Software Engineering

Books or notes are **not** allowed.
Write only on these sheets. **Concise** and **readable** answers please.

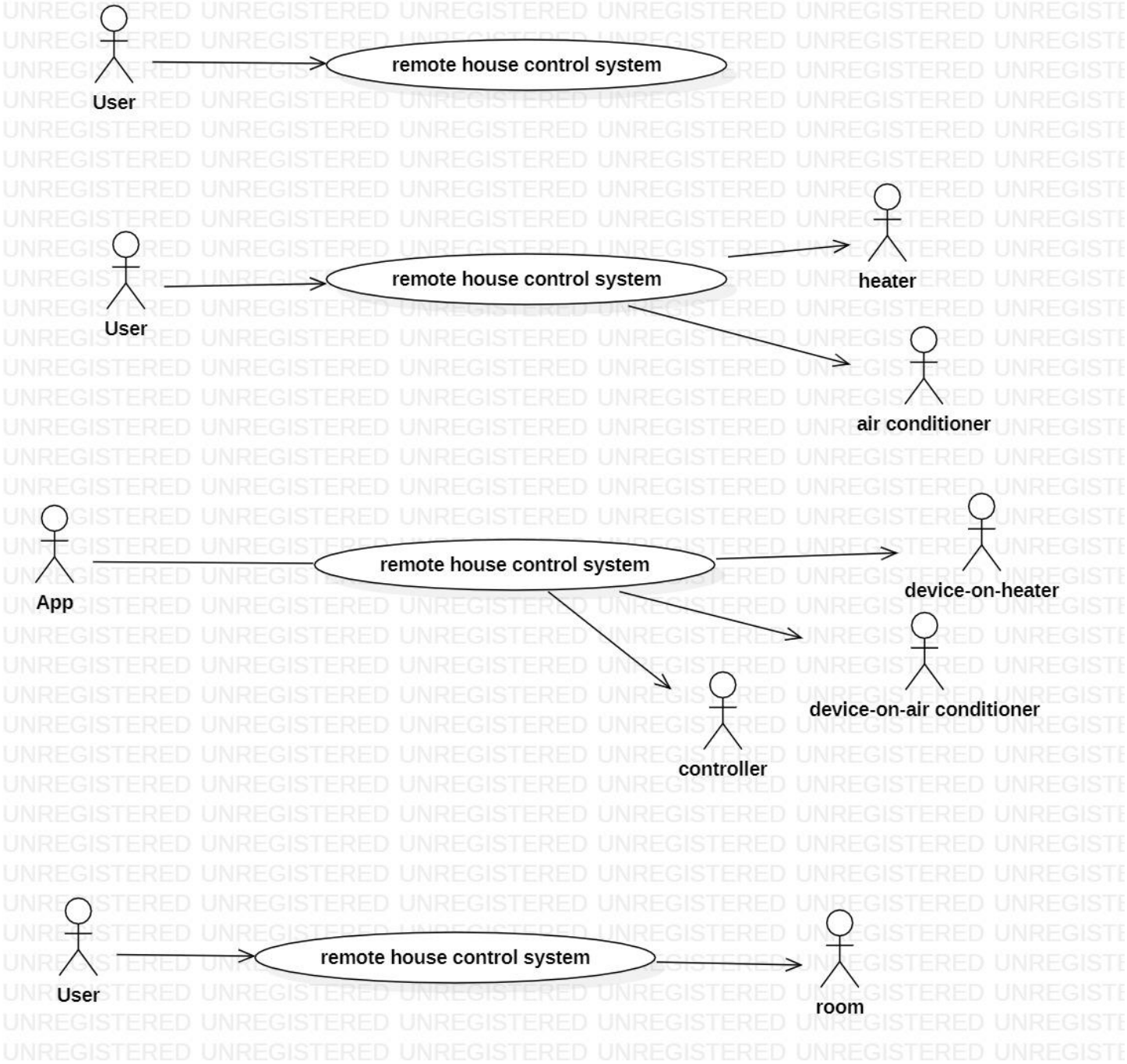
Surname, name, matricola _____

House heating - remote control

Appliances to control remotely the functions of a house (ex heating, air conditioning) are more and more popular.
A common approach is to have a temperature sensor and a power valve on each heater. Both are integrated in a device, that can therefore read the temperature of the room, the temperature of the heater, and control the heater (from off to on, in different positions like 1 to 4). The device also has a Bluetooth connection.
Similarly each air conditioner has a temperature sensor and an electric switch (from off to on in different positions) and a Bluetooth connection, all in one device.
Each room in the house can have one or more heaters and air conditioners
