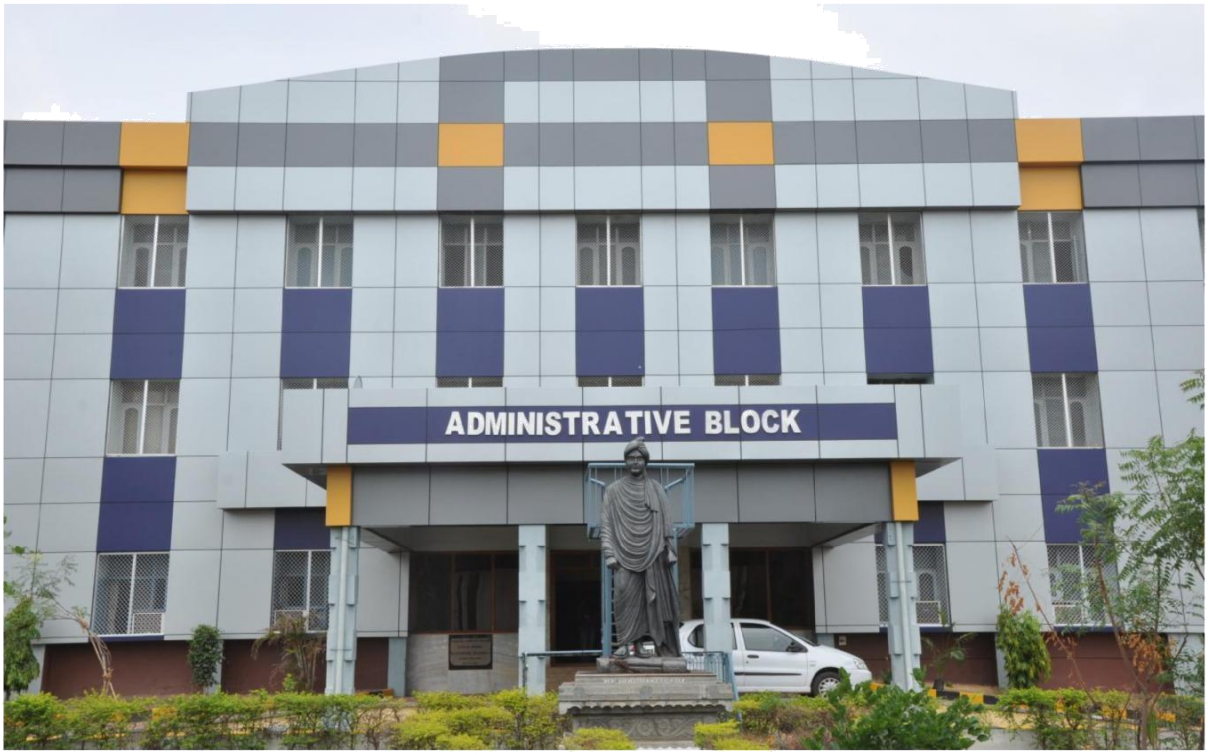


# Scheme – 2023

## Department of Mechanical Engineering

**G. Pulla Reddy Engineering College**
**(Autonomous): Kurnool**

**Accredited by NBA of AICTE and NAAC of UGC**

**Affiliated to JNTUA, Anantapuramu**

# Scheme and Syllabus for

# Honors in Mechanical Engineering

**(With Effect from the Batch Admitted in 2023-24)**

**G. PULLA REDDY ENGINEERING COLLEGE (Autonomous): KURNOOL**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**Honors in MECHANICAL ENGINEERING (For Mechanical Engineering students)**

