GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: EMBEDED NETWORKS
(COURSE CODE: 3361706)

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation And Control	Sixth

1. RATIONALE

Embedded networks are widely used in portable Automatic systems like automobiles, Aeronautics etc. To control speed, autofocus, safety, interconnection and communication of various sensors is necessary. The students studying this course are supposed to learn the concept of real time networking, protocols like CAN, ZIGBEE, MODBUS etc. The course in addition, will provide knowledge of applications and interfacing of embedded networks. Thus this course is an important course for instrumentation engineers working in the area of imbedded instrumentation.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Explain real time embedded systems and embedded networks.**
- **Interface sensors, transducers, motors, relays and various input/output devices with Communication Highway.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Identify network types and topologies.
ii. Explain Real Time Operating System (RTOS).
iii. Build Controller Area Network (CAN).
iv. Program Controller Area Network (CAN).
v. Explain Advanced Wireless Networks (ZigBee).

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**150**
3	0	2	05	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Concept of Networking.	1a. Define Network. 1b. Explain Network types. 1c. Explain Class A, B, C, D networks with their features.	1.1 Need for Networking.
	1d. Explain different Network Topologies. 1e. Discuss advantages and disadvantages of different network topologies.	1.2 Network Topologies.
	1f. Explain OSI reference Model.	1.3 OSI reference Model.
	1g. Explain different types of cables used in Networking with their category description. 1h. Explain Cable connectors used in Networking. 1i. Define Patch cable and Cross over cable. 1j. Discuss factors for the selection of cable.	1.4 Cables used for Networking.
	1k. Define CSMA / CA, CSMA / CD, CSMA / CR. 1l. Discuss applications of CDMA / CA, CSMA / CD, CSMA / CR.	1.5 Concept of CSMA / CA, CSMA / CD, CSMA / CR.
Unit– II Real Time Operating System (RTOS).	2a. Explain concept and characteristics of RTOS. 2b. Explain need of RTOS. 2c. Explain structure of RTOS. 2d. Define multitasking and concurrency. 2e. Explain conditions required for multitasking in RTOS. 2f. Discuss advantages and disadvantages of multitasking in RTOS.	2.1 Introduction to RTOS.
Unit – III Industrial Embedded Networking.	3a. Discuss Serial and Parallel transmission. 3b. Define the given terms.	3.1 Bus System. Terms: Bus line, Bus Subscriber, Gateway, Master / slave controller.
	3c. Give functional description of CAN. 3d. Explain architecture of CAN. 3e. Explain features of CAN. 3f. Compare CAN with OSI model.	3.2 Controller Area Network (CAN).
	3g. Explain each field of CAN data frame.	3.3 CAN data frame.
	3h. Discuss Pinout diagram for DNA – CAN 503. 3i. Discuss CAN Bus wiring. 3j. Explain CAN protocol and standard specifications. 3k. Explain pin assignment of 9 – pole	3.4 Installation of CAN.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	DSUB connector. 3l. Explain pin assignment of 5 – pole combicon connector. 3m. Explain rules for installation of CAN. 3n. Explain isolation in CAN transceiver.	
	3o. Troubleshoot the CAN.	3.5 Troubleshooting of CAN.
	3p. Explain architecture of smart sensors. 3q. Explain various types of smart sensors.	3.6 Introduction to Smart Sensors.
Unit – IV CAN Programming and Applications.	4a. Discuss steps for CAN programming. 4b. Draw flow chart for CAN transmitter. 4c. Draw flow chart for CAN receiver.	4.1 Programming CAN.
	4d. Explain the given applications.	4.2 Applications of CAN: 4.2.1 Auto door locking in automobiles. 4.2.2 Speed Control. 4.2.3 Head light control. 4.2.4 ABS in automobile. 4.2.5 Air Bag control in automobiles.
Unit – V Advanced Wireless Networks.	5a. Explain ZigBee stack architecture. 5b. Describe importance of ZigBee. 5c. Compare ZigBee with other wireless technologies. 5d. Describe ZigBee applications in brief	5.1 Introduction to Zigbee.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Concept of Networking.	**08**	07	04	03	**14**
II	Real Time Operating System (RTOS).	**06**	03	02	02	**07**
III	Industrial Embedded Networking.	**16**	07	11	10	**28**
IV	CAN Programming and Applications.	**06**	04	06	04	**14**
V	Advanced Wireless Networks	**06**	03	02	02	**07**
	Total	**42**	**23**	**26**	**21**	**70**

