# MECHATRONICS ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL
P.O. SRINIVASNAGAR, MANGALORE -575025
KARNATAKA, INDIA

# About Mechatronics Engineering Program

The first interdisciplinary Masters program in the department was started in Mechatronics Engineering in the year of 2008 with the annual intake of 27 students. The program emphasizes on fundamental principles of Mechanical, Electrical, Electronics and Computer Engineering required in the field of Mechatronics Engineering for various applications. Students are encouraged to do projects in their course work to get experiential learning. Many of the courses are attached with laboratory to give a "Do It Yourself" experience to the students. Students undergo training in various industries during internships, and get exposure of various avenues in Mechatronics Engineering applications. The program has traversed path of knowledge dissemination and the generation as well as delivering the well qualified mechatronics engineering post graduates to the nation.

# Department Vision and Mission

## Vision

Create globally competent mechanical engineers capable of working in an interdisciplinary environment, contributing to society through innovation, entrepreneurship and leadership

## Mission

1) Produce Mechanical Engineers with a strong theoretical and practical knowledge to contribute to society with high moral and ethical values
2) Nurture students with a global outlook for a sustainable future and sound health.
3) Enable to be productive members of interdisciplinary teams, capable of adapting to changing environments of engineering, technology and society.
4) Inculcate critical and deep-thinking abilities among students and develop entrepreneurial skills, innovative ideas and leadership qualities.
5) Create facilities for continued education, training, research and consultancy

# Program Educational Objectives (PEOs)

PEO-1: Create ability in students to design, develop products and applications involving mechatronics and be able to use engineering tools that will enhance their productivity

PEO-2: Inculcate to review the fundamentals of Mechanical, Electrical, electronics and communication, computer science and their integration to develop mechatronics systems

PEO-3: Prepare students to be effective engineers with good analytical and problem-solving skill to innovate, research and develop in multidisciplinary environment

PEO-4: Create awareness of societal and the environmental implications and make them suitable for engineering career in industrial environs as well as for pursuing higher academics

# Program Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

# Faculty Members (Mechatronics Engineering)

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|---|---|
| **S.M. Kulkarni, Ph.D. (IISc- Bangalore)**<br>**Professor**<br>**Research Interests:** Mechanisms and Machine Design CAD, Composite Materials, Product Development and MEMS<br>**Mobile:** +919449086656<br>**Mail-id:** smk@nitk.edu.in | |
| **K.V. Gangadharan, Ph.D. (IIT- Madras)**<br>**Professor**<br>**Research Interests:** Vibration and Control Dynamics, FEM, Condition Monitoring, Experimental Methods in Vibration<br>**Mobile:** +919448478752<br>**Mail-id:** kvganga@ nitk.edu.in | |
| **Vijay H. Desai, Ph.D. (NITK- Surathkal)**<br>**Professor**<br>**Research Interests:** Composite Materials,Functionally Graded Materials, Machining, Sensors and Actuators, Manufacturing Processes<br>**Mobile:** +919449332960<br>**Mail-id:** vijayhdesai64@nitk.edu.in | |
| **Srikantha S. Rao, Ph.D. (NITK- Surathkal)**<br>**Professor**<br>**Research Interests:** Artificial Intelligence in anufacturing<br>**Mobile:** +919448302579<br>**Mail-id:** ssrcsr@nitk.edu.in | |
| **Mervin A. Herbert, Ph.D. (IIT- Kharagpur)**<br>**Associate Professor**<br>**Research Interests:** Friction Stir Welding, Semi solid processing of composites, applications of Artificial Neural Network<br>**Mobile:** +919481213227<br>**Mail-id:** merhertoma@nitk.edu.in | |
| **K.R. Guruprasad, Ph.D. (IISc- Bangalore)**<br>**Associate Professor (On Lien)**<br>**Research Interests:** Robotics, Multi- agent (robot) systems, Voronoi partition, Physics of Musical instruments<br>**Mobile:** +919449378018<br>**Mail-id:** krgprao@nitk.edu.in | |

