

# Bekir Bediz

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## CONTACT INFORMATION

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## ACADEMIC

**Sabanci University (SU)**, Istanbul, Turkey

Assistant Professor, Mechatronics Engineering, August 2016 — Present

**Carnegie Mellon University (CMU)**, Pittsburgh, PA, USA

Post-doctoral Research Associate, Mechanical Engineering, February 2015 — July 2015

**Advisor:** Prof. O. Burak Ozdoganlar

Ph.D., Mechanical Engineering, December 2014

**Dissertation:** Three dimensional dynamics of micro tools and miniature ultra-high-speed spindles

**Advisor:** Prof. O. Burak Ozdoganlar

**Expertise:** Structural dynamics, rotor dynamics, vibrations, experimental modal analysis, micro-manufacturing.

**GPA:** 4.00/4.00

**Middle East Technical University (METU)**, Ankara, Turkey

M.Sc., Mechanical Engineering, July 2009

**Dissertation:** In vivo human tibial bone strength measurement by modal vibration analysis

**Advisors:** Prof. H. Nevzat Ozguven, Prof. Feza Korkusuz

**Expertise:** Structural dynamics, vibration, experimental modal analysis

**GPA:** 3.86/4.00

B.S., Mechanical Engineering, June 2006

**GPA:** 3.86/4.00

## JOURNAL PUBLICATIONS

**Bediz, B.**, Romero, L. A., Ozdoganlar, O. B., 2015, 'Three dimensional dynamics of rotating structures under mixed boundary conditions', *Journal of Sound and Vibration*, v.358(8), pp. 176–191.  
(doi:10.1016/j.jsv.2015.08.015)

**Bediz, B.**, Gozen, B. A., Korkmaz, E., Ozdoganlar, O. B., 2014, 'Dynamics of ultra-high-speed (UHS) spindles used for micromachining', *International Journal of Machine Tools and Manufacture*, v.87, pp. 27-38.  
(doi:10.1016/j.ijmactools.2014.07.007)

**Bediz, B.**, Korkmaz, E., Ozdoganlar, O. B., 2014, 'An impact excitation system for repeatable, high-bandwidth modal testing of miniature structures', *Journal of Sound and Vibration*, v.333, pp. 2743-2761.  
(doi:10.1016/j.jsv.2014.02.022)

Filiz, S., **Bediz, B.**, Romero, L. A., Ozdoganlar, O. B., 2014, 'Three dimensional dynamics of pretwisted beams: A spectral-Tchebychev solution', *Journal of Sound and Vibration*, v.333, pp. 2823-2839.  
(doi:10.1016/j.jsv.2014.01.010)

