

15001

Roll No. _____

Total No of Pages: **2****15001**

M. Tech. I Sem. (Main) Exam., Dec. - 2018
Geotechnical Engineering
IMGE1 Geotechnical Engineering

Time: 3 Hours**Maximum Marks: 100**
Min. Passing Marks: 33*Instructions to Candidates:*

*Attempt any **five** questions. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

- Q.1 (a) Discuss Mohr – coulomb theory. [8]
(b) State all the shear tests. Explain direct shear test with a neat sketch. [12]
- Q.2 (a) Differentiate between the strength characteristics of granular and cohesive soils. [8]
(b) Write Skempton's pore pressure parameters and their applications. [12]
- Q.3 (a) State all the Methods of accelerating consolidation. [10]
(b) What is the difference between one dimensional, two dimensional and three dimensional consolidation? [10]
- Q.4 (a) Discuss Briefly Earth Pressure Theories. [10]
(b) Discuss Active and Passive Earth Pressure in detail. [10]
- Q.5 (a) Enumerate general states of Plastic Equilibrium. [10]
(b) What are Anchored Bulkheads? [10]

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- Q.6 (a) What is Lambe's Stress Path Method? Discuss. [10]
(b) Discuss Cofferdams. [10]
- Q.7 (a) Explain Theory of Anchoring. [10]
(b) What do you understand by Reinforced Earth? Write its applications. [10]
- Q.8 Write short note – [4×5=20]
(a) Sand Drains
(b) Wall friction
(c) Sheet piling and Bracing systems
(d) Stress path
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15002

Roll No. _____

Total No of Pages: **2****15002**

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Geotechnical Engineering
1MGE2 Design of Embankment Dams

Time: 3 Hours**Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five questions**. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

- Q.1 (A) Enumerate how Dam site is located? [8]
(B) State all the components of a dam with their function. Draw a neat diagram. [12]
- Q.2 (A) Briefly describe the types of Embankment Dams? [10]
(B) How Impervious core helps in seepage control? [10]
- Q.3 (A) Discuss Laplacion Equation and its significance. Also briefly describe flow net. [12]
(B) State the causes of failure of a Dam. [8]
- Q.4 (A) Enumerate & describe all the components of a Dam with a diagram. [10]
(B) Discuss the suitability criteria of material for Embankment. [10]
- Q.5 (A) Discuss various treatments of foundation. [10]
(B) Write design steps of Relief Well. [10]

- Q.6 (A) Define the term Compaction. Explain the methods of compactions. [10]
(B) Describe Drainage of Embankment. [10]
- Q.7 (A) Discuss Construction methods of a typical Rockfill Dam. [10]
(B) Describe the types of membranes in Rockfill Dam. [10]
- Q.8 Write short note: [4×5=20]
(A) Criteria for safe design of dam
(B) Free Board
(C) Rockfill Dam
(D) Slope protection

15003

Roll No. _____

Total No of Pages: **2****15003****M. Tech. I-Sem. (Main) Exam., Dec. - 2018****Geotechnical Engineering
1MGE3 Rock Engineering****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 (A) What is Dilation? [5]

(B) Discuss Singh and Rao criteria for strength of Rocks in unconfined conditions. [10]

(C) Differentiate between Porosity & Permeability. [5]

Q.2 Write short note- [4×5=20]

(a) RMR classification

(b) State the factors affecting strength of Rock mass

(c) Rock grouting

(d) Jointed Rocks

Q.3 (A) What do you understand by the term 'Rock Bolting'? Also discuss its mechanism. [10]

(B) In what way grouting will improve Rock's properties? [10]

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[40]

- Q.4 (A) How does Information about Elasticity and Plasticity of a rock mass help in designing structures over them? [12]
(B) How tunnel size can effect support pressure? [8]
- Q.5 (A) State all the Engineering properties of Rocks? Discuss any one in detail. [12]
(B) Explain Uniaxial compressive strength. [8]
- Q.6 (A) Discuss In – situ shear tests. [10]
(B) Explain Terzaghi's classification of Rocks. [10]
- Q.7 (A) What is the necessity of In – situ tests? [5]
(B) State the tests for Internal stresses. [5]
(C) Discuss Plate Load test. [10]
- Q.8 (A) Identity & Describe the limitations of 'Hock and Brown Criteria'? [10]
(B) Define Bearing Capacity of Rocks? Also state related methodologies. [10]
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15004

