ROBOTICS AND AUTOMATION

INDEX

Semester – III

COURSE DESCRIPTION		
Course Code	**20RBT205**	**Course Credit: 4**
Course Name	**Digital Electronics**	
L-T-J-P	**3-1-0-0**	
Pre-requisite	Nil	
Year of Introduction	2021	

COURSE OBJECTIVES	
1	To familiarize number representation and conversion between different digital formats.
2	To analyse logical processes and implement logical operations using combinational and sequential circuits.
3	To understand characteristics of memory and their classification.
4	To understand concepts of programmable logic devices.
5	To implement combinational and sequential circuits using Verilog.

COURSE OUTCOMES (COs)		REVISED BLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Represent numbers in different digital formats and to perform logical operations	3
CO2	Choose a digital IC based on its characteristics	3
CO3	Analyse and synthesize combinational logic circuits and to derive minimal logic functions	4
CO4	Analyse and design sequential logic circuits	4
CO5	Familiarize A/D and D/A conversion techniques	1
CO6	Familiarize the basic concepts of memory, programmable logic devices	1
CO7	Design basic combinational and sequential logic circuits using Verilog	5

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	-	-	-	-	-	-	-	2
CO2	2	3	3	2	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	2	-	-	-	-	-	3
CO4	3	3	3	2	-	2	-	-	-	-	-	3
CO5	3	3	3	2	-	2	-	-	-	-	-	3
CO6	3	2	2	2	-	-	-	-	-	-	-	2
CO7	3	3	3	2	2	2	-	-	-	-	-	3

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

CO-PSO MAPPING

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PSO1	2	1	3	3	3	2	3
PSO2	3	2	2	3	3	2	3

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1 Hr.
Course content delivery hours	48 Hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 Hrs.
Total Instructional Hours	**53 Hrs.**

SYLLABUS

Module 1 deals with various number systems and codes. It also introduces various concepts related to logic families, TTL and CMOS in particular. Module 2 covers topics on Boolean laws and algebra followed by the design of different combinational circuits. This is followed by the design of various sequential circuits. The familiarization of A/D and D/A conversion and related circuits follows in Module 4. The concept of memory and programmable logic devices are included in Module 5. Besides, it includes design of various combinational and sequential circuits using Verilog.

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**Number Systems and Codes**			
Decimal – Binary - Octal and hexadecimal and their conversions - Binary addition and subtraction - unsigned and signed numbers - 1's complement and 2's complement arithmetic .		1,2	10	20%
ASCII code -Excess -3 code - Gray code.				
Logic Gates – NOT, AND, OR, NAND, NOR, XOR, XNOR				
Characteristics of digital ICs - Speed, Power dissipation, fan-out, current and voltage parameters, noise margin, operating temperature - TTL and CMOS Logic-NAND gate realisations .				
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Boolean Laws and Theorems**			
Laws and rules of Boolean algebra - De Morgan's theorem - NAND and NOR implementations - Sum of Products form, product of sums form - K map representation and simplification (upto four variables)		3	10	20%
Adders - Half adder and full adder -Subtractors- half subtractor and full subtractor- Ripple Carry Adder - Carry Look ahead adders				
Multiplexers - Demultiplexers				
Encoders - BCD to decimal decoders				
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Sequential Circuits**			
Flip-Flops - SR, JK, D and T flip-flops, JK Master Slave Flip-flop - Conversion of flip-flops.		4	9	20%
Shift Registers -SISO, SIPO, PISO, PIPO.				
Counters - Asynchronous Counters- up counter-down counter-decade counter - Mod N counters.				
Module-IV		**COs**	**Hrs**	**ESE Marks**
Module Title	**A/D and D/A Converters**			
Digital to Analog conversion – R-2R ladder - weighted resistors - D/A converter specifications - Familiarisation of DAC 0808.		4,5	10	20%
Analog to Digital Conversion - Flash ADC -Successive approximation - Integrating ADC - A/D converter specifications - Familiarisation of ADC 0808.				
Module-V		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Memory and Logic Design using Verilog**			
Memory - ROM - PROM – EPROM – RAM - Solid state drives.		6,7	9	20%
Sequential Programmable Logic Devices – PAL – PLA – FPGA.				

Introduction to Verilog - Design using Verilog basic gates, arithmetic circuits, basic combinational circuits, sequential logic circuits.			

TEXT BOOKS	
1	Thomas L. Floyd, Digital Fundamentals. India: Pearson Education, 2015. ISBN-13 9780132737968
2	R.J Tocci and N.S.Widmer, Digital Systems, Principles and Applications. Pearson Education, 2010. ISBN-10: 0135103827, ISBN-13: 978-0135103821
3	Albert P Malvino, Donald P Leach, Digital Principles and Applications. India: McGraw Hill Education, 2014. ISBN-10: 9789339203405, ISBN-13: 978-9339203405
REFERENCE BOOKS	
1	M Morris Mano, Digital Logic and Computer Design. India: Pearson Education, 2008. ISBN-9789332542525,9789332542525
2	S Salivahanan, S Arivazhagan, Digital Circuits and Design. India: Oxford University Press, 2018. ISBN-10: 0199488681, ISBN-13: 978-0199488681
3	Taub& Shilling, Digital Integrated Electronics. India: McGraw Hill Education, 2017. ISBN-10: 9780070265080, ISBN-13: 978-0070265080
4	John F. Wakerly, Digital Design: Principles and Practices. Pearson Education, 2008. ISBN-10: 8131713660, ISBN-13: 978-9332508125
5	S. Brown and Z. Vranesic, Fundamentals of Digital Logic with Verilog Design. Europe: Tata McGraw Hill, 2017. ISBN: 9780072838787, 9780072838787

MODES OF EVALUATION	SCORE WEIGHTAGE / SPLIT MARKS
Continuous Internal Evaluation	**50**
Internal Test - I	12.5
Internal Test - II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**

End Semester Examination Pattern

There will be two parts; Part A and Part B.
Part A : 30 marks
Part B : 70 marks
Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

		Total Pages:	3
Register No.:		Name:	

SAINTGITS COLLEGE OF ENGINEERING KOTTAYAM, KERALA

(AN AUTONOMOUS COLLEGE AFFILIATED TO
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT205**		
Course Name:	**Digital Electronics**		
Max. Marks:	**100**	**Duration:**	**3 hours**

PART A

(Answer all questions, each carries 3 marks)

	Question	CO	BTL	MARKS
1.	Prove that A+A'B+AB'=A+B	3	2	3
2.	Convert the hexadecimal number $(B2D.FC)_{16}$ into decimal, binary and octal	1	3	3
3.	Using K map, derive the Boolean expression for F(A, B, C, D) = ∑m(0, 1, 3, 4, 6, 9, 11) + d(2, 5)	3	3	3
4.	Draw the truth table for a half subtractor. Implement the circuit using logic gates.	3	1	3
5.	Draw the circuit diagram of a typical TTL NAND gate.	2	1	3
6.	Differentiate between asynchronous and synchronous counters.	4	4	3
7.	Explain the principle of working of a BCD to decimal decoder.	4	1	3
8.	Design a 3-bit ring counter.	4	6	3
9.	Mention the significance of programmable logic devices.	6	1	3
10.	Write a Verilog code for D Flipflop.	7	6	3

