GOVERNMENT OF RAJASTHAN

BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR

SEMESTER SCHEME-2020-21

III SEMESTER

(SESSION 2021-2022 & ONWARDS)

AN INTRODUCTION TO ROBOTICS

Course Code	ER-3001(Same as RA 3001)
Course Title	**AN INTRODUCTION TO ROBOTICS**
Number of Credits	4 (L-4,T-0, P-0)
Prerequisites	NIL
Course Category	PC

UNIT-1 INTRODUCTION:

1.1 What is Robotics Engineering ?
1.2 Brief History of Robotics
1.3 Working Definition of Robot
1.4 Basic Principles in Robotics
1.5 Advantages & Disadvantages of Robots
1.6 Robot Applications
1.7 Growth of the Industry
1.8 Social Issues & Safety

UNIT-2 ROBOTS COMPONENTS

2.1 Power source
2.2 Actuation
- 2.2.1 Electric motors
- 2.2.2 Linear actuators
- 2.2.3 Series elastic actuators
- 2.2.4 Air muscles
- 2.2.5 Muscle wire
- 2.2.6 Electroactive polymers
- 2.2.7 Piezo motors
- 2.2.8 Elastic nanotubes

2.3 Sensors in Robotics
- 2.3.1 Light Sensors i.e. Photo resistor, Photovoltaic cell
- 2.3.2 Sound Sensor
- 2.3.3 Proximity Sensor
  - a) Infrared (IR) transceiver
  - b) Ultrasound Sensor
  - c) Photo resistor
- 2.3.4 Tactile Sensors
  - a) Touch Sensor or Contact Sensor
  - b) Force Sensor
- 2.3.5 Temperature Sensor
- 2.3.6 Navigation and Positioning Sensors
- 2.3.7 Acceleration Sensor

2.4 Manipulation
- 2.4.1 Mechanical grippers
- 2.4.2 Suction end-effectors
- 2.4.3 General purpose effectors

2.5 Locomotion
- 2.5.1 Rolling robots
  - 2.5.1.1 Two-wheeled balancing robots
  - 2.5.1.2 One-wheeled balancing robots
  - 2.5.1.3 Spherical orb robots
  - 2.5.1.4 Six-wheeled robots
  - 2.5.1.5 Tracked robots
- 2.5.2 Walking applied to robots
  - 2.5.2.1 ZMP technique

2.5.2.2 Hopping
2.5.2.3 Dynamic balancing (controlled falling)
2.5.2.4 Passive dynamics
2.5.3 Other methods of locomotion
2.5.3.1 Flying
2.5.3.2 Snaking
2.5.3.3 Skating
2.5.3.4 Climbing
2.5.3.5 Swimming (Piscine)
2.5.3.6 Sailing
2.7 Human-robot interaction
2.7.1 Speech recognition
2.7.2 Robotic voice
2.7.3 Gestures
2.7.4 Facial expression
2.7.5 Artificial emotions
2.7.6 Personality
2.7.7 Social intelligence
2.8 Robot Control Methods
2.8.1 Lead-Through Programming
2.8.1 Teach Programming
2.8.1 Off-Line Programming
2.8.1 Autonomous
2.8.1 Teleoperation
2.8.1 Telerobotic
2.8.1 Lead-Through Programming
2.8.1 Lead-Through Programming

UNIT-3 TYPES OF ROBOTS

(Based on Drive Technologies, Work Envelope Geometries, Motion Control Methods)
3.1 Classification by Degrees of Freedom
3.2 Classification by Robot Motion
3.3 Classification by Platform
3.4 Classification by Power Source
3.5 Classification by Intelligence
3.6 Classification by Application Area

UNIT-4ROBOT SPECIFICATIONS (TECHNICAL ROBOTICS TERMS)

4.1 Number of Axes, Capacity & speed, Reach & Stroke, Tool Orientation
4.2 Repeatability, Precision and Accuracy, Operating Environment
4.3 Degrees of Freedom, Joints, Coordinates, Reference Frames, Programming Modes
4.4 Workspace, Characteristics

