KG REDDY
College of Engineering
& Technology

Course File On

EMBEDDED SYSTEM DESIGN

By

Vijaya Bhasker Reddy
Assistant Professor,
Electronics and Communication Engineering
K. G. Reddy College Of Engineering and Technology
2018-2019

HOD
ECE

HEAD
DEPT. OF ELECTRONICS & COMMUNICATIONS ENGINEERING
K.G. REDDY COLLEGE OF ENGINEERING & TECHNOLOGY
CHILKUR (V), MOINABAD, R.R. DIST.501 504.

Principal
KGRCET

PRINCIPAL
K.G. Reddy College of Engineering & Technology
Chilkur (Vill), Moinabad (Mdl), R.R. Dist

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& Technology
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Department of Electronics and Communication Engineering

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Department of Electronics and Communication Engineering

Academic Year: 2018-2019 IV B. Tech Semester: I MID-II Section-A

Course Name: ESD

Course Instructor

CO Attainment

Embedded Systems Design A70440	C405.1	Design embedded systems for a specific application.
	C405.2	Identify the significance of Real Time Operating Systems(RTOS).
	C405.3	Analyze the types of memory and interfacing to external hardware.
	C405.4	Describe embedded firmware design approaches.
	C405.5	Analyze the issues for development of task communication techniques and device drivers.

CO-PO MAPPING

Course Name	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
ESD	2			3									
	1	3					2						
	2	3											
			3							2			
	3	2											
	2	2.6	3	-	-	-	-	-	-	2	-	-	

COURSE ATTAINMENTS

Academic Year	**2018-2019**
Attainment Level	
Level 3	55 % students scoring more than or equal to **40 %** of marks
Level 2	45 % students scoring more than or equal to **40%** of marks
Level 1	35% students scoring more than or equal to **40 %** of marks

Type of Question	**Descriptive**				**Objective**	**Assignment**	
Question wise Marks	**Q1 (5 M)**	**Q2 (5M)**	**Q3 (5 M)**	**Q4 (5M)**	**3M,3M,4M**	**2M,3M**	**Total**
Course Outcomes	**CO3**	**CO4**	**CO4**	**CO5**	**CO3, CO4,CO5**	**CO4,CO5**	**25**
15QM1A0401	5		4		8	5	22
15QM1A0405	5	1	5		6	5	21
15QM1A0406	5		5	2	2	5	17
15QM1A0407	3		3		3	5	14
15QM1A0408	5		4		4	5	18
15QM1A0409	4		4		2	5	15
15QM1A0410	4		4		6	5	19
15QM1A0412	5		4		3	5	17
15QM1A0413	5	2	5		7	5	22
15QM1A0414	5		3	1	3	5	16
15QM1A0415	4		4		4	5	17
15QM1A0416	4		4		5	5	18
15QM1A0417	5		4		4	5	18
15QM1A0418	5		5		5	5	20
15QM1A0419	5		4		4	5	18
15QM1A0420	5		5		9	5	24
15QM1A0421	3	1	3		3	5	14
15QM1A0422	5		5		10	5	25
15QM1A0423	5		5		8	5	23
15QM1A0424	2		3		3	5	13
15QM1A0425	4		3		5	5	17
15QM1A0426	5		4	2	6	5	20
15QM1A0427	4		4		5	5	18
15QM1A0428	3	2	3		4	5	15
15QM1A0429	5		5		8	5	23
15QM1A0430	5		4		8	5	22
15QM1A0431	5		5		8	5	23
15QM1A0432	5		5		8	5	23
15QM1A0433	3		2		7	5	17
15QM1A0434	5		4		8	5	22
15QM1A0435	5		5		6	5	21
15QM1A0436	5		5	1	6	5	21
15QM1A0437	5		5		9	5	24

15QM1A0438	5		5		7	5	22
15QM1A0439	5		5		6	5	21
15QM1A0440	3	1	3		7	5	18
15QM1A0441	4		5		6	5	20
15QM1A0442	4		3		6	5	18
15QM1A0443	3		2		7	5	17
15QM1A0445	5		3		8	5	21
15QM1A0447	3		3	2	7	5	18
15QM1A0449	1		2		9	5	17
15QM1A0450	3		3		6	5	17
15QM1A0451	5	2	5		8	5	23
15QM1A0452	3		3		6	5	17
40% Marks	2	2	2	2	4	2	
PA=NS/(No of Students Attempted)	45	6	45	5	45	45	
No of Students attaining >=40% Marks	44	3	45	3	43	45	
Percentage of Students attaining >=40% Marks **(Y/X*100)**	97.7	50	100	60	95.6	100	
Level	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3 Attainment	**5*3/8**				**3*3/8**		**3**
CO4 Attainment		**5*3/15**	**5*3/15**		**3*3/15**	**2*3/15**	**3**
CO5 Attainment				**5*3/12**	**4*3/12**	**3*3/12**	**3**

Gap Analysis:

Cos	Attainment Percentage	Target	Target in Level	Attainment in Level	Gap= Attainment in Level- Target in Level
CO3	96.65	55%	3	3	0
CO4	86.4	55%	3	3	0
CO5	85.2	55%	3	3	0

Action Taken Report:

