Course Handout

Institute/School Name	Chitkara University Institute of Engineering & Technology		
Department Name	Department of Computer Science and Engineering		
Programme Name	B.E (Computer Science & Technology)		
Course Name	Embedded System and Internet of Things	Session	July – Dec 2025
Course Code	24ECE0202	Semester/Batch	3rd /2024
L-T-P(Per Week)	3-0-2	Course Credits	04
Pre-requisite	Basics of Electronics, Programming Fundamentals, Computer Architecture Basics, Networking Basics	NHEQF Level	5.5
Course Coordinator	Dr. Manvinder Sharma / Dr. Danvir Mandal	SDG Number	1, 7, 9, 11, 12

1. Objectives of the Course

Embedded system and Internet of Things (IoT) are integral aspects of modern technology, enabling devices to sense, communicate, and interact with the environment. This course aims to provide students with a comprehensive understanding of embedded systems and IoT technologies. Through hands-on learning and theoretical study, students will gain insights into the design, programming, and applications of these systems. The main objectives are:

- To familiarize the students with the fundamental concepts and architecture of embedded systems.
- To apply the concept of basic building blocks of Embedded systems and Internet of things (IoT).
- To familiarize students with the concepts, architectural design, communication protocols, and challenges associated with the Internet of Things (IoT) paradigm.
- To enable students to develop practical skills in programming embedded systems and IoT devices using the Arduino platform, including interfacing with various sensors and actuators.

2. Course Learning Outcomes (CLOs)

Student should be able to:

	CLOs	Program Outcomes (PO)	NHEQF Level Descriptor[1]	No. of Lectures
CLO01	To understand and articulate the architecture and components of embedded systems, including processors, memory, and peripherals.	PO1, PO2, PO3,PO4, PO7	Q1	10
CLO02	To develop the ability to conceptualize, design, and execute embedded system projects that meet specific requirements	PO1, PO2, PO4, PO5, PO7, PO8, PO 11	Q2	12
CLO03	To apply programming concepts for interfacing sensors, actuators, and other devices with microcontrollers	PO1, PO2, PO3, PO5, PO7, PO 11, PO 12	Q3	10
CLO04	To analyze and explore the principles and applications of Internet of Things (IoT)	PO1, PO2, PO3, PO4, PO5, PO7, PO 11	Q2	9
CLO05	To analyze communication interfaces such as RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee and apply in both embedded systems and IoT projects	PO1, PO2, PO4, PO5, PO7, PO 11, PO 12	Q3	8
Total Contact Hours				50

CLO-PO Mapping

CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Type of Assessment's[3]
CLO01	H	M	L	M			M						Summative (Sessional Test and End Term Exam)
CLO02	H	H		H	L			M	M		L		Summative (Sessional Test and End Term Exam)

CLO03	M	H	H		L						M	H	Formative, (Continuous Lab Assessments) and Summative (Sessional Tests and End Term Exam)
CLO04	L	M	H	M	M		H				L		Summative (Sessional Tests and End Term Exam)
CLO05	H	M		H	M		M			L	L		Formative, (Continuous Lab Assessments) and Summative (Sessional Tests and End Term Exam)

H=High, M=Medium, L=Low

3. Recommended Books:

B01: Embedded Systems: Architecture, Programming and Design by Raj Kamal, TMH, 2nd Ed., 2011.
B02: The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay; Pearson Education India, Second Edition, 2014.
B03: Internet of Things (IoT): Principles, Paradigms, and Applications of IoT by Rajkumar Buyya and Amir Vahid Dastjerdi; Elsevier, First Edition, 2016.
B04: Arduino Cookbook by Michael Margolis; O'Reilly Media, Third Edition, 2018.
B05: Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C by Yifeng Zhu; E-Man Press LLC, Third Edition, 2017.

Reference Books:

RB1: Real-Time Systems and Programming Languages by Alan Burns and Andy Wellings; Addison-Wesley, Fourth Edition, 2009.
RB2: The Internet of Things: Key Applications and Protocols by Olivier Hersent, David Boswarthick, and Omar Elloumi, Wiley, 1st Ed., 2012.

