GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -V

Course Title: **Field and Service Robotics**
(Course Code:4354103)

Diploma programmer in which this course is offered	Semester in which offered
Automation and Robotics	Fifth

1. RATIONALE

According to the International Federation of Robotics (IFR), "a service robot is a robot which operates semi or fully autonomously to perform services useful to the well being of human and equipment, excluding manufacturing operations." Service is the task that characterizes this class of robots as very different from conventional industrial robots. Service is mainly devoted to benefits for humans and therefore it is identified with features of human-machine interactions and variety of operations. These two aspects have stimulated a great attention in the last decade both in research for design and in practice for applications. Those activities are still growing and the fecundity of output yields an optimistic future of developments.
The field of service robots is a promising frame to achieve mechatronic developments and understanding both from providers and users.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- To study various types of robots in field & service.
- To know the basic knowledge about humanoid robots.
- Understand various roles that robotics can play in field & service.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

CO-1	Recognize the fundamentals of fields and Service Robotics.
CO-2	Create the localization strategies and mapping technique for fields and service robots.
CO-3	Identify various Fields robots and their potential applications.
C0-4	Identify various services robots and their potential applications.
CO 5	To Know the basic knowledge about the Humanoid robots and Mobile Robots.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	0	3	30*	70	-	-	100

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit I : Introduction to Field And Service Robots	a. Describe the history of field and service robotics. b. Classify the types of field and service robots. c. Compare non conventional and conventional robots. d. Compare field robots and service robots. e. Give examples of field robots and service robots.	1.1 History of Field &Service Robotics. 1.2 Present Status and Future trends. 1.3 Field and Service Robots. ▪ Need, ▪ Classification ▪ Application, ▪ Specifications, ▪ Examples. 1.4 Non Conventional Industrial Robots. 1.5 Comparison of Field & service robots.
Unit II: Robot motion plan and navigation & Localization	a. State the difference between traditional scheme and nontraditional scheme of robots. b. Explain the given traditional scheme method. State its merit and demerit. c. Explain the given analytical approach method. State its merit and demerit.	2.1 Introduction 2.2 Motion planning scheme: ▪ Traditional scheme ▪ non-traditional scheme 2.3 Traditional scheme 2.3.1 Graph based method ▪ Visibility graph ▪ Vernoi diagram ▪ Cell decomposition ▪ Tangent graph ▪ Accessibility graph 2.3.2 Analytical approach

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	d. Explain the given nontraditional scheme method.	▪ Path velocity decomposition ▪ Incremental planning ▪ Relative velocity approach ▪ Potential field approach ▪ Reactive control strategy 2.4 Non-traditional scheme ▪ Fuzzy logic based approach ▪ Neural network based approach
Unit III: Field Robots	a. Define field robots. b. Classify the field robots. c. Describe the application of given field robot.	3.1 Basic Concept of Field Robots. 3.2 Field robots: 3.2.1 Agriculture & farming 3.2.2 Aerial Robots 3.2.3 Collision Avoidance 3.2.4 Robots for Mining, exploration 3.2.5 Underwater robots 3.2.6 Space applications 3.2.7 Undersea Operation 3.2.8 Nuclear Power Plant Service 3.2.9 Mining 3.2.10 Construction
Unit IV: Service Robots	a. Define service robots. b. Classify the service robots. c. Classify hospital service robot. d. Classify Clinical robot. e. Describe the application of given service robot.	4.1 Introduction to service robots 4.2 Service Applications 4.3 Commercial Cleaning 4.4 Fast Food Service 4.5 Gasoline Station Attendant 4.6 Guard Service 4.7 Household Tasks 4.8 Medical Application of Robots: 4.9 Hospital service robot 4.9.1 Hospital Transport Robot 4.9.2 Hospital Pharmacy Robot 4.9.3 Para pharmacist 4.9.4 Cell Culture Robot 4.10 Clinical robot 4.10.1 Para nurse 4.10.2 Para surgeon 4.10.3 The PAM Robot 4.10.4 Robot For Hip Surgery 4.10.5 Tumor Extracting Robot
Unit IV: Humanoid Robots & Mobile Robots	a. Describe the history of humanoid robots. b. Explain the characteristics of humanoid robots. c. Draw kinematic structure of humanoid robot.	5.1 Introduction to Humanoid Robots 5.1.1 Historical Development 5.1.2 Characteristics Of Humanoid robots 5.1.3 Kinematic Structure 5.2 Application of Humanoid Robots ▪ research and space exploration ▪ personal assistance and care giving