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|---|---|
| **P. Navin Karanth, Ph.D. (NITK- Surathkal)** <br> **Associate Professor** <br> **Research Interest:** CAD,CAM, CAE, Hydraulics and Pneumatics Mechatronics System Design, AI, Medical Devices, Automation & PLC <br> **Mobile:** + 919449085052 <br> **Mail-id:** navinkaranth.p@nitk.edu.in | |
| **Arun Kumar Shettigar, Ph.D. (NITK- Surathkal)** <br> **Assistant Professor** <br> **Research Interests:** Friction Stir Welding/ Processing, Additive friction stir deposition, micro machining, Machinability study, Artificial intelligence <br> **Mobile:** +919731652895 <br> **Mail-id:** akshettigar@nitk.edu.in | |
| **Mruthynjaya Swamy K. B., Ph.D. (IIT-Kharagpur)** <br> **Assistant Professor** <br> **Research Interests:** Development of Micro and Nanodevices, Systems and technologies, design, Microfabrication, PAckaging and testing of MEMS sensors/Actuators Technology and Process development of probe-assisted Nano-Lithography Technique <br> **Mobile:** +919483006499 <br> **Mail-id:** swamy_kbm@nitk.edu.in | |
| **Khyati Verma, Ph.D. (IIT-Delhi)** <br> **Assistant Professor** <br> **Research Interests:** Impact Biomechanics, Head Trauma, Mechanical Behaviour of soft tissues under impact tissue biomechanics, Constitutive modelling, Finite element Modelling <br> **Mobile:** +91 9711843988 <br> **Mail-id:** kverma@nitk.edu.in | |

## Current Research Areas

- Medical device development such as Ulnar Neuropathy Device, A Nerve Trimming Kit Micro pump, exoskeleton etc.
- Automation & IOT
- Robotics path planning, 3D printing using robot
- Artificial Intelligence and Machine Learning
- Sensors development, Actuator applications in Pneumatics, Hydraulics, BLDC, SRM etc
- Smart Materials, Piezoelectric and Magneto Rheological Device
- MEMS, Nano Materials and Precision Engineering
- Automotive Electronics, E-Mobility, Autonomous Vehicle
- Vehicle Dynamics, Condition Monitoring, Fracture Mechanics, Structural Health Monitoring

# Completed R&D Projects

| Sl No. | Project Title, Duration, Funding Agency | Amount ( Lakhs) |
|---|---|---|
| 1. | Magneto Rheological Fluid, Funding Agency: - MHRD, Investigators: K.V. Gangadharan, Ravikiran Kadoli and Vijay H. Desai | 16.00 |
| 2. | Active Vibration Control of Flexible Structures using Magnetostrictive Materials, Funding Agency: - MHRD, Investigators: K. V. Gangadharan, Ravikiran Kadoli and Vijay H. Desai. | 15.00 |
| 3. | FIST program on setting up of 'Composites Laboratory', Funding Agency: DST, Investigators: - S.M.Kulkarni and Vijay H. Desai | 35.45 |
| 4. | Development of Dynamics Laboratory, Funding Agency: MHRD, Coordinator: K.K. Appukuttan and K. V. Gangadharan. | 20.00 |
| 5. | Fabric bag filter, Funding Agency: - Thermax, Pune, Investigators: K.V. Gangadharan, Ravikiran Kadoli and Vijay H. Desai. | 10.00 |
| 6. | Design Of Oil Skimming Application With Super Hydrophobic Sponge, Dr. Pruthviraj U (PI) App Mech, Dr. K V Gangadharan (CO.PI), MRPL 2019-2021. | 44.00 |
| 7. | TPEM - FAME India Scheme - "Switched Reluctance Motor & Controller For 2W & 3W", 2018-2021Dr. K V Gnagadharan (PI) , Co Pis Dr. Jeyaraj , Dr. Navin Karanth, Dr. Venkitesh Perumal (EE), Dr. Suresh Y, (EE) , Dr. Krishnan C (EE) + Mr. Srinivas . Ms/ Aditya Auto Dept. of Heavy Industries , 2018-2021. | 1700.00 |
| 8. | Virtual Lab Phase III, Dr. K V Gangadharan(PI), Dr. Pruthviraj (AppMech), Dr. Mohit T (CS), NMEICT(MHRD), 2017-2021 | 100.00 |
| 9. | Sensors, Actuators and Controllers for an Industrial Automation Laboratory PI. Prof Vijay Desai & Dr. Navin Karanth P. 2016-2021 | 235.00 |
| 10. | Virtual Lab Phase II, Dr. K V Gangadharan(PI), Dr. Pruthviraj (AppMech), Dr. Mohit T (CS), NMEICT(MHRD), 2015-2020 | 400.00 |
| 11. | Design Innovation Center PI: Prof. S. M. Kulkarni, MHDR 2017-2020 | 75.00 |