Legends: R = Remember; **U** = Understand; **A** = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes in Psychomotor Domain)	Approx. Hours Required
1	I	Debug Local Area Network.	02
2	I	Debug CWAN.	02
3	I	Debug Bus topology.	02
4	I	Identify OSI layers through LAN / CWAN.	02
5	I	Check different cables and connectors.	02
6	I	Install cables for LAN / CWAN.	02
7	II	Develop and Execute Programs for reading data from sensor.	02
8	II	Develop and Execute Programs for writing data to the output device.	02
9	III	Interface CAN 9 – pole DSUB connector.	02
10	III	Interface CAN 9 – pole combicon connector.	02
11	III	Develop a CAN data frame for given conditions.	02
12	III	Troubleshoot error in CAN.	02
13	IV	Develop and execute programs for CAN interfacing.	02
14	IV	Case study – 1. Auto door locking in automobile.	02
15	IV	Case study – 2. Speed Control in automobile.	02
16	IV	Case study – 3. Head light control in automobile.	02
17	IV	Case study – 4. ABS in automobile.	02
18	IV	Case study –5. Air Bag control in Automobile.	02
19	V	Develop wireless program using ZigBee module.	02
Total Hours			**38**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

Following are the proposed student activities such as:

i. Perform various tasks related to Embedded Networks in laboratory.
ii. Perform various practical using simulators in laboratory.
iii. Visit various industries using embedded instrumentation.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Arrange seminar/symposium where student should present on different aspects of embedded networks.
ii. Ask students to do mini projects related to embedded networks.
iii. Arrange expert lecture by engineers having experience of using embedded networks for instrumentation purposes.

10. SUGGESTED LEARNING RESOURCES

A) Books

Sl. No.	Title of Book	Author	Publication
1.	Embedded / Real-Time Systems: Concepts, Design and Programming	Dr. Prasad K. V. K. K.	Dreamtech Press/Wiley India, 2003
2.	Real-Time Systems	Krishna C. M. and Shin K. G.	Mcgraw-Hill,1997
3.	Simple Real Time Operating System	Chowdary Venkateswara	Trafford Publishing, 2007
4.	Understanding and using the controller area network communication protocol	Di Natale, M.Zeng, H.giusto ,P,Ghosal	Springer publication, 2012
5.	Modern Automative technology	James E.Duffy	Goodheart-willcox company 2009
6.	Embedded Networking with CAN and CANopen	Olaf Pfeiffer, Andrew Ayre, Christian Keydel	Copperhill Technologies Corporation, 2008

B) Major Equipment/ Instrument with Broad Specifications

i.	Various Networking Cables and Connectors.	Capable to support "C" programming and required simulators.
ii.	Networking Tools.	With inbuilt power supply, keyboard, LCD displays, ports for interfacing peripheral and memory.
iii.	Simulators.	Capable to interface LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor With PIC 18 Development kit.
iv.	Hardware modules for CAN, ZigBee, MODBUS etc.	

C) Software / Learning Websites

i. http://www.zigbee.org/en/about/faq.asp
ii. http://anideaclub.blogspot.in/2013/04/microcontroller-zigbee.html
iii. www.microchip.com/pic/
iv. www.engineersgarage.com/articles/pic-microcontroller-tutorial
v. www.best-microcontroller-projects.com/pic-microcontroller.html
vi. www.pic18-simulator-ide.software.informer.com
vii. www.gpsim.sourceforge.net
viii. http://inst.cs.berkeley.edu/~ee249/fa08/Lectures/handout_canbus2.pdf
ix. http://www.eecs.umich.edu/eecs/courses/eecs373/Lec/W12Student/373CANpreso.pdf
x. http://www.ueidaq.com/media/catalog/product/pdf/manual/dnx-can-503-manual.pdf
xi. http://www.ecnmag.com/articles/2009/10/isolated-can-transceiver-assures-robust-fieldbus-design
xii. http://www.ti.com/lit/wp/spry200/spry200.pdf
xiii. http://electronicsforu.com/newelectronics/circuitarchives/view_article.asp?sno=840&title%20=%20Electronics+in+Cars&id=11280&article_type=8&b_type=new
xiv. http://guides.machinescience.org/mod/book/view.php?id=706&chapterid=46
xv. http ://www.howstuffworks.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. V. Dabhi**, Lecturer, Government Polytechnic, Gandhinagar.
- **Prof. A. M. Patel**, Lecturer, Government Polytechnic, Palanpur.
- **Prof. (Smt.) S. K. Raval**, Lecturer, Government Polytechnic, Ahmedabad.
- **Prof. M. J. Vadhavaniya,** Lecturer, Government Polytechnic, Gandhinagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat.