

FAN TONG

Carnegie Institution for Science
Department of Global Ecology

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Research Interests

Energy Transitions, Energy-Climate-Health Nexus, Near-Zero-Emissions Energy Systems, Energy Systems Modeling, Industrial Ecology, Data Visualization, Sustainability.

Current Employment

Department of Global Ecology, Carnegie Institution for Science, Stanford, CA, U.S. 2017/08-present
Postdoctoral Research Scientist. Advisor: Dr. Ken Caldeira.

Education

Carnegie Mellon University, Pittsburgh, PA, 2012-2016

Ph.D. in Engineering and Public Policy, 2016

Thesis: The Good, the Bad, and the Ugly: Economic and Environmental Implications of Using Natural Gas to Power On-Road Vehicles in the United States.

Committee: Paulina Jaramillo (co-chair), Inês M.L. Azevedo (co-chair), Chris T. Hendrickson, Jeremy Michalek, Zhen (Sean) Qian.

Master of Science (M.S.) in Engineering and Public Policy, 2015. GPA: 3.98/4.

Peking University, Beijing, China, 2011-2012

Undergraduate coursework in Economics at National School of Development. GPA: 93.2/100.

Part-time study while working.

Tsinghua University, Beijing, China, 2006-2011

Graduate coursework in Electrical Engineering, GPA: 93.7/100. Quit after one-year study.

Bachelor of Engineering (B.E.) in Electrical Engineering, GPA: 88.1/100.

Honors and Awards

1. 2017 International Society for Industrial Ecology Student Chapter Scholarship.
2. 2016 Energy Week Student Poster Competition Second Prize, Carnegie Mellon University.
3. 2016 Graduate Student Assembly (GSA) Conference Travel Support, Carnegie Mellon University.
4. 2016 Ji-Dian Liang Fellowship, Carnegie Mellon University.
5. 2015 United States Association for Energy Economics (USAEE) Pittsburgh Registration Fee Scholarship.

6. 2014 Graduate Student Assembly (GSA) Conference Travel Support, Carnegie Mellon University.
7. 2013-14 Northrop Grumman Fellowship, Carnegie Mellon University.
8. 2013-14 Steinbrenner Institute Graduate Research Fellowship, Carnegie Mellon University.
9. 2008-09 Tsinghua Friendship-Toshiba Scholarship (first-class honor, top 5%), Tsinghua University.

Publications

Peer-reviewed Journal Articles

1. **Tong, F.**; Hendrickson, C; Biehler, A.; Jaramillo, P.; & Seki, S. (2017). Life Cycle Ownership and Environmental Externality of Alternative Fuel Options for Transit Buses. *Transp. Res. Part D Transp. Environ.* **2017**, *57*, 287–302. (<https://doi.org/10.1016/j.trd.2017.09.023>)
2. Qin, Y.; Edwards, R.; **Tong, F.**; Mauzerall, D.L. Can Switching from Coal to Shale Gas Bring Net Carbon Reductions to China? *Environ. Sci. Technol.*, 2017, *51* (5), 2554-2562. (<http://dx.doi.org/10.1021/acs.est.6b04072>)
3. **Tong, F.**; Jaramillo, P.; Azevedo, I. Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Light Duty Vehicles. *Energy & Fuels*, 2015, *29*, 6008–6018. (<http://dx.doi.org/10.1021/acs.energyfuels.5b01063>)
4. **Tong, F.**; Jaramillo, P.; Azevedo, I. Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Medium and Heavy-Duty Vehicles. *Environ. Sci. Technol.*, 2015, *49* (12), 7123-7133. (<http://dx.doi.org/10.1021/es5052759>)
5. Gilbraith, N.; Jaramillo, P.; **Tong, F.**; Faria, F. Comments on Jacobson et al.'s proposal for a wind, water, and solar energy future in New York State. *Energy Policy*, 2013, (60), 68-69. (<http://dx.doi.org/10.1016/j.enpol.2013.05.006>)
6. Sun, Z.; Feng, L.; **Tong, F.**; Yang, S. Comparative studies on curriculums of energy economics & management majors in Chinese and overseas universities. *Research in Higher Education of Engineering*, 2017, *166*, 130-134. (in Chinese)
7. Yang, Y.; **Tong, F.** What's inside the 'energy bible'? An Evaluation of *World Energy Outlook Series*, *Macroeconomics*, 2012, *4*, 3-13. (in Chinese)

Working Papers

8. **Tong, F.**; Azevedo, I; Jaramillo, P. Should We Build A National Refueling Infrastructure to Power Natural Gas Trucks? Invited to revise and resubmit to *Journal of Infrastructure Systems*.
9. **Tong, F.**; Jaramillo, P.; Azevedo, I. Joint Assessment of Climate Change and Air Pollution Damages for Vehicle Pathways Across the United States. Invited to revise and resubmit to *Proceedings of the National Academy of Sciences*.
10. Qin, Y.; **Tong, F.**; Yang, G.; Mauzerall, D.L. Challenges in using natural gas as a carbon mitigation option in China. Invited to revise and resubmit to *Energy Policy*.
11. **Tong, F.**; Azevedo, I.; Michalek, J. A review of hydrogen production pathways, cost, and decarbonization potential for transportation applications. *In preparation*.

Non-peer-reviewed Publications

12. Seki, S; **Tong, F.**; Hendrickson, C.; Biehler, A.; Jaramillo, P. Which Alternative Fuel Technology is Best for Transit Buses? Jan 2017. Policymaker Guide produced by Scott Institute for Energy Innovation & Traffic21 Institute at Carnegie Mellon University. Available at <http://www.cmu.edu/energy/education-outreach/policymaker-outreach/guides.html>.
13. **Tong F.**; Peña, I.; Azevedo, I. Greening Giants: The Good, the Bad, and the Ugly, *TheEnergyCollective*, Dec 5, 2014. <http://theenergycollective.com/inesliaz/2165626/greening-giants-good-bad-and-ugly>.

Book Chapters

14. A contributing writer for the Han, W. & Yang, Y. *China Energy Outlook*. Beijing, China: China Economic Publishing House, 2012.
- “What is the Future of World Oil Market: A Comparison of *World Energy Outlook* (IEA) and *World Oil Outlook* (OPEC)” (Yang, Y. & **Tong, F.**)
- “Understanding Japan’s Energy Concern: An Evaluation of *Asian Energy Outlook* (IEEJ)” (Yang, Y. & **Tong, F.**)

Conferences & Presentations

Conference Presentations with Peer-reviewed Abstract

1. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2017). A Review of Hydrogen Production Pathways, Cost and Decarbonization Potential. The 35th United States Association for Energy Economics (USAEE)/International Association for Energy Economics (IAEE) North American Conference. Houston, TA, USA. Nov 12-15, 2017. (Oral presentation; Accepted).
2. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2017). A Spatial Assessment of Vehicles' Climate Change and Air Pollution Damages across the United States. The 35th United States Association for Energy Economics (USAEE)/International Association for Energy Economics (IAEE) North American Conference. Houston, TA, USA. Nov 12-15, 2017. (Oral presentation; Accepted).
3. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2017). Life Cycle Air Pollution Damages of Petroleum and Natural Gas Pathways for Powering Light-Duty Vehicles and Heavy-Duty Vehicles. International Society for Industrial Ecology-International Symposium on Sustainable Systems and Technology (ISIE-ISSST) 2017 Joint Conference. Chicago, IL, USA. Jun 25-29, 2017. (Oral presentation).
4. **Tong, F. (speaker)**, Hendrickson, C., Biehler, A., Jaramillo, P., Seki, S. (2017). Life Cycle Ownership and Social Costs of Alternative Fuel Options for Transit Buses. International Society for Industrial Ecology-International Symposium on Sustainable Systems and Technology (ISIE-ISSST) 2017 Joint Conference. Chicago, IL, USA. Jun 25-29, 2017. (“Lightening-session” oral presentation and poster presentation).
5. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2016). Life Cycle Air Pollution Damages of Petroleum and Natural Gas Pathways for Powering Light-Duty Vehicles and Heavy-Duty Vehicles. Engineering Sustainability 2017. Pittsburgh, PA, USA. Apr 9-11, 2017. (Poster presentation).
6. **Tong, F. (speaker)**, Hendrickson, C., Biehler, A., Jaramillo, P., Seki, S. (2017). Alternative Fuel Assessment for Port Authority Transit Buses. Transportation Research Board (TRB) 96th Annual Meeting. Washington, DC, USA. Jan 8-12, 2017. (Poster presentation).

7. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2016). "Spatial Analysis of Air Quality Impacts from Using Natural Gas for Road Transportation." The International Symposium on Sustainable Systems and Technology (ISSST 2016). Phoenix, AZ, USA, May 16-18, 2016. (Poster presentation)
8. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2016). "Spatial Analysis of Air Quality Impacts from Using Natural Gas for Road Transportation." American Association for the Advancement of Science (AAAS) Annual Meeting 2016. Washington DC, USA, Feb 11-15, 2016. (Poster presentation)
9. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2015). "Spatial Analysis of Air Quality Impacts from Using Natural Gas for Road Transportation." The 33rd United States Association for Energy Economics (USAEE)/International Association for Energy Economics (IAEE) North American Conference. Pittsburgh, PA, USA, Oct 25-28, 2015. (Oral presentation)
10. **Tong, F.**, Jaramillo, P. (speaker), Azevedo, I.L. (2015). "The benefits of using natural gas for road transportation - a county-level analysis of reduced criteria air pollutants from natural gas use for light duty and heavy duty vehicles". 8th Conference of the International Society for Industrial Ecology (ISIE), Guildford, UK, July 7-10, 2015. (Poster presentation)
11. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2015). "The benefits of using natural gas for road transportation - a county-level analysis of reduced criteria air pollutants from natural gas use for light duty and heavy duty vehicles". The International Symposium on Sustainable Systems and Technology (ISSST 2015), Dearborn, MI, USA, May 18-20, 2015. (Oral presentation)
12. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2014). "A Comparison of Air Emissions from Natural Gas Pathways for Road Transportation". The 4th Annual Energy Policy Research Conference. San Francisco, CA, USA, September 4-5, 2014. (Oral presentation)
13. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2014). "A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation". The American Society of Civil Engineers (ASCE) Shale Energy Engineering Conference 2014. Pittsburgh, PA, USA, July 20-23, 2014. (Poster presentation)
14. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2014). "A Comparison of Air Emissions from Natural Gas Pathways for Road Transportation". The 37th International Association for Energy Economics (IAEE) International Conference. New York City, NY, USA, June 15-18, 2014. (Oral presentation)
15. **Tong, F.**, Jaramillo, P. (speaker), Azevedo, I.L. (2014). "A Comparison of Air Emissions from Natural Gas Pathways for Road Transportation". The International Symposium on Sustainable Systems and Technology (ISSST 2014), Oakland, CA, USA, May 18-21, 2014. (Oral presentation)

Other Conferences

16. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2017). Life Cycle Air Pollution Damages of Petroleum and Natural Gas Pathways for Powering Light-Duty Vehicles and Heavy-Duty Vehicles. Steinbrenner Colloquium. Carnegie Mellon University. Pittsburgh, PA, USA. Apr 7, 2017. (Poster presentation).
17. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L. (2017). Life Cycle Air Pollution Damages of Petroleum and Natural Gas Pathways for Powering Light-Duty Vehicles and Heavy-Duty Vehicles. 2017 Innovation with Impact – Graduate Interdisciplinary Exhibition. Carnegie Mellon University. Pittsburgh, PA, USA. Apr 6, 2017. (Poster presentation).

18. **Tong, F. (speaker)**, Hendrickson, C., Biehler, A., Jaramillo, P., Seki, S. Alternative Fuel Assessment for Port Authority Transit Buses. Carnegie Mellon University's Energy Week 2017. Pittsburgh, PA, USA. Mar 27-31, 2017. (Poster presentation; accepted).
19. **Tong, F. (speaker)**, Hendrickson, C., Biehler, A., Jaramillo, P., Seki, S. Alternative Fuel Assessment for Port Authority Transit Buses. Traffic21 Institute and the Technologies for Safe and Efficient Transportation National University Transportation Center for Safety (T-SET) Consortium Meeting. Pittsburgh, PA, USA. Nov 3, 2016. (Poster presentation).
20. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2016). Does using natural gas to power vehicles reduce greenhouse gas (GHG) emissions? The Center for Climate and Energy Decision Making (CEDM) Annual Meeting. Pittsburgh, PA, USA. May 23-24, 2016.
21. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2016). "Does using natural gas to power vehicles reduce greenhouse gas emissions?" Earth Day Environmental Colloquium, Steinbrenner Institute for Environmental Education and Research, Carnegie Mellon University. Pittsburgh, PA, USA. Apr 22, 2016.
22. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2016). "Spatial Analysis of Air Quality Impacts from Using Natural Gas for Road Transportation". Carnegie Mellon University's Energy Week. Pittsburgh, PA, USA. Mar 14-18, 2016. (Poster presentation)
23. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2015). "A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation". The First Annual Conference on Energy & Resource Systems Engineering. Beijing, P. R. China. Dec 18-19, 2015.
24. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2015). "A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation". The Center for Climate and Energy Decision Making (CEDM) Annual Meeting. Pittsburgh, PA, USA. May 21-22, 2015.
25. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2014). "A Comparison of Air Emissions from Natural Gas Pathways for Road Transportation". The Center for Climate and Energy Decision Making (CEDM) Annual Meeting. Pittsburgh, PA, USA. May 20-21, 2014.
26. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2014). "A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation". Annual Steinbrenner Institute for Environmental Education & Research (SEER) Expo. Pittsburgh, PA, USA. Apr 22, 2014.
27. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2013). "An Analysis of the Trade-offs of Different Natural Gas Consumption Pathways". Center for Climate and Energy Decision Making (CEDM) Annual Meeting. Pittsburgh, PA, USA. May 20-22, 2013.

Invited Talks

28. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2017). "Joint Assessment of Climate Change and Air Pollution Damages for Vehicle Pathways across the United States". The Center for Air, Climate and Energy Solutions (CACES) Webinar Series. Stanford, CA, USA. Nov 1, 2017. (Scheduled)
29. **Tong, F. (speaker)** (2017). "Challenges in Using Natural Gas as a Mitigation Option in China". School of Chemical Engineering and Technology, Sun Yat-sen University, Guangzhou, P.R. China. Jul 21, 2017.

30. **Tong, F. (speaker)** (2017). “Which Alternative Fuel Technology is Best for Transit Buses?” Carnegie Mellon University’s policy briefing event on Capitol Hill (“*Pipelines, Trucks, Buses and Automobiles: Where, When, Which?*”). Cannon House Office Building, Washington, DC, USA. May 3, 2017.
31. **Tong, F. (speaker)** (2017). “A County Level Assessment of Health and Climate Damages Cost for Light-Duty and Heavy-Duty Vehicles.” Energy Systems Division, Argonne National Laboratory. Argonne, IL, USA. Feb 13, 2017.
32. **Tong, F. (speaker)** (2017). “Does Using Natural Gas to Power Vehicles Reduce Greenhouse Gas (GHG) Emissions?” National Resources Defense Council (NRDC). New York, NY, USA. Feb 7, 2017.
33. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2016). “Life Cycle Air Pollution Damages of Using Natural Gas to Power On-Road Vehicles.” The Center for Air, Climate and Energy Solutions (CACES) Kick-off Meeting. Pittsburgh, PA, USA. Sep 29-30, 2016.
34. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2016). “Spatial Analysis of Air Quality Impacts from Using Natural Gas for Road Transportation”. Scott Hall Dedication Event, Carnegie Mellon University. Pittsburgh, PA, USA. Apr 30, 2016. (Poster presentation).
35. **Tong, F. (speaker)** (2015). “Environmental Implications of Using Natural Gas to Power On-Road Vehicles in the United States”. School of Business Administration, China University of Petroleum, Beijing. Beijing, P. R. China. Dec 18, 2015.
36. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2015). “A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation”. Institute of Transportation Studies (ITS), University of California, Davis. Davis, CA, USA. Oct 2, 2015.
37. **Tong, F. (speaker)**, Jaramillo, P., Azevedo, I.L., (2014). “A Comparison of Greenhouse Gas Emissions from Natural Gas Pathways for Road Transportation”. Institute of Transportation Studies (ITS), University of California, Davis. Davis, CA, USA. Sep 3, 2014.

Teaching

Teaching Assistant. 19-653/24-640 Climate Change Mitigation. Carnegie Mellon University. 2016 Spring.

- Graduate-level course with focus on science, technology, social science, and public policy issues related to climate change sciences and mitigation. The course attracts senior undergraduate students, master’s students, and doctoral students from diverse academic backgrounds, such as Chemistry, Chemical Engineering, Civil and Environmental Engineering, Energy Science Technology and Policy, Engineering and Public Policy, Mechanical Engineering, and Social and Decision Sciences (SDS).
- Helped design and graded problem sets, in-class quizzes, mid-term, and final exams, held tutorial sessions and office hours, led in-class paper discussions, and gave two guest lectures on *Natural Gas and Climate Change*, and *Transportation and Climate change*.

Project Manager. 19-452/88-452/90-720 Project Course: Providing Information to Non-English Speakers during Disasters. Carnegie Mellon University. 2014 Fall.

- A unique undergraduate capstone project course offered for senior undergraduate students majoring in Engineering and Public Policy (offered as a double major, where the primary majors are in engineering) and Social and Decision Sciences at Carnegie Mellon University. Read [here](#) for more information.

- Worked as the project manager to help students work in multidisciplinary teams on “a ‘cutting edge’ project topic with very little in the way of “pre-digested” analysis or solutions.” The deliverables of the project include two presentations and a long technical report (100-200 pages), which are examined by an external review panel consisting of real-world experts working on similar topics and professors on campus that have the expertise.

Professional Activities

Referee

- **Journals:** Proceedings of the National Academy of Sciences (PNAS), Environmental Science & Technology (ES&T), Applied Energy, Journal of Cleaner Production (JCP), Journal of Industrial Ecology (JIE), Energy Policy, Transportation Research Part D: Transport & Environment (TRD), Transport Policy, International Journal of Sustainable Transportation (IJST), Sustainability, Energies, Environmental Pollution, Energy, Ecology and Environment (EEAE), and Journal of Natural Gas Science & Engineering (JNGSE).
- **Conferences:** 97th Transportation Research Board (TRB) Annual Meeting 2018, International Society for Industrial Ecology-International Symposium on Sustainable Systems and Technology (ISIE-ISSST) 2017 Joint Conference, and COTA (Chinese Overseas Transportation Association) International Conference for Transportation Professionals (CICTP2017).
- **Reports:** National Renewable Energy Laboratory (NREL), and PRIME coalition.

Professional Affiliations

- American Chemistry Society (ACS) 2015-2017, International Society of Industrial Ecology (ISIE) 2017-2018.
- American Association for the Advancement of Science (AAAS) 2015-2016, International Association of Energy Economics (IAEE)/United States Association for Energy Economics (USAEE) 2014-2015 & 2017-2018.

Other

- Session chair for International Society for Industrial Ecology-International Symposium on Sustainable Systems and Technology (ISIE-ISSST) 2017 Joint Conference.
- Volunteer service for International Symposium on Sustainable Systems and Technology (ISSST) 2015, 2016, and 2017 (help organize the 4Space workshops, distribute CFPs, take photos, and keep time during the session).

Previous Employment

Carnegie Mellon University, Department of Engineering and Public Policy, Pittsburgh, PA, U.S.