- Korkmaz, E., **Bediz, B.**, Gozen, B. A., Ozdoganlar, O. B., 2014, 'Dynamic characterization of multi-axis dynamometers', *Precision Engineering*, v.38(1), pp. 148-161.  
(doi:10.1016/j.precisioneng.2013.08.006)
- Bediz, B.**, Korkmaz, E., Khilwani, R., Donahue, C., Erdos, G., Falo Jr., L. D., Ozdoganlar, O. B., 2014, 'Dissolvable microneedle arrays for intradermal delivery of biologics: fabrication and application', *Pharmaceutical Research*, v.31(1), pp. 117-135.  
(doi:10.1007/s11095-013-1137-x)
- Suphekar, S. D., Gozen, B. A., **Bediz, B.**, Ozdoganlar, O. B., Skerlos, S. J., 2013, 'Feasibility of supercritical carbon dioxide based metalworking fluids in micromilling', *Journal of Manufacturing Science and Engineering*, v.135(2), 024501.  
(doi:10.1115/1.4023375)
- Filiz, S., **Bediz, B.**, Romero, L. A., Ozdoganlar, O. B., 2012, 'A spectral-Tchebychev solution for three-dimensional vibrations of parallelepipeds under mixed boundary conditions', *Journal of Applied Mechanics*, v.79(5), 051012.  
(doi:10.1115/1.4006256)
- Bediz, B.**, Kumar, U., Ozdoganlar, O. B., and Schmitz, T. L., 2012, 'Modeling and experimentation of three-dimensional dynamics of endmills', *International Journal of Machine Tools and Manufacturing*, v.53(1), pp. 39-50.  
(doi:10.1016/j.ijmactools.2011.09.005)
- Bediz, B.**, Ozguven, H. N., and Korkusuz, F., 2009, 'Vibration measurements predict the mechanical properties of tibia', *Journal of Clinical Biomechanics*, v.25, pp. 365-371.  
(doi:10.1016/j.clinbiomech.2010.01.002)
- CONFERENCE PUBLICATIONS
- Korkmaz, E., Gozen, B. A., **Bediz, B.**, Ozdoganlar, O. B., 2015, 'High-frequency compensation of dynamic distortions in micromachining force measurements', *North American Manufacturing Research Conference*.
- Bediz, B.**, Ozdoganlar, O. B., 2015, 'Modeling three-dimensional dynamics of rotating micro endmills including attachment errors', *International Conference on Micromanufacturing*.
- Hao, B., Korkmaz, E., **Bediz, B.**, Ozdoganlar, O. B., 2014, 'A novel test artifact for performance evaluation of additive manufacturing processes', *American Society for Precision Engineering Conference*.
- Korkmaz, E., **Bediz, B.**, Gozen, B. A., Ozdoganlar, O. B., 2014, 'Accurate measurement of micromachining forces through high frequency correction of multi-axis dynamometers', *Proceedings of International Conference on Micromanufacturing*.
- Korkmaz, E., **Bediz, B.**, Gozen, B. A., Ozdoganlar, O. B., 2013, 'Force measurement characteristics of multi-axis dynamometers', *North American Manufacturing Research Conference*.
- Korkmaz, E., **Bediz, B.**, Khilwani, R., Erdos, G., Falo Jr., L. D., Ozdoganlar, O. B., 2013, 'A novel technique for fabrication of dissolvable microneedle arrays', *7<sup>th</sup> International Conference on Microtechnologies in Medicine and Biology*.
- Hao, B., Korkmaz, E., **Bediz, B.**, Ozdoganlar, O. B., 2013, 'Geometric qualification of polymer micro and meso-scale features fabricated by UV-based additive manufacturing', *International Conference on Micromanufacturing*.
- Korkmaz, E., **Bediz, B.**, Khilwani, R., Erdos, G., Falo Jr., L. D., Ozdoganlar, O. B., 2013, 'Fabrication of water-soluble and biodegradable microneedle arrays for drug delivery', *Nano and Micro Manufacturing*.
- Bediz, B.**, Korkmaz, E., Ozdoganlar, O. B., 2013, 'An impact excitation system for repeatable, high-bandwidth modal testing of miniature structures', *IMAC-XXXI Conference & Exposition on Structural Dynamics*.

- Bediz, B.**, Korkmaz, E., Gozen, B. A., Ozdoganlar, O. B., 2012, ‘Dynamic characterization of a miniature ultra-high-speed (UHS) spindle through experimental modal analysis’, *Proceedings of the 12<sup>th</sup> International euspen conference*, June 4-8, Stockholm, Sweden.
- Korkmaz E., **Bediz, B.**, Gozen, B. A., Ozdoganlar, O. B., 2012, ‘Identification of dynamometer dynamics for accurate measurement of micro-cutting forces,’ *Proceedings of International Conference on Micromanufacturing*, Northwestern University, IL, March 12-14.
- Bediz, B.**, Khilwani, R., Kota, N., Salas, G., Ozdoganlar, O. B., 2011, ‘Mechanical micro-manufacturing and its applications’, *Manufacturing for Growth*, Napa Valley, CA.
- Bediz, B.**, Kumar, U., Ozdoganlar, O. B., Schmitz, T. L., 2011, ‘Three-dimensional endmill dynamics: Modal development and experimental validation’, in *Proc. of the ASME, 2011 International Manufacturing Science and Engineering Conference*, Corvallis, OR, June 13-17, 111-118.
- Khilwani, R., **Bediz, B.**, Long, G. A., Ozdoganlar, O. B., 2011, ‘Micromachining of polymers’, *Proceedings of International Conference on Micromanufacturing*, Japan.
- Ozdoganlar, O. B., Schmitz, T. L., **Bediz, B.**, Kumar, U., 2011, ‘Three-dimensional endmill dynamics: Modal development and experimental validation,’ in *Proc.*, 2011 NSF Engineering Research and Innovation Conference, Atlanta, GA, Jan 4-7.
- Bediz, B.**, Ozguven, H. N., Korkusuz, F., 2008, ‘Measuring structural dynamic properties of human tibia by modal testing’, *Proceedings of the 26th International Modal Analysis Conference*, Orlando, Florida, February.

INVITED TALKS  
AND LECTURES

(Keynote) **Bediz, B.**, October 2016, ‘A novel fabrication technique for dissolvable microneedle arrays’, 8th National Biomechanics Congress, Ankara, Turkey.