Cos	Action Report
CO3	Attained
CO4	Attained
CO5	Attained

COURSE INSTRUCTOR

HOD-ECE

KG Reddy College of Engineering and Technolgoy

(Approved by AICTE, Affiliated to JNTU Hyderabad)

CO-PO Attainment

Academic Year: 2018-2019 IV B. Tech Semester: I Section-A

Course Name: ESD Course Code A70440 Name of the Faculty: VIJAYA BHASKER REDDY

		PO1		PO2		PO3		PO4		PO5		PO6		PO7		PO8		PO9		PO10		PO11		PO12		PSO1		PSO2		PSO3		PSO4	
COs	CO attainment %	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained	Planned	Attained
CO1	99	2	1.99		0.00		0.00	3	2.98		0.00		0.00		0.00		**0.00**		0.00		**0.00**		0.00		0.00	1	0.99	2	1.99		0.00	3	0.00
CO2	96	1	0.96	3	2.87		0.00		0.00		0.00		0.00	2	1.92		**0.00**		0.00		**0.00**		0.00		0.00		0.00		0.00		0.00		0.00
CO3	99	2	1.97	3	2.96		0.00		0.00		0.00		0.00		0.00		**0.00**		0.00		**0.00**		0.00		0.00		0.00		0.00	2	0.06		0.00
CO4	96		0.00		0.00	3	2.87		0.00		0.00		0.00		0.00		**0.00**		0.00	2	**1.92**		0.00		0.00		0.00		0.00	2	0.00		0.00
CO5	95.50	3	2.87	2	1.91		0.00		0.00		0.00		0.00		0.00		0.00		0.00		**0.00**		0.00		0.00	2	1.91	2	1.91		0.00		0.00
Total		8.00	7.78	8.00	7.74	3.00	2.87	3.00	2.98	0.00	0.00	0.00	0.00	2.00	1.92	0.00	0.00	0.00	0.00	2.00	1.92	0.00	0.00	0.00	0.00	3.00	2.90	4.00	3.90	4.00	0.06	3.00	0.00
Attainement %			97.26		96.74		95.80		99.40						95.80		H		H		95.80		H		H		96.80		97.45		1.48		0.00
Attained Level			H		H		H		H						H						H						H		H		H		
Average		1.60	1.56	1.60	1.55	0.60	0.57	0.60	0.60	0.00	0.00	0.00	0.00	0.40	0.38	0.00	0.00	0.00	0.00	0.40	0.38	0.00	0.00	0.00	0.00	0.60	0.58	0.80	0.78	0.80	0.01	0.60	0.00

Attainment Level		Thresold Value
H	3	65% of students got >=40% marks.
M	2	55% of students got >=40% marks.
L	1	45% of student got >=40% of marks

Faculty

HoD

6. MICRO LESSON PLAN

Topic wise Coverage [Micro Lesson Plan]			
Lecture No	**Topic To Be Covered**	**Scheduled Date**	**Actual Date**
UNIT –I **Introduction to Embedded Systems**			
L1	Definition of Embedded System, Embedded Systems Vs General Computing Systems	15/07/19	15/7/19
L2	History of embedded systems and Classification	15/07/19	15/7
L3	Major application areas of embedded systems	16/7/19	15/7
L4	Purpose of embedded systems	17/7/19	15/7
L5	Characteristics and Quality Attributes of embedded systems	17/7/19	17/7
L6		19/7/19	17/7
L7	Review on Unit –I (Writing the minute note/ Presentation/ Group activity)	20/7/19	19/7
L8	Activity- Test / Quiz / Assessment (Assignment)	20/7/19	19/7
UNIT – II **Typical Embedded System**			
L9	Core of an embedded system	23/7/19	20/7
L10	General purpose and Domain specific processors	24/7/19	20/7
L11	ASICs and PLDs	31/7/19	22/7
L12	Commercial Off-The-Shelf Components (COTS)	31/7/19	22/7
L13	Memory : RAM, ROM	31/7/19	22/7
L14	Memory according to the type of interface	1/8	23/7
L15	Memory shadowing	1/8	24/7
L16	Memory selection for embedded systems	2/8	31/7

L17	Sensors and actuators	5/8	21/8/19
L18	Communication interface : On-board	6/8/19	2/8
L19	Communication interface : External Communication Interfaces	7/8/19	5/8
L20	Review of Unit – II (Writing the minute note/ Presentation/ Group activity)	16/8	7/8
L21	Activity- Test / Quiz / Assessment (Assignment)	17/8	14/8
	UNIT – III Embedded Firmware		
L22	Reset Circuit	19/8/19	16/8/19
L23			16/8/19
L24	Brown-out protection circuit	20/8/19	19/8/19
L25			19/8/19
L26	Oscillator unit	26/8/19	22/8/19
L27	Real time clock	3/9/19	26/8/19
L28			26/8/19
L29	Review of Unit – III (Partial) (Writing the minute note/ Presentation/ Group	6/9/19	4/9/19
L30	Activity- Test / Quiz / Assessment(Assignment)	8/9/19	4/9/19
	Mid Term 1		
L31	Watchdog timer	9/9/19	6/9/19
L32	Embedded firmware design approaches	19/9/19	8/9/19
L33		19/9/19	9/9/19
L34		20/9/19	9/9/19
L35		20/9/19	19/9/19