Postdoctoral Research Associate for Prof. Inês Azevedo and Prof. Jeremy Michalek, 2016-2017.

Research Assistant for Prof. Paulina Jaramillo and Prof. Inês Azevedo, 2012-2016.

Research Assistant for Prof. Chris Hendrickson, 2014-2016.

Energy Research Institute, National Development and Reform Commission, P. R. China

Research Assistant for Dr. Yufeng Yang; Internship: 2010-2011; Full-time employment: 2011-2012.

- Analyzed the coal and electricity markets in China to understand the price regimes and conflicts.
- Analyzed existing energy outlook publications as well as developed the first China Energy Outlook.

Tsinghua University, Research Institute of Information Technology (RIIT), P. R. China

Research Assistant for Prof. Yunzhou Li, 2009-2011.

- Built a link-level physical-layer Matlab simulation tool for the LTE-Advanced communication technology
- Proposed and examined the performance of different designs of cell-specific reference signals (pilot symbols).

Research Assistant for Prof. Mingxing Xu, 2009.

- Implemented a voiceprint application on a Symbian S60 cellphone with teammates.

EMC Computer System (China) Co., Ltd, P. R. China

Software Engineer (Summer Internship), 2009.

Skills

Languages Native in Chinese; Fluent in English.

Programming and Computer Skills Python, R, Matlab, SQL, ArcGIS, Stata, Eviews, C/C++, Java, @Risk, Analytica.

Selected Coursework

Carnegie Mellon University (Pittsburgh, PA, U.S.)

Economics: Ph.D. Microeconomics (90-908), Computational Methods for Economics (47-805), Econometrics (90-906), Environmental Economics and Policy (73-433).

Policy Analysis: Introduction to Theory and Practice of Policy Analysis (19-701), Workshop in Applied Policy Analysis (19-705), The Shale Gas Revolution (90-779), Seminar in Climate & Energy Decision Making Under Uncertainty (19-883), Climate Change Mitigation (19-653).

Quantitative Methods: Quantitative Methods for Policy Analysis (19-702), Special Topics in ECE: Optimization in Energy Networks (18-879M), Probability and Estimation Methods for Engineering Systems (12-704).

Peking University (Beijing, China)

Economics: Econometrics, Intermediate Microeconomics, Intermediate Macroeconomics, Financial Econometrics, Information Economics, Engineering Economics.

Tsinghua University (Beijing, China)

Mathematics and Statistics: Fundamental Functional Analysis, Matrix Analysis and Applications, Convex Optimization for Signal Processing and Communications, Advanced Calculus I, II, III, Advanced Algebra and Geometry I, II, Probability and Statistics, Stochastic Process, Introduction to Methods of Mathematics and Physics, Numerical Analysis and Algorithms.

Computer Science and Engineering: Computer Languages and Programming, C++ Program Design and Training, Advanced Matlab Programming and its Application, Data Structure, Principles of Microcomputer, Computer Networks, Image Processing, Principles of Imaging Information.

Electrical Engineering (Network and Communication): Advanced Digital Communication, Advanced Signal Processing, Principles of Modern Communications, Mobile Communication Terminal Design, Project of RF Communication System, Wireless and Mobile Network Technologies, Digital Signal Processing, Digital Signal Processing Laboratory and design, Signals and Systems, Communication RF Circuits Design, Communication Circuits Laboratory, Communication System Laboratory.

Physics and Electrical Engineering (Fundamental): General Physics (1), General Physics (2), General Physics (3), Lab. of Physics (1), Lab. of Physics (2), Quantum Mechanics and Statistical Mechanics, Fundamentals of Semiconductor Devices, Electromagnetic Fields and Waves, Electromagnetic field and Microwave Experiment, Fundamentals of Microwave Engineering, Principle of Circuits, Lab. of Principle of Circuits, Digital Logic Circuits & Systems, Fundamentals of Analog Electronics, Laboratory of Electronic Circuits, Project of Electronic Circuits.

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