PART B

(Answer any one full question from each module, each carries14 marks)

MODULE I					
11.	a)	Write a short note on classification of binary codes.	1	1	6
	b)	Perform the unsigned binary subtraction 10101101 – 1110111 by 1's complement method	1	3	8
OR					
12.	a)	Convert the decimal number -25.125 to a single- precision floating point binary number.	1	3	6
	b)	Determine single error correcting code for the data 01110 using even parity.	1	3	8
MODULE II					
13.	a)	Explain the working of a carry look ahead adder with the help of a diagram.	3	1	7
	b)	Draw a 4 to 1 multiplexer using logic gates.	3	1	7
OR					
14.	a)	Explain the working of a ripple carry adder with the help of a diagram.	3	1	7

<table>
<tr><td></td><td>b)</td><td>Express the output logic function Y in standard SOP form and standard POS form.
<table><tr><td>A</td><td>B</td><td>C</td><td>Y</td></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr></table></td><td>3</td><td>2</td><td>7</td></tr>
<tr><td colspan="6">MODULE III</td></tr>
<tr><td>15.</td><td>a)</td><td>Draw and explain the working of a JK Flip flop.</td><td>4</td><td>1</td><td>6</td></tr>
<tr><td></td><td>b)</td><td>Explain with diagram the working of a 3-bit parallel in serial out shift register.</td><td>4</td><td>1</td><td>8</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">16.</td><td>a)</td><td>Design a mod 10 counter and explain its timing diagram.</td><td>4</td><td>6</td><td>8</td></tr>
<tr><td>b)</td><td>Design a 3-bitasynchronous down counter.</td><td>4</td><td>6</td><td>6</td></tr>
<tr><td colspan="6">MODULE IV</td></tr>
<tr><td rowspan="2">17.</td><td>a)</td><td>Explain the working of a successive approximation ADC.</td><td>5</td><td>4</td><td>6</td></tr>
<tr><td>b)</td><td>Design a synchronous 4-bit up counter.</td><td>4</td><td>6</td><td>8</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">18.</td><td>a)</td><td>With a neat diagram, explain the operation of a 3-bit Johnson counter.</td><td>4</td><td>1</td><td>7</td></tr>
<tr><td>b)</td><td>With suitable diagram, explain the operation of a DAC.</td><td>5</td><td>1</td><td>7</td></tr>
<tr><td colspan="6">MODULE V</td></tr>
<tr><td rowspan="2">19.</td><td>a)</td><td>Differentiate between SRAM and DRAM with diagrams.</td><td>6</td><td>4</td><td>8</td></tr>
<tr><td>b)</td><td>Describe the structure of a PLA.</td><td>6</td><td>1</td><td>6</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">20.</td><td>a)</td><td>Differentiate between PROM, PLA and PAL.</td><td>6</td><td>4</td><td>7</td></tr>
<tr><td>b)</td><td>Write Verilog Code for a full adder circuit.</td><td>7</td><td>1</td><td>7</td></tr>
</table>

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Minor

COURSE DESCRIPTION		
Course Code	20RBT281	Course Credit: 4
Course Name	Basics of Robotics	
L-T-J-P	3-1-0-0	
Pre-requisite	Nil	
Year of Introduction	2020	

COURSE OBJECTIVES	
1	To familiarize students with robot classifications and configurations.
2	To familiarize the students with the different sensors and actuators.
3	To provide the fundamentals of different end effectors.
4	To acquaint the students with Forward Kinematics and Inverse Kinematics, Trajectory planning, dynamic modelling, control and applications of robots

COURSE OUTCOMES (COs)		REVISED BLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Demonstrate the anatomy, specifications and applications of Robots	2
CO2	Choose the appropriate sensors and actuators for robots	3
CO3	Choose appropriate Robotic configuration and gripper for a particular application	3
CO4	Analyse kinematic model of robotic manipulators	4
CO5	Plan trajectories in joint space and Cartesian space	3
CO6	Develop dynamic model and design the controller for robotic manipulators	3

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	3
CO2	2	1	-	-	-	-	-	-	-	-	-	3
CO3	2	1	-	-	-	-	-	-	-	-	-	3
CO4	3	2	2	-	-	-	-	-	-	-	-	3
CO5	3	2	2	-	-	-	-	-	-	-	-	3
CO6	3	2	2	-	-	-	-	-	-	-	-	3

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

CO-PSO MAPPING

	CO1	CO2	CO3	CO4	CO5	CO6
PSO1	1	2	2	2	2	2
PSO2	3	3	3	3	2	3

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1 hr.
Course content delivery hours	48 hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 hrs.
Total Instructional Hours	**53 hrs.**

SYLLABUS

Robot Definitions- Types of Robots- Anatomy- Kinetic Chains-Robot Considerations for Applications. Sensor Classification-Internal Sensors and External Sensors- Vision-Robot Actuators- Hydraulic, Pneumatic and Electronic Types. Robot Configurations- Different Classifications- Classification of End Effectors- Types of Grippers- Robot Coordinate Systems. Robot Coordinate Systems-homogeneous co-ordinates and Transformations-D-H Representation, Arm Equation, Motion Planning-Joint Space Trajectory Planning and Cartesian Trajectory Planning. Dynamics-Control Techniques.

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**Fundamentals of Robotics**			
Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots- wheeled & Legged Robots, Aerial Robots.		1	9	20%
Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers.				
Open kinematic vs. closed kinematic chain, degrees of freedom.				
Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment.				
Robot Applications- medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining.				
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Sensors and Actuators**			
Sensor classification- touch, force, proximity, vision sensors.		2	11	20%
Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, noncontact type.				
Vision - Elements of vision sensor, image acquisition, image processing- Selection of sensors.				
Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors.				
Hydraulic actuators- Components and typical circuit, advantages and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages.				
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Robotic configurations and end effectors**			
Robot configurations-PPP, RPP, RRP, RRR-features of SCARA, PUMA Robots.		3	9	20%
Classification of robots based on motion control methods and drive technologies, 3R concurrent wrist.				
Classification of End effectors - mechanical grippers, special tools, Magnetic				

grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.			
Module-IV	**COs**	**Hrs.**	**ESE Marks**
Module Title **Kinematics and Motion Planning**			
Robot Coordinate Systems- Fundamental and composite rotations, homogeneous co-ordinates and transformations, Kinematic parameters, D-H representation, Direct Kinematics. The Arm equation- forward Kinematic analysis of a typical robots upto 3 DOF.	4&5	10	20%
Motion Planning- joint space trajectory planning-cubic polynomial, linear trajectory with parabolic blends.			
Cartesian space planning, Point to point vs continuous path planning.			
Module-V	**COs**	**Hrs.**	**ESE Marks**
Module Title **Dynamics and Control of Robots**			
Dynamics- Dynamic model of a robot using Lagrange's equation, dynamic modelling of 1DOF robot, including motor and gearbox, 2R planar manipulator.	6	9	20%
Control Techniques- Transfer function and state space representation, Performance and stability of feedback control, PID control of a single link manipulator, selection of PID controller gains.			