GRANT  
PROPOSALS

‘Karmaşık Dinamik Yapıların Spektral-Tchebychev Tekniği ile Modellenmesi ve Yapısal Özelliklerinin Hesaplanması’, PI: **Bediz B.**, TÜBİTAK, 2232 Yurda Dönüş Araştırma Burs Programı. (accepted, December 2015)

RESEARCH  
EXPERIENCE

**Dynamics and Vibrations of Micro-scale Structures:**

- ***Spectral-Tchebychev solution for 3D dynamics of parallelepipeds, including beams, plates, and solids:*** Constructed a new approach to determine the three-dimensional vibrations of parallelepipeds with different boundary conditions. An integral form of the boundary value problem was derived using the extended Hamiltons principle and solved by three dimensional spectral-Tchebychev (3D-ST) technique. The natural frequencies and mode shapes determined through this approach was compared with and shown to be in excellent agreement with those from a finite-element solution.
- ***Dynamics of pretwisted structures with curved cross-section:*** Constructed a spectral-Tchebychev (ST) technique for solution of three-dimensional dynamics of unconstrained pretwisted beams with curved cross-sections. In general, the dynamic response of pretwisted beams with curved cross-sections present three-dimensional (3D) motions, including coupled bending-bending-torsional-axial motions which necessitates a 3D solution approach. The integral boundary value problem obtained through Hamilton’s principle was simplified using two-coordinate transformations and solved using three dimensional spectral-Tchebychev (3D-ST) technique. Different case studies were investigated including beams with cutting tool and airfoil geometries and the results were compared with the those obtained from a finite elements solution.
- ***Three-Dimensional dynamics of rotating structures:*** Developed a spectral-Tchebychev (ST) based technique for solution of three dimensional (3D) dynamics of rotating structures. In particular, structures that exhibit coupled dynamic response require a 3D modeling approach to capture their dynamic behavior. Rotational motions further complicate this behavior, inducing coriolis, centrifugal softening, and (nonlinear) stressstiffening effects.

Therefore, a 3D solution approach is needed to accurately capture the rotational dynamics. The presented 3D-ST technique provides a fast-converging and precise solution approach for rotational dynamics of structures with complex geometries and mixed boundary conditions.

- ***Development of a novel impact excitation system:*** Developed an impact excitation system (IES) for repeatable, high-bandwidth, controlled-force modal testing of miniature structures. Furthermore, a dynamic model of the system was derived and experimentally validated to enable identification of the system parameters that yield single-hit impacts with desired bandwidth and force magnitude. It is concluded that the IES significantly improves repeatability in terms of the impact bandwidth, location, and force magnitude, while providing a high excitation-bandwidth and excellent coherence values.
- ***Dynamics of ultra-high-speed (UHS) miniature spindles:*** Developed an experimental methodology to identify the miniature UHS spindles through modal testing. In this approach, the response of the miniature UHS spindle-holder-tool assembly in two mutually perpendicular directions was measured using two fiber optic laser Doppler vibrometers (LDV) (necessitates an alignment procedure to set the lasers perpendicular to each other). To obtain sufficient excitation bandwidth and single-hit impacts, a custom made impact excitation system was used. The tests were performed from a cylindrical artifact attached to the UHS spindle.
- ***Hybrid modeling of machine tool-spindle-holder-cutting tool assemblies by combining the spectral-Tchebychev and receptance coupling techniques:*** Constructed a model for the three-dimensional (3D) dynamic response of endmills while considering the actual fluted cross-sectional geometry and pretwisted shape of the tools. The model was solved using three-dimensional spectral-Tchebychev (3D-ST) technique and the results were compared with the ones obtained through a finite element analysis. To demonstrate its application, the 3D-ST model for the fluted section of an endmill was coupled to the spindle holder to predict the tool-point dynamics using receptance coupling substructure analysis (RCSA) with a flexible connection.
- ***Characterization of multi-axis dynamometers:*** Worked in developing an accurate determination of three-dimensional (3D) dynamic force measurement characteristics of multi-axis dynamometers within a broad range of frequencies. In machining science and technology, it is highly critical to make precise measurements of machining forces. However, these devices cause inaccuracies at frequencies above their specified bandwidth. To address this, modal tests were performed using impact testing method to determine force-to-force frequency response functions (between the applied impact forces and the three-dimensional forces measured by the dynamometer).

#### **Application-Oriented Research:**

- ***Transdermal drug delivery using dissolvable microneedle arrays:*** Designed and evaluated a new micro-machining based approach for fabricating dissolvable microneedle arrays (MNAs) with diverse geometries and from different materials for skin micro-environments. MNAs with different geometries and from carboxymethyl cellulose, polyvinyl pyrrolidone, and maltodextrin were created reproducibly using the developed micromilling/spin-casting based fabrication approach. Furthermore, the application of MNAs for precise and specific delivery of biomolecules to skin microenvironments in vitro and in vivo was investigated.
- ***Feasibility of supercritical carbon dioxide based metalworking fluids in micro-machining:*** Took part in a study investigating the feasibility of using supercritical carbon dioxide based metalworking fluids (scCO<sub>2</sub>-MWF) to improve micromachinability of metals. Burr formation, average specific cutting energy, surface roughness, and tool wear were analyzed and compared to those obtained from dry machining. It was shown that scCO<sub>2</sub>-MWF improve the micromachinability of copper and stainless steel.