In the house a controller device must also be installed. This controller device is connected via Bluetooth to the other devices on heaters and air conditioners, so it can read their status and control them. The controller has also a touch screen where the user can view the status of all devices, and plan the conditioning (ex set all rooms to 20 degrees from Monday to Friday). Further, the controller is connected to the internet. All functions available on the controller are also available remotely, via an app available on Android and IoS.

In the following you should analyze and model the remote house control system (composed of devices on heaters and air conditioners, controller, app)

1 Select the correct context diagram



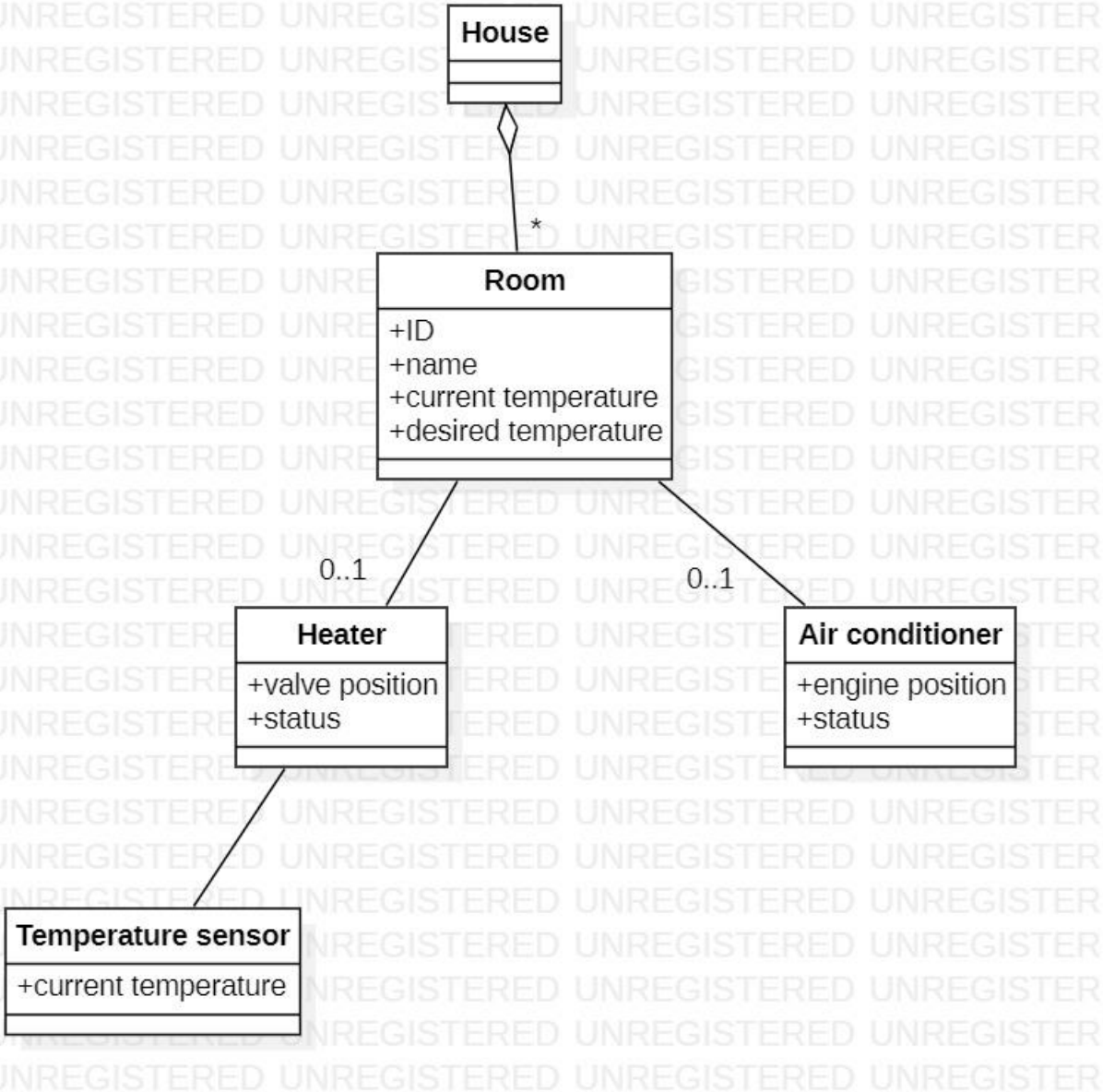
Correct Answer B 2.0
A 0.5
C -0.1
D 0.5
See also question 6 on system design.