TEXT BOOKS	
1	Saha, S. K. (2014). Introduction to robotics. Tata McGraw-Hill Education.
2	Robert. J. Schilling , "Fundamentals of robotics – Analysis and control", Prentice Hall of India 1996.
3	R K Mittal and I J Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi,2003.
REFERENCE BOOKS	
1	Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
2	Ashitava Ghosal, "Robotics-Fundamental concepts and analysis", Oxford University press.
3	Robotics Technology and Flexible Automation, Second Edition, S. R. Deb
4	Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
5	John Iovine- "PIC Robotics: A Beginner's Guide to Robotics Projects Using the PIC Micro", McGraw Hill.

MODES OF EVALUATION	**SCORE WEIGHTAGE / SPLIT MARKS**
Continuous Internal Evaluation	**50**
Internal Test - I	12.5
Internal Test - II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**
End Semester Examination Pattern	
There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.	

	Total Pages:		3
Register No.:		Name:	

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SAINTGITS
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THIRD SEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT281**		
Course Name:	**Basics of Robotics**		
Max. Marks:	**100**	**Duration:**	**3 hrs.**

PART A

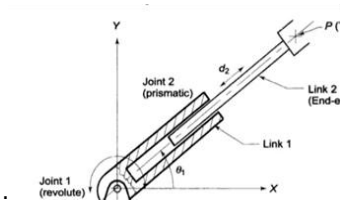
(Answer all questions, each carries 3 marks)

	Question	CO	BTL	MARKS
1.	Define reach and stroke of a robotic manipulator.	1	1	3
2.	List the characteristics of spot-welding robot?	1	1	3
3.	A strain gauge of gauge factor 2 and resistance of the unreformed wire 100 Ω is used to measure the acceleration of an object of mass 3kg. If the strain is 10^{-6}, cross sectional area=10mm^2 and Young's modulus =6.9N/m^2, examine the acceleration of the object.	2	4	3
4.	Compare hydraulic and pneumatic actuators.	2	2	3
5.	Explain the features of a SCARA robot	3	2	3
6.	List the advantages and disadvantages of a pneumatic gripper?	3	1	3
7.	If a point P= [3 0 -1 1]^T, find the new location of the point P, if it is rotated by π about z-axis of fixed frame and then translated by 3 units along y axis.	4	1	3
8.	Examine how will you compute end effector position and orientation of a robotic arm?	4	4	3
9.	Explain the necessity of dynamic modelling of robotic manipulators?	6	2	3
10.	Is a robotic system linear or nonlinear? Express your views.	6	2	3

PART B

(Answer any one full question from each module, each carries 14 marks)

MODULE I					
6.	a)	Explain in detail the specifications of a robotic manipulator.	1	1	8
	b)	Discuss the typical anatomy of a robotic manipulator?	1	2	6
OR					

7.	a)	Explain in detail any two industrial applications of Robots. Compare point to point control and continuous path control.	1	1	14
		MODULE II			
8.	a)	Explain how will you choose appropriate sensor for a robotic application?	2	2	8
	b)	Discuss the applications of vision sensor	2	2	6
		OR			
9.	a)	Outline the method of varying position using servo motor and stepper motor.	2	2	8
	b)	Explain the working of typical hydraulic actuator.	2	2	6
		MODULE III			
10.	a)	Explain in detail all robotic configurations.	3	2	14
		OR			
11.	a)	Describe the types of end effector & gripper mechanisms with simple sketches.	3	2	14
		MODULE IV			
12.	a)	Analyse the forward kinematic model of the following robot 	4	4	14
		OR			
13.	a)	The second joint of a SCARA robot has to move from 150 to 450 in 3 sec. Analyse the coefficients of the cubic polynomial to interpolate a smooth trajectory. Also obtain the position, velocity and acceleration profiles	5	4	8
	b)	Examine how will you plan a straight line trajectory in Cartesian space?	5	4	6
		MODULE V			
14.	a)	Analyse the dynamic model of 1 DOF robot operated by electric motor.	6	3	8
	b)	Examine the process of building a servo controlled robotic arm?	6	3	6
		OR			
15.	a)	Analyse the schematic of PID controlled robotic manipulator and derive the closed loop transfer function. Explain how gains are computed for the PID controller?	6	3	9
	b)	Examine on the stability of the above controller	6	3	5

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Semester – IV

COURSE DESCRIPTION		
Course Code	20RBT202	Course Credit: 4
Course Name	Kinematics and Dynamics of Mechanisms	
L-T-J-P	3-1-0-0	
Pre-requisite	NIL	
Year of Introduction	2020	

COURSE OBJECTIVES	
1	To provide basic knowledge on the basics of mechanisms, mechanical drives and analysis.
2	To make the students aware of the velocity and acceleration analysis of links.
3	To provide detailed idea on the static force analysis, inverse dynamic analysis and planar mechanisms.
4	To provide idea on the forward dynamic analysis and about single and multi DoF systems.
5	To make the students aware of rigid body rotation and to apply Euler's equation.
6	To provide basic knowledge on the vibration of single DoF systems.

COURSE OUTCOMES (COs)		REVISEDBLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Explain the kinematic details of links, kinematic pairs and degrees of freedom	2
CO2	Determine the displacement, velocity and acceleration at any point in planar mechanisms.	5
CO3	Analyze the static and dynamic forces developed in various links of simple mechanisms.	4
CO4	Explain inverse and forward dynamics in planar mechanisms, behaviour of rigid body and manipulator dynamics	2
CO5	Apply the fundamentals and solve free, damped and forced vibration of single DoF systems	3
CO6	Explain the kinematic details of links, kinematic pairs and degrees of freedom	2

CO-PO MAPPING												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3
CO4	3	3	3	-	-	-	-	-	-	-	-	3
CO5	3	3	3	-	-	-	-	-	-	-	-	3
CO6	3	3	1	-	-	-	-	-	-	-	-	3
Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"												

CO-PSO MAPPING						
	CO1	CO2	CO3	CO4	CO5	CO6
PSO1	3	3	3	3	3	3
PSO2	2	2	2	2	2	2
Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"						

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1 Hr.
Course content delivery hours	48 Hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 hrs.
Total Instructional Hours	**53 Hrs**

SYLLABUS

Links, kinematic pairs - kinematic chain - mechanism and machine - mobility/degrees of freedom (DoF) - Kutzbach's formula - Velocity analysis - angular velocity of a rigid link and relative velocity of points- instantaneous centre- graphical method - Corioli's acceleration component- graphical method of acceleration analysis - position analysis- analytical method- Static force analysis- Free body diagrams- nature of joint reaction forces - virtual work- D'Alembert's principle- equivalent dynamical systems- Inverse dynamic analysis- Mass moment of inertia- Forward dynamic analysis- rigid body motion- lagrangian formulation- Free undamped and damped vibration- under damped system- critically damped system- over damped system- Harmonically forced vibration- phase plane representation.