# SCHEME OF INSTRUCTION AND EXAMINATION

| S. No. | Course Code | Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | HME01 | Automotive Thermal Systems | 3 | 0 | 0 | 3 |
| 2 | HME02 | Simulation and Modelling of Manufacturing Systems | 3 | 0 | 0 | 3 |
| 3 | HME03 | Supply Chain Management | 3 | 0 | 0 | 3 |
| 4 | HME04 | Advanced Mechanism Design | 3 | 0 | 0 | 3 |
| 5 | HME05 | Bio Mechanics | 3 | 0 | 0 | 3 |
| 6 | | Applied Project Work | 0 | 0 | 6 | 3 |
| **Total** | | | **15** | **0** | **6** | **18** |

| AUTOMOTIVE THERMAL SYSTEM (ATS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Honors:** Mechanical Engineering | | | | | | **Scheme:** 2023 | | |
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exam** | **TOTAL** |
| **HME01** | **PC** | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| **Sessional Exam Duration: 2 Hrs** | | | | | | **End Exam Duration: 3 Hrs** | | |

| **Course Outcomes:** At the end of the course, students will be able to | |
|---|---|
| **CO1:** | Apply the knowledge of heat transfer concepts for design formulation |
| **CO2:** | Analyse the energy quality and quantity |
| **CO3:** | Identify different compressor systems and its applications and able to calculate its efficiencies |
| **CO4:** | List the basic components and analyse the working of heat exchangers |
| **CO5:** | Apply the thermal management methods in power electronics and controllers |

**UNIT – I**

**Fundamentals and Systematic Approach to Heat Transfer Concepts:** Energy, Heat & Work, First Law of Thermodynamics, Heat Engines, Refrigerators, and Heat Pumps, Second Law of Thermodynamics, Carnot Cycle, Conduction, Convection-Parallel flow on an Isothermal Plate, A cylinder in cross flow, Flow in Ducts, Free Convection, Radiation. Formulation of Thermal System Design- Requirement and Specifications, Design Variables, Constraints. Designing a workable system, Optimization methods -overview and significance

**UNIT – II**

**Automotive Engine Thermal Management:** Fundamentals of First & Second Law of Thermodynamics to the engine performance (Volumetric efficiency and Thermal Efficiency), heat balance equation, Fundamentals of Exergy, Energy analysis, Thermal Models and Operating Strategy- smart valve, variable speed pump, variable speed fan. Applications of Thermoelectric generators and Thermoelectric coolers, Applications of heat pipes and heat sink.

**UNIT – III**

**Fundamentals of Automotive Climate Control:** Psychrometric properties, Use of psychrometric chart, coefficient of performance, Refrigerants – Types of refrigerants, Properties and Selection of refrigerants, Factors affecting the air flow, Types of fans, Axial and Centrifugal fans, Load calculations, Winter air-conditioning, Two-phase flow effects in the Evaporator and Condenser, air side heat transfer on the Evaporator and Condenser, System mass effects, Simplified cabin thermal model. Convective thermal interaction-cabin air and atmosphere.

**UNIT – IV**

**Fundamentals- Heat Exchangers:** Functions of radiator, compressor, Functions of condenser, evaporator, expansion valve, Classification of heat exchangers – According to transfer process, Number of fluids, surface compactness, Construction features, flow arrangements, heat transfer mechanisms, Selection and design of heat exchangers based on – Types, heat transfer rate, cost, pumping power, size and materials. Coolant- function, types, and required properties. Advanced cooling system with smart valve, variable speed pump, variable speed fan, engine block, radiator, and sensors (temperature, mass flow rate and power).

**UNIT – V**

**Thermal Management in EV systems:** Temperature sensitivity and heat generation of batteries- electro-thermal, Internal heat generation, Rate of Discharge, Battery ageing, Thermal runaway, battery heat transfer medium. Role of thermal management in power