Roll No. _____

Total No of Pages: **2****15004**

M. Tech. I Sem. (Main) Exam., Dec. - 2018
Geotechnical Engineering
1MGE4.1 Ground Improvement Techniques

Time: 3 Hours**Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL _____2. NIL _____

- Q.1 (a) What do you understand by reclaimed soil? Describe its characteristics. [10]
(b) Describe various types of clay minerals of expansive soil. [10]
- Q.2 (a) What are different types of compacting methods in the field? [8]
(b) Discuss the suitability of each method. [6]
(c) Describe the methods of quality control of compaction. [6]
- Q.3 (a) Describe Vibrofloatation method of compaction of granular soil. [12]
(b) What do you understand by compaction pile? [8]
- Q.4 (a) Describe the consolidation of clayey soil by vertical drains. [10]
(b) Describe the method of preloading of soil consolidation. [10]
- Q.5 Describe the method of sand column for improvement of clayey. [20]

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[40]

- Q.6 (a) What are various types of grouts? [10]
(b) Describe pressure grouting. [10]
- Q.7 (a) Describe the mechanism of Flyash-lime stabilisation. [10]
(b) Discuss cement stabilization of soil. [10]
- Q.8 (a) What do understand by geosynthetics? [8]
(b) What are the uses of reinforced soil? [12]
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15101/15204

Roll No. _____

Total No of Pages: 2

15101/15204
M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Computer Science & Engineering
1MCS1 Advanced Data Structures
Common to CS, SE

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) Explain the concept of the local heuristics with the help of suitable examples. [10]

(b) Minimize the following linear programming problem. [10]

Minimize: $30x_1 + 40x_2$

Subject to $20x_1 + 30x_2 \geq 3000$

$40x_1 + 30x_2 \geq 4000$

$x_1, x_2 \geq 0$

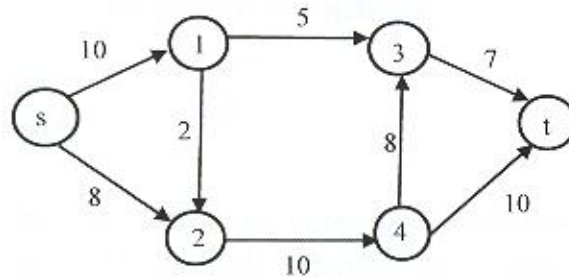
Q.2 Describe in detail the simplex method in linear programming with an example. Explain the concept of the prime dual. [20]

Q.3 Explain the concept of randomized algorithm. Describe the Faster Min-cut algorithm. Prove that algorithm Fast-Cut succeeds in finding a min-cut with probability $\Omega(1 / \log n)$. [20]

Q.4 (a) Explain the algorithm Quick hull for computing convex hull & analyze its complexity. [10]

(b) Explain the concept of beach line with reference to the Voronoi Diagrams. [10]

- Q.5 (a) Explain the matching algorithm used in Graph theory. [5]
- (b) Given a graph which represents a flow network where every edge has a capacity. Also given, two vertices source 's' and sink 't' in the graph, find the maximum possible flow from s to t with following constraints $s = 0$ and $t = 5$. [15]



- Q.6 (a) Explain the difference between the persistent and non-persistent data structures. What are partial persistent and full persistent data structures? [8]
- (b) Is it possible to implement partial persistence efficiently? Explain with proper proof and also give space and time complexity analysis for the same. [12]
- Q.7 (a) Explain the list ranking algorithm in PRAM with an example. [10]
- (b) Explain the basic techniques used in parallel sorting and searching. Explain parallel bubble sorting or parallel merge sorting. [10]
- Q.8 Write Short notes on (any four): [4×5=20]
- Monte Carlo Method
 - Point Location
 - Chan's Algorithm for Convex Hull
 - Approximation Algorithm
 - Self Adjustment data structures
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- Q.3 (a) Explain the "Lines of Code" and "Function Points" based software cost estimation matrices. [10]
- (b) What are the important aspects related with use-case modelling of software? Explain with a suitable example. [10]
- Q.4 (a) Compare and contrast between the terms "Maintenance" and "re-engineering" of existing software using a suitable example. [10]
- (b) Explain the five levels of Capability Maturity Model as applied to Software Process Improvement. [10]
- Q.5 (a) In the context of modern software development techniques, focus upon the importance of Beta Testing and Regression Testing. [10]
- (b) What is "Cyclomatic Complexity" of software? What is its significance in the design of Test-Cases for software testing? [10]
- Q.6 (a) Using a suitable example, focus upon the role of "Baseline" in Software Configuration Management. [10]
- (b) Compare and contrast between "Top-down" and "Bottom-up" approach for software development. [10]
- Q.7 (a) Explain why Software Quality Assurance is considered as an Umbrella activity to be applied throughout Software Development Life Cycle. [10]
- (b) Explain how version control is an integral part of software configuration management. Also define the term "Beta Version" of software. [10]
- Q.8 Explain the desirable attributes of effective software matrices. Also discuss the types of metrics used for requirement, design, cost-analysis and testing purposes. [20]
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Total No of Pages: 2