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	D. Explain the given application of humanoid robots. e. Compare legged mobile robot and wheeled mobile robots.	▪ education and entertainment ▪ search and rescue ▪ manufacturing and maintenance ▪ public relations ▪ healthcare 5.3 Future Scope Of Humanoid Robot 5.4 Legged Mobile Robots 5.4.1 Leg configurations and stability 5.4.2 Examples of legged robot locomotion 5.5 Wheeled Mobile Robots 5.4.1 Wheeled locomotion: the design space 5.4.2 Wheeled locomotion: case studies

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to Field And Service Robots**	**3**	**6**	**4**	**-**	**10**
2	**Robot motion plan and navigation & Localization**	**10**	**6**	**8**	**-**	**14**
3	**Field Robots**	**8**	**6**	**10**	**-**	**16**
4	**Service Robots**	**10**	**6**	**8**	**-**	**14**
5	**Humanoid Robots & Mobile Robots**	**10**	**6**	**12**	**-**	**18**
Total		**42**				**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- ❖ Prepare lists of filed robots with application.
- ❖ Prepare lists of services robots with applications.
- ❖ Find applications where fields and service robots are used.
- ❖ Prepare charts and diagrams of different field & service robots.
- ❖ Prepare a report on a given specified field or service robots.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Smart Cleaning Robot
2. Security robot.
3. Robot assistant.
4. Metal detector robot
5. Seed sowing robot application
6. Educational robot
7. Medical assistant / nursing robot

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Fundamentals of Robotics: Manipulators, Wheeled & legged robots	D. K. Pratihar	Narosa Publication House, New Delhi, 2022, ISBN: 978-81-8487-577-5

Sr. No	Title of Book	Author	Publication with place, year and ISBN
2	Robots in Service	Joseph f Engelberger	Springer publication ISBN 978-94-010-6985-4
3	Introduction to autonomous mobile robots	Ronald Siegwart, Illah Reza Nourbakhsh, David Scaramuzza	A Bradford Book, The MIT Press, 2004, ISBN 0-262-19502-X
4	Robots & Robotics: Principles, systems and industrial applications	Mark R Miller, Rex Miller	Tata Mc Graw Hill , ISBN: 978-1-25-985979-3

14. SOFTWARE/LEARNING WEBSITES

1. FieldPrinter - Dusty Robotics BIM-driven Layout Solution
   https://youtu.be/-qiap7KThW8?si=qgqRIKoQT1Unr1PE
2. Aigro **ROBOT** at work: Weeding at tree cultivation farm!
   https://youtu.be/CPtaEbrO78Q?si=XBbXCX--zLxBhlOm
3. Collaborative robotic arm picking grapes - Start the Smart Orchard
   https://youtu.be/DxGz3qD0Rgo?si=8R-K_VglxLpS9D3j
4. The Future of Farming Robots
   https://youtu.be/uD4mJCgsmdM?si=3nPdga2gcbe2FUGr
5. Field Trials Utah: Robot team simulates Mars mission in Utah
   https://youtu.be/pvKIzldni68?si=Xaz9NZeVxiKtmoxs
6. AGROBOT Robotic Strawberry Harvester
   https://youtu.be/M3SGScaShhw?si=Wvy1NqqYrQdyDbEI
7. Are Fruit-Picking Drones The Future Of Harvesting?
   https://youtu.be/IzaaSIEDg7s?si=GSjuNTtnwilZpDBm
8. Autonomous Spray Robot at Work on a Shropshire Farm
   https://youtu.be/Oyvdj3Dc_Io?si=LbXHAbcjcaJdUHdH
9. Universal Field Robots: 2020 Project Updates
   https://www.youtube.com/watch?v=qXJG2sjoFww
10. Fruitplukrobot PPS Handsfree production in agri-food kort
    https://www.youtube.com/watch?v=c1GTXuutvwI
11. Advance ROBOTs of the Mighty DRDO
    https://www.youtube.com/watch?v=ltVgDeClaiE
12. Indian Army का Robotic Mule
    https://www.youtube.com/watch?v=JMHW3pO2oKU
13. A perching and drilling aerial robot
    https://www.youtube.com/watch?v=eDKwBM2RLOg
14. DRDO's SWARM Robot technology | SWARM UGVs
    https://www.youtube.com/watch?v=0_l8AqzgAHE
15. Swarm Robots Cooperate with AR Drone
    https://www.youtube.com/watch?v=i3ernrkZ91E&list=RDQM_ADfxdC0nAY&index=1
16. AGILOX X-SWARM TECHNOLOGY