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. **ROBOTICS: FUNDAMENTAL CONCEPTS AND ANALYSIS , By AshitavaGhosal, Publisher-OUP India, 2006**
2. **Introduction to Robotics, By S K Saha,Publisher- Tata McGraw-Hill Education**
3. **Introduction To Robotics: Analysis,Control,Applications, 2nd EditionBy Saeed Benjamin Niku · 2011, Publisher:Wiley India Pvt. Limited**
4. **Fundamentals of Robotics Engineering, By Harry H. Poole, Publisher:Springer Science & Business Media, 2012**

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ELECTRONICS DEVICES AND CIRCUITS

Course Code	ER3002(Same as EF/EL/RA 3002)
Course Title	Electronic Devices And Circuits
Number of Credits	3 (L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE CONTENTS:

UNIT 1 – SEMICONDUCTOR AND DIODES

1.1 Definition, Extrinsic/Intrinsic, N-type & p-type
1.2 PN Junction Diode – Forward and Reverse Bias Characteristics
1.3 Zener Diode – Principle, characteristics, construction, working
1.4 Diode Rectifiers – Half Wave and Full Wave
1.5 Filters – C, LC and PI Filters

UNIT 2 – BIPOLAR JUNCTION TRANSISTOR (BJT)

2.1 NPN and PNP Transistor – Operation and characteristics
2.2 Common Base Configuration – characteristics and working
2.3 Common Emitter Configuration – characteristics and working
2.4 Common Collector Configuration – characteristics and working
2.5 High frequency model of BJT
2.6 Classification of amplifiers
2.7 negative feedback

UNIT 3 – FIELD EFFECT TRANSISTORS

3.1 FET – Working Principle, Classification
3.2 MOSFET Small Signal model
3.3 N-Channel/ P-Channel MOSFETs – characteristics
3.4 Enhancement and depletion mode
3.5 MOS- FET as a Switch
3.6 Common Source Amplifiers
3.7 Uni-Junction Transistor – equivalent circuit and operation

UNIT 4 – SCR DIAC & TRIAC

4.1 SCR – Construction, operation, working, characteristics
4.2 DIAC - Construction, operation, working, characteristics
4.3 TRIAC - Construction, operation, working
4.4 characteristics SCR and MOSFET as a Switch
4.5 DIAC as bidirectional switch
4.6 Comparison of SCR, DIAC, TRIAC, MOSFET

UNIT 5 – AMPLIFIERS AND OSCILLATORS

5.1 Feedback Amplifiers – Properties of negative Feedback, impact of feedback on different parameters
5.2 Basic Feedback Amplifier Topologies: Voltage Series, Voltage Shunt Current Series, Current Shunt
5.3 Oscillator – Basic Principles, Crystal Oscillator, Non-linear/ Pulse Oscillator

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Analog Circuits By AK MainiKhanna Publishing House Ed. 2018 (ISBN: 978-93-86173-584)
1. Electronic Devices and Circuits S. Salivahanan and N. Suresh Kumar McGraw Hill Education; Fourth edition (1 July 2017) ISBN: 978-9339219505
2. Electronics Devices and circuit theory Boyestad&Nashelsky Pearson Education India; 11 edition (2015) ISBN: 978-9332542600
3. Electronic Principles Albert Malvino& David Bates Tata McGraw Hill Publication 2010 ISBN: 978-0070634244
4. Electronics Devices & Circuits Jacob Millman McGraw Hill Education; 4 edition (2015)ISBN: 978-9339219543

SUGGESTED SOFTWARE/LEARNING WEBSITES:

1. https://www.electronics-tutorials.ws/
2. https://www.youtube.com/watch?v=Rx43l-QpeWQ
3. https://electronicsforu.com/resources/electronic-devices-and-circuit-theory

DIGITAL ELECTRONICS

Course Code	ER3003(Same as EF/EL/RA/MT 3003)
Course Title	Digital Electronics
Number of Credits	3 (L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE CONTENTS:

UNIT 1 – NUMBER SYSTEMS & BOOLEAN ALGEBRA

1.1 Introduction to different number systems – Binary, Octal, Decimal, Hexadecimal
1.2 Conversion from one number system to another.
1.3 Boolean variables – Rules and laws of Boolean algebra
1.4 De-Morgan's Theorem
1.5 Karnaugh Maps and their use for simplification of Boolean expressions