15103

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Computer Science & Engineering

1MCS3.2 Critical System Design

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

- Q.1 (a) Release time, Deadline and Timing constraints are an important factor in a real-time system. Explain the value of these three factors in a real-time system. [12]
- (b) Elaborate the relation between period execution time and faces of a periodic task in a real-time system. [8]
- Q.2 (a) Define partial order relation (precedence relation) in respect to the critical real-time system. [10]
- (b) Explain a work-conserving scheduling approach for a critical real-time system. [10]
- Q.3 What do you mean by weighted Round Robin approach for scheduling time shared applications? State and prove that the Round Robin algorithm used in high speed switched networks. [20]

- Q.4 (a) Justify that, in a critical real-time system, the online scheduling algorithm is used without knowledge about the jobs that will be released in the future. [10]
- (b) Elaborate job slices characteristics of cyclic scheduling algorithm. [10]
- Q.5 (a) Explain necessary and sufficient schedule ability test for fixed critical priority system. [8]
- (b) Describe how to determine by simulation the schedulability of each task in a system of independent periodic, which may be non preemptable and may suspend itself? [12]
- Q.6 Explain Notation and Assumptions regarding clock driven scheduling. [20]
- Q.7 (a) In respect to, time relativity of the jobs explain temporal distance constraints. [10]
- (b) In tabular format, explain the difference between Clock driven, Weighted Round Robin and Priority-driven approach for a critical system design. [10]
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Total No of Pages: 2

15104

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Computer Science & Engineering

1MCS4.2 Information System Security

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL _____

2. NIL _____

- Q.1 (a) Explain principle behind One Time Pads. Why they are highly secure? [10]
(b) What is Play Fair Cipher? Explain in detail. [10]
- Q.2 (a) Explain various types and modes of symmetric key algorithms. [10]
(b) Explain principal of DES algorithm with the help of diagram. [10]
- Q.3 (a) Explain steps for Digital Certificate Creation. [10]
(b) What is the role of certificate revocation list in X.509 authentication server?
Explain in detail. [10]
- Q.4 (a) How RSA can be used for performing digital signature? Explain Knapsack Algorithms. [10]
(b) Explain various mechanism for protecting Private keys. [10]

- Q.5 (a) Describe the Diffie-Hellman key exchange algorithm in detail. [10]
- (b) Explain, how PGP provide confidentiality and authentication service for E-mail applications. [10]
- Q.6 (a) How does certificate based authentication works? Explain with the help of diagram. [10]
- (b) Discuss Java cryptography architecture in detail. [10]
- Q.7 (a) What is firewall? Explain working of packet filters. [10]
- (b) Explain the concept of dual signature in context of Secure Electronics Transaction (SET). Briefly describe the sequence of events that are required for a SET transaction. [10]
- Q.8 Write short notes on (ANY TWO) - [2×10=20]
- (a) International Data Encryption Algorithm (IDEA)
- (b) Hashes and Message Digest
- (c) Virtual Private Network (VPN)
- (d) Secure Hyper Text Transfer Protocol (SHTTP)
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Total No of Pages: 2

15105

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Computer Science & Engineering

1MCS 4.3 Grid Computing

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

Attempt any five questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL

2. NIL

Q.1 (a) Why do we need Computational Grids? Explain various types of Grid applications. [12]

(b) Describe the numerous classes of Grid users. [8]

Q.2 (a) Describe the functionality of following in Grid Computing Environment: [12]

(i) Load Balancing

(ii) Compilation at Run-Time

(b) Explain the relationship between Grid service and Web service. [8]

Q.3 (a) Describe the Open Grid Services Architecture (OGSA) and its various types of services used in Grid Computing. [12]

(b) Describe the relationship of Grid Architecture to other distributed technologies. [8]

