

## Inter-disciplinary Specialization in Robotics (IDSR)

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An Inter-disciplinary Specialization in Robotics (IDSR) was conceived in 2011 mainly to create manpower for the future industrial needs of the country and to boost up the research environments in the area of Robotics. The plan was taken up to synergize with the funded project of “Probramme for Autonomous Robotics” (PAR) sponsored by BARC/BRNS in 2010 in order to provide infrastructural/financial supports to the students who want to fabricate/buy something. About 12-14 faculty members and about 25-30 students from the departments of Computer Science and Engineering (CSE), Electrical Engineering (EE), and Mechanical Engineering (ME) take part in the activities of PAR.

It was envisioned that the UG students from the departments of CSE, EE, ME, and integrated M. Tech students from the department of Mathematics will acquire knowledge from other disciplines which are relevant for the area of Robotics. However, the students in other departments who are admitted through JEE will be allowed to specialize in IDSR provided they plan their course accordingly. Under the “Open category credits” of the institute a student will be allowed to exercise the IDSR option, where a student has to complete 20 credits. Through this specialization it is expected that the students will have much broader and comprehensive understanding about the subject of Robotics and will be able to take up much challenging career either in industries or in research. After several rounds of discussions in BUGS and Senates, it was finally approved in 2013. However, due to sabbatical leaves by 1-2 key faculty members, the administrative responsibilities to other few key faculty, and the implementation of the new curriculum, it has not began. It is now proposed to be considered by the senate.

In order to fulfil the above sated objectives, a new course on “Robotics Technology” and “Mini-Project in Robotics” will be floated as new core courses which will enable students from single or multiple departments come together to form teams and work in the area of robotics. It is expected that the course along with the mini project will actually make the students appreciate the inter-disciplinary nature of the area, i.e., robotics. In fact, it may not be irrelevant to mention that the students of the above departments have been already working together since 2003 in order to take part in one of the toughest robotic competitions in India, i.e., Robocon. The present IDSR will provide the students an opportunity to pursue similar collaborations for academic purposes.

The above core course on Robotics Technology and the Mini Project will be coordinated by a coordination committee comprising of one faculty member from each of the participating departments, i.e., CSE, EE, and ME.

### Eligibility/Restrictions

Any student of IIT Delhi admitted through JEE is eligible for IDSR. A student needs to complete 20 credits.

### Courses (will be updated with new courses and course numbers)

	ME Students	EE Students	CSE/Mathematics Students	Other Students
Core 1	CSP 315 Embedded System Design Laboratory (0-1-6, 4 credits) or EEL375 Embedded Systems (3-0-4, 5 credits)	MEL211 Kinematics and Dynamics of Machines (3-0-2, 4 credits)	EEL301 Control Engineering – I (3-1-0, 4 credits) or MEL312 Control Theory and Applications (3-1-2, 5 credits)	Select any of the Core 1 courses on the left. Since the course may have pre-requisites, plan in advance.
Core 2 (new)	JRL310 Robotics Technology (3-0-0, 3 credits)			

Core 3 (new)	JRD301 Mini Project in Robotics (7 credits)			
Electives	Select 8-9 credits	Select 9 credits	Select 8-9 credits	Select 8-9 credits

### Electives:

Any number of courses from the following list to complete 20 credit requirements of the IDSR.

CSL201 Data Structures (3-0-2, 4 credits)  
 CSL333 Artificial Intelligence (3-0-2, 4 credits)  
 CSL740 Software Engineering (3-0-2, 4 credits)  
 CSL840 Computer Vision (3-0-2, 4 credits)  
 CSL852 Computational Geometry (3-0-2, 4 credits)  
 CSL864 Special Topics in Artificial Intelligence (3-0-2, 4 credits)

EEL482 Mechatronics (3-0-0, 3 credits)  
 EEL704 Robotics and Automation (3-0-0, 3 credits)  
 EEL705 Embedded System and Applications (3-0-0, 3 credits)  
 EEL709 Pattern Recognition (3-0-0, 3 credits)  
 EEL715 Image Processing (3-0-2, 4 credits)  
 EEL771 Random processes in Control and Estimation (3-0-0, 3 credits)  
 EEL781 Neural Networks (3-0-0, 3 credits)  
 EEL806 Computer Vision (3-0-2, 4 credits)  
 EEL853 Agent Technology (3-0-0, 3 credits)