4. Other readings and relevant websites:

SerialNo	Link of Journals, Magazines, websites and Research Papers
1.	https://nptel.ac.in/courses/108/106/108106051/
2.	https://nptel.ac.in/courses/106/106/106106238/
3.	https://www.instructables.com/circuits/arduino/projects/
4.	https://create.arduino.cc/projecthub
5.	https://learn.sparkfun.com/tutorials/arduino-overview/all
9.	https://library.chitkara.edu.in/subscribed-books.php

5. Recommended Tools and Platforms

- NPTEL, SWAYAM, ThingSpeak and Blynk
- TinkerCAD, Wokwi (Simulators)

6. Course Plan: Theory+ Lab Plan

Theory Plan

Lect. No.	Topic(s)
1-2	**Introduction to Embedded Systems**: Introduction to Embedded Systems, Embedded system characteristics and applications, features of embedded systems.
3-4	Harvard & Von Neumann architectures, Architecture of Embedded System.
5-6	Application specific ICs (ASICs), Types of ASIC, Applications
7-8	Overview of Embedded Networking & Standards: RS232, SPI, I2C, USB, Bluetooth, Zigbee
9-10	Real time embedded systems, its features, Soft v/s Hard Real time embedded systems
11-14	**Microcontrollers and Programming**: Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports.
15-17	Addressing Modes, Instruction Set and Programming

18	Flag bits and PSW register
19-22	Timers and Serial Port, Interrupt Handling, Arithmetic instructions and programs
ST-1	
23-26	**Introduction to Internet of Things (IoT)**: Introduction to Internet of Things, Characteristics of IoT, Application Areas of IoT, Industrial IoT, Real time analytics in IoT and fog computing.
27-30	Layered architecture of IoT, SOA based Architecture, API Oriented Architecture, IoT challenges, IoT Communication protocols and comparison
31	Introduction to Cloud computing, Introduction to Big data.
32-35	Threats and vulnerabilities in IoT systems- Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms
36-37	Light weight cryptography- Symmetric Key LWC Algorithms, Asymmetric LWC algorithms
38-40	**Arduino and Programming:** Introduction to Arduino, Architecture of Arduino, Pin diagram of Arduino, Types of Arduino
41-42	Arduino Programming Structure, Bare minimum code, Variables, Serial monitor
43-44	Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc)
ST-2	
45-46	Case Studies of Smart home automation, Smart cities, Case Studies of Healthcare and wearable devices
End Term Exam	

7. Delivery/Instructional Resources Theory Plan:

Lect. No.	Topics	CLO	Book No, CH No, Page No	TLM[2]	ALM[3]	Web References	Audio-Video
1-8	Introduction to Embedded Systems, Embedded system characteristics and applications, Harvard & Von Neumann architectures, Architecture of Embedded System, Application specific ICs (ASICs), Overview of Embedded Networking & Standards: RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee.	1, 5	B1 (3-4), B1 (10-18), B1 (52), B1 (45-48), B5 (29-34), B5 (73-79), RB1 (33-47), B1 (160-175) RB2 (93-94)	Lecture Discussion	Questioning, Group Discussion	https://www.tutorialspoint.com/embedded_systems/es_overview.htm https://www.geeksforgeeks.org/difference-between-von-neumann-and-harvard-architecture/ https://aruneworld.com/embedded/embedded-protocol/	https://nptel.ac.in/courses/108102045 https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105193/
9-10	Real time Embedded Systems, features, Soft v/s Hard Real time embedded systems	1	RB1 (17-23)	Lecture Discussion	Questioning, Group Discussion	https://www.geeksforgeeks.org/difference-between-hard-real-time-and-soft-real-time-system/ https://testbook.com/key-differences/difference-between-hard-real-time-and-soft-real-time-	https://www.digimat.in/nptel/courses/video/106105172/L13.html