- Q.4 (a) How performance analysis and visualization can be performed in Grid Computing?
Explain through an example. [10]
- (b) Explain various types of Grid Protocols. [10]
- Q.5 (a) Explain the detailed working of following libraries: [12]
- (i) RIO Library
- (ii) Nimrod Parameter Study Library
- (b) How message passing interfaces works in Grid Computing? [8]
- Q.6 Write short notes on: (any two) [2×10=20]
- (i) Globus Toolkit (GT)
- (ii) Grid Portal Development
- (iii) Legion Software
- (iv) Instrumentation and Measurement in Grid Computing
- Q.7 (a) **“Grid computing is about sharing resources in a transparent manner with good Quality of Service (QOS)”**. Justify this statement by explaining it based on QOS parameters of Grid Computation. [10]
- (b) Explain the working of all the layers of Condor those are responsible for Submit (client-side) and Execute (Server-side) task in Grid Environment. [10]
- Q.8 (a) How resources can be managed and reserved in Grid Computing? [10]
- (b) Explain the suitable scheduling algorithm which is mainly used in Grid Execution Environment. [10]
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15201

Roll No. _____

Total No of Pages: **2**

15201

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Software Engineering
1MSE1 Software Engineering Design Methodology

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) Explain the Various Phases of Rapid Prototyping. [10]

(b) Differentiate Rapid Application Development and Traditional SDLC in Software Development Process with the help of example. [10]

Q.2 What do you mean by Object Modeling Technique (OMT)? Using the UML graphical notation for object classes, design for a bank account, identifying attributes and operations. Use your own experience to decide on the attributes and operations that should be associated with these objects. [20]

Q.3 (a) Discuss classification and types of CASE tools. [10]

(b) Schematically draw the architecture of CASE environment. [10]

- Q.4 What is event based modeling in software development? Design an event based model with state diagram & sequential diagram with the help of suitable example. [20]
- Q.5 Explain Function Point Analysis (FPA) and COCOMO Model for software cost estimation with the help of any case study. [20]
- Q.6 (a) What is Spiral Model? Explain Eight Management Elements of spiral model. [10]
(b) How does the Spiral Model address the need of accurately determining the software requirements? [7]
(c) Why Spiral Model is called Meta Model? [3]
- Q.7 Explain following with suitable examples: [20]
(i) Reverse Engineering
(ii) SSADM
(iii) Visual Modeling
(iv) Activity Diagram
- Q.8 (a) Explain why the Process of Project planning is iterative and why a plan must be continually reviewed during a software project? [10]
(b) Some very large software projects involve writing millions of line of code. Explain why the effort estimation models, such as COCOMO, might not work well, when applied to very large systems. [10]

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Roll No. _____

Total No of Pages: 2

15202

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Software Engineering
1MSE2 Software Architecture

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

- Q.1 (a) What are Software Architecture Components? Explain Architecture View. [10]
(b) Explain various Software Architecture styles and Frameworks in detail. [10]
- Q.2 (a) Differentiate functional and non-functional properties of Software Architecture. [10]
(b) Explain Software Architecture patterns in detail. [10]
- Q.3 (a) What is Sufficiency? Explain Coupling and Cohesion. [10]
(b) Explain Completeness and Primitiveness separation of Software Architecture policies. [10]
- Q.4 (a) Explain Event-Based Architectural Style in detail. [10]
(b) What is Layered Systems? Explain Repositories. [10]

- Q.5 (a) Explain reverse engineering in detail. [10]
(b) What is code generation for software implementation? [10]
- Q.6 (a) Explain various features of any good quality software in detail. [10]
(b) What are Fault Tolerant Software? Explain Reusability for quality software. [10]
- Q.7 (a) What is Information Hiding? Explain abstraction in Software Architecture. [10]
(b) Explain the concept of Modularization Separation in detail. [10]
- Q.8 Write shot notes on ANY TWO – [2×10=20]
(a) Pipes and Filters
(b) Changeability
(c) Testing and Debugging
(d) Implicit Invocation
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15203

Roll No. _____

Total No of Pages: 2

15203

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Software Engineering
1MSE3 Optimizing Compilers

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL _____

2. NIL _____

Q.1 (a) Explain the organization of an optimizing compiler. [10]

(b) Describe various factors affecting compiler optimization. [10]

Q.2 (a) What is the structure of data? Discuss data flow optimization with suitable example. [10]

(b) What is Static Single Assessment? Describe SSA – based optimization. [10]

Q.3 (a) How can Alias Analysis be defined? Categorize and explain various categories of Alias optimization. [10]

(b) Describe the difference between alias analysis and pointer analysis with suitable example. [10]