MAL353 Algebraic Methods in Computer Science (3-1-0, 4 credits)  
 MAL380 Numerical Linear Algebra (3-1-0, 4 credits)  
 MAL715 Digital Image Processing (3-0-2, 4 credits)  
 MAL745 Software Engineering (3-0-2, 4 credits)

MEL411 Mechatronics (3-0-2, 4 credits)  
 MEL413 Design of Mechanisms (3-1-0, 4 credits)  
 MEL739 Mechanics of Robot (3-0-2, 4 credits)  
 MEL749 Mechatronic Product Design (3-0-2, 4 credits)

### Participating Faculty

CSE: K. Paul, S. Banerjee, P. Kalra; EE: S. Chaudhary, S. Dutta Roy, I.N. Kar, Brijesh Lal, S. Bhasin; ME: S.K. Saha, S. Mukherjee, S. Jha, and J. Khatait

### **Administration:**

Based on the feedbacks from the departments/centres and the discussion in the BUGS and Senate meetings, the following policy will be followed to run the IDSR:

- A coordination committee comprising of one faculty member from each of the participating departments (CSE, EE, and ME) will be coordinating the activities of the IDSR. The committee will not only float the core course on Robotics Technology but also manage the floating and evaluation of the Mini Project.

## COURSE TEMPLATE

<b>1.</b>	<b>Department/Centre proposing the</b>	Inter-disciplinary Specialization in Robotics (IDSR)
<b>2.</b>	<b>Course Title</b> ( <i>&lt; 45 characters</i> )	ROBOTICS TECHNOLOGY
<b>3.</b>	<b>L-T-P structure</b>	3-0-0
<b>4.</b>	<b>Credits</b>	3
<b>5.</b>	<b>Course number</b>	JRL 301
<b>6.</b>	<b>Status</b> ( <i>category for program</i> )	Core for the students of IDSR.

<b>7.</b>	<b>Pre-requisites</b> ( <i>course no./title</i> )	EC80
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<b>8.</b>	<b>Status vis-à-vis other courses</b> ( <i>give course number/title</i> )	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	NO

<b>9.</b>	<b>Not allowed for</b> ( <i>indicate program names</i> )	Other than the students of IDSR
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<b>10.</b>	<b>Frequency of offering</b>	<input type="checkbox"/> Every sem <input type="checkbox"/> 1 <sup>st</sup> sem <input type="checkbox"/> 2 <sup>nd</sup> sem <input checked="" type="checkbox"/> Either sem
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<b>11.</b>	<b>Faculty who will teach the course</b> S.K. Saha, S. Mukherjee, S. Chaudhury, I.N. Kar, S. Dutta Roy, K. Paul, S. Bhasin, J.Khatait
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<b>12.</b>	<b>Will the course require any visiting faculty?</b>	No
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<b>13.</b>	<b>Course objective</b> ( <i>about 50 words</i> ): To be able to correlate the knowledge from different domains for the application in Robotics.
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<b>14.</b>	<b>Course contents</b> ( <i>about 100 words</i> ) ( <i>Include laboratory/design activities</i> ): Types of robots (serial, parallel, mobile, walking machines, etc.). Robot components (Sensors including robot vision, Actuators). Kinematic constraints, Degree of freedom (DOF) and Mobility. DH parameters, Coordinate transformations, Matrix methods. Forward kinematics of robot manipulators with examples. Inverse kinematics. Jacobian and singularity. Robot Dynamics. Trajectory planning. Position, velocity and force control. Computed Torque control. Linear and Nonlinear controller design of robot. Control hardware and integration. Programming.
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**15. Lecture Outline** *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Types of robots (Serial, Parallel, Mobile, Walking m/cs, etc.)	2
2	Sensors (including robot vision)	5
3	Actuators (Pneumatic, Hydraulic, Electric)	3
4	Kinematic constraints, DOF and Mobility	2
5	DH Parameters, Coordinate Transformation, Matrix methods	4
6	Forward kinematics of robot manipulators with examples	4
7	Forward and inverse kinematics, Jacobian and Singularity	4
8	Robot dynamics	2
9	Trajectory planning	2
10	Position, velocity and force control	5
11	Computed torque control	2
12	Linear and non-linear control design	3
13	Control hardware (microcontrollers, etc.) and integration	2
14	Programming	2
COURSE TOTAL (14 times 'L')		42

