24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What is an embedded system? Differentiate it with non embedded systems with suitable example. In RTOS, describe mutual exclusion through sleep and wake for task synchronization. [1+3+4]
2. What is Optimization? What are the parameter you consider for Optimization of single purpose processors. [4+4]
3. Define datapath and controller of a general purpose processor. Explain ASIP with its types. [4+4]
4. Define write ability and storage permanence of memory. Design a ROM to store the following information: [3+5]

X	Y	Z	F1	F2	F3	F4
0	0	0	0	0	1	0
0	0	1	1	1	0	0
0	1	0	0	1	0	1
0	1	1	1	1	1	1
1	0	0	0	0	1	1
1	0	1	0	1	0	1
1	1	0	1	0	1	0
1	1	1	0	0	1	1

5. a) What is interrupt? Explain summary of flow of actions of interrupt driven I/O using fixed ISR location. [4]
   b) What is arbitration? With neat diagram explain Daisy-chain arbitration. [4]
6. Explain the conditions favoring deadlock situation. Three Processes P1, P2 and P3 with estimated completion time 5, 8, 7 ms respectively enters the ready queue together. Calculate WT, TAT for each process and calculate AWT and ATAT using Round Robin Pre-emptive scheduling algorithms with time slice of 2 ms. [2+6]
7. Differentiate between closed – loop and open – loop control systems. Draw a typical block diagram of a PID control system and describe PID turning. [3+5]
8. Draw a top down view and schematic for the following function: F = xz + yz'. Describe with suitable diagram about positive photoresist used in photolithography. [5+3]
9. What is seven segment display and write its types. Design a circuit with 7 segments display which is used as a counter watch which display second and minute. [2+6]
10. Explain different models is VHDL. Write a VHDL code for a full adder using two half adders and one OR gate in structural model. [3+5]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What is a design metric and explain the purposes of embedded system. Define task scheduling, list out its types and explain the factors affecting on selection of scheduling algorithm. [4+4]
2. Design a single-purpose processor that outputs Fibonacci numbers up to 'n' places. Start with a function computing the desired result, translate it into a state diagram, and sketch a probable datapath. [8]
3. Define pipelining and show 6 stage pipeline concepts. Explain DSP with characteristics and advantages. [4+4]
4. Explain the operation of storing data in One Time Programmable ROM. Why it can't be reprogrammed? Compose 1K × 8 ROMs into a 4K × 8 ROM. [2+2+4]
5. What is arbitration? Explain priority arbitration with the help of a block diagram and steps along with its types. [2+6]
6. Define threads and differentiate between user level thread and kernel level thread. Three processes with IDs P1, P2, P3 with estimated completion time 6, 8, 2 milliseconds respectively enters the ready queue together in the order P1, P2, P3. Process P4 with the estimated execution time 4 milliseconds enters the ready queue after 1 millisecond. Calculate the waiting time and Turn Around Time (TAT) for each process and the average waiting time and TAT in the non-preemptive shortest-job-first scheduling. [3+5]
7. Draw the block diagram of closed-loop control system for speed control of an automobile and explain the conditions for no unbound and no oscillation showing all the design steps. [8]
8. Show various steps of photolithography process using appropriate diagrams. Describe briefly about Full custom VLSI technology. [4+4]
9. Explain the addressing modes used in 8051 microcontroller with example. Write an assembly language programming to blink the 8 Led connected at Port 2 of the 8051 microcontroller. [4+4]
10. Explain COMPONENT with its declaration. Write a VHDL code for a JK flip-flop using PROCESS. [3+5]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define Embedded System. Clarify the statement 'Digital Camera is a good example of an Embedded System'. In RTOS, explain context switching with suitable diagram. [1+3+4]
2. Design a single purpose processor to determine the value of x to the power n. Start the design from the function computing the desired result, FSMD, datapath and controller. [8]
3. Explain the design flow of embedded software development. Explain in brief about programmer's view for general purpose processor. [4+4]
4. Define write ability and storage permanence of memory. Explain associative cache mapping technique with its merits and demerits. [3+5]
5. Describe two-level bus architecture in detail. Describe priority arbitration method and compare it with daisy-chain arbitration. [3+5]