# Ongoing and sanctioned R&D Projects

| Sl No. | Project Title, Duration, Funding Agency | Amount ( Lakhs) |
|---|---|---|
|  | Development Of Brushless Dc (Bldc) Motors For An Automotive Power Window Application, Dr. K V Gnagadharan (PI) + Mr. Srinivas (Co PI) . Ms/ Aditya Auto, Dept. of Heavy Industries, 2020-2022. | 375.00 |
| 2. | Explore – Experiential Learning Reengineered, IITM Allumni Association (IITMAA), PI: Prof. Gangadharan K V,  Co-PIs: Dr. Sheena (SOM) and Dr. Pruthviraj U (WROE), , 2020-2024 | 24.00 |
| 3. | E Mobility, NITK+NITKAlumni, PI: Prof. Gangadharan K V and Co-PI: Dr. Pruthviraj U (WROE), 2020-2023 | 15.00 |
| 4. | Fight Against CoVID19 – Face Shield, ONGC, NMPT, OMPL, MRPL, Stratasys, PI: Prof. Gangadharan K V and Co-PI: Dr. Pruthviraj U (WROE), 2020-2022. | 44.00 |
| 5. | Comparative analysis of different Control strategies to finalize the effective control law for Augmentative Exoskeleton. PI. Dr. K R Guruprasad, DRDO 2021-2023 | 24.38 |

# Laboratories and Facilities

| Name of Laboratory | Equipment and Software |
|---|---|
| **Mechatronics Studio** | Microprocessor kits, PLC and Robot kits, Servo Drives, Lead screws, spindle drives. NI Elvis board III, HMI pannel, Micro machining. |
| **CAD Laboratory** | AUTOCAD, ANSYS, ADAMS, DEFORM, EES, NIST-REFPROP, SIMPACK, |
| **Bosch Automotive Electronics Laboratory** | LabCAR, Engine ECU EDC17C55 with ETK, Break out box, Engine : 2.2L 103kw mHawk XUV 5OO BS4 mHawk140, CRDI engine 5th generation Variable Geometry Turbo charger (VGT) with eddy current Dyno |
| **Micro System Laboratory (Design Innovation Center)** | FDM based Rapid Prototyping Machine, Laser engraving Machine, 20Sim Software, |
| **Automation Laboratory 1** | Multi function sensor development tool XDK kit (05 Nos) Table top programmable 4 axes CNC turning and milling machine (01 Nos.) Flexible Manufacturing System Module Desktop Computer with Factory I/O |
| | Vision based Quality Inspection Camera, Component Inspection Platform, Inspection Interface Unit |
| | Robot mobile training cell Standard Robotic cell Automation Studio software and Automation Studio I/O Interface Box Ethernet KRL 2.2 |
| | Robot Sensor Interface 3.3 |
| | Fused deposition modeling setup for Robotic 3D printing |
| **Automation Laboratory 2** | Hydraulic Control Module Pneumatic Control Module, Fluidic muscle with fittings Electro-pneumatic pressure regulator (EPR), Accessories, Air Pressure, Distribution IoT Controller Kit with Software IoT Sensors, Pressure, flow, temperature, Aqua sensors with manifold and couplings Sensorics Module Thermal Imager Laser Distance sensor ModBus Data Logger with Software and Wifi Transmission NI DAQ for analog input, output, bridge and chassis Delta controller - with IO capabilities, communication port: built in RS232,RS485 |
| **Bosch Power tools laboratory** | Bosch power tools for metal, wood and concrete working, |
| **Center for System Design** | NI Elvis board II, NI Data Acquisition cards, modules, NI- Virtual Instrumentation software, Kistler Cutting Tool Dynamometer, shakers, BLDC, Stepper, Servo, Piezo, Magnetostrictive, actuators |