TEACHING EXPERIENCE **2016 Summer: Lecturer in TOBB University of Economics and Technology**  
**MAK310** Numerical Methods

**2015 Fall: Lecturer in Middle East Technical University**  
**ME212** Principles of Production Engineering

**2010 - 2011: Teaching Assistant in Carnegie Mellon University**  
**24452** Mechanical Systems Experimentation

**2006 - 2009: Teaching Assistant in Middle East Technical University**  
**ME200** Mechanical Engineering Orientation  
**ME208** Dynamics  
**ME301** Theory of Machine I  
**ME302** Theory of Machine II  
**ME307** Machine Elements I  
**ME401** Internal Combustions Engines  
**ME403** Heating, Ventilating, Air Conditioning, and Refrigeration  
**ME407** Mechanical Engineering Design  
**ME410** Mechanical Engineering Systems Laboratory  
**ME426** Internal Combustions Engine Design

REFEREE SERVICE **Journal of Manufacturing Science and Engineering**  
**Journal of Sound and Vibration**

INTERNSHIP EXPERIENCE **Arcelik A.S. Bulasik Makinasi Fabrikasi (Dishwasher Plant), Turkey (Summer 2005)**  
*Design intern:* Participated in the design of thermal insulation of a production line.  
**Turk Traktor, Turkey (Summer 2004)**  
*Manufacturing intern:* Worked on the gear manufacturing processes.

FELLOWSHIPS & HONORS

- Outstanding Reviewer Award, Journal of Sound and Vibration (Elsevier), 2016
- Carnegie Mellon University, Graduate Student Organization Conference Funding, 2013
- John and Claire Bertucci Fellowship, Carnegie Mellon University, 2012
- Doctorate Research Fellowship, Carnegie Mellon University, 2009–2015
- Middle East Technical University, Graduate Courses Performance Award, 2007
- 1<sup>st</sup> rank in Izocam Insulation (HVAC) competition, 2006
- Graduate Fellowship of Scientific and Technical Research Council of Turkey (TUBITAK), 2006
- Graduation with the 5<sup>th</sup> rank in the department (out of 293 students), 2006
- Deans High Honor Certificates, 2002-2006

HARDWARE & SOFTWARE SKILLS

- **Programming Languages:** MATLAB, MathCad, Labview, C#, Python
- **CAD Software:** Solidworks
- **Finite Element Analysis Packages:** ANSYS, COMSOL
- **Productivity Applications:** T<sub>E</sub>X(L<sup>A</sup>T<sub>E</sub>X, B<sub>B</sub>T<sub>E</sub>X), MS Office (Word, Excel, Powerpoint), Adobe Illustrator, Adobe Photoshop
- **Measurement systems & Instrumentation:** Laser Doppler Vibrometry (LDV), Scanning Electron Microscopy, National Instruments PXI devices, Impact hammer testing equipment

REFERENCES **Prof. O. Burak Ozdoganlar** (Ph.D. thesis advisor)  
Ver Planck Professor, Mechanical Engineering, Phone: +1-412-268-9890  
Director, Institute for Complex Engineered Systems (ICES), E-mail: ozdoganlar@cmu.edu  
Courtesy Appointments, Biomedical Engineering, Materials Science & Engineering  
Carnegie Mellon University  
5000 Forbes Avenue, Scaife Hall 312, Pittsburgh, PA, 15213, USA

**Prof. H. Nevzat Ozguven** (M.Sc. thesis advisor)  
Vice President and Professor of Mechanical Engineering,  
Middle East Technical University  
Universiteler Mahallesi, Dumlupinar Bulvari No:1  
06800 Cankaya Ankara/TURKEY

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**Dr. Louis A. Romero**  
Mathematician at Sandia National Laboratories, and  
Adjunct Faculty,  
University of New Mexico,  
Albuquerque NM 87131

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**Prof. Feza Korkusuz** (M.Sc. thesis advisor)  
Professor of Department of Sports Medicine,  
Hacettepe University  
Hacettepe Mh. 06230 Ankara/TURKEY

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**Prof. Tony L. Schmitz** (Ph.D. thesis committee member)  
Professor of Mechanical Engineering,  
University of North Carolina  
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