[2] Teaching Learning Methods, Refer to Annexure D2L Brightspace

[3] Active Learning Methods D2L Brightspace

						system	
11-18	Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports, Addressing Modes, Instruction Set and Programming, flag bits and PSW register	2, 3	B1 (62-71) B2(4-7), B2 (50-72), B2 (89-94), B2 (50-72), B2 (89-94)	Lecture Discussion Demonstration method using a simulation or a tool	Problem Solving, Review	https://www.tutorialspoint.com/microprocessor/microcontrollers_overview.htm https://ebooks.inflibnet.ac.in/csp13/chapter/8051-architecture/ https://electronicsforyou.in/psw-register-in-8051-microcontroller/	https://archive.nptel.ac.in/courses/106/105/106105193/ https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22#google_vignette https://archive.nptel.ac.in/courses/108/105/108105102/
19-22	Timers and Serial Port, Interrupt Handling, Arithmetic instructions and programs, Logic instructions and programs `	2, 3	B2(100-106)	Lecture Discussion	Numerical, Quiz, Problem Solving	https://www.geeksforgeeks.org/microcontrollers-8051-interrupts/ https://www.tutorialspoint.com/arithmetic-group-in-8051l https://technobyte.org/logical-instructions-8051/	https://archive.nptel.ac.in/courses/108/105/108105102/ https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22#google_vignette
ST-1							
23-31	Introduction to Internet of Things, Industrial IoT, Real time analytics in IoT and fog computing. Architectural design of IoT, SOA based Architecture, API based Architecture, IoT Communication protocols and comparison, Cloud computing, Big data	4	B3(3-5),B3 (14) B3 (32) B3 (183), B3(8-9), B3 (184-185), B3(188-193)	Lecture Discussion	Questioning, Group Discussion	https://www.javatpoint.com/iot-internet-of-things https://www.techtarget.com/iotagenda/definition/fog-computing-fogging https://www.nabto.com/iot-protocols-comparison/ https://www.compute	https://archive.nptel.ac.in/courses/106/105/106105166/ https://nptel.ac.in/courses/106105166

						r.org/publications/tech-news/trends/big-data-and-cloud-computing	
32-37	IoT challenges, Threats and vulnerabilities in IoT systems- Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms. Light weight cryptography- Symmetric Key LWC Algorithms, Asymmetric LWC algorithms	4	B3 (185), B3 (189-193), B3 (194-195)	Lecture Discussion	Quiz, Numerical, Group Discussion, Problem Solving	https://www.geeksforgeeks.org/challenges-in-internet-of-things-iot/ https://www.techtarget.com/iotagenda/definition/IoT-gateway https://www.nec.com/en/global/techrep/journal/g17/n01/170114.html https://www.sciencedirect.com/topics/computer-science/lightweight-cryptography	https://archive.nptel.ac.in/courses/106/105/106105167/ https://archive.nptel.ac.in/courses/106/104/106104189/
38-42	Introduction to Arduino, Architecture of Arduino, Types of Arduino, Arduino Programming Structure, Bare minimum code, Variables, Serial Monitor	2, 3, 5	B4 (6-8), B4 (15), B4 (11-14), B4 (21-25), B4 (94),	Lecture Discussion Demonstration method using a simulation or a tool	Hands On Practice, Lab Think/Pair/Share	https://www.arduino.cc/en/Guide/Introduction https://www.tutorialspoint.com/arduino/index.htm https://www.javatpoint.com/arduino	https://www.youtube.com/watch?v=ZSUANscJrYc https://nptel.ac.in/courses/106105166
43-44	Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc),	2, 3, 5	B4 (167-190)	Lecture Discussion Demonstration method using a simulation or a tool	Hands On Practice, Lab Group Discussions	https://www.geeksforgeeks.org/actuators-in-iot/ https://www.electronicshub.org/different-types-sensors/	https://archive.nptel.ac.in/courses/108/105/108105102/
ST-2							
45-46	Case Studies of Smart home automation, Smart cities, Healthcare and wearable devices.		B4 (135-145), RB2 (285-300)	Lecture Discussion	Group Discussions, Questioning	https://www.mdpi.com/1424-8220/22/2/527/htm	https://nptel.ac.in/courses/106105166

End Term Exam

Lab Plan:

Lab No.	Experiment	CLO	TLM	ALM	Web References	Audio-Video
1	Introduction to Arduino, read value of Switches and control LED through Arduino	1	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	Reading Switch- https://roboticsbackend.com/arduino-push-button-tutorial/ Blinking LED- https://www.geeksforgeeks.org/led-blinking-using-arduino/	https://www.youtube.com/watch?v=nL34zDTPkcs
2	To Implement and analyze Serial Monitor on Arduino	2	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://docs.arduino.cc/software/ide-v2/tutorials/ide-v2-serial-monitor/	https://www.youtube.com/watch?v=j2qrRxQ9mSs
3	To Implement Gas leakage detector circuit using MQ-02/03 Gas sensor with Arduino	3	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://circuitdigest.com/microcontroller-projects/interfacing-mq3-alcohol-sensor-with-arduino	https://www.youtube.com/watch?v=yLtBn0UIkgc
4	To Interface IR Sensor and Ultrasonic Sensor with Arduino	3	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	IR sensor- https://circuitdigest.com/microcontroller-projects/interfacing-ir-sensor-module-with-arduino Ultrasonic Sensor- https://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/	https://www.youtube.com/watch?v=hlJauJmM3gs
5	To Implement Temperature and Humidity monitoring setup with Arduino and DHT sensor	3	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://www.circuitbasics.com/how-to-set-up-the-dht11-humidity-sensor-on-an-arduino/	https://www.youtube.com/watch?v=OogldLc9uYc
6	To Implement light based audio response circuit using LDR sensor and buzzer with Arduino	3	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://steemit.com/utopian-io/@pakganern/active-buzzer-with-ldr-and-led-arduino	https://www.youtube.com/watch?v=SkGmtsA69ts
7	To control Servo motor and DC motor with Arduino	3	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	Servo motor- https://docs.arduino.cc/tutorials/generic/basic-servo-control/ DC motor- https://www.tutorialspoint.com/arduino/arduino_dc_motor.htm	Servo motor https://www.youtube.com/watch?v=QbgTl6VSA9Y DC motor https://www.youtube.com/watch?v=XrJ_zLWFGFw
8	To display various characters using 16x2 LCD, I2C and Aurdino	3, 5	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://www.geeksforgeeks.org/how-to-interface-i2c-lcd-display-with-arduino/	https://www.youtube.com/watch?v=CvqHkXeXN3M
9	To Setup a cloud platform to log the data and establish a communication link between IoT devices and cloud platform	4	Demonstration method using a simulation or tool	Review, Hands On Activity	Thingspeak- https://learn.sparkfun.com/tutorials/internet-of-things-experiment-guide/configure-thingspeak Blynk- https://blynk.io/getting-started	https://www.youtube.com/watch?v=wE-ysLM5bbs
10	To Design an IoT based system to acquire sensor data and show on cloud platform (use any arduino, nodemcu)	3, 4, 5	Demonstration method using a simulation and Hardware, Hands on practice	Review, Hands On Activity	https://how2electronics.com/dht11-humidity-temperature-nodemcu-thingspeak/#google_vignette	https://www.youtube.com/watch?v=wE-ysLM5bbs
11	Introduction to raspberry pi	1	Demonstration method using a simulation and	Review, Hands On Activity	https://www.electronicwings.com/raspberry-pi/raspberry-pi-introduction	https://www.youtube.com/watch?v=eZ74x6dVYes

			Hardware, Hands on practice			

8. Remedial Classes[4]

Supplement course handout, which may perhaps include special lectures and discussions that would be planned, and schedule notified accordingly.

9. Self-Learning[5]

Assignments to promote self-learning, survey of contents from multiple sources.

S.No	Topics	CLO	ALM	References/MOOCS
1	Introduction to Basic Electronics and Components	CLO01	Independent Reading, Survey of Online Resources	https://nptel.ac.in/courses/108101091
2	Arduino and Node MCU for Projects	CLO03	Video Lectures, Case Studies	https://circuitdigest.com/internet-of-things-iot-projects

10. Delivery Details of Content Beyond Syllabus[6]

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.No	Advanced Topics, Additional Reading, Research papers and any	CLO	POs	ALM	References/MOOCS
1	Developing Secure IoT Applications	CLO04	PO1, PO2, PO3, PO4, PO5, PO7, PO 11	Group work, Problem Solving	https://www.coursera.org/learn/developing-secure-iot-applications