# Siemens Centre of Excellence in Automation

| Name of Laboratory | Equipment and Software |
|---|---|
| **Product Digitalization Lab & Process Digitalization Lab** | NX Academic Perpetual License Core |
| **Advanced Analysis Lab-Software/ Hardware** | Simcenter 3D Academic Bundle, Simcenter STAR CCM |
| **Advanced Analysis Lab- Hardware** | PCB 356A02 Triaxial, general purpose ICP® accelerometer |
| **Factory Automation Lab** | S7 1200 PLC & S7 1500 PLC with HMI, PLC Software |
| **Mechatronics Lab** | Mechatronics Modular Manufacturing System consisting of: Feeder Station, Inspection Station, Buffer Station, Processing Station, Sorting Station, Compressor, Tool kit, SIMATIC S7-1200 PLC and Siemens TIA Portal Software. |
| **Prototype Lab** | 3D Scanner, Coordinate Measuring Machine |

AGV based FMS Module
from MTAB Engineers (P)
Ltd.



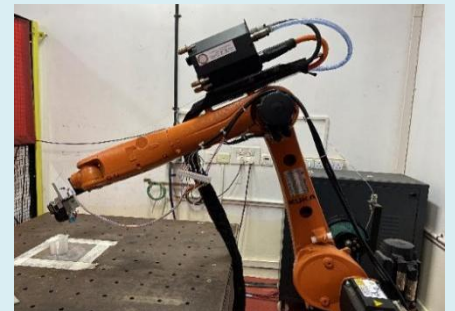Component Inspection
Platform



Sensorics Module from
Pepperl & Fuchs (India)
Pvt. Ltd



Hydraulic Control Module
from Bosch Rexroth (India)
Pvt. Ltd



Pneumatic Control Module
from Bosch Rexroth (India)
Pvt. Ltd



Standard Robotic cell
intergrated with complete
MIG welding unit  from
KUKA robot



Robot mobile training cell-
Full module from KUKA
robot



Barcode Readers



Positioning System



Sensors Kit



Position Guide Vision Kit



Radio Frequency
Identification Kit

# Consultancy Potential

- System modeling of mechatronic applications
- Artificial intelligence and Machine learning for manufacturing and medical applications
- Device development for biomedical applications
- Micro machining applications for MEMS devices
- Computer Aided Design and Manufacturing solutions for 3 and 5 axis applications
- Virtual Instrumentation, Condition monitoring and Diagnostics
- Robot motion control and path planning solutions
- Vibration analysis of machineries and equipment

# MOUs Partners

1. National Instruments India (NI)
2. Volvo India, Bangalore (Academic Preferred Partner) NITK is the only partner in India and 9th partner globally
3. Moog India Technology Centre Bangalore (MITC)
4. ProSIM R&D Ltd Bangalore
5. Larsen & Toubro Limited (L&T Construction), India
6. AB Volvo Group Sweden
7. Robert Bosch Engineering and Business Solutions Limited (RBEI), Bangalore
8. Mercedes-Benz Research and Development Indian Private Limited (MBRDI), Bangalore
9. Institute National DE LA Recherche Agronomique (INRA), France
10. Council of science and industrial research: Center for glass and ceramics research institute (CSIR-CGCRI), Kolkata
11. Bhabha Atomic Research Center (BARC), Mumbai
12. National Aerospace Laboratories (NAL), Bangalore
13. Central Power Research Institute (CPRI), Bangalore
14. Central Manufacturing Technology Institute (CMTI), Bangalore

# Research Publications (2020-22)

1. Karthik Rao M C, Rashmi L Malghan, Arun Kumar Shettigar, Shrikantha S Rao & Mervin A Herbert (2022) Application of back propagation algorithms in neural network based identification responses of AISI 316 face milling cryogenic machining technique, Australian Journal of Mechanical Engineering, 20:3, 698-705, DOI: 10.1080/14484846.2020.1740022