L36	Development languages	23/9/19	19/9/19
L37		23/9/19	19/9/19
L38	Review of Unit – III (Writing the minute note/ Presentation/ Group activity)	27/9/19	23/9/19
L39	Activity- Test / Quiz / Assessment(Assignment)	3/10/19	23/9/19
	UNIT – IV **RTOS based Embedded System Design**		
L40	Operating Systems (OS) basics	4/10/19	25/9/19
L41	Types of operating systems	4/10/9	27/9/19
L42	Tasks	5/10/19	3/10/19
L43	Processes	14/10/19	3/10/19
L44	Threads	14/10/9	4/10/19
L45	Multiprocessing and Multitasking	23/10/19	4/10/19
L46	Task scheduling	23/10/9	5/10/19
L47		25/10/19	5/10/19
L48	Review of Unit – IV (Writing the minute note/ Presentation/ Group activity)	29/10/19	14/10/19
L49	Activity- Test / Quiz / Assessment(Assignment)	30/10/19	14/10/19
	UNIT – V **Task Communication**		
L50	Shared memory	31/10/19	14/10/19
L51	Message passing	1/11/19	23/10/19
L52	Remote Procedure Call (RPC) and Sockets	1/11/19	24/10/19
L53	Task synchronization	4/11/19	25/10/19
L54	Task communication/ synchronization issues	4/11/19	25/10/19

L55	Task synchronization techniques	5/11/19	29/10/19
L56		5/11/19	29/10/19
L57	Device drivers	6/11/19	29/10/19
L58		6/11/19	29/10/19
L59	How to choose RTOS	7/11/19	30/10/19
L60			
L61	Review of Unit – V (Writing the minute note/ Presentation/ Group activity)	7/11/19	30/10/19
L62	Activity- Test / Quiz / Assessment(Assignment)	8/11/19	31/10/19
L63	Review of all units	8/11/19	31/10/19
L64	Embedded system design process with examples like automatic chocolate vending machine, smart card etc.	9/11/19	1/11/19
L65	Embedded C programming with some examples.	9/11/19	1/11/19
L66	Real time projects in Automotive domain and IOT.	9/11/19	1/11/19
L67			
Mid Term – II			

6. TEACHING REFERENCE PLAN

A. VijayaBhaskerReddy.

INTRODUCTION TO EMBEDDED SYSTEMS

03/05/2018

Definition of Embedded System

An Embedded system is an electronic/ electromechanical system designed to perform a specific function and is a combination of both Hardware and software.

Embedded systems are the electronic systems that contain a microprocessor or a micro-controller, but we donot think them as computers, the computer is hidden or embedded in the system.

— Todd. D. Morton

Embedded system is any device that includes a programmable computer but is not itself intended to be general purpose computer.

— Wayne Wolf

NOTE: A way of working, organizing or performing one or many tasks according to a fixed set of rules, program or plan.

Embedded systems Vs General computing systems

Criteria	General purpose computer	Embedded system
Contents	It is a combination of generic hardware and a general purpose OS for executing a variety of applications.	It is a combination of special purpose hardware and embedded OS for executing specific set of applications.
Operating system	It contains general purpose operating system (OS).	It may or may not contain OS.
Alterations	Applications are alterable by user	Applications are non-alterable by the user
Power consumption	More	Less
Response time	Not critical	Critical for some applications (Hard real time systems).

History of Embedded systems:

→ The first recognised embedded system is the Apollo Guidance computer (AGC) developed by MIT Lab.

→ They run the inertial guidance systems of both the command module (CM) and the lunar excursion module (LEM).

→ AGC was designed on 4K words of ROM and 256 words of RAM.

→ The clock frequency of first microchip used in AGC was 1.024 MHz.

→ The computing unit of AGC consists of 11 instructions and 16 bit word Logic.

→ It used 5000 ICs. The user interface of AGC is Known DSKY which resembles a calculator type keypad with array of numerals.

→ The first mass-product embedded system was guidance computer for the minuteman-i-missile in 1961.

→ In the year 1971 intel introduced the world's first microprocessor chip called the 4004, was designed for use in business calculator.

→ It was produced by japanse company busicom.

Classification of Embedded system:

The classification of embedded systems are based on following criteria.

(i) on Generation

(ii) On complexity and performance

(iii) on Deterministic Behaviour

(iv) on triggering.

(i) classification Based on Generation:

① First Generation:

→ Built around 8 bit microprocessor and 4 bit microcontroller (8085, Z80)

→ simple in hardware circuit and firmware developed in assembly code.

→ Ex: Digital telephone Keypads stepper motor etc.,.

② Second Generation

→ Built around 16 bit microprocessor and 8 bit microcontroller.

→ They are more complex and powerful than 1G microprocessor and microcontroller

→ Ex: Data acquistion systems like ADC, SCADA (system control and data acquistional) system

③ Third Generation:

→ Built around 32 bit microprocessor and 16 bit microcontroller

→ Concepts like digital signal processors (DSP's), Application specific integrated circuits (ASIC's) Evolved.

→ Ex: Robotics

→ The instruction set of processors became more complex and powerful and the concept of instruction pipelining also evolved.

④ Fourth Generation:

→ Built around 64 bit microprocessor and 32 bit micro-controller

→ The concept of system on chips (SOC), multicore processors evolved.

