BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
K.K. BIRLA GOA CAMPUS
Comprehensive Examination 2022-23

Subject Name: Internet of Things: Design and Dev (CS G518)	Date: 29/12/2022
Candidate's Name:	Total Marks: 90
Candidate's Email:	Duration: 150 mins
Candidate's Campus Id:	Examiner: Sougata Sen

Instructions:

Answer all questions. In case you have made any assumption, mention that clearly in the answer sheet. Assumptions not mentioned in your answer sheet will not be considered.

Answer all questions briefly, and to the point. Unnecessary verbosity will be strictly penalized.

Q1. A breathalyzer records blood alcohol content and determines whether an individual is "over-the-limit" or "within-limit". For a total of 330 samples, the precision of the test is 83.8983%, the recall is 91.6667% and the accuracy is 83.0303% in determining "over-the-limit". Calculate the total number (rounding off to the nearest integer) of true positives, false positives, true negatives and false negatives of the system for the 330 samples. Show your calculations. Explain the meaning of precision and recall with respect to the breathalyzer in no more than 4 sentences. (6 marks + 4 marks)

Q2. Explain lines 4, 5 and 10 in the following code snippet. Provide details of the keywords, functions, and any parameter that is relevant. (6 marks)

```
1   import keras
2   import numpy as np
3
4   model = keras.Sequential([keras.layers.Dense(units=1, input_shape=[1])])
5   model.compile(optimizer='sgd', loss='mean_squared_error')
6
7   xs = np.array([-1.0, 0.0, 1.0, 2.0, 3.0, 4.0], dtype=float)
8   ys = np.array([-3.0, -1.0, 1.0, 3.0, 5.0, 7.0], dtype=float)
9
10  model.fit(xs, ys, epochs=150)
11
12  print(model.predict([10.0]))
```

Q3. In quantization, a 32-bit floating point number is usually converted to an 8-bit integer. Let us assume that in addition to an 8-bit int, you also have access to a 2-bit int. Consider the following matrix

2.09	-0.98	1.48	0.09
0.05	-0.14	-1.08	2.12
-0.91	1.92	0	-1.03
1.87	0	1.53	1.49

A. Given the following matrix, compute the equivalent 8-bit and 2-bit integer-based quantized matrix. You may

use linear quantization, i.e., having a look up table where you store the smallest and largest values in the matrix, and then quantizing the range evenly. In case you are using any other quantization approach, mention the approach used clearly. Compute the saving in terms of space when using (a) 8-bit integer, and (b) 2-bit integer. Ensure you clearly mention all the memory requirements (including any additional memory required to reconstruct the original matrix).(3+3 marks for the quantized matrices, 3+3 marks for the space saving computation)

B. Convert both the matrices (8-bit and 2-bit int matrices) back to the not-quantized matrices. Compute the Root mean square error in both cases between the original and converted matrices. (3+3marks)

Q4. "*...a naive combination of checkpointing and direct access to non-volatile memory in an intermittent device can lead to memory inconsistencies.*"

Why does a naive checkpointing and accessing the NVM lead to memory inconsistency? Explain with an example. (4 + 4 marks)

Q5. The paper "*Challenges to ensuring human safety throughout the life-cycle of Smart Environments*" describes numerous challenges in a smart environment. Mention any 5 challenges mentioned in the paper. Mention at least one research question or potential directions for solutions mentioned in the paper for each of those challenges. (5 + 5 marks)

Q6. The paper "*From Backpacks to Smartphones: Past, Present, and Future of Wearable Computers*" predicts the future of wearable computing as follows

The Future

Our discussion shows that although existing smart phone platforms certainly aren't perfect from the point of view of wearable applications, the main concerns aren't the computing units and their form factors. The key issue is the connectivity between the main computing unit (which will remain some sort of commercial, mobile phone-like "brick") and other devices, sensors in particular. The latter are what really differentiate a wearable system from a mobile phone. In most cases, the other devices should and will be tightly integrated and possibly even built with textile technology. Thus, it seems that there's little space for further research on dedicated wearable computing platforms. We also argue against the classical wearable vision of a computer (or for that matter, a phone or a MP3 player) that's fully integrated into clothing (possibly even built on a textile substrate). Instead we envision future wearable systems that consist of four main layers:

A. Describe the four layers envisioned by the authors. (1.5 x 4 marks)

B. Describe in 3-4 sentences, the purpose of one of the wearable systems described in the paper. (3 marks)

Q7. Mention the title (or the author name) of one paper that you mentioned in your literature review of your project. Explain what that paper describes. Describe how your project work was different from that paper? (2+3+3 marks)

Q8. Select the correct choices in the questions below. Each subpart can have one or more than one correct options. To get marks, you will have to select all the correct options. (4 x 3 marks)

A Select the correct options for the **SPiDR** system:

a. The SPiDR system does not require any actuators.

b. The SPiDR system requires fingerprinting the area.

c. The performance of the SPiDR system does not vary even when the materials in the scene are changed.

d. The SPiDR system is useful for depth-map reconstruction.

B Select the correct options for the **Battery-free Game Boy** paper:

a. The ENGAGE platform mentioned in the paper harvests energy from both environment, as well as from gaming actions.

b. The battery-free platform currently does not produce any sound or haptic feedback.

c. The capability of the platform to connect to another battery-free platform allows sharing of power between the two devices.

d. A patch contains a copy of the volatile memory region as well as the accompanying metadata required to successfully manage and restore a patch.

C Select the correct options for the **FastDeepIoT** paper:

a. The authors of FastDeepIoT test the framework on a Raspberry Pi and show that it outperforms the state of the art frameworks.

b. FastDeepIoT utilizes TensorFlow benchmark tool to profile the execution time of all deep learning components on the target device.

c. The FastDeepIoT paper aims to understand non-linear relation between neural network structure and performance to improve execution time and energy consumption without impacting accuracy.

d. The FastDeepIoT paper aims to understand non-linear relation between neural network structure and performance to improve accuracy of prediction in real-time systems.

Q9. Specifically, for TensorFlow Lite:

A. What are (i) FlatBuffers, (ii) tensor arena, and (iii) an activation function? (2 x 3 marks)

B. How does the activation function affect the output? What would happen if you did not use an activation function in the neural network? (3 marks)