11. Evaluation Scheme & Components:

Assessment Type[7]	Evaluation Component[8]	Type of Component[9]	No. of Assessments[10]	% Weightage of Component	Max. Marks	Mode of Assessment	CLO
Formative	Component1	Continuous Evaluations of Lab	5*	25%	25	Written Test/Viva/PPT	1 - 5
Summative	Component2	STs	2**	25%	25	Computer based Test	1 – 5
Summative	Component3	End Term Examination (ETE)	1***	50%	50	Computer based Test	1 - 5
	Total		**100%**				

* There will be two Continuous Evaluations (CE) for a lab in a semester as **CE-1 (Lab work)** and **CE-2 (Project work)**, one will be considered as continuous/day to day evaluation and another one will be based on developed project. Average marks of CE-1 and CE-2 will be taken as final marks. Lab file record, lab performance in whole semester and internal viva with experiment performance will be taken in consideration of CE-1.
* The evaluation for Continuous Evaluation **CE-1 (Lab work)** has three sub components **performance, viva** and **file**. Evaluation of performance and viva will be in two lab evaluations. These evaluations will be done in mid of semester and after ST-3 respectively. However, File work is continuously checked in each lab and is evaluated in each lab.
* The Continuous Evaluation **CE-2 (Project work)**) will compromise of three evaluations which are **Project & Title defend presentation**, **progress evaluation presentation** and **final project presentation**.

** All STs are compulsory. ST1 and ST2 have weightage of 50% out of total weightage of component 2 individually.

***It is mandatory to complete Components 1 and 2. Further, as per Academic Guidelines minimum 75% attendance is required to become eligible for

[4] Refer to Annexure
[5] Refer to Annexure
[6] Refer to Annexure
[7] Refer to Annexure 2 of NCrF
[8] Refer to Annexure
[9] Refer to Annexure
[10] Refer to Annexure

appearing in the End Semester Examination.

12. Syllabus of the Course:

Subject:			
S.No.	**Topic(s)**	**No. of Lectures**	**Weightage %**
1.	**UNIT I - Introduction to Embedded Systems** Introduction to embedded processors, features of embedded system, Embedded system characteristics and applications, Harvard & Von Neuman architectures, Architecture of Embedded System, Application specific ICs (ASICs) and basic types, Overview of Embedded Networking & Standards: RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee, Real time embedded systems and features, Soft vs Hard Real time embedded systems.`	10	20%
2	**Unit II- Microcontrollers and Programming** Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports, Addressing Modes, Instruction Set and Programming, flag bits and PSW register, Timers and Serial Port, Interrupt Handling. Arithmetic instructions and programs; logic instructions and programs	12	30%
ST-1			
3	**Unit III- Introduction to Internet of Things (IoT)** Introduction to Internet of Things, Characteristics of IoT, Application Areas of IoT, Industrial IoT, Real time analytics in iot and fog computing. Layered architecture of IoT, SOA based Architecture, API Oriented Architecture, IoT challenges, IoT Communication protocol comparison, Cloud computing, Big data, threats and vulnerabilities in IoT systems- Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms, Light weight cryptography- Symmetric Key LWC Algorithms, Asymmetric LWC algorithms	15	30%
4	**Unit IV- Arduino and Programming** Introduction to Arduino, Architecture of Arduino, Types of Arduino, Arduino Programming Structure , Bare minimum code, Variables, Serial Moitor, Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc) .	7	15%
ST-2			
5	Case Studies of Smart home automation, Smart cities, Healthcare and wearable devices	2	5%
	End Term Exam		

13. Academic Integrityy Policy:

Education at Chitkara University builds on the principle that excellence requires freedom where Honesty and integrity are its prerequisites. Academic honesty in the advancement of knowledge requires that all students and Faculty respect the integrity of one another's work and recognize the importance of acknowledging and safeguarding intellectual property. Any breach of the same will be tantamount to severe academic penalties.

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Manvinder Sharma / Dr. Danvir Mandal	
Head-Academic Delivery		
Dean DICE	Dr. Rajneesh Talwar	
Date(DD/MM/YYYY)	26/06/2025	

Annexure

1. **Pre- requisite**
   Mention The Pre-requisite skill set or course/s if it is expected to be studies before this course, otherwise write “not applicable”.