**16. Brief description of tutorial activities**

Not Applicable (NA)
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**17. Brief description of laboratory activities**

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

**18. Suggested texts and reference materials**

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Saha, S.K., Introduction to Robotics, 2 <sup>nd</sup> Edition, McGraw-Hill Higher Education in India, New Delhi, 2014
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Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson, Delhi, 3 <sup>rd</sup> Edition, 2009
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**19. Resources required for the course** *(itemized & student access requirements, if any)*

19.1	Software	MATLAB, RoboAnalyzer, ReDySim, ADAMS, RecurDyn
19.2	Hardware	Nil
19.3	Teaching aides (videos,	Nothing specific

	etc.)	
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	LCD projector
19.7	Site visits	No

**20. Design content of the course** *(Percent of student time with examples, if possible)*

20.1	Design-type problems	15%
20.2	Open-ended problems	10%
20.3	Project-type activity	15%
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	No

Date:

(Signature of the Head of the Department)

## COURSE TEMPLATE

<b>1.</b>	<b>Department/Centre proposing the</b>	Inter-disciplinary Specialization in Robotics (IDSR)
<b>2.</b>	<b>Course Title</b> ( <i>&lt; 45 characters</i> )	MINI PROJECT IN ROBOTICS
<b>3.</b>	<b>L-T-P structure</b>	0-0-8
<b>4.</b>	<b>Credits</b>	4
<b>5.</b>	<b>Course number</b>	JRD301
<b>6.</b>	<b>Status</b> ( <i>category for program</i> )	Core for the students of IDSR

<b>7.</b>	<b>Pre-requisites</b> ( <i>course no./title</i> )	EC80, Robotics Technology
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<b>8.</b>	<b>Status vis-à-vis other courses</b> ( <i>give course number/title</i> )	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

<b>9.</b>	<b>Not allowed for</b> ( <i>indicate program names</i> )	Other than the students of IDSR.
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<b>10.</b>	<b>Frequency of offering</b>	<input checked="" type="checkbox"/> Every sem <input type="checkbox"/> 1 <sup>st</sup> sem <input type="checkbox"/> 2 <sup>nd</sup> sem <input type="checkbox"/> Either sem
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<b>11.</b>	<b>Faculty who will teach the course</b> S.K. Saha, S. Mukherjee, S. Chaudhury, I.N. Kar, S. Dutta Roy, K. Paul
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<b>12.</b>	<b>Will the course require any visiting faculty?</b>	No
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<b>13.</b>	<b>Course objective</b> ( <i>about 50 words</i> ): To encourage student to apply their knowledge to a very specific application in robotics. This course is to provide the students the opportunity to integrate their knowledge form different domains. For example, a mechanical student who will be doing this project should have the scope to use some of his/her knowledge from EE or CSE course to come up with a reasonably complete solution for the problem at hand.
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<b>14.</b>	<b>Course contents</b> ( <i>about 100 words</i> ) ( <i>Include laboratory/design activities</i> ): Hardware of software based activities.
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**15. Lecture Outline** (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Nothing specific	
2		
3		
4		
5		

6		
7		
COURSE TOTAL (14 times 'L')		

**16. Brief description of tutorial activities**

Not Applicable (NA)

**17. Brief description of laboratory activities**

Module no.	Experiment description	No. of hours
1	NA	
2		
3		
4		
5		
6		
COURSE TOTAL (14 times 'P')		

**18. Suggested texts and reference materials**

STYLE: Author name and initials, Title, Edition, Publisher, Year.

NIL

**19. Resources required for the course** (*itemized & student access requirements, if any*)

19.1	Software	Whatever available
19.2	Hardware	Whatever available
19.3	Teaching aides (videos, etc.)	Nothing specific
19.4	Laboratory	Nil
19.5	Equipment	Nil
19.6	Classroom infrastructure	Nil
19.7	Site visits	No

**20. Design content of the course** (*Percent of student time with examples, if possible*)

20.1	Design-type problems	20%
20.2	Open-ended problems	20%
20.3	Project-type activity	100%
20.4	Open-ended laboratory work	No
20.5	Others (please specify)	No

Date:

(Signature of the Head of the Department)