6. Write any four differences between thread and process. Three Processes P1, P2 and P3 with estimated completion time 4, 10, 5 ms and priorities 1, 3, 2 respectively enters the ready queue together. A new process P4 with estimated completion time 3 ms and priority 0 enters the ready queue after 5ms of start of operation. Calculate WT, TAT for each process and calculate AWT and ATAT using preemptive priority based scheduling algorithms. [2+6]
7. What are the challenges of modeling a real physical system and how can you overcome it? Write an algorithm to implement the PID controller in software. [3+5]
8. Explain the importance of photolithography in IC manufacturing. Explain the two broad categories of Semi-Custom IC technology. [5+3]
9. Draw the circuit diagram of the minimum configuration for 8051 microcontroller to operate. Also show the connection of LED at P1.7 and switch at P1.1 in the same circuit. Using an Assembly language, generate a pulse of 75% duty cycle at pin P1.7 when the switch at 1.1 is ON. [4+4]
10. Write an algorithm and VHDL code for a custom processor that calculates Least Common Multiple (LCM) of two numbers as a finite state machine. [3+5]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Define embedded system. What are the typical characteristics of embedded system? [1+3]
2. Design a single-purpose processor that calculates Factorial of an integer number 'n'. Start with a function computing the desired result, translate it into a state diagram and sketch a probable datapath. [8]
3. Explain the design flow of embedded software development. Explain in brief about programmer's view for general purpose processor. [4+4]
4. What are the basic techniques for cache mapping? How direct mappings differ from fully associative mapping? [8]
5. Design an interface circuit of a microprocessor with 16-bit address with 2 RAMs and 2 ROMs of 8 Kbyte each. [8]
6. a) How RTOS is different from GPOS? Differentiate between process and thread. [4+4]
   b) Consider three processes with process IDs P1, P2, P3 with estimated completion time 9, 6, 3 ms respectively, enters the ready queue together in order P1, P2, P3. Calculate Waiting Time and Turn Around Time for each process and average waiting time and average turn around time in RR (Round-Robin) algorithm with time slice 2 ms. Assume there is no I/O waiting for the process. [4]
7. Design an open loop automobile cruise controller and derive the conditions for no oscillation and reduction of road disturbance and determine the performance parameters. [8]
8. Explain the importance of photolithography in IC manufacturing. Explain the two broad categories of Semi-Custom IC technology. [5+3]
9. Describe the different purpose of port 3 and port 2 of 8051 microcontroller. Write an assembly language programming for 8051 microcontroller to read the data from switches connected at port 1 and send it to port 2 for display in LED. [4+4]
10. Explain PROCESS in VHDL. Write a VHDL code for a full adder using 2 half adder as component. [3+5]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the common characteristics of embedded systems? How does a digital camera satisfy those characteristics? [4]
   b) Briefly describe the kernel operating system services. [4]
2. Design a single-purpose processor that outputs Fibonacci numbers up to 'n' places. Start with a function computing the desired result, translate it into a state diagram and sketch a probable datapath. [8]
3. Briefly explain the criterion for selecting processor? Explain the data path operation and its instruction cycles. [4+4]
4. What do you mean by write ability and storage permanence of memory? Explain associative cache mapping. [3+5]
5. What is the difference between memory-mapped I/O and standard I/O. Explain the operation of peripheral to memory transfer without DMA, using vectored interrupt. [3+5]
6. Differentiate between multiprocessing and multi tasking in RTOS. Three processes with process IDs, P1, P2, P3 with estimated completion time 6, 4, 2 ms respectively, enters the ready queue together in order P1, P2, P3. Calculate waiting time and TAT(Turn Around Time) for each process and average waiting time and TAT. Assume there is no I/O waiting for the processes and RR (Round-Robin) algorithm with time slice = 2 ms. [2+6]
7. Differentiate between closed loop and open loop control system. With neat diagram write the steps for designing Closed loop control system. [3+5]
8. Discuss the advantages and disadvantages of Full-Custom IC technology. Explain the basic steps of photo lithography process. [3+5]
9. Draw the pin diagram of 8051 microcontroller and explain ports 1 and 2 only. Write a program using C-programming language to find the sum between two 8-bit BCD data stored in RAM locations 50H and 51H and store the BCD sum at RAM locations 52H and 53H. [3+5]
10. Write an algorithm and VHDL code for a custom processor that calculates Least Common Multiple (LCM) of two numbers. [3+5]