| |
|---|
| electronics and controllers, heat sink design and configuration, Application of microfluidics and nano fluids. |
| **Text Books:** |
| **1.** Yunus A Cengel and Afshin J Ghajar, Heat and Mass Transfer, Tat McGraw Hill Education Private Limited, New Delhi. |
| **2.** C Balaji, Theramal system design and optimization, Springer, New Delhi. |
| **3.** W F Stoecker, Design of Thermal Systems Third Edition, McGraw – Hill, New York. |
| **4.** Ho Sung Lee, Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells, John Wiley & Sons |
| **Reference Books:** |
| **1.** Jaluria and Yogesh ,Design and optimization of thermal systems CRC Press |
| **2.** Quansheng Zhang, Automotive Air Conditioning Optimization, Control and Diagnosis, Springer |
| **3.** James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley |
| **4.** Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press |
| **Question Paper Pattern:** |
| **Sessional Exam:** The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.<br><br>**End Examination:** The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions. |

## SIMULATION AND MODELLING OF MANUFACTURING SYSTEMS (SMMS)

| **Honors:** Mechanical Engineering | | | | | | **Scheme:** 2023 | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exam** | **TOTAL** |
| **HME02** | **PC** | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| **Sessional Exam Duration:** 2 Hrs | | | | | | **End Exam Duration:** 3 Hrs | | |

**Course Outcomes:** At the end of the course, students will be able to

| | |
|---|---|
| **CO1:** | Understand the approaches to modelling and simulation of manufacturing systems. |
| **CO2:** | Understand the modelling in simulation and distributions |
| **CO3:** | Identify various software languages for simulation of manufacturing systems |
| **CO4:** | Analyze the output data in manufacturing system |
| **CO5:** | Illustrate the applications of simulation in manufacturing systems and solve problems |

### UNIT – I

System – ways to analyze the system – Model – types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors

### UNIT – II

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

### UNIT – III

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform –normal – Binomial – uniform – poisson. Simulation languages – comparison of simulation languages with general purpose languages – software features – statistical capabilities – G P S S

### UNIT – IV

Output data analysis – Types of Simulation w.r.t output data analysis – warmup period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons

### UNIT – V

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system .

**Text Books:**


1. A M Law and Kelton, Simulation Modelling and Analysis, McGraw Hill, New York.
2. Narahari and M Vishwanathan, Performance modelling of automated manufacturing systems, Prentice hall England wood Cliffs, NJ, USA.


**Reference Books:**


1. A Carrie, Simulation of Manufacturing Systems, Wiley, New York.
2. S M Ross, A Course in Simulation, McMillan, New York.
3. H A Taha, Simulation Modelling and SIMNET, PH Englewood Cliffs, New Jersey.
4. J Banks. and J S Carson, Discrete Event System Simulation, PH Englewood Cliffs, New Jersey

**Online Learning Resources:**

1. https://nptel.ac.in/courses/112102318
2. https://nptel.ac.in/courses/112104188
3. https://nptel.ac.in/courses/112104189
4. https://nptel.ac.in/courses/112101005

**Question Paper Pattern:**

**Sessional Exam:** The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

**End Examination:** The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

## SUPPLY CHAIN MANAGEMENT (SCM)

| Honors: Mechanical Engineering | | | | | | Scheme: 2023 | | |
|---|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | | |
| | | L | T | P | C | Continuous Internal Assessment | End Exam | TOTAL |
| HME03 | PC | 3 | 0 | 0 | 3 | 30 | 70 | 100 |
| Sessional Exam Duration : 2 Hrs | | | | | | End Exam Duration: 3 Hrs | | |

**Course Outcomes :** At the end of the course the student will be able to

| | |
|---|---|
| CO1: | Understand the strategic role of supply chain management in the cost reduction and offering best services to the customer |
| CO2: | Understand the design of transportation and distribution network |
| CO3: | Understand the supplier and customer echelons of supply chain |
| CO4: | Analyze the logistic systems |
| CO5: | Evaluate Recent trends in supply chain management and e-commerce |

### UNIT – I

**Introduction to Supply Chain Management:** Supply chain - objectives - importance - decision phases - process view -competitive and supply chain strategies - achieving strategic fit – supply chain drivers - obstacles – framework - facilities -inventory-transportation-information-sourcing-pricing.