https://www.youtube.com/watch?v=0su28tGmPNM

Service Robotics

17. Food Service Robot in India | Inker Robotics
    https://www.youtube.com/watch?v=a7z8ZmlOqc4
18. Kitchen robot' that will cook meals from scratch unveiled
    https://www.youtube.com/watch?v=GyEHRXA_aA4
19. Meet Anna™ – The Smart Household Robot
    https://www.youtube.com/watch?v=VvRRY_vhDjE
20. Hotel Service Robot
    https://www.youtube.com/watch?v=Q_QkI8qu-GE
21. INDIA'S FIRST FULLY AUTOMATIC ROBOTIC CAFÉ
    https://www.youtube.com/watch?v=5YskLB7GL_o
22. fascinating Robotics Gallery at Gujarat Science City!
    https://www.youtube.com/watch?v=JgIwO_7vHck
23. Sona 1.5 Service robot at Modern coach factory indian railways by club first
    https://www.youtube.com/watch?v=bly5zIqnlB4
24. Robots are delivering food to your door
    https://www.youtube.com/watch?v=cZTCmx6N7Xc
25. Medical robots - the future of health care
    https://www.youtube.com/watch?v=gFA4O8I3fg8
26. FACTS about SERVICE ROBOTS - worldwide 2021
    https://www.youtube.com/watch?v=9Lr7dlNGu7I

MOOC Lecture video Link

27. Lecture 21: Trajectory Planning (youtube.com)

https://www.youtube.com/watch?v=zSvCAW-mowg&list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_&index=22

28. Lecture 22: Trajectory Planning (Contd.) (youtube.com)
https://www.youtube.com/watch?v=OVGH_e0kjSE&list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_&index=23

Wheeled and mobile robots

29.
https://www.youtube.com/watch?v=f5GMjGRsKi4&list=PLyqSpQzTE6M9CXsZljkH_lCxRSiaXF566&index=2

30.
https://www.youtube.com/watch?v=pj3ioPCYOjI&list=PLyqSpQzTE6M9CXsZljkH_lCxRSiaXF566&index=3

31. https://www.youtube.com/watch?v=m_AFbI0Iezo&list=PLyqSpQzTE6M9CXsZljkH_lCxRSiaXF566&index=31

32. https://www.youtube.com/watch?v=ZBMIGbKLi30&list=PLyqSpQzTE6M9CXsZljkH_lCxRSiaXF566&index=48

15. PO-COMPETENCY-CO MAPPING

Semester V	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long Learning
CO 1. Recognize the fundamentals of fields and Service Robotics	2	-	-	-	2	2	2
CO 2. Create the localization strategies and mapping technique for fields and service robots.	2	-	2	1	2	2	2
CO 3. Identify various Fields robots and their potential applications.	3	-	2	2	2	3	3
CO 4. Identify various services robots and their potential applications.	3	-	2	2	2	3	3
CO 5. To know the basic knowledge about the Humanoid robots and Mobile Robots.	2	-	1	1	2	2	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
1.	Mr. Jigar V Jariwala	G P Gandhinagar	**9429263408**	Jigarvjariwala32@gmail.com
2.	Mr. Tarlesh T Patel	G P Dahod	9499557944	pateltarlesh@gmai.com

BOS Resource Persons

Sr. No.	Name and Designation	Department	Contact No.	Email
1.				
2.				