→ Highly complex and very powerful

→ Ex: Smart phones.

NOTE: firmware

↳ permanent software programmed in to a ROM

↳ It is a software program or set of instructions programmed on a Hardware device

Software

↳ means computer instructions or data.

(ii) Classification Based on complexity and performance:

① Small scale:

→ Simple in application need

→ performance not time critical

→ Built around low performance and low cost 8 bit or 16 bit microprocessor / microcontroller

→ It may or may not contain OS for functioning

→ Ex: Electronic toy.

② Medium scale:

→ slightly complex in hardware and firmware requirement.

→ Built around medium performance and low cost 16 bit or 32 bit microprocessor / microcontroller

→ usually contain OS or RTOS

→ Ex: Industrial machines.

③ Large scale / complex systems:

→ Highly complex Hardware and firmware

→ Built around 32 or 64 bit RISC microprocessor / microcontroller or PLD or multicore system processors

→ Response is time critical

→ Ex: Mission-critical applications.

(iii) classification Based on Deterministic Behaviour:

→ The classification is applicable for real time systems

→ The task execution behaviour for an embedded system may be deterministic or non-deterministic.

→ Based on execution behaviour real time embedded systems are divided into hard and soft.

NOTE: ① A system in which the output can be predicted with 100% certainity is known as Deterministic system

② A hard real time system is Hardware and software that must operate with in the confines of a stringent deadline.

Ex: Aircraft control system.

(iv) Classification Based on Triggering:

Embedded systems which are reactive in nature can be based on triggering.

Reactive systems can be

① Event triggered

② Time triggered

NOTE: In an event triggered real time system when a significant event in the outside world happens, it is detected by some sensor, which then causes the attached CPU to get an interrupt.

Event triggered systems are thus interrupt driver.

Major Application Areas of Embedded Systems:

Embedded systems are used in different applications like automobiles, telecommunications, smart cards, missiles, satellites, computer networking and digital consumer electronics.

The application areas and the products in the embedded domain are countless.

① consumer electronics: Camcorders, Cameras.....

2. Household appliances : washing machine, refrigerators....
3. Automotive industry : Anti lock breaking system (ABS), engine control...

Mistake backside

4. Home automation & security systems : Ac's, sprinklers, fire alarm....
5. Telecom : cellular phones, telephone switches....
6. computer peripherals : printers, scanners....
7. Computer Networking systems : Network routers and switches, firewalls etc.,.
8. Healthcare : EEG, ECG, scanners...
9. Banking and retail : ATM, POS...
10. Card Readers : Barcode, Smartcard Readers
11. Measurement & instrumentation : Digital multimeters, digital CRO's, Logic analyzers...
12. Wearble Devices : Health and fitness trackers, smartphone screen extension for notification etc.,.
13. Cloud computing and IOT.

NOTE :

1. Automation is the use of various control systems for operating equipment such as machinery processes in factories aircraft and vehicles with minimal or reducing human intervention.
2. Logic Analyser is an electronic instrument that captures and displays multiple signal from a digital circuit.

③ IOT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Purpose of Embedded systems:

Embedded systems are used in various domains like consumer electronics, retail and banking applications... within the domain itself, a/c to the application usage content, they may have different functionalities. Each embedded system is designed to serve the purpose of any one or combination of the following tasks.

① Data collection/storage/Representation
② Data communication
③ Data processing
④ Maintoring
⑤ control
⑥ Application specific user interface.

① Data collection/storage/Representation:

① Embedded system designed for the purpose of data collection performs acquistion of data from the external world.

② Data collection is usually done for storage, analysis, manipulation and transmission.

③ Data can be analog or digital.

④ Embedded systems with analog data captures techniques collect data directly in the form of analog signal ⑤ where as embedded systems with digital data collection mechanism converts the analog to digital signal using ADC.

⑤ If the data is digital it can be directly captured by digital embedded system.

⑥ A digital camera is a typical example of an embedded system with data collection / storage / representation of data. Images are captured and the captured images may be stored with in the memory of the camera. The captured image can be presented to the user through a graplica lcd unit.

⑦ Analog CRO's, digital CRO's without storage memory are typical example of this.

② Data communication:

→ Embedded data communication systems are deployed in applications from complex satellite communication to simple home networks systems.

→ The data collected by an embedded terminal may require transferring of the same to some other terminal system located remotely.

→ The transmission of data is achieved either by wireline medium or wireless medium

→ Data can be transmitted by analog means or digital means

→ wireless modules : Bluetooth, wifi, zigbee, EDGE, GPRS etc.,

→ wireline modules : USB, TCP/IP, RS-232C

→ Certain ES act as a dedicated transmission unit between the sending and receiving terminals ; offering functionalities

like encrypting, decrypting etc.,.

→ Network hubs, routers, switches are examples of dedicated data transmission ES.

③ Digital signal processing (DSP):

→ The data (voice, image, video, electrical signals) collected by the embedded systems may be used for various kinds of data processing.

→ ES with signal processing functionalities are employed in applications demanding signal processing like speech coding, audio-video codec.

→ A digital hearing aid is a typical example of an embedded system employing data processing.

→ Digital hearing also improves the hearing capacity of hearing impaired person

④ Monitoring:

→ All embedded products coming under the medical domain are with monitoring functions.