2. **NHEQF levels**

The NHEQF levels represent a series of sequential stages expressed in terms of a range of learning outcomes against which typical qualifications are positioned/located. NHEQF level 4.5 represents learning outcomes appropriate to the first year (first two semesters) of the undergraduate programme of study, while Level 8 represents learning outcomes appropriate to the doctoral-level programme of study.

Table 1: Higher education qualifications at different levels on the NHEQF

NHEQF level	Examples of higher education qualifications located within each level
Level 4.5	Undergraduate Certificate. Programme duration: First year (first two semesters) of theundergraduate programme, followed by an exit 4-credit skills-enhancement course(s).
Level 5	Undergraduate Diploma. Programme duration: First two years (first four semesters) of the undergraduate programme, followed by an exit 4-credit skills-enhancement course(s) lasting two months.
Level 5.5	Bachelor's Degree. Programme duration: First three years (Six semesters) of the four-yearundergraduate programme.
Level 6	Bachelor's Degree (Honours/ Honours with Research). Programme duration: Four years(eight semesters).
Level 6	Post-Graduate Diploma. Programme duration: One year (two semesters) for those whoexit after successful completion of the first year (two semesters) of the 2-year master's programme.
Level 6.5	Master's degree. (e.g. M.A., M.Com., M.Sc., etc.) Programme duration: Two years (four semesters) after obtaining a 3- year Bachelor's degree (e.g. B.A., B.Sc., B.Com.etc.).
Level 6.5	Master's degree. (e.g. M.A., M.Com., M.Sc., etc.) Programme duration: One year (two semesters) after obtaining a 4 - year Bachelor's degree (Honours/ Honours with Research) (e.g. B.A., B.Sc., B.Com. etc.).
Level 7	Master's degree.(e.g. M.E./M.Tech. etc.) Programme duration: Two years (four semesters) after obtaining a 4-year Bachelor's degree. (e.g. B.E./B.Tech. etc.)
Level 8	Doctoral Degree

3. NHEQF level descriptors

Each NHEQF level is structured based on the defined learning outcomes which lead to the expected graduate attributes/profile. The level descriptors reflect the expected outcomes of learning that should be achieved and demonstrated by graduates of a specific programme of study leading to a qualification at a specific NHEQF level.

Click Learning outcomes descriptors for qualification for all levels on the NHEQF

4. Course Outcomes

The number of Course Outcomes is recommended to be 4-5 for courses that do not contain practical component and 6 for those courses with a practical component. Flexibility can be sought by the post-graduate courses in this regard.

5. Theory/lab Plan

The following are the guidelines to be followed while creating plans

- Each session may be planned for a duration of 45/50mins (irrespective of the double hour or single hour scheduled in timetable).
- Every session must incorporate at least one active learning method which may or may not be part of the assessments.
- Put BoS Approved Syllabus in the topics. Deviations (if any) from BoS approved syllabus must be brought to the notice of BoS chairman & Dean Academics, After approval, revised handout should be submitted.
- The Topics elaborated in the Theory/Lab plan must match those in the course execution plan.

6. Teaching Learning Methods

The following are some of the Teaching & Learning methods that can be incorporated in session wise teaching learning plan.

- **Teacher-centered Learning Methods:**
  i. Lecture
  ii. Discussion
  iii. Demonstration method using a simulation or a tool
  iv. Reviewing
  v. Questioning

- **Learner-centered teaching & Learning methods:**
  i. **Active learning**, in which students solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during class;
  ii. **Cooperative learning**, in which students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability; and
  iii. **Inductive teaching and learning**, in which students are first presented with challenges (questions or problems) and learn the course material in the context of addressing the challenges.
  iv. **Inductive methods** include inquiry-based learning, case based instruction, problem-based learning, project-based learning, discovery learning, and just-in-time teaching. It is important to integrate authentic, reflective and collaborative learning experiences when designing for student-centered learning.

7. **Active Learning Methods**

The following are some of the Active Learning Methods that can be incorporated in session wise teaching learning plan.