2. B. Mukherjee, K. B. M. Swamy and S. Sen, &quot;A New Analysis on Reduction of Undesired Beam Bending in Electrostatic Comb Drive MEMS Actuator,&quot; in IEEE Transactions on Instrumentation and Measurement, vol. 69, no. 2, pp. 488-500, Feb. 2020

3. M Manvi, K. B. M. Swamy, "Microelectronic materials, microfabrication processes, micromechanical structural configuration based stiffness evaluation in MEMS: A review", Microelectronics engineering, Volume 263, 2022, 111854

4. Yashas M; Do Rosario Carvalho A.D; and Navin Karanth P, "Desai V. Design and Fabrication of a Test Rig for Performance Analysis of a Pneumatic Muscle Actuator", Lecture Notes in Mechanical Engineering, DOI: 10.1007/978-981-15-4739-3_3, vol 23, pp 33-45, 2021.

5. Mohith S; Upadhya A.R; Navin K.P; Kulkarni S.M; and Rao M, "Recent trends in piezoelectric actuators for precision motion and their applications: a review", Smart Materials and Structures, DOI:10.1088/1361-665X/abc6b9, vol 30, no 13002, 2021.

6. S. Mohith, A. R. Upadhya, K. P. Navin, S. M. Kulkarni, and M. Rao, "Recent trends in piezoelectric actuators for precision motion and their applications: a review," Smart Materials and Structures, vol. 30, no. 1, 2021, doi: 10.1088/1361-665X/abc6b9.

7. S. Kumawat, S. Bhaktha, and K. V. Gangadharan, "Enhancing Torque performance with Dual Teeth Switched Reluctance Motor: A Novel Approach," 2021. doi:10.1109/IPRECON52453.2021.9640842.

8. U. R. Poojary and K. V. Gangadharan, "Material modeling of frequency, magnetic field and strain dependent response of magnetorheological elastomer," Journal of Materials Science, vol. 56, no. 28, pp. 15752 15766, 2021, doi: 10.1007/s10853-021-06307-0.

9. S. Mohith, N. Karanth P, S. M. Kulkarni, V. Desai, and S. S. Patil, "Performance comparison of piezo actuated valveless micropump with central excitation and annular excitation for biomedical applications," Smart Materials and Structures, vol. 30, no. 10, 2021, doi: 10.1088/1361-665X/ac1dbe.

10. K. N. Ravikumar, C. K. Madhusudana, H. Kumar, and K. V. Gangadharan, "Classification of gear faults in internal combustion (IC) engine gearbox using discrete wavelet transform features and K star algorithm," Engineering Science and Technology, an International Journal, vol. 30, 2022, doi: 10.1016/j.jestch.2021.08.005.

11. M. S, N. K. P, and S. M. Kulkarni, "Analysis of annularly excited bossed diaphragm for performance enhancement of mechanical micropump," Sensors and Actuators A: Physical, vol. 335, 2022, doi: 10.1016/j.sna.2022.113381.

12. Subramanya R Prabhu, Arun Shettigar, Mervin A Herbert &amp; Shrikantha S Rao (2022) Influence of machine variables on the microstructure and mechanical properties of AA6061/TiO2 friction stir welds, Advances in Materials and Processing Technologies, DOI: 10.1080/2374068X.2022.2094072.

13. H. Nejkar and K. B. M. Swamy, "Theoretical Estimation of Elastic Characteristics of Natural Reinforced Composite- A Comparative Analysis," IOP Conf. Ser. Mater. Sci. Eng., vol. 1248, p. 012083,2022, doi: 10.1088/1757-899X/1248/1/012083.

14. Allien V; Kumar H; and Desai V, "Free vibration analysis and selection of composite for high strength and stiffness using multi-attribute decision making", International Journal of Materials Research, DOI:10.3139/146.111879, vol 112, pp 189-197, 2021.

15. Rao M; Malghan R.L; Shettigar A.K; and Herbert M.A, "Rao S.S. Advantages of cryogenic machining technique over without-coolant and with-coolant machining on SS316",Engineering Research Express, DOI:10.1088/2631-8695/abecd6, vol 3, no 15040,2021.

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