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**Basics of mechanisms**			
Basic kinematic concepts and definitions- kinematic link- kinematic pairs- kinematic chain- mechanism- machine- Mobility/degrees of freedom (DoF)- Greubler's criterion- Kutzbach's criterion- determination of DoF of planar linkages- numerical problems		1	9	20%
Grashof's law- kinematic inversions of four bar chain and slider crank chain- mechanical advantage- transmission angle- numerical problems				
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Velocity and acceleration analysis**			
Definition of velocity analysis- angular velocity of a rigid link and relative velocity of points- Velocity and acceleration polygons- instantaneous centre- Kennedy's theorem- graphical method		2	9	20%
Definition of acceleration analysis- angular acceleration of a rigid link and relative acceleration of points- Corioli's component of acceleration- derivation- graphical method				
Definition of position analysis- loop closure equations- derivation of solutions for simple mechanisms like four bar- slider crank - analytical method (theory only)				
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Static and Dynamic Force Analysis**			
Static force analysis- static equilibrium- Free body diagrams, nature of joint reaction forces- force analysis (four bar linkages only)- graphical method- superposition- principle of virtual work- friction in mechanisms (theory only)		3	10	20%
Dynamic force analysis- Inertia force and inertia torque- D'Alembert's principle- equivalent offset inertia force- force analysis (four bar linkages only)- equivalent dynamical systems (theory only)				
Static force analysis- static equilibrium- Free body diagrams, nature of joint reaction forces- force analysis (four bar linkages only)- graphical method- superposition- principle of virtual work- friction in mechanisms (theory only)				

Module-IV		COs	Hrs	ESE Marks
Module Title	**Inverse and Forward Dynamic Analysis**			
Definition of inverse and forward dynamics- Mass moment of inertia- Parallel axis theorem, Inverse dynamic analysis of a simple link under pure rotation		4	10	20%
Inverse dynamic analysis of a simple four bar mechanism (theory only)				
Definition of rigid body- acceleration of a rigid body- types of motion of rigid body- translation- rotation- general plane motion				
Lagrangian formulation of manipulator dynamics (theory only)				
Module-V		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Vibration of Single DoF Systems**			
Basic definitions- types of vibrations- basic features of vibrating systems		5	10	20%
Free undamped and damped vibration- under damped, critically damped, and over damped systems- logarithmic decrement- numerical problems- no derivation				
Harmonically forced vibration of undamped and damped systems- numerical problems- no derivation				
Magnification factor- vibration isolation- transmissibility- phase plane representation-basic concept only				

TEXT BOOKS	
1	Kinematics and Dynamics of Machinery, Author: Norton R L, Publisher: McGraw-Hill
2	Theory of Machines and Mechanisms 4th Edition, Author:John J. Uicker. Jr, Gordon R. Pennock, Joseph E. Shigley,Publisher:Oxford HED
3	Kinematics and Dynamics of Planer mechanisms, Author. Jeremy Hirsihham, Publisher. McGraw-Hill
REFERENCE BOOKS	
1	Kinematics, Dynamics and Design of Machinery, 3rd Edition, 2016", Authors: Kenneth J. Waldron,Gary L. Kinzel, Sunil K. Agrawal, Publisher: Willey
2	Fundamentals of Kinematics and Dynamics of Machines and Mechanisms, Author: Oleg Vinogradov, Publisher:CRCpress
3	Theory of Machines, Author:Rattan S S,Publisher:Tata McGraw-Hill
4	Mechanism and Machine Theory, Author: Ambekar, Publisher: A G, Prentice Hall
5	Theory of Machines, Author: V P Singh, Publisher: DhanpatRai& Co

MODES OF EVALUATION	**SCORE WEIGHTAGE / SPLIT MARKS**
Continuous Internal Evaluation	**50**
Internal Test - I	12.5
Internal Test - II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**
End Semester Examination Pattern	
There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.	

	Total Pages:		4
Register No.:		Name:	

SAINTGITS COLLEGE OF ENGINEERING KOTTAYAM, KERALA

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IV SEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT202**		
Course Name:	**Kinematics and Dynamics of Mechanisms**		
Max. Marks:	**100**	**Duration:**	**3 Hours**

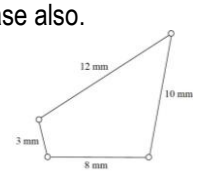
PART A

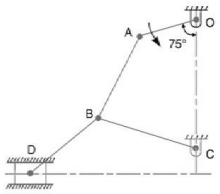
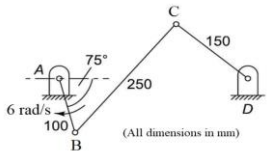
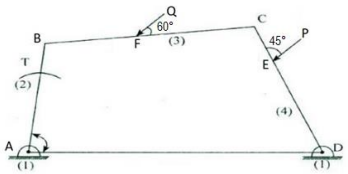
(Answer all questions, each carries 3 marks)

	Question	CO	BTL	Marks
1.	Define the terms: (i) link, (ii) kinematic pair and (iii) kinematic chain.	1	1	3
2.	Define degree of freedom of a mechanism. Mention its significance.	1	1	3
3.	Develop an expression for Corioli's component of acceleration on a slider move up with velocity V m/s along a rotating link with clockwise angular velocity 'ω' rad/s.	2	3	3
4.	Explain the vector loop method in position analysis for simple mechanisms.	2	2	3
5.	Show the free body diagrams of various linkages in a slider crank mechanism.	3	2	3
6	Define D'Alembert's principle.	3	1	3
7	Explain the application of the principle of virtual work to determine unknown static force in a planar mechanism, with the help of an example.	4	2	3
8	What is rigid body?	4	1	3
9	Outline the displacement time graph for critically damped, under damped and over damped vibration of a spring mass damper system. Write solutions for each case.	5	2	3
10	Define the terms: (i) damping factor, (ii)magnification factor and (iii) transmissibility	5	1	3

PART B

(Answer any one full question from each module, each carries14 marks.)

MODULE I					
11.	a	What are binary, ternary and quaternary links?	1	1	3
	b	Show the inversions of the mechanism shown in figure which leads to double crank, double rocker and crank rocker mechanisms. Identify the nature of motion of each link in each case also. 	1	3	11

		OR			
12.	a	Define transmission angle. Mention the extreme angles for the same.	1	1	3
	b	A crank-rocker mechanism ABCD has the dimensions AB = 30mm, BC = 90mm, CD = 75mm and AD (fixed link) = 100mm. Determine the maximum and the minimum values of the transmission angle. Locate the toggle positions and indicate the corresponding crank angles and the transmission angles.	1	4	11
		MODULE II			
13.		In the mechanism given below, the angular velocity of the crank OA is 600 r.p.m. The dimensions of various links are: OA = 28 mm; AB = 44 mm; BC = 49 mm and BD = 46 mm. The distance between centres of rotation O and C is 65mm.The path of travel of slider is 11 mm below the fixed-point C. Determine the: (i) linear velocity of the slider and (ii) angular velocity of links AB, BC and BD (iii) acceleration of slider (iv) angular acceleration of link AB 	2	5	14
		OR			
14.	a	State and prove Kennedy's theorem.	2	3	14
	b	For the four link mechanism shown in figure, determine the angular velocities of the links BC and CD using instantaneous centres. 			
		MODULE III			
15.		A four bar mechanism under the action of two external forces is shown below. The dimensions of the links are AB = 50 mm, BC = 66 mm, CD = 55 mm, CE = 25 mm, CF = 30 mm, AD=100 mm, angle BAD = 60°, P = 500N and Q = 600N. Determine the torque to be applied on the link AB for static equilibrium. 	3	3	14
		OR			
16.		In a four bar mechanism the link AB rotates with angular velocity of 20rad/s and angular acceleration of 100 rad/s both in clockwise direction when it make an angle of 45° with link AD which is fixed. The length of various linkages are	3	3	14