2 define the interfaces. Be consistent with the context diagram

Actor	Physical interface	Logical interface
User	Smartphone / PC	GUI
Heater	Device-on-heater / bluetooth	Read room temp, read heater temp, read heater status, set heater valveposition
Air conditioner	Device on air conditioner / bluetooth	Read room temp, read air conditioner status, set air conditioner power

Remark that for air conditioner and heater the logical interface is not Bluetooth

3 Select the correct answer



1 Room.current temperature and Temperature sensor.current temperature are always the same -0.05
2 Room.current temperature and Temperature sensor.current temperature are always different -0.05

3. Room.current temperature and Temperature sensor.current temperature could be different or not 1
4. none of the above -0.05

The two attributes are not related because are on two different classes – having the same name does not mean they have the same value. You should consider only the UML to answer this question, not the text describing the system.

4 Functional requirements
Select one
1 Read device status (working or not, current room temp)
Show device status (collect values and show on screen)
Plan (define desired temperature per room, per time period)
Control (in function of current and desired temperature, control device in room – per all rooms)
Authorize user
0.75

2 Read device status (working or not, current room temp)
Show device status (collect values and show on screen)
Plan (define desired temperature per room, per time period)
Control (in function of current and desired temperature, control device in room – per all rooms)
Provide internet access to the user
0.75

3 Read device status (working or not, current room temp)
Show device status (collect values and show on screen)
Plan (define desired temperature per room, per time period)
Control (in function of current and desired temperature, control device in room – per all rooms)
Compute energy consumption
0.75

4 Set up house configuration (n rooms, devices per room)
Read device status (working or not, current room temp)
Show device status (collect values and show on screen)
Plan (define desired temperature per room, per time period)
Control (in function of current and desired temperature, control device in room – per all rooms)
Authorize user
1

The answers are pretty similar, #4 includes authorization of user that is an essential functionality.

5 NFR
Define 3 key NFR

Name	Description
Usability	Any user should be able to self learn and use the app in < 10 minutes
Efficiency	All functions should have response time < 0.5 sec

Portability	App should run on Ios (from version 10 up) and Android (from version 11 up)
Security	Only the owner of the house should be able to use the application

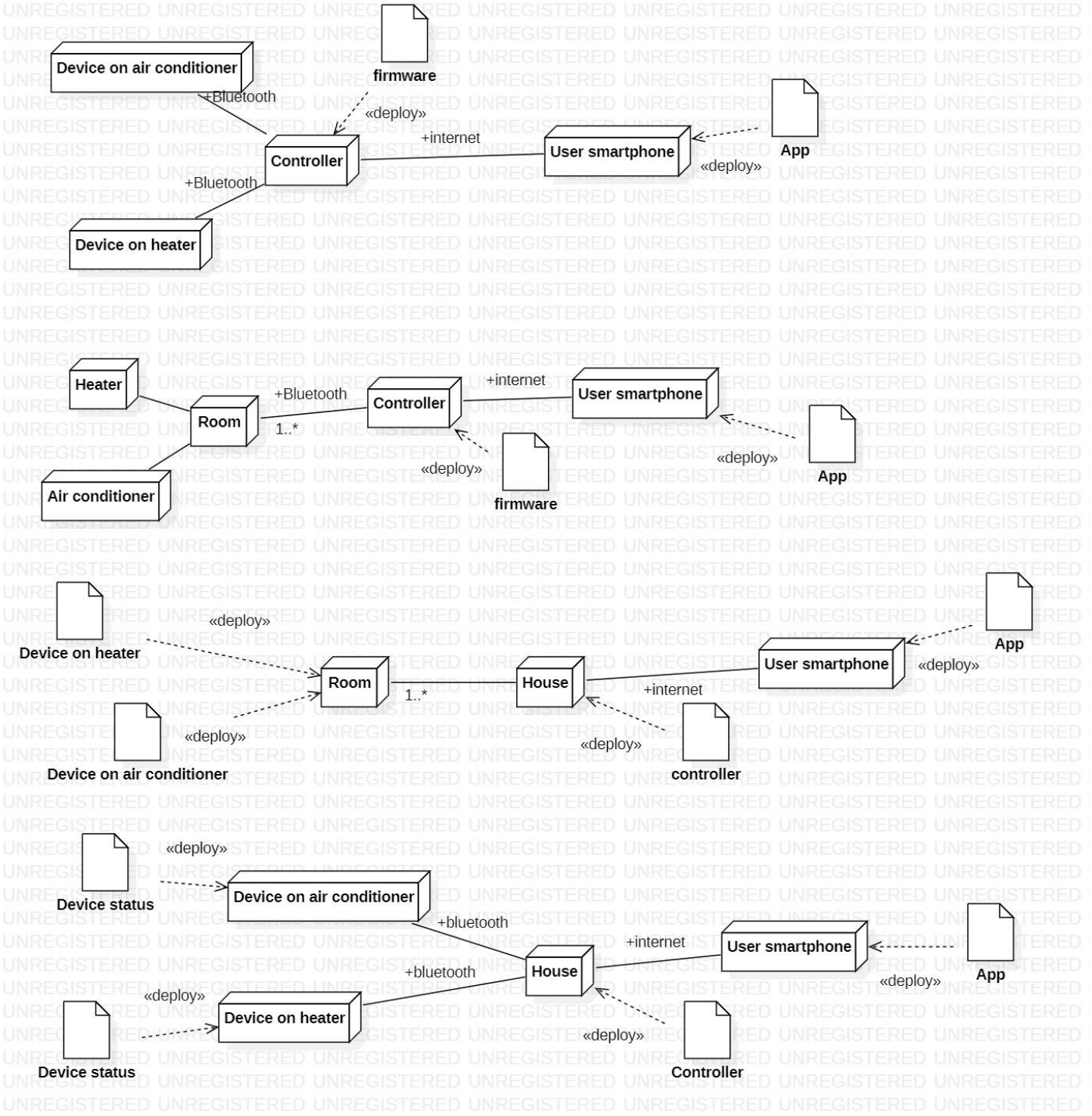
Remember that NFR must be MEASURABLE.
Statements like ‘System should be easy to use’, ‘System should be reliable’ mean nothing.

6 System design

The remote house control system is composed of:
1 Controller, app 0.5
2 Device on heater (temperature sensor heater, temperature sensor room, valve controller), device on air conditioner (temperature sensor room) 0.5
3 Controller (touch screen, firmware), App for smartphone, device on heater (temperature sensor heater, temperature sensor room, valve controller), device on air conditioner (temperature sensor room) 1.0
4 Controller, device on heater (temperature sensor heater, temperature sensor room, valve controller), device on air conditioner (temperature sensor room) 0.5

From the text “you should analyze and model the remote house control system (composed of devices on heaters and air conditioners, controller, app)”

7 Deployment diagram
Select the correct deployment diagram



Correct Answer A 1
B 0.25
C 0.05
D -0.05
Remember that nodes (cubes icons) are computing nodes, artifacts (sheets) are software components. So Room, House are clearly not nodes, Device on heater Device on air conditioner are clearly not artifacts.

8 BB

Define black box tests for the following function, using equivalence classes and boundary conditions.

double computeBillAmount(int contractType, int consDay, int ConsNight)

The function computes the amount of an electric bill during a month period.
contractType can be 1 or 2,
consDay is the number of KWatt hours (KWh) consumed during the day in the month period
consNight is the number of KWh consumed during the night in the month period

The amount is computed as follows:
For contractType 1 the cost of Kwh day is 1, the cost of Kwh night is 0,5, if the total consumption (consDay + consNight) exceeds 50 then a 10% penalty fee is added
For contractType 2 the cost of Kwh day is 2, the cost of Kwh night is 1, if the total consumption (consDay + consNight) exceeds 100 then a 5% penalty fee is added

Ex computeBillAmount(1, 10, 10) → 15 = (10*1 + 10*0,5)
computeBillAmount(1, 30, 30) → 49.5 = (30*1 + 30*0,5)*1.1 = 45 * 1.1 = 49.5 (penalty applied)
computeBillAmount(2, 10, 10) → 30 = (10*2 + 10*1)
computeBillAmount(2, 60, 60) → 189 = (60*2 + 60*1)*1.05 = 180 * 1.05 = 189 (penalty applied)

Contract Type	consDay	consNight	consDay+consNight	Test case
[minint, 0]	-	-	-	(-50, 10, 10) → error
1	[minint, 0[	-	-	(1, -30, 30) → error
	[0, maxint]	[minint, 0[	-	(1, 30, -30) → error
		[0, maxint]	[0, 50]	(1, 10, 10)
			[51, 100]	(1, 30, 30)
			[101, maxint]	(1, 30, 80)
2	[minint, 0[	-	-	(2, -30, 30) → error
	[0, maxint]	[minint, 0[	-	(2, 30, -30) → error
		[0, maxint]	[0, 50]	(2, 10, 10)
			[51, 100]	(2, 30, 30)
			[101, maxint]	(2, 30, 80)
[3, maxint]	-	-	-	(4, 10, 10) → error

Boundary condition tests
ContractType: minint-1, minint, minint-1, -1, 0, 1,2, 3, maxint-1, maxint, maxint+1
consDay : minint-1, minint, minint-1, -1, 0, 1, maxint-1, maxint, maxint+1
consNight : same as consDay
consDay+consNight : minint-1, minint, minint-1, -1, 0, 1, 49, 50, 51, 99, 100, 101, 102, maxint-1, maxint, maxint+1

Remember that tests for invalid classes MUST be defined (they may be the most important).
The constraint on consumption to define a penalty can be written in one column only (two are not needed).
Writing this constraint on consDay (ex consDay 0-50 51-maxint) is wrong, because the penalty depends on the sum of ConsDay, ConsNight

9 Showing correctness for a software function can be done:
a-in all cases -0.1
b-in some cases 1
c- It is not a meaningful problem, testing can be used instead -0.05
d- none of the above -0.05

correctness == exhaustive testing, which is feasible in some (rare) cases. See also question 12

10 A project is estimated to require 16.000 person hours. 4 people can work full time on the project, and a working week contains 40 hours. The project will last:

a- 100 calendar weeks 0.5
b- 110 weeks 0.05
c- More than 100 calendar weeks 1
d- None of the above -0.05

Mathematically 16.000 / (4*40) = 100. However this is a mathematical lower bound, most likely the duration will be >= 100 calendar weeks

11 In an agile process an iteration produces

a- A complete system -0.05
b- A partial version of the final system 1
c- An initial documentation of the final system -0.1
d- None of the above -0.05

12 Exhaustive testing means

a- Defining and applying enough test cases until the effort available for testing is exhausted -0.05
b- Defining and applying all possible test cases 1
c- Defining and applying test cases until a very high level of coverage is achieved -0.05
d- Defining and applying test cases until the computing capability of the testing processor is exhausted -0.1
e- None of the above -0.05