- One Minute Paper
- Group Discussion
- Student-Created PPT, Charts, Matrices, Flowcharts, Models
- The Fish Bowl
- Debate
- Video Synthesis
- Quiz/Test Questions
- Brain Storming Sessions
- Case Study
- Shadowing
- Leading Question
- Puzzle, Enigma, Contradiction
- Statement-Opinion-Summary
- Think / Pair / Share
- Peer Review
- Just in Time Teaching
- Statement-Opinion-Summary
- Peer Survey
- Focused Listing
- Role-Playing
- Student Field Work with Reflection
- Infusing Humor into Class Sessions
- Inviting Effective Guest Speakers

8. Remedial Classes

After every Sessional Test, identify weak learners, provide supplement course handout. Student list and Impact Observed report should be submitted to Dean through proper channel.

9. Self Learning

Plan 10% of topics in self-learning mode with discussions, ALM's and Assessment happing in the class.

10. Content Beyond Syllabus

Plan Advanced Topics, Experiments, Additional Reading, Research papers in self-learning mode with ALM's and Assessment happing in the regular class or lab. Usually caters advanced learners. Identify Advanced learners. For Extra classes, schedule should be notified accordingly.

11. Assessment Type

1. Assessment broadly can be classified into the following types:

a. **Diagnostic assessments**: Diagnostic assessments are intended to help teachers identify what students know and can do in different domains to support their students' learning. These help teachers determine strengths of students in various areas to
better address their specific needs.
b. **Formative assessments**: Formative assessment refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, or a course. Formative assessments help teachers identify concepts that students are struggling to understand, skills they are having difficulty acquiring, or learning standards they have not yet achieved so that adjustments can be made to lessons, instructional techniques, and academic support.
c. **Summative assessments**: Summative assessment is an assessment administered at the end of an instructional unit in a course. These assessments are intended to evaluate student learning by comparing performance to a standard or benchmark.
d. **Ipsative assessments**: Ipsative assessment involves comparisons between past and current work to identify a learner's growth over time, rather than progress toward an external set of criteria. Therefore, Ipsative assessment is an internal or self-referenced assessment.
e. **Norm-referenced assessments**: Norm-referenced tests report whether test takers performed better or worse than a hypothetical average student, which is determined by comparing scores against the performance results of a statistically selected group of test takers, typically of the same age or grade level, who have already taken the exam.
f. **Criterion-referenced assessments**: Criterion-Reference tests measure the performance of test takers against the criteria covered in the curriculum.
g. **Peer-to-Peer randomised Assessments**: Peers will be able to provide assessment in this case
h. **Industry Validation of Effectiveness**: In the Vocation Education, Industry validation of effectiveness of training is particularly important.
i. **Self-assessments**: To evaluate how much the learner has grasped by self-learning.

2. Other Assessment Methods: Conducting an assessment takes time, thought, attention, planning, and often collaboration. Each assessment tool, whether a short survey or detailed rubric, will be useful only insofar as it both addresses the outcomes well and is feasible to use.

a**. Rubrics**: For assessing qualitative student work such as essays, projects, reports, or presentations. Rubrics serve well to clearly denote the specific expectations for an assignment, for collecting data for assessment of student learning outcomes. and for student performance. Rubrics can be used for grading, for providing feedback to students, and for informing and encouraging students to think about their own learning.
b. **Portfolios and E-Portfolio**: Portfolios can provide a window into the process of student learning across a semester-long project that can be assessed (usually by using a rubric).
c. **Curriculum Mapping**: A good curriculum map can serve to focus assessment, and the improvements that follow, where it will be most useful, informative, or effective.
d. **Structured Interviews**: While time-consuming, structured interviews are useful when specific questions need to be asked. It also leaves room for unplanned topics or ideas to emerge.
e. **Student Experience Surveys**: Student experience in research universities (SERU), including administration of on-line census SERU Undergraduate and Graduate Surveys, can yield important information about student perceptions and experiences.

12. Evaluation Component & Types

As per LMs we need to figure it out whether it is component 1, 2 or 3. In Types of Evaluation Component, we need to specify what type of evaluation we are performing like Continuous Evaluation or Sessional Test or End Term Examination.

13. No. of Assessments and Weightage of Components

Department will give guideline for number of assessments, mandatory or optional and weightage.