UNIT 2 – LOGIC GATES

2.1 Logic Gates – AND, OR, NOT, NAND, NOR, XOR, XNOR: Symbolic representation and truth table
2.2 Implementation of Boolean expressions and Logic Functions using gates
2.3 Simplification of expressions

UNIT 3 – COMBINATIONAL LOGIC CIRCUITS

3.1 Arithmetic Circuits – Addition, Subtraction, 1's 2's Complement, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Parallel and Series Adders
3.2 Encoder, Decoder
3.3 Multiplexer – 2 to 1 MUX, 4 to 1 MUX, 8 to 1 MUX, Applications
3.4 Demultiplexer – 1 to 2 DEMUX, 1- 4 DEMUX, 1- 8 DEMUX

UNIT 4 – SEQUENTIAL LOGIC CIRCUITS

4.1 Flip Flops – SR, JK, T, D, FF, JK-MS, Triggering
4.2 Counters – 4 bit Up – Down Counters, Asynchronous/ Ripple Counter, Decade Counter- Mod 3, Mod 7 Counter, Johnson Counter, Ring Counter
4.3 Registers – 4bit Shift Register: Serial in Serial Out, Serial in Parallel Out, Parallel in Serial Out, and Parallel inParallel Out

UNIT 5 – MEMORY DEVICES

5.1 Classification of Memories – RAM Organization, Address Lines and Memory Sixe,
5.2 Static RAM, Bipolar RAM, cell Dynamic RAM, D RAM, DDR RAM
5.3 Read only memory – ROM organization, Expanding memory, PROM, EPROM, EEPROM, Flash memory
5.4 Data Converters – Digital to Analog converters, Analog to Digital Converters

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Digital principles & Applications Albert Paul Malvino& Donald P. Leach McGraw Hill Education; Eighth edition ISBN: 978-9339203405
2. Digital Electronics Roger L. TokheimMacmillian McGraw-Hill Education (ISE Editions); International 2 Revised edition ISBN: 978-0071167963
3. Digital Electronics – an introduction to theory and practice William H. Gothmann Prentice Hall India Learning Private Limited; 2 edition ISBN: 978-8120303485
4. Fundamentals of Logic Design Charles H. Roth Jr. Jaico Publishing House; First edition ISBN: 978-8172247744
5. Digital Electronics R. AnandKhanna Publications, New Delhi (Edition 2018) ISBN: 978-93-82609445

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SENSORS AND INSTRUMENTATION

Course Code	ER-3004 (Same as RA 3004)
Course Title	SENSORS AND INSTRUMENTATION
Number of Credits	3 (L-3,T-0, P-0)
Prerequisites	NIL
Course Category	PC

COURSE OUTCOMES:

Upon Completion of the course the students will be able to

CO1: Familiar with various calibration techniques and signal types for sensors.
CO2: Apply the various sensors in the Automotive and Robotics applications
CO3: Describe the working principle and characteristics of force, magnetic and heading sensors.
CO4: Understand the basic principles of various pressure and temperature, smart sensors.
CO5: Ability to implement the DAQ systems with different sensors for real time applications.

COURSE CONTENTS:

UNIT I INTRODUCTION

Basics of Measurement – Classification of errors, Error analysis , Static and dynamic characteristics of transducers , Performance measures of sensors ,Classification of sensors , Sensor calibration techniques ,Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT , Synchro , Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages:
Magneto resistive , Hall Effect ,Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors – Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances,Manufacturing, Environmental monitoring.

REFRENCES/SUGGESTED LEARNING RESOURSES:

1.Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009
2.Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, DhanpatRai& Co, New Delhi, 2013.
3.C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley &Sons,Canada, 2001
4.Hans Kurt Tönshoff (Editor), Ichiro , “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
5.John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
6.Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
7.RichardZurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press,2015

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ELECTRIC CIRCUITS & NETWORK

Course Code	ER3005(Same as EF/EL 3005)
Course Title	Electric Circuits & Network
Number of Credits	3 (L-2,T-1, P-0)
Prerequisites	NIL
Course Category	PC

COURSE CONTENTS:

UNIT – 1 BASIC OF NETWORK AND NETWORK THEOREM

1.1 Node and Mesh
1.2 Analysis Superposition Theorem
1.3 Thevenin Theorem
1.4 Norton Theorem
1.5 Maximum Power transfer theorem
1.6 Reciprocity Theorem

UNIT– 2 GRAPH THEORY

2.1 Graph of network, tree, and incidence matrix
2.2 F- Tie Set Analysis
2.3 F-Cut Set Analysis
2.4 Analysis of resistive network using cut-set and tie-set Duality

UNIT– 3 TIME DOMAIN AND FREQUENCY DOMAIN ANALYSIS

3.1 Solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-Ccircuits
3.2 Initial and Final conditions in network elements
3.3 Forced and Free response, time constants Steady State and Transient State Response
3.4 Analysis of electrical circuits using Laplace Transform for standard inputs (unit, Ramp, Step)

UNIT– 4 TRIGONOMETRIC AND EXPONENTIAL FOURIER SERIES

4.1 Discrete spectra and symmetry of waveform
4.2 Steady state response of a network to non-sinusoidal periodic inputs
4.3 power factor, effective values
4.4 Fourier transform and continuous spectra

UNIT- 5 TWO PORT NETWORK

5.1 Two Port Network
5.2 Open Circuit Impedance Parameters
5.3 Short Circuit Admittance Parameters
5.4 Transmission Parameters
5.5 Hybrid Parameters
5.6 Interrelationship of Two Port Network
5.7 Inter Connection of Two Port Network

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Networks and Systems Ashfaq Husain Khanna Publishing House
2. Network Analysis M. E. Van Valkenburg Prentice Hall of India
3. Engineering Circuit Analysis W. H. Hayt, J. E. Kemmerly and S. M. Durbin McGraw Hill
4. Electrical Circuits Joseph EdministerSchaum's Outline, Tata McGraw Hill
5. Basic Circuit Theory Lawrence P. Huelsma Prentice Hall of India
6. Network & Systems D. Roy Choudhury Wiley Eastern Ltd
7. Linear Circuit Analysis De Carlo and Lin Oxford Press

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AN INTRODUCTION TO ROBOTICS LAB

Course Code	ER-3006 (Same as RA 3006)
Course Title	AN INTRODUCTION TO ROBOTICS LAB
Number of Credits	1 (L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

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PRACTICALS:

1. Study of Robo-Analyzer(a 3D model based software) user manual.(http://www.roboanalyzer.com)
2. Study of different types of robots based on configuration and application.
3. Study of robotic actuators.
4. Study of different sensing element used in robots.
5. Study of robotic manipulator.
6. Study of robotic locomotion technique used in robots.
7. Study of different Human-robot interactions.
8. Study of robot specifications.
9. Study of different type of links and joints used in robots.
10. Study the basic terminology and notation used in robot geometry and kinematics. (robots with planar geometry)

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ELECTRONIC DEVICES AND CIRCUITS LAB

Course Code	ER3007(Same as EF/EL/RA 3007)
Course Title	Electronic Devices and Circuits Lab
Number of Credits	1 (L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

PRACTICAL OUTCOMES (PROs)

The practical in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

PRACTICALS:

1. Construct the circuit and plot the VI characteristics of the PN Junction Diode ,find the cut in voltage
2. Construct the circuit and plot the characteristics of a Zener Diode. Find thebreakdown voltage
3. Construct a Half Wave Rectifier and obtain regulation characteristics –WithoutFilters and with Filters Compare the results
4. Construct a Full Wave Rectifier and obtain regulation characteristics –WithoutFilters and with Filters Compare theresults
5. Construct a Bridge Rectifier and obtain regulation characteristics – Without Filters and with Filters
6. Obtain the characteristics of DIAC and TRIAC
7. Simulate half wave, full wave and bridge rectifier using simulation tool likePSpice/ Orcad/ Multisim.
8. Develop a simulation model for Voltage Series and Voltage Shunt Feedback Amplifiers
9. Develop circuits for Voltage Series and Voltage Shunt Feedback Amplifiers andObtain output plots. Compare the results with the simulation model.
10. Develop a simulation model for Current Series and Current Shunt Feedback Amplifiers
11. Develop circuits for Current Series and Current Shunt Feedback Amplifiers andObtain output plots. Compare the results with the simulation model

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Analog Circuits By AK MainiKhanna Publishing House Ed. 2018 (ISBN: 978-93-86173-584)
2. Electronic Devices and Circuits S. Salivahanan and N. Suresh Kumar McGraw Hill Education; Fourth edition (1 July 2017) ISBN: 978-9339219505
3. Electronics Devices and circuit theory Boyestad&Nashelsky Pearson Education India; 11 edition (2015)ISBN: 978-9332542600
4. Electronic Principles Albert Malvino& David Bates Tata McGraw Hill Publication 2010 ISBN: 978-0070634244
5. Electronics Devices & Circuits Jacob Millman McGraw Hill Education; 4 edition (2015)ISBN: 978-9339219543

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DIGITAL ELECTRONICS LAB

Course Code	ER 3008(Same as EF/EL/RA 3008)
Course Title	Digital Electronics Lab
Number of Credits	1 (L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

PRACTICAL OUTCOMES (PROs)

The practical in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

PRACTICALS:

1. To verify the truth tables for all logic fates – NOT OR AND NAND NORXOR XNOR using CMOS Logic gates and TTL Logic Gates
2. Implement and realize Boolean Expressions with Logic Gates
3. Implement Half Adder, Full Adder, Half Subtractor, Full subtractor using ICs
4. Implement parallel and serial full-adder using ICs
5. Design and development of Multiplexer and De-multiplexer using multiplexer ICs
6. Verification of the function of SR,D, JK and T Flip Flops
7. Design controlled shift registers
8. Construct a Single digit Decade Counter (0-9) with 7 segment display
9. To design a programmable Up-Down Counter with a 7 segment display
10. Study of different memory ICs
11. Study Digital- to – Analog and Analog to Digital Converters
12. Simulate in Software (such as PSpice) an Analog to Digital Converter
13. Simulate in Software (such as PSpice) an Analog to Digital Converter

REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Digital principles & Applications Albert Paul Malvino& Donald P. Leach McGraw Hill Education; Eighth edition ISBN: 978-9339203405
2. Digital Electronics Roger L. TokheimMacmillian McGraw-Hill Education (ISE Editions); International 2 Revised edition ISBN: 978-0071167963
3. Digital Electronics – an introduction to theory and practice William H. Gothmann Prentice Hall India Learning Private Limited; 2 edition ISBN: 978-8120303485
4. Fundamentals of Logic Design Charles H. Roth Jr. Jaico Publishing House; First edition ISBN: 978-8172247744
5. Digital Electronics R. AnandKhanna Publications, New Delhi (Edition 2018) ISBN: 978-93-82609445

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SENSORS AND INSTRUMENTATION LAB

Course Code	ER-3009(Same as RA 3009)
Course Title	**SENSORS AND INSTRUMENTATION LAB**
Number of Credits	2 (L-0,T-0, P-2)
Prerequisites	NIL
Course Category	PC

PRACTICALS OUTCOMES (PROs):

The practical in this section are PrOs (i.e. sub-components of the Cos) to be developed and assessed in the student for the attainment of the competency.

PRACTICALS:

1. Measurement of displacement using following transducers :
    - 1.1 Potentiometer
    - 1.2 L.V.D.T.
    - 1.3 Capacitive
2. To draw the resistance temperature characteristics of
    - 2.1 RTD
    - 2.2 Thermistor
3. To draw the temperature characteristics of Thermocouple
4. Measurement of flow by differential pressure flow meter
5. Measurement of flow by magnetic flow meter
6. Study of various pressure elements
7. Measurement of stress / pressure / weight by strain gauge.
8. Velocity and speed measurement by suitable transducer
9. To draw the input/ output characteristics of P V Cell
10. To draw the input/ output characteristics of Photo diode
11. To draw the input/ output characteristics of Photo conductive (LDR)
12. Measurement of light intensity by lux meter.

REFRENCES/SUGGESTED LEARNING RESOURSES:

1.Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009
2.Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, DhanpatRai& Co, New Delhi, 2013.
3.C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley &Sons,Canada, 2001
4.Hans Kurt Tönshoff (Editor), Ichiro , “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
5.John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
6.Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
7.RichardZurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press,2015

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