### UNIT – II

**Designing the distribution network :** Role of distribution - factors influencing distribution - design options - e-business and its impact – distribution networks in practice –network design in the supply chain - role of network -factors affecting the network design decisions in modelling for supply chain. Role of transportation - modes and their performance – transportation infrastructure and policies - design options and their trade-offs tailored to transportation

### UNIT – III

**Supply Chain Analysis:** Sourcing - In-house production or Outsourcing - 3rd and 4th PLs - supplier rating and assessment, supplier selection - design collaboration - Procurement process – Sourcing: planning and analysis. Pricing and revenue management for multiple customers, perishable products, seasonal demand, bulk and spot contracts.

### UNIT – IV

**Dimensions of Logistics:** Macro and micro dimensions of logistics; interfaces with other areas - approach to analyzing logistics systems - logistics and systems analysis - techniques of logistics system analysis - factors affecting the cost and importance of logistics. Demand Management and Customer Service Outbound to customer logistics systems - Demand Management –Traditional Forecasting – Collaborative planning, fore casting and replenishment (CPFRP) - customer service - channels of distribution.

### UNIT – V

**Recent Trends in Supply Chain Management**: Introduction, New Developments in Supply Chain Management, Outsourcing Supply Chain Operations, Co-Maker ship, The Role of E-Commerce in Supply Chain Management, Green Supply Chain Management, Distribution Resource Planning, World Class Supply Chain Management

**Text Books:**


1. Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation‖, Pearson/PHI.
2. Janat Shah, Supply Chain Management, Pearson Publication


**Reference Books:**


1. Coyle, Bardi, Longley, A Logistic approach to Supply Chain Management –Cengage

| | |
|---|---|
| | Learning |
| **2.** | Donald J Bowersox, Dand J Closs, M Bixby Coluper, ―Supply Chain Logistics Management‖, 2nd edition, TMH, 2008. |
| **3.** | Wisner, Keong Leong and Keah-Choon Tan, ―Principles of Supply Chain Management A Balanced Approach‖, Cengage Learning, 1/e |

**Online Learning Resources:**

1. https://nptel.ac.in/courses/109105494
2. https://nptel.ac.in/courses/110108056
3. https://nptel.ac.in/courses/110106045
4. https://nptel.ac.in/courses/110105141

**Question Paper Pattern:**

**Sessional Exam:** The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

**End Examination:** The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

## ADVANCED MECHANISM DESIGN (AMD)

**Honors: Mechanical Engineering** | **Scheme: 2023**

| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | Continuous Internal Assessment | End Exam | TOTAL |
| HME04 | PC | 3 | 0 | 0 | 3 | 30 | 70 | 100 |

**Sessional Exam Duration : 2 Hrs** | **End Exam Duration: 3 Hrs**

**Course Outcomes :** At the end of the course the student will be able to

| | |
|---|---|
| **CO1:** | Understand the fundamentals of kinematics analysis and synthesis and planar mechanisms using algebraic and vector methods |
| **CO2:** | Analyze planar complex mechanisms using analytical and graphical kinematic methods. |
| **CO3:** | Perform type, number, and dimensional synthesis of mechanisms using analytical methods and graphical techniques. |
| **CO4:** | Analyze static and dynamic forces in planar mechanisms using friction models and the virtual work method. |
| **CO5:** | Analyze spatial mechanisms and robotic manipulators using Denavit-Hartenberg parameters for forward and inverse kinematics. |

### UNIT – I

Introduction – review of fundamentals of kinematics - analysis and synthesis – terminology, definitions and assumptions – planar, spherical and spatial mechanisms‟ mobility – classification of mechanisms – kinematic Inversion – Grashoff`s law Position and displacement – complex algebra solutions of planar vector equations – coupler curve generation velocity – analytical methods - vector method – complex algebra methods – Freudenstein‟s theorem

### UNIT – II

Planar complex mechanisms - kinematic analysis - low degree complexity and high degree complexity, Hall and Ault`s auxiliary point method – Goodman‟s indirect method for low degree of complexity mechanisms Acceleration – analytical methods – Chase solution - Instant centre of acceleration. Euler-Savory equation - Bobillier construction

### UNIT – III

Synthesis of mechanisms: Type, number and dimensional synthesis – function generation – two position synthesis of slider crank and crankrocker mechanisms with optimum transmission angle – three position synthesis – structural error – Chebychev spacing - Cognate linkages – Robert-Chebychev theorem – Block‟s method of synthesis, Freudenstein‟s equation

### UNIT – IV

Static force analysis of planar mechanism – static force analysis of planar mechanism with friction – method of virtual work Dynamic force analysis of planar mechanisms - Combined static and inertia force analysis

### UNIT – V

Kinematic analysis of spatial revolute-Spherical-Spherical-Revolute mechanism – Denavit-Hartenberg parameters – forward and inverse kinematics of robotic manipulators

**Text Books:**


1. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines, East West Publisher, New Delhi.
2. Arthur G. Erdman and G.N. Sandor, Advanced Mechanism Design: Analysis and Synthesis, Vol. II, PHI, New Delhi.


**Reference Books:**


1. Shighley Joseph Edwards and Uicker John Joseph, Theory of Machines and

Mechanism", 2e, McGraw Hill,New York.
2. Arthur G. Erdman and G.N. Sandor, Advanced Mechanism Design: Analysis and Synthesis, Vol. I, PHI, New Delhi.

**Online Learning Resources:**

1. https://nptel.ac.in/courses/112101005
2. https://nptel.ac.in/courses/112104230
3. https://nptel.ac.in/courses/112107258

**Question Paper Pattern:**

**Sessional Exam:** The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

**End Examination:** The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

| BIOMECHANICS (BM) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Honors: Mechanical Engineering** | | | | | | **Scheme: 2023** | | |
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| | | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exam** | **TOTAL** |
| **HME05** | **PC** | **3** | **0** | **0** | **3** | **30** | **70** | **100** |
| **Sessional Exam Duration : 2 Hrs** | | | | | | **End Exam Duration: 3 Hrs** | | |

| | |
|---|---|
| **Course Outcomes :** At the end of the course the student will be able to | |
| **CO1:** | Apply the knowledge of human body biomechanical system. |
| **CO2:** | Analyze the Biomechanical analysis of joints |
| **CO3:** | Analyze the Postural stability and Gait analysis. |
| **CO4:** | List the basic mechanical properties of bone. |
| **CO5:** | Identify different Visco-elastic properties of soft tissues. |

**UNIT – I**

Introductory Mechanics – Statics and Dynamics – Basic Principles. The human body as a biomechanical system – basic terminologies.

**UNIT – II**

Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints

Biomechanical analysis of joints of upper limb - Shoulder, Elbow, wrist, hand and fingers.

**UNIT – III**

Upper limb as a mechanical system – analysis of reaching as movement of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator

**UNIT – IV**

Biomechanical analysis of joints – Spine, Hip, Knee, Ankle. Introduction to Postural stability and Gait analysis. Gait analysis in health and disease - basics. Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling.

**UNIT – V**

Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling. Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voight models. Basic Biofluid mechanics - Flow properties of blood in the intact human cardiovascular system.

**Text Books:**

1. David A. Winter, Biomechanics and Motor Control of Human Movement .
2. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System

**Reference Books:**

1. Francisco Valero-Cuevas, Fundamentals of Neuromechanics
2. Susan Hall, Basic Biomechanics.

**Online Learning Resources:**

1. https://nptel.ac.in/courses/112105305
2. https://nptel.ac.in/courses/112104029

**Question Paper Pattern:**

**Sessional Exam:** The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any

one of them. Each of these questions may contain sub-questions.

**End Examination:** The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.