→ They are used for determining the state of some variables using input sensors.

→ Electro cardiogram (ECG) machine is intended to do the monitoring of the heart beat of a patient but it cannot impose control over the heart beat.

→ Other examples with monitoring function are digital CRO, digital multimeters & logic analyzers.

⑤ Control:

→ ES with control functionalities impose control over some variables a/c to the changes in input variables.

→ A system with control functionality contains both sensors and actuators.

→ Sensor is connected to the input port for capturing the changes in measuring variable.

→ The actuators connected to the output port are controlled a/c to the changes in input variables.

→ Air conditioner system is used to control the room temperature to a specified limit is a typical example for control purpose.

→ An Ac contains a room temperature sensing element which may be a thermistor and a handheld unit for setting up the desired temperature.

⑥ Application specific user interface:

→ Buttons, switches, Keypad, lights, bells, display units etc., are examples of application specific user interfaces.

→ Mobile phone is example for this.

→ In mobile phone the user interface is provided through the Keypad, graphic LCD module, system speaker, vibration alert etc.,...

NOTE:

① Sensor Definition:

Sensors are frequently used to detect and respond to electrical or optical signals. A sensor converts the physical parameter (temperature, humidity etc.,.) in to a signal which can be measured electrically.

② Actuator: It is a device that moves or controls some mechanism. It converts energy in to motion.

PART - II

Characteristics and Quality Attributes of Embedded Systems:

Characteristics of an Embedded system:

Some of the important characteristics of embedded system are

1. Application and domain specific
2. Reactive and Real-time
3. operates in harsh environment
4. Distributed
5. Small size and weight
6. Power concerns.

1. Application and domain specific:

Each embedded system is having certain function to perform and developed in such a manner to do the intended function only. They cannot be used for any other purpose.

For Ex: You cannot replace the embedded control unit of your microwave oven with your air conditioners embedded control unit, because the embedded control unit of microwave oven and air conditioner are specifically designed to perform certain specific tasks.

2. Reactive and Real-time:

Embedded systems are in constant interaction with the real world through sensor and user defined devices which are connected to the input port of the system.

Any changes happening in the Real-world are captured by the sensors or input devices in real-time and the control algorithm running inside the unit reacts in a desired manner to bring the controlled variables to the desired level. (7)

③ Operates in harsh Environment:

Certain embedded systems are designed to operate in high environments like high temperature of the deserts or very low temperature of the mountains or extreme rains.

These embedded systems have to be capable of sustaining the enviromental conditions it is designed to operate in.

④ Distributed:

Certain embedded systems are part of a larger system and thus form components of a distributed system.

These components are independent of each other but have to work together for the larger system to function properly.

Ex: A car has many embedded systems controlled to its dashboard each one is an independent embedded system yet the entire car can be said to function properly only if all the systems work together.

⑤ Small size and Weight:

Product aesthetics (size, weight, shape, style etc..) will be one of the deciding factor to choose a product.

An embedded system that is compact in size and has light weight will be desirable or more popular

than the one that is bulky and heavy.

Ex: Currently available cell phones. The cell phones that have the maximum features are popular but also their size and weight is an important characteristic.

⑥ Power Concerns:

→ It is desirable that the power utilization and heat dissipation of any embedded system be low.

→ If more heat is dissipated then additional units like heat sinks or cooling fans need to be added to the circuit.

→ If more power is required then a battery of higher power or more batteries need to be accomadated in the embedded system.

Quality Attributes of Embedded systems:

These are the attributes that together form the deciding factor about the quality of an embedded system.

There are two types of quality attributes.

① Operational Quality Attributes:

These are the attributes related to operation or functioning of an embedded system. the way an embedded system operates affects its overall quality.

② Non-operational quality Attributes:

These are attributes not related to operation or functioning of an embedded system. The way an embedded system operates affects its overall quality. These are the attributes that are associated with the embedded system before it can be put in operation.

Operational Attributes:

The important quality attribute coming under this category are

1. Response
2. Through put
3. Reliability
4. Maintainability
5. Security
6. Safety

1. Response:

→ It is a measure of quickness of the system, it gives you an idea about how fast your system is tracking the changes in input variables.

→ Most of the embedded system demand fast response which should be real-time.

Ex: 1. An embedded system deployed in flight control should respond in real-time manner.

2. Electronic toy is not time critical.

2. Throughput:

→ It deals with the efficiency of system. It can be defined as rate of production or process of a defined process over a state period of time.

→ In case of card reader like the ones used in buses, throughput means how much transaction the reader can perform in a minute or hour or day.

→ It is generally measured in terms of benchmark. A benchmark is a reference point which something can be measured.

③ Realibility:

→ It is measure of how much percentage you rely upon the proper functioning of the system. Mean time between failures (MTBF) and mean time to repair are terms used in defining system realiability.

→ MTBF can be defined as the average time the system is functioning before a failure occurs.

→ MTTR can be defined as the average time the system has spent in repairs.

④ Maintainability:

→ It deals with support and maintenance to the end user or a client in case of technical issues and product failures or on the basis of a routine system checkup.

→ It can be classified into two types.

ⓐ Scheduled or periodic maintenance:

→ This is the maintenance that is required regularly after a periodic time interval.

Ex: (i) Periodic cleaning of AC's

(ii) Refilling of printer cartridges.

ⓑ Maintenance to unexpected failure:

→ This involves the maintenance due to a sudden breakdown in the functioning of the system.

Ex: (i) AC not powering on

(ii) Printer not taking paper inspite of a full paper stack.

⑤ Security:

→ Confidentiality, integrity and availiability are three corner stones of information security.

→ Confidentiality deals with protection data from unauthorized disclosure.

→ Integrity gives protection from unauthorized modification.
→ Availability gives protection from unauthorized user.
→ Certain embedded system have to make sure they conform to the security measures.

Ex: An electronic safety deposit locker can be used only with a pin number like a password.

⑥ Safety:

Safety deals with the possible damage than can happen to the operating person and environment due to the breakdown of a embedded system or due to the emission of hazardous materials from the embedded products.

A safety analysis is a must in product engineering to evaluate the anticipated damage and determine the best course of action to bring down the consequence of damages to an acceptable level.

Non-operational Quality Attributes:

The important quality attributes coming under this category are

① Testability and debugability
② Evolvability
③ Portability
④ Time to prototype and market
⑤ Per unit and total cost.

① Testability and Debugability:

→ It deals with how easily one can test his/her design, application and by which mean he/she can test it.
→ In hardware testing the peripherals and total hardware function in desired manner. Firmware testing is

functioning in expected way.

→ Debugability is means of debugging the product as such for figuring out the probable sources that create unexpected behaviour in the total system.

② Evolvability:

→ For Embedded system, the qualitative attribute "Evolvability" refer to case with which the embedded product can be modified to take advantage of new firmware or hardware technology.

③ Portability:

→ It is measure of "system independence".

→ An embedded product can be called portable if it is capable of performing its operation as it is intended to do in various environments irrespective of different processor and or controller and embedded operating systems.

④ Time to Prototype and market:

→ Time to market is the time elapsed between the conceptualization of a product and time at which the product is ready for selling or use.

→ Product prototyping help in reducing time to market.

→ Prototyping is an informal kind of rapid product development in which important feature of the under consider are develop. In order to shorten the time to prototype, make use of all possible option like use of reuse, off the self component etc.,.

5 Per unit cost and Revenue:

→ cost is an important factor which needs to be carefully mointored proper market study and cost benefit analysis should be carried out before taking decision on the per unit cost of the embedded product.

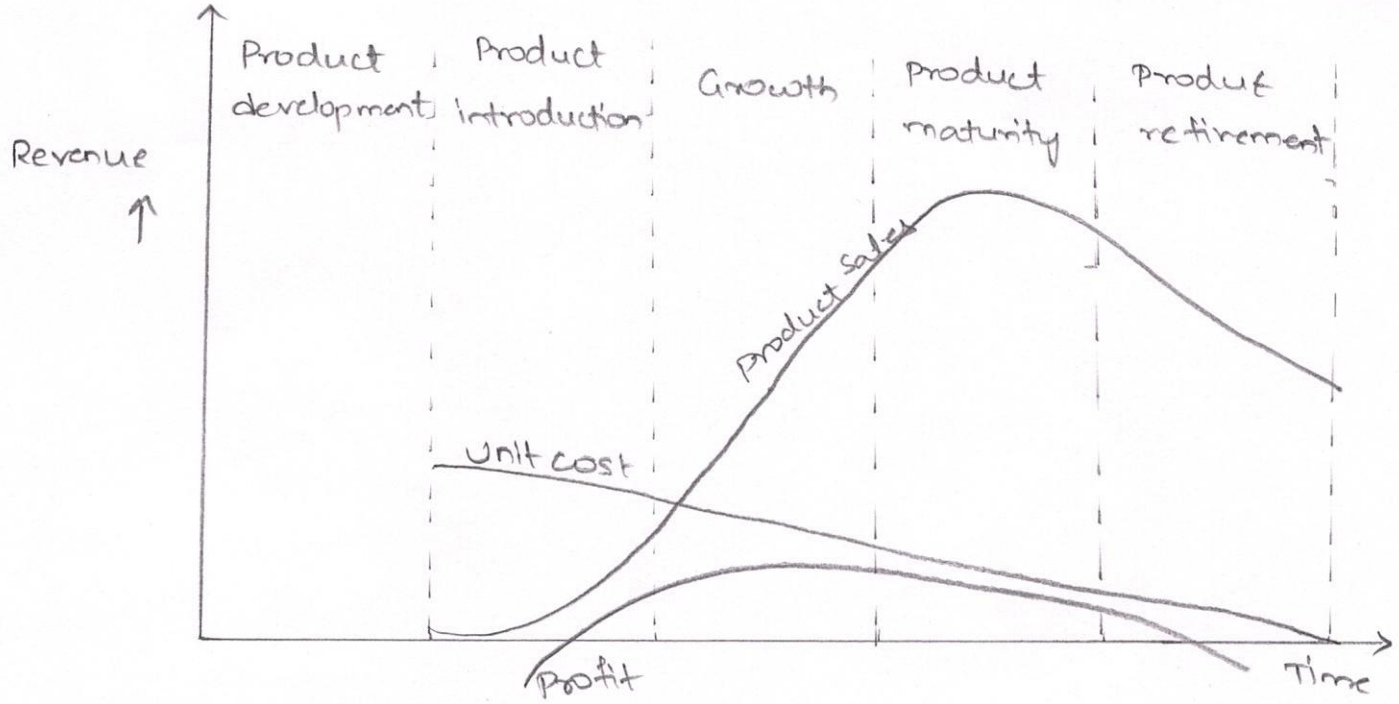
→ When the product is introduced in the market, for the initial period the sales and revenue will be low.