		AB=CD=400 mm, BC=500mm and AD=750mm. Neglect the gravitational effect and friction. The mass of link is 5kg/m. Find the torque on output link.			
		MODULE IV			
17.		Determine mass moment of inertia for a connecting rod using experimental method	4	3	14
		OR			
18.		Develop an expression for state-space and configuration space equation	4	4	14
		MODULE V			
19.	a)	List the governing equations for (i) free vibration, (ii) forced vibration.	6	3	14
	b)	A machine part of 2kg mass vibrates in a viscous medium. Determine the damping coefficient when a resonant amplitude of 12.5 mm with a period of 0.1s,if the system is excited by a harmonic force of 4Hz frequency, what will be the percentage increase in amplitude of vibration when the damper is removed as compared to that with damper?			
		OR			
20.	a)	Explain phase plane representation using neat figures.	5	3	4
	b)	A vibrating system consists of a mass of 50 kg, a spring of stiffness 30kN/m and a damper. The damping provided is only 20% of the critical value, Determine the: (i) damping factor (ii) critical damping coefficient (iii) natural frequency of damped vibrations (iv) logarithmic decrement (v) ratio of two consecutive amplitudes	5	3	10

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COURSE DESCRIPTION		
Course Code	20RBT206	Course Credit: 4
Course Name	Microcontrollers and Embedded Systems	
L-T-J-P	3-1-0-0	
Pre-requisite	NIL	
Year of Introduction	2020	

COURSE OBJECTIVES	
1	Learn the architecture of 8051 microcontroller
2	Learn the assembly language programming of 8051
3	Learn to interface peripherals to 8051
4	Understand what an embedded system is
5	Learn to build embedded systems using Arduino
6	Learn the basics of embedded OS

COURSE OUTCOMES (COs)		REVISED BLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Understand the internal architecture of 8051 Microcontroller	2
CO2	Develop simple programs for 8051 using assembly language programming	3
CO3	Interface 8051 microcontroller with peripherals using ALP	3
CO4	Interpret the architecture and design concept of embedded systems	2
CO5	Design embedded systems based on Arduino	3
CO6	Explain the concepts of embedded operating system	2

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	2	-	-	-	-	2	2
CO2	3	3	3	-	-	2	-	-	-	-	2	2
CO3	3	3	3	-	-	2	-	-	-	-	2	2
CO4	3	1	-	-	-	-	-	-	-	-	2	2
CO5	3	3	3	-	-	2	-	-	-	-	2	2
CO6	2	1	-	-	-	1	-	-	-	-	1	1

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

CO-PSO MAPPING

	CO1	CO2	CO3	CO4	CO5	CO6
PSO1	3	3	3	3	2	-
PSO2	2	2	2	2	1	-

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1 Hr.
Course content delivery hours	48 Hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 Hrs.
Total Instructional Hours	**53 Hrs**

SYLLABUS
Working and applications of microcontrollers will be studied using the widely used 8051 microcontrollers. Assembly language programming and interfacing will be dealt with. The understanding on 8051 will be extended to a more advanced and recent cost-effective microcontroller, which is Arduino. Programming of Arduino for small applications will be introduced. The concepts of embedded real time operating systems also will be introduced.

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**8051 microcontroller**			
Review – Basics of Computer Architecture.		1	10	20 %
Difference between microprocessor and microcontroller Architecture, 8051pin diagrams; Architecture, I/O Port structure, Register organization - special function registers, Memory organization.		1		
Instruction set, Addressing modes.		2		
Simple Assembly language programs: Arithmetic (Addition, Subtraction, Multiplication & Division),Transfer a block of data from one internal memory location to another.		2		
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**8051 microcontroller Programming and Peripherals**			
Timers/Counters-Serial Communication (ALP).		2	10	20 %
Interrupt structure-programming (ALP).		2		
Interfacing of peripherals(ALP and embedded C programming) - LED, ADC, DAC.		3		
Interfacing of sensors, simple Switch and keyboard interfacing, 7segment LED (ALP).		3		
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	Embedded Systems Overview			
Introduction to Embedded Systems: Definition, Features, Simple Example of Embedded Systems, Applications of embedded systems-Consumer electronics, Robotics, Automobiles		4	10	20 %
Embedded System Architecture :HW-Processor, Controller, SoC, Memory, Peripherals; SW-Application, Middleware, OS, Device Drivers, Tool chain-Assembler, Interpreter, Compiler, Linker, Loader, Debugger		4		
Embedded system design process: Requirement Analysis, Specification Development, Architecture, Design HW and SW component Development, Module Integration, Testing		4		
Module-IV		**COs**	**Hrs**	**ESE Marks**
Module Title	**Embedded System Board Study(Arduino Uno)**			
Arduino Uno Board: Board Study (Board level Block schematic)- Chip (Features only- Architecture not needed), GPIO ,Memory ,Programming Interface		5	9	20 %

Programming: Arduino IDE, Sample Code (LED, Switch, DC motor, Stepper motor control), Temperature monitoring system using LM35 Temperature sensor &Seven Segment display			
Module-V	**COs**	**Hrs.**	**ESE Marks**
Module Title Introduction to OS and Communication Protocols.			
Embedded Operating system basic concepts: Functional layers in a computer system OS terminology, Kernel Functions (Overview only), Types of Kernels (Monolithic kernel & Microkernel),Tasks/Processes Task State diagram.	6	9	20 %
RTOS – Hard and Soft RTOS – Examples of RTOS.	6		
Communication Protocols:RS232, I2C, SPI and USB.	6		

TEXT BOOKS	
1	Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems :Using Assembly and C, Pearson, 2nd Edition,2007
2	Lyla B Das,Embedded Systems:An Integrated Approach,1st Edition,2012
3	Michael Mc Roberts, Beginning Arduino, Apress, 1st Edition, 2011
REFERENCE BOOKS	
1	Kenneth Ayala, The 8051 Microcontroller, Cengage Learning, 3rd Edition, 2012
2	Raj Kamal, Embedded Systems Architecture, programming and Design, Tata McGraw-Hill, 3rd Edition, 2013
3	TammyNoergaard, Embedded Systems Architecture, AComprehensiveGuideforEngineers andProgrammers,Newnes–Elsevier,2nd Edition,2012
4	James Arthur, Arduino: The complete guide to Arduino for beginners, including projects, tips, tricks, and programming, Ingram, 1st Edition, 2019

MODES OF EVALUATION	**SCORE WEIGHTAGE / SPLIT MARKS**
Continuous Internal Evaluation	**50**
Internal Test – I	12.5
Internal Test – II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**
End Semester Examination Pattern	
There will be two parts; Part A and Part B. Part A : 30 marks Part B : 70 marks Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.	