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42 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Differentiate between single-purpose processors, general-purpose processors, and application-specific processors. Using the simplified revenue model, derive the percentage revenue loss equation for any rise angle, rather than just for 45 degrees. [2+2]
2. What is optimization? Explain optimization of single purpose processor in detail with suitable example. [8]
3. Describe the operation of general - purpose processor in terms of datapath and controller. [5]
4. Explain the testing and debugger. [3]
5. Describe ROM and introduce its types in detail. Sketch the internal design of a 4 × 3 ROM. [6+2]
6. Explain different types of arbitration methods used in peripherals devices to gain control of system bus. Describe the significance of I^2C serial communication protocol. [8]
7. Describe the context switching process in detail. Three processes with process IDs P1, P2, P3 with estimated completion times 6, 8, 2 milliseconds respectively enters the ready queue together. Process P4 with estimated execution completion time 4 milliseconds enters the ready queue after 1 millisecond. Calculate the waiting time and turn-around-time for each process and the average waiting time and turn-around-time in the non-preemptive shortest-job-first scheduling. [3+3]
8. Explain in detail the Coffman conditions that favor deadlock. Differentiate between user-level threads and Kernel-level threads. [3+3]
9. Explain the operation of a PID control with a clean block diagram. [5]
10. Define the following terms used in control system: Controller, Plant, Actuator. [3]
11. Describe the steps involved in manufacturing an IC. Show the top-down view of the circuit F = xz + y on an IC. [4+4]
12. Show the internal structure of the 8051 microcontroller. Provide a comparison chart of the 8051 family members. [4+4]
13. Write the code for BCD counter to display 0 to 9999 in seven segment using VHDL. [8]

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42 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What is an Embedded system? Describe its various applications. [1+3]
2. Design a dual-purpose processor that calculates the median and variance of 5 numbers entered by the user, by showing the algorithm, FSMD, FSM, data-path and controller design. [8]
3. Differentiate between application specific instruction set-processor and general purpose processor. Also discuss on issues related to selection of a particular processor. [8]
4. Design a ROM that will store the following words in the corresponding addresses. [5]

X	Y	z	F_1	F_2
0	0	0	1	0
0	0	1	1	0
0	1	0	0	1
0	1	1	0	1
1	0	0	0	0
1	0	1	1	1
1	1	0	0	1
1	1	1	1	0

5. Compose 2^{k+1}×m memory using 2^k×m memories. [3]
6. Describe the purpose of the direct-memory-access (DMA) controller. Draw the flow of actions between peripheral and memory using DMA. [2+2]
7. Describe the advanced communication principles used in embedded systems. [4]
8. Distinguish between process and thread. Write different states of task with appropriate example. [6]
9. What are the advantages of multithreading program? Write a simple multithreading program in C. [6]
10. Write the pseudo-code for a PID controller. What is the purpose of PID tuning, and what are the benefits of computer based control implementations? [4+4]
11. Explain the IC manufacturing steps with a neat block diagram. [5]
12. List the three major IC technologies with brief definitions. [3]
13. Write 8051 program and draw circuit diagram to display number from 99 to 00 in seven segment display. The program should write in both assembly and C. [8]
14. How does a FPGA differ from a microcontroller? Design a sequence detector for the string "1101", that outputs a one when the input matches this string, show the FSM and its VHDL implementation. [1+7]

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37E TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Embedded System Design Using ARM Technology *(Elective I) (CT725)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1) Explain Embedded System Hardware. Briefly describe the role of Interrupt Controller and Memory Controller. [5]

2) Explain ARM exceptions and modes for ARMv7-A and ARMv7-M Architectures. [5]

3) (a) Describe SPI peripheral for bus interfacing. (4)

(b) Explain the data transfer instruction execution with three-stage pipeline organization data flow block diagram. [6]

4) Explain leaf procedures, Nested procedures and Recursion and translate the following C code into Assembly code. [6]

```
while (save[i] == k)
        i +=1;
```

5) Develop the bootloader in ARM Assembly that loads program from Flash ROM to SRAM with startaddress and endaddress in Flash ROM with starting address 0x00000000 in destination and relinquish the control to program. [6]

6) (a) Explain branch instructions and Write ARM Instruction mnemonic for data processing instructions, data transfer instructions and branch instructions. [4]

(b) Draw the binary encoding format figure for ARM Data transfer Instruction for single word and unsigned byte. Translate the following ARM data transfer instruction instructions into machine instruction code in 32-bit format. [8]

```
LDRB r5, [r1, #4]
LDR r3, [r7], #8
STRB r0, [r3, r8]
STR r1, [r2, r4 LSL #4]
```

7) Differentiate between 16-bit Thumb Instruction Set and 32-bit Thumb Instruction Set and explain Thumb Software Interrupt instruction. [6]

8) (a) Explain the objective of ARM reference peripheral specification and describe the base components. [5]

(b) Describe AMBA and explain bus signals used by bus masters. [5]

9) (a) Develop the initialization code that includes the vector table and initialization of stack pointer for IRQ and FIQ mode. [5]

(b) Describe the steps to build Embedded Linux System. [5]

10) Explain briefly MPEG-1 standard and describe the operation for MPEG-1 in terms of block diagram. Write the steps to develop the MP3 player to play music using ARM Cortex-M4 Microcontroller? [10]