→ There won't be much competition when the product sales and revenue increase

→ During the maturing phase, the growth will be steady and revenue reaches highest point and at retirement time there will be a drop in sales volume.

The product life cycle (PLC):

Every embedded product has a PLC which starts with the design and development phase.



The total revenue increases from the product introduction stage to the product maturity stage. The revenue peaks at maturity stage and starts falling in the retirement stage. The unit cost is very high during the introductory

stage. The profit increases with increase in sales and attains a steady value and then falls with a dip in sales. You can see a negative value for profit during the initial period, it is because during the product development phase there is only investment and no returns. Profit occurs only when the total returns exceed the investment and operating cost.

Embedded System Design
Assignment

T. Madhuri
16QMIA0438
ECE

5/5

1. TASK Communication:

a. message passing

Message passing is an synchronous information exchange mechanism used for Inter Process/Thread Communication. The major difference between shared memory and message passing technique is that, through Shared memory lots of data can be shared whereas only limited amount of info/data is passed through message passing. Based on the message passing operation between the processes, message passing is classified into

Message Queue:

Usually the process which wants to talk to another process posts the message to a First-In-First-out (FIFO) queue called 'Message Queue', which stores the message temporarily in a system defined memory object, to pass it to the desired Process.

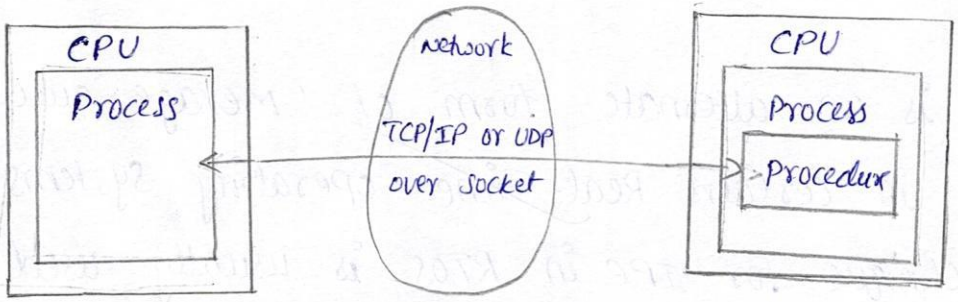
b. Mail box:

Mail box is an alternate form of 'Message queues' and it is used in certain Real-Time operating Systems for IPC. Mailbox technique for IPC in RTOS is usually used for one

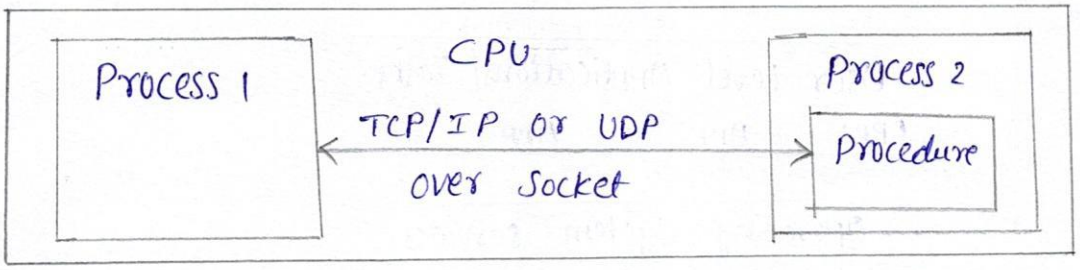
way messaging. The task/thread which wants to send a message to other tasks/threads creates a mailbox for posting the messages. The threads which are interested in receiving the message posted to the mailbox by the mailbox creator thread can subscribe to the mailbox.

c) Remote Procedure Call (RPC):

Remote Procedure Call or RPC is the Inter Process Communication (IPC) mechanism used by a process to call a procedure of another process running on the same CPU or on a different CPU which is interconnected in a network. In the object oriented language terminology RPC is also known as Remote Invocation or Remote Method Invocation. RPC is maily used for distributed applications like client-server applications. With RPC it is possible to communicate over a heterogeneous network client and server applications are running on different operating systems. The CPU/process containing the procedure which needs to be invoked remotely is known as server. The CPU/process which initiates an RPC request is known as client.



Processes running on different CPUs which are networked



Concept of Remote Procedure call (RPC) for IPC

2.a) Device Drivers:

Device driver is a piece of software that acts as a bridge between the operating system and the hardware. In an operating system based product architecture, the user applications talk to the operating system kernel for all necessary information exchange including communication with the hardware peripherals. The architecture of the OS kernel will not allow direct device access from the user application. All the device related access should flow through the OS kernel and the OS kernel routes it to the concerned hardware peripheral. The device driver abstracts the hardware from user applications.

→ However regardless of the OS types, a device driver implements the following:

1. Device (Hardware) Initialisation and Interrupt configuration
2. Interrupt handling and processing
3. client Interfacing (Interfacing with user applications).