		Total Pages:	2
Register No.:		Name:	

SAINTGITS COLLEGE OF ENGINEERING KOTTAYAM, KERALA

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FOURTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT206**		
Course Name:	**Microcontrollers and Embedded Systems**		
Max. Marks:	**100**	**Duration:**	**3 Hours**

PART A

(Answer all questions, each carries 3 marks)

	Question	CO	BTL	MARKS
1.	Which are different types of computer memory?	1	2	3
2.	Difference between microprocessor and microcontroller Architecture.	1	2	3
3.	Explain interrupt structure of 8051	1	2	3
4.	Which are the registers used for timer programming in 8051?	1	2	3
5.	Explain the distinct features of embedded systems	4	2	3
6.	What is meant by hardware software co-design?	4	2	3
7.	Briefly explain features of Arduino Uno board	5	2	3
8.	What is an IDE? What are the features of Arduino IDE?	5	2	3
9.	Differentiate between Monolithic kernel & Micro kernel.	6	2	3
10.	Why do we need RTOS?	6	2	3

PART B

(Answer any one full question from each module, each carries 14 marks)

MODULE I					
11.	a)	With the help of Block Diagram explain architecture of a computer	1	2	6
	b)	Explain register organization of 8051 microcontroller	1	2	8

OR					
12.	a)	Write an ALP program to Transfer a block of data from one internal memory location to another.	1	3	8
	b)	Explain the different addressing modes of 8051.	1	2	6
MODULE II					
13.	a)	Write an ALP to interface LCD with 8051.	3	3	10
	b)	Explain the registers used for serial port programming in 8051.	3	2	4
OR					
14.	a)	Explain with the help of a program how keyboard can be interfaced with 8051.	3	3	10
	b)	Explain the structure of TMOD register.	2	2	4
MODULE III					
15.	a)	Compare embedded system with a general-purpose computing system.	4	2	6
	b)	Explain Embedded product development Life Cycle water fall model	4	2	8
OR					
16.	a)	Explain the selection criteria of an embedded processor for an application.	4	2	4
	b)	What is the function of Assemblers, Compilers, linkers, Loaders and Debuggers.	4	2	10
MODULE IV					
17.	a)	Explain the technical specifications of Arduino Uno.	5	2	8
	b)	Which are the general pin functions of Arduino Uno?	5	2	6
OR					
18.	a)	What does GPIO Stand for? What are its functions? How do you configure them?	5	2	10
	b)	Write a program for blinking of LED using Arduino Uno.	5	3	4
MODULE V					
19.	a)	With the help of a diagram explain Functional layers in a computer system OS terminology	6	2	8
	b)	Compare General Purpose OS with Real Time OS	6	2	6
OR					
20.	a)	Explain the important functions of OS kernel	6	2	7
	b)	Discuss the features of Communication Protocols RS23 and I2C	6	2	7

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Minor

COURSE DESCRIPTION		
Course Code	20RBT282	Course Credit: 4
Course Name	Introduction to Industrial Automation	
L-T-J-P	3-1-0-0	
Pre-requisite	Nil	
Year of Introduction	2020	

COURSE OBJECTIVES	
1	Design and implement automated systems using pneumatics.
2	Provide hydraulic solutions for designing automated systems.
3	Understand the design aspects of modern CNC machines.
4	Apply PLC programming and implement it on PLC kits.
5	Understand the working and application of different sensors.

COURSE OUTCOMES (COs)		REVISED BLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Understand the basic concepts of automation methodologies and trends in manufacturing automation	2
CO2	Understand the working principle and applications of different types of sensors.	2
CO3	Study the design aspects of modern CNC machines.	1
CO4	Study the basic principles and operation of different types of material handling devices.	1
CO5	Develop different pneumatic circuits based on their applications.	6
CO6	Familiarize the basic concepts of PLC programming.	2
CO7	Understand different automated inspection methods.	2

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	-	-	-	-	-	-	-
CO2	3	2	2	1	2	1	-	-	-	-	-	-
CO3	3	2	2	2	2	1	-	-	-	-	-	-
CO4	3	2	2	2	1	1	-	-	-	-	-	-
CO5	3	3	2	2	2	1	-	-	-	-	-	-
CO6	3	3	2	2	2	-	-	-	-	-	-	-
CO7	3	3	2	2	2	2	-	-	-	-	-	-

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

CO-PSO MAPPING

	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PSO1	2	3	1	2	2	2	3
PSO2	1	3	1	1	1	1	1

Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1Hr.
Course content delivery hours	48 Hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 Hrs.
Total Instructional Hours	**53 Hrs.**

SYLLABUS

The aim of this course is to introduce students with present Industrial Automation scenario. The broad knowledge of sensors, methodologies and essential components of present industrial Automation Industry is provided in the syllabus. Thus, this course is very important for students who want to use their knowledge of electronic engineering for working in industrial automation sector.

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**Automation methodologies**			
Concept of Mechanization and Automation.		1	9	20%
Types of Automation Detroit type Automation - Automated flow lines.				
Fundamentals of Transfer Lines - Trends in manufacturing – GT and Cellular Manufacturing.				
Flexible manufacturing systems – features of FMS, computer integrated manufacturing.				
Need for AI and expert systems in CIM, Automated assembly system – flexible assembly automation.				
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Sensors and actuators for automation**			
Classification of position and motion sensors - inductive type - electromechanical switches - rotary position sensors.		2	9	20%
Resolver – encoders - integrated motion systems				
Fundamental sensor methodologies – LVDT – RVDT - photo electric - thermo electric – capacitive - magnetic detectors - impedance type gauging transducers, linear potentiometer - strain gauges.				
Electrical , Hydraulic and pneumatic actuators and their comparison - Examples.				
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Elements of CNC systems:**			
Servomotor and servo system design trends - Stepper motors and controls.		3,4	10	20%
Adaptive control, ball screws and guide ways – spindle - bearings and mountings.				
Accessories and selection of drives for CNC machines - Material Handling and Identification Technologies.				
Overview of Material Handling Systems - Principles and Design Consideration.				
Material Transport Systems - Storage Systems - Overview of Automatic Identification Methods.				
Module-IV		**COs**	**Hrs**	**ESE Marks**
Module Title	**Pneumatic/Hydraulic/Electro pneumatic/electro hydraulic Automation**			
Pneumatic/Hydraulic Automation: control valves – direction - pressure and flow.		5	10	20%
Sequential control of single /multiple actuator systems.				
Electro pneumatic/electro hydraulic automation: Symbols: Basic electrical elements – relay – solenoid – timers.				
Pneumatic – electrical converters.				

Module-V		COs	Hrs.	ESE Marks
Module Title	**Automation Control**			
Sequence control and programmable controllers – logic control and sequencing elements		6,7	10	20%
Ladder diagram – PLC - programming the PLC - Practical Examples on PLC ladder programming.				
Inspection automation: Inspection automation - off-line and on-line inspections - computerized coordinate measuring machine.				
Online inspection systems - laser interferometer.				
Non-contact inspection methods - Automatic gauging and size control systems - thickness measurement - machine vision systems.				

TEXT BOOKS	
1	Automation, Production Systems and Computer Integrated Manufacturing, Groover M.P, Prentice – Hall Ltd, 1997.
REFERENCE BOOKS	
1	Computer Control of Manufacturing Systemsll, Yoram Koren, Tata McGraw-Hill Edition 2005.
2	CNC Machines, Radhakrishnan P, New Central Book Agency, 1992.
3	Mechatronics: A Multidisciplinary Approach, 4/Ell, W. Bolton. Pearson Education India.
4	Mechatronics, HMT, Tata McGraw-Hill, 1998. 6. ―Pneumatic Control for Industrial Automationll, Peter Rohner & Gordon Smith, John Wiley and Sons, 1987.
5	Standard Handbook of Industrial Automation, Onsidine D M C & Onsidine G D C, Chapman and Hall, NJ, 1986.

