screen readers to operate on the page.

\[ 15 \text{ (5 each part) marks} \]
Figure 9: Interaction sequence of estate agency