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32 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Embedded System *(CT655)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the common characteristics of embedded systems? Explain. [4]
2. Design a processor that calculates the LCM of two numbers. Show the design of data path only and construct the diagram of controller. [8]
3. What are the programmer considerations? Explain the software development processes according to embedded systems. [2+6]
4. a) Explain the operations of storing and earsing the data in UV-EPROM. [6]
   b) Describe the cache write techniques. [2]
5. Explain arbitration systems that implemented to communicate with peripheral devices from the microprocessor. Differentiate between memory mapped I/O with standard I/O. [8]
6. Explain the basic functions of Real-time kernel. [6]
7. Describe the control switching mechanism. [4]
8. Define throughput of a system. [2]
9. What is PID tuning? Discuss on the practical issues related with computer based control. [8]
10. Define the photolithography. Explain the various steps involved in photolithography. [2+6]
11. Why 8051 microcontroller is used ? Write an assembly program to get data from P0 and send it to P1 and compare with corresponding C program. [3+5]
12. Write the VHDL code for processor (GCD) that calculates greatest common divisor of two integer data with its state diagram. [8]

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32G TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2064 Poush

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Embedded System *(Elective)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. Define and describe embedded system with suitable example.
2. Justify "Processor is the heart of any embedded system." Also mention the structural units of a processor.
3. What is Direct Memory Access (DMA)? Why such circuitry is needed? Explain with its block diagram.
4. What is device driver? Explain its importance while connecting the peripherals in the system.
5. Describe the terms IRQ, ISR, IVT, PUSH, POP and Interrupt Latency used in Interrupt based designs.
6. Briefly explain RTOS (Real Time Operating System) with its services.
7. What is a scheduler? Describe its role in managing task states in detail.
8. In an RTOS environment, different tasks may share same variables and functions. Explain the problem(s) faced due to this type of sharing and also suggest the solutions.
9. Explain Spiral Model of Embedded Software Development Life Cycle.
10. Differentiate Microprocessor and Microcontroller highlighting its uses. Also explain the Addressing Modes of 8051 microcontroller.

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36H TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division.
2069 Bhadra

Exam.	Regular / Back ♦		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Embedded System Design Using ARM Technology *(EG785EX)*
(Elective II)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1) Describe the design metrics and design methodologies for designing and developing low-end and high-end mobile handsets. [5]

2) Differentiate between privileged mode vs. unprivileged mode. Explain Exception/Interrupts and Vector Table. [5]

3) Describe pipelining and explain the ARM instruction execution for Data Transfer instructions with data flow block diagram [10]

4) Write c program for recursive procedure that calculates factorial n and write the ARM assembly code for the following C statement. [5]
g = h + A [8];
A [12] = h + A [8];
Assume A is an array of 100 words and that the compiler has associated the variables g and h with registers r1 and r2 and uses r5 as temporary register. Let's also assume that the starting address or base address of the array is in r3.

5) Explain leaf and nested procedure. Translate the following C program for leaf procedure that computes Y = (A+B) + (C+D) + (A*D) into ARM Assembly Code. [5]

```
Int leaf_ad (int A, int B, Int C, Int D)

    Int Y;
    Y = (A+B) + (C+D) + (A*D)
    Return Y;
```

The parameter variables A, B, C, and D correspond to the argument registers r0, r1, r2 and r3 and Y corresponds to r4. Use r7, r8, r9, and r10 as temporary variables for stack use.

6) (a) Explain ARM registers usage in both privileged and unprivileged mode and write ARM exceptions and its corresponding modes and functionalities. [10]

(b) Write the single register store instructions for Half-word using different addressing mode using the following information for ARM instruction set. [6]

Base register = rn = r1
Source/destination register = rd = r8
Immediate offset = 4
Register = r5
Scaled register offset = r6, LSL #20
(a) Preindex/auto index/post index with immediate offset
(b) Preindex/auto index/post index with register offset
(c) Preindex/auto index/post index with scaled register offset (with immediate value for scaled register)

7) Explain Thumb entry and exit and write the following thumb data processing instructions for processing data. [8]

1. Move Instruction
2. Arithmetic Instruction
3. Logical Instruction
4. Comparison Instruction
5. Logical Shift Instruction
6. Multiply Instruction

8) Explain hardware prototyping tool and describe JTAG boundary scan architecture and the ARM debug architecture with EmbeddedICE. [8]

9) Explain firmware and embedded operating system and steps to develop firmware and embedded operating system. [8]

10) Describe the frame, slot, physical signals (reference signals and synchronization signals), OFDM symbols, short and long cyclic prefix, OFDM, and OFDMA for LTE standard. [10]

Or

Write the LTE protocol stack for eNodeB and UE and describe the downlink logical, transport and physical channels functions.

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