MODES OF EVALUATION	SCORE WEIGHTAGE / SPLIT MARKS
Continuous Internal Evaluation	**50**
Internal Test – I	12.5
Internal Test – II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**
End Semester Examination Pattern	
There will be two parts; Part A and Part B. Part A contain 5 questions from each module, having 5 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 15 marks.	

		Total Pages:	3
Register No.:		Name:	

SAINTGITS COLLEGE OF ENGINEERING KOTTAYAM, KERALA

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4thSEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT282**		
Course Name:	**Introduction to Industrial Automation**		
Max. Marks:	**100**	**Duration:**	**3 Hours**

Instructions to Candidates

There will be two parts; Part A and Part B. Part A contain 5 questions from each module, having 5 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 15 marks.

PART A

(Answer all questions, each carries 5 marks)

	Question	CO	BTL	MARKS
1.	Explain the concept of part family.	1	2	5
2.	Differentiate between RTD and thermocouple.	2	4	5
3.	Explain the stick slip effect in friction guide ways.	3	2	5
4.	Explain cushioning in pneumatic cylinders.	5	2	5
5.	With suitable example explain latching in PLC Ladder logic.	6	2	5

PART B

(Answer any one full question, each carries 15 marks)

MODULE I					
6.	a)	With neat sketch explain different types of automated transfer lines used in an industry.	1	2	10
	b)	Discuss the nature and role of CIM elements.	1	2	5
OR					
7.	a)	Explain the significance of group technology in present manufacturing scenario.	1	2	8
	b)	Explain different types of FMS layout.	1	2	7
MODULE II					
8.	a)	Explain the construction and working of LVDT.	2	2	7
	b)	Explain the working of eddy current and capacitance type proximity sensors.	2	2	8

OR					
9.	a)	With neat sketches explain the working of i) resolver ii) Synchros.	2	2	10
	b)	Illustrate the configuration of Gray coded absolute encoder.	2	3	5
MODULE III					
10.	a)	Explain the preloading of ball screws in recirculating ball screw mechanism.	3	2	8
	b)	With neat sketches explain adaptive control of machine tools.	3	2	7
OR					
11.	a)	Explain the different types of industrial trucks used for material handling.	4	2	7
	b)	Explain the different types of conveyors used for automated material handling.	4	2	8
MODULE IV					
12.	a)	Design a pneumatic circuit for A+B+ B-A- sequencing operation using Karnaugh-Veitch method	6	5	6
	b)	With neat sketch explain basic components of a pneumatic system.	5	2	9
OR					
13.	a)	With neat sketches explain the basic electrical devices used in electro pneumatic control.	5	2	9
	b)	With a neat sketch explain the use of an on-delay timer in an electro pneumatic circuit.	5	2	6
MODULE V					
14.	a)	Design PLC ladder logic for operating two cylinders in the sequence A+B+A-B-.	6	5	8
	b)	Develop a PLC ladder program to glow three lights in sequence with a delay of 15 seconds in between. The circuit has only one switch to control the sequence.	6	5	7
OR					
15.	a)	Briefly explain coordinate measuring machine.	7	2	8
	b)	Explain the scanning laser optical measurement system with a neat sketch.	7	2	7

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Honours

COURSE DESCRIPTION		
Course Code	20RBT292	Course Credit: 4
Course Name	Sensors and Actuators for Robots	
L-T-J-P	3-1-0-0	
Pre-requisite	Nil	
Year of Introduction	2020	

COURSE OBJECTIVES	
1	To select appropriate sensory devices, actuators for robotic applications
2	To provide basic idea of internal and external sensors and their working
3	To familiarize students on vision-based sensors in robotic applications
4	To know the basic actuation mechanisms in robotics

COURSE OUTCOMES (COs)		REVISEDBLOOM'S TAXONOMY LEVEL
At the end of the course students will be able to:		
CO1	Understand different type of sensors and their applications in Robotics	2
CO2	Explain fundamental principle of working of sensors and actuators for robots	1
CO3	Interpret typical manufacturer's data sheet of sensors and actuators and use them for selection in typical applications	2
CO4	Understand the basic principles of vision-based sensors	2
CO5	Explain the fundamental ideas of action mechanisms in Robots	1

CO-PO MAPPING												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	3
CO2	3	2	2	-	-	-	-	-	-	-	-	3
CO3	3	2	2	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-
Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"												

CO-PSO MAPPING						
	CO1	CO2	CO3	CO4	CO5	CO6
PSO1	1	2	2	1	-	-
PSO2	1	2	2	2	3	-
Correlation levels: 1- Low; 2-Medium; 3-High; No Correlation- "-"						

COURSE IMPLEMENTATION CLOCK (IN HOURS)	
Course introduction with thorough briefing of Course Objectives and expected Course Outcomes	1 Hr.
Course content delivery hours	48 Hrs.
Internal Test (2 Assessment Tests of two-hour duration)	4 hrs.
Total Instructional Hours	**53 Hrs.**

SYLLABUS

Requirement of sensors in robots used in industry, agriculture, medical field, transportation, military, space and undersea exploration, human-robot interactions, robot control, robot navigation, tele-operational robot etc. Proprioceptive or Internal sensors - Interpreting typical manufacturer's data sheet of internal sensors - the use of Proprioceptive sensors in robots. Exteroceptive or External sensors- Interpreting typical manufacturer's data sheet of external sensors - use of Exteroceptive sensors in robots. Vision based sensors- Requirement of actuators for robotic applications, Electric actuators- Linear actuation mechanisms- Transmission mechanisms- Micro-actuators

COURSE CONTENT

Module-I		**CO(s)**	**Hrs.**	**ESE Marks**
Module Title	**Proprioceptive or Internal sensors**			
Requirement of sensors in robots used in industry, agriculture, medical field, transportation, military, space and undersea exploration - human-robot interactions - robot control - robot navigation - tele-operational robot etc.		1, 2	10	20%
Position sensors - encoders - linear, rotary, incremental linear encoder - absolute linear encoder - Incremental rotary encoder - absolute rotary encoder – potentiometers - LVDTs.				
velocity sensors - optical encoders - tacho generator - Hall effect sensor - Acceleration sensors.				
Heading sensors – Compass - Gyroscope sensor – IMU – GPS - real time differential GPS - active optical and RF beacons - ultrasonic beacons - reflective beacon				
Force sensors - strain gauge based and Piezo electric based - Torque sensors - Electronic skin - micro-cantilevers.				
Module-II		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Exteroceptive or External sensors**			
Contact type, noncontact type, Tactile, proximity - detection of physical contact or closeness - contact switches – bumpers - inductive proximity - capacitive proximity - semiconductor displacement sensor.		1, 2	10	20%
Range sensors - IR, sonar, laser range finder - optical triangulation (1D) - Structured light(2D) - performance comparison range sensors.				
Motion/ speed sensors - speed relative to fixed or moving objects - Doppler radar - Doppler sound.				
Module-III		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Vision based sensors**			
Vision based sensors - Elements of vision sensor - image acquisition - image processing - edge detection - feature extraction - object recognition - pose estimation and visual servoing - hierarchy of a vision system.		1,4	10	20%
CCD and CMOS Cameras – Monochrome – stereovision - night vision cameras - still vs video cameras - Kinect sensor - Block schematic representations.				
Criteria for selection of sensors – range - dynamic range – sensitivity – Linearity - response time - band width – accuracy - repeatability & precision - Resolution & threshold - type of output, size and weight - environmental conditions - interfacing.				