Role of Device driver in Embedded OS based products

b) How to Choose RTOS:

The decision of choosing an RTOS for an embedded design is very crucial. A lot of factors needs to be analysed carefully before making a decision on the selection of an RTOS. These factors can be either functional or non-functionally.

(1) Functional Requirements:

Processor Support: It is not necessary that all RTOS's support all kinds of processor architecture.

Memory Requirements: OS also requires working memory RAM for loading the OS services. Since embedded systems are memory constrained, it is essential to evaluate the minimal ROM and RAM requirements for the OS under consideration.

Real-time capabilities: The task/process scheduling policies plays an important role in the 'Real-time' behaviour of an OS. Analyse the real-time capabilities of the OS under consideration and the standards met by the OS for real-time.

Kernel and Interrupt latency: The kernel of the OS may disable interrupts while executing certain services and it may lead to interrupt latency. For an embedded system whose response requirements are high, this latency should be minimal.

Inter process communication & Task synchronisation: Certain kernels may provide a bunch of options whereas others provide very limited options. Certain kernels implement policies for avoiding priority inversion issues in resource sharing.

Modularisation support: It is very useful if the OS supports modularisation where in which the developer can choose the essential modules and re-compile the OS image for functioning.

Support for Networking and communication: Ensure that the OS under consideration provides support for all the interfaces required by the embedded product.

Development language support: Certain operating systems include the run time libraries required for running application written in languages like Java and C#. The OS may include these components as built-in component, if not, check the availability of the same from a third party vendor for the OS under consideration.

(2) Non-functional Requirements:

Custom Developed off the shelf: Depending on the OS requirement, it is possible to go for the complete development of an operating system suiting the embedded system needs or use an off the shelf, readily available operating system, which is either a commercial product or an open source product, which is in close match with the system requirements.

Cost: The total cost for developing or buying the OS and maintaining it in terms of commercial product and custom build needs to be evaluated before taking a decision on the selection of OS.

Development and Debugging Tools Availability: Certain operating systems may be superior in performance, but the availability of tools for supporting the development may be limited. Explore the different tools available for the OS under consideration.

Ease of use: How easy it is to use a commercial RTOS is another important feature that needs to be considered in the RTOS selection.

After Sales: For a commercial embedded RTOS, after sales in the form of e-mail, on-call services, etc. for bug fixes, critical patch updates and support for production issues, etc. should be analysed thoroughly.

K. G. Reddy College of Engineering &Technology

(Approved by AICTE, Affiliated to JNTUH)
Chilkur (Vil), Moinabad (Mdl), RR District

Name of the Exam: I Mid Examinations **September– 2018**
Year-Sem & Branch: IV-I & ECE **Duration: 60 Min**
Subject: Embedded System Design **Date & Session 06-09-2018 AN**
Answer **ANY TWO** of the following Questions 2**X5=10**

Q.NO	QUESTION	Bloom's level	Course outcome
1	a) Define Embedded System. Give few examples. b) Explain in detail the classification of embedded systems.	L1,L2	CO1
2	a) Differentiate between general purpose processors and domain specific processors. b) Discuss the role of sensors in embedded system design.	L2,L4	CO1,CO3
3	a) Briefly explain Brown-out protection circuit. b) Explain the function of Watchdog timer in an embedded system	L2	CO1,CO3
4	Discuss about given terms in an Embedded System a) Portability b) Power concerns c) Reactive and Real-time d) Reliability	L2	CO1

Code No: 117CZ

R13

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech IV Year I Semester Examinations, November/December - 2016
EMBEDDED SYSTEM DESIGN
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) Define "Time-to-market". [2]
b) What is the quality attribute "Portability" in the embedded system design context. [3]
c) What is the role of ASIC in Embedded System design? [2]
d) What is Actuator? [3]
e) What is the role of Reset Circuit in embedded system? [2]
f) What are the merits and drawbacks of 'recursion'? [3]
g) What is an Operating system? What are its primary functions? [2]
h) What is task control block (TCB)? [3]
i) Define Coffman conditions. [2]
j) How multiple threads of a process co-operate? [3]

PART-B

(50 Marks)

2. Define an embedded system? Explain the characteristics of Embedded Systems. [10]

OR

3. Explain the various purposes of embedded systems in detail with illustrative examples. [10]

4.a) Explain the different factors that needs to be considered in the selection of memory for embedded systems.
b) Explain the difference between I^2C and SPI communication interface. [5+5]

OR

5. Explain the different communication buses used in automotive application. [10]

6. Explain the different sections of a memory segment allocated to an application by the memory manager. [10]

OR

7. Explain the difference between 'pointer to constant data' and 'constant pointer to data' in Embedded C programming. Explain the syntax for declaring both. [10]

8.a) Explain starvation in the process scheduling context. Explain how starvation can be effectively tackled.

b) What is the difference between a General Purpose kernal and Real-Time kernel? Give an example for both. [5+5]

OR

9. Explain the different multitasking models in the operating system context. [10]

10. Explain in detail, the different task communication synchronization issues encountered in Inter Process communication. [10]

OR

11. Explain the architecture of device driver, with neat sketch and give the applications of device drivers. [10]

---ooOoo—