Module-IV		COs	Hrs	ESE Marks
Module Title	**Actuators for Robots**			
Requirement of actuators for robotic applications - Pneumatic and Hydraulic actuators - physical components - comparison of hydraulic and pneumatic systems.		3	10	20%
Components of electro hydraulic and pneumatic systems.				
Electric actuators – advantages - DC motors - DC and AC servo motors - various types of Stepper motors - brushless DC motors – PMSM – SRM - Motor characteristics - Selection of motors - block schematic of typical electric drive - closed loop speed and torque control.				
Module-V		**COs**	**Hrs.**	**ESE Marks**
Module Title	**Actuation mechanisms**			
Linear actuation mechanisms - Belt-driven and screw-driven actuators - Pneumatically and hydraulically driven linear actuators - Rack-and-pinion driven actuators - Linear motor driven actuators.		5	9	20%
Transmission mechanisms - Cams and Cam followers - working principle - Gears and gear trains - ratchet and pawl - belt drive - advantages of belt drive - bearings classification and selection of bearings.				
Micro-actuators – Electrostatic – Electromagnetic – Piezoelectric – Fluid – Thermal - Shape memory alloy - characteristics of micro actuators – Stroke - Force/torque – Stiffness – Input energy –Efficiency – Linearity – Hysteresis – Response time – Drift - Bandwidth.				

TEXT BOOKS	
1	Robotics Engineering: An Integrated Approach, by Richard D. Klafter, Prentice Hall Inc.
2	Clarence W. de Silva, Sensors and Actuators: Control System Instrumentation, CRC Press 2007, ISBN-13: 978-1420044836
3	Introduction to Robotics, S K Saha, McGraw Hill Eduaction.
REFERENCE BOOKS	
1	D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.
2	W. Bolton, “Mechatronics”, Pearson Education Limited.
3	Automation, Production Systems and Computer Integrated Manufacturing, Groover M.P, Prentice – Hall Ltd., 1997.
4	Pillai S. K. “A first course on electric drives”, Wieley Eastern Ltd, New Delhi.
5	Journal of sensors, Special issue- Sensors for Robotics, AiguoSong ,Guangming Song, Daniela Constantinescu, Lei Wang, and Quanjun Song, Volume 2013.

MODES OF EVALUATION	**SCORE WEIGHTAGE / SPLIT MARKS**
Continuous Internal Evaluation	**50**
Internal Test - I	12.5
Internal Test - II	12.5
Assignments / Quiz / Seminars etc.	15
Attendance	10
End Semester Examination (ESE)	**100**
Total	**150**
End Semester Examination Pattern	
There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and	

carry 14 marks.

		Total Pages:	
Register No.:		Name:	

SAINTGITS COLLEGE OF ENGINEERING KOTTAYAM, KERALA

(AN AUTONOMOUS COLLEGE AFFILIATED TO
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH. DEGREE EXAMINATION, MONTH AND YEAR

Course Code:	**20RBT292**		
Course Name:	**SENSORS AND ACTUATORS FOR ROBOTS**		
Max. Marks:	**100**	**Duration:**	**3 Hours**

PART A

(Answer all questions, each carries 3 marks)

	Question	CO	BTL	MARKS
1.	How proprioceptive sensors differ from exteroceptive sensors?	1	2	3
2.	Mention the applications of force sensors.	1	1	3
3.	A robot is moving in an environment amidst obstacles which are black in colour. Which sensor is preferred in this scenario for range measurement and obstacle avoidance? Justify your answer.	2	3	3
4.	Explain the uses of tactile sensors.	2	2	3
5.	Can we compute depth of an object using camera? Justify your answer.	3	2	3
6.	What is visual servoing?	3	1	3
7.	If the payload of a robotic manipulator is a car, which actuator is preferred? Justify your answer.	4	4	3
8.	Which motors are generally used for position control applications?	4	3	3
9.	Which are the commonly used linear actuating mechanisms for robots?	5	2	3
10	What are pneumatic muscles?	5	2	3

PART B

(Answer any one full question from each module, each carries 14 marks.)

MODULE I					
11	a)	What is LVDT? What are the parameters that can be measured by this? Describe with a neat diagram the principle of operation and output characteristics of the same.	1	2	10
	b)	A robot's control memory has 8-bit storage capacity, it has two rotational joints and one linear joint. The linear link can vary its length from as short as 0.2 meters to as long as 1.2 meters. Compute the control resolution for encoder of each joint. .	1	3	4
OR					

12	a)	What is Gyroscope? Enumerate various sources of errors in Gyroscopes? How will you rectify them while gyroscopes are used in robotic applications?	1	2	10
	b)	Can we use GPS sensors in indoor environments? Justify your answer.	1	3	4
MODULE II					
13	a)	Which are the sensors used to detect closeness of objects? And how will you compute the same?	2	2	10
	b)	How range is measured using optical triangulation method?	2	3	4
OR					
14		Consider a scenario where a surveillance vehicle chases a car, which violated traffic rules. Which all sensors are to be used in the surveillance vehicle to compute the position and relative velocity of the target vehicle (car)? Explain the working of the sensors being used.	2	3	14
MODULE III					
15	a)	Which are the elements of a vision sensor? How will you extract features using vision sensor?	4	2	10
	b)	What are the advantages of CMOS cameras?	4	2	4
OR					
16		Explain the criteria for selection of sensors for different applications	1	3	14
MODULE IV					
17	a)	Compare hydraulic and pneumatic actuators?	3	2	8
	b)	What is FRL unit? What are its functions?	3	2	6
OR					
18	a)	With the help of neat diagram explain the working of stepper motor?	3	2	8
	b)	In which context Brushless DC motors are used for robotic applications? Mention one application for the same.	3	2	3
	c)	How much power is required to lift a 20Kg weight by a DC motor if the lifting speed is 0.2m/s?	3	4	3
MODULE V					
19	a)	Explain the working of Rack-and-pinion driven actuator with the help a diagram.	5	2	8
	b)	Explain in detail about different transmission mechanisms.	5	2	6
OR					
20	a)	Compare electro thermal, electro-optical and electrochemical actuators.	5	2	7
	b)	Which are the characteristics of micro-actuators?	5	2	7

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B.Tech. Programme in Robotics and Automation

Corrected Course Codes – Semester VIII

PROGRAMME ELECTIVE - IV

Slot	Course Code	Course Name	L-T-P	Hrs.	Credit
C	20RBT414	Design for Manufacturing and Assembly	2-1-0	3	3
	20RBT424	Natural Language Processing	2-1-0		
	20RBT434	Digital Control Systems	2-1-0		
	20RBT444	Probabilistic Robotics	2-1-0		
	20RBT454	Industry 4.0	2-1-0		
	20RBT464	Supervisory Control	2-1-0		