- Q.4 (a) Explain the register allocation using graph coloring with example. [10]
- (b) What is the importance of instruction scheduling and rescheduling. [10]
- Q.5 (a) Explain the inter procedural optimization with example. [10]
- (b) Describe dependence based transformation loop unrolling in procedural level optimization. [10]
- Q.6 (a) Explain the loop optimization technique with suitable example. [10]
- (b) What is the importance of inline expansion optimization technique? [10]
- Q.7 (a) Describe difference between global optimization and local optimization. [10]
- (b) Explain the global value numbering with algorithm and suitable example. [10]
- Q.8 (a) Explain the local symbol table management. [10]
- (b) Explain constant folding optimization technique. [10]
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- (b) Discuss the following sun earth angles: [10]
- (i) Declination angle,
 - (ii) Zenith angle,
 - (iii) Angle of Incidence,
 - (iv) Solar Azimuth angle
- Q.4 (a) What is the process of production of biogas from biomass? What are the main advantages of anaerobic digestion of biomass? [10]
- (b) What are different types of gasifiers? Explain up draft gasifier with neat sketch. [10]
- Q.5 (a) Explain the working of horizontal axis two blade wind mill with suitable diagram. [10]
- (b) What factors are taken into consideration in site selection of a wind power plant? [10]
- Q.6 (a) Explain the working principle of geothermal energy system. [10]
- (b) What is a fuel cell? Describe the working principle of H_2-O_2 cell. Give its limitations.
- Q.7 Write short notes on:
- (a) Open and closed MHD system. [10]
 - (b) Ocean thermal energy and availability. [10]
- Q.8 (a) How can power be generated in single basin tidal system? [10]
- (b) Explain photovoltaic cell with diagram. [10]
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15302/15702

Roll No. _____

Total No of Pages: 3

15302/15702
M. Tech. I Sem. (Main) Exam., Dec. - 2018
Thermal Engineering
1METE2 Advanced Thermodynamics
Common to RET, TE

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. Combustion and Gas Tables

2. NIL

Q.1 (a) Two identical bodies of constant heat capacity are at the same initial temperature T_i . A refrigerator operates between these two bodies until one body is cooled to temperature T_2 . If the bodies remain at constant pressure and undergo no change of phase, show that the minimum amount of work needed to do this is – [10]

$$W_{(\min.)} = C_p \left[\frac{T_1^2}{T_2} + T_2 - 2 T_i \right]$$

(b) Air expands through a turbine from 500 kPa, 520°C to 100 kPa, 300°C. During expansion 10 kJ/kg of heat is lost to the surroundings which is at 98 kPa, 20°C. Neglecting the K.E. and P.E. changes, determine per kg of air: [10]

(i) the decrease in availability

(ii) the maximum work and

(iii) the irreversibility

For air, take $C_p = 1.005$ kJ/kg K, $h = C_p \cdot T$, where C_p is constant, and the P, V and T are usual properties.

Q.2 (a) Explain why the specific heat of a Saturated Vapour may be negative. [8]

(b) Explain Joule – Kelvin effect. What is inversion temperature? Why does the hydrogen gas need to be precooled before being throttled to get the cooling effect? [12]

Q.3 (a) Derive the third T.ds equation [12]

$$T ds = C_v \left(\frac{\partial T}{\partial p} \right)_v . dp + C_p \left(\frac{\partial T}{\partial v} \right)_p . dv$$

and show that the three Tds equations may be written as:

(i) $T ds = C_v dT dp + \frac{\beta T}{k} . dv$

(ii) $T ds = C_p dT - v\beta T . dp$

(iii) $T ds = \frac{C_v}{\beta} . k . dp + \frac{C_p}{\beta k} . dv$

(a) Give the Gibbs phase rule for a non – reactive system. Why is the triple point of a system non-variant? [8]

Q.4 (i) Establish the condition of equilibrium of a closed composite system consisting of two simple systems separated by a movable diathermal wall that is impervious to the flow of matter.

(ii) If the walls were rigid and diathermal, permeable to one type of material, and impermeable to all others, state the condition of equilibrium of the composite system. [20]

Q.5 (a) What is enthalpy of formation? What is the significance of adiabatic flame temperature and how it is determined? [8]

(b) A mixture of 1kmol of gaseous ethane and 3 kmol of oxygen at 25°C reacts in a constant volume bomb. Heat is transferred until the products are cooled to 600K. Determine the amount of heat transfer from the system. [12]

- Q.6 A small gas turbine uses $C_8H_{18} (l)$ for fuel and 400% theoretical air. The air and fuel enter at $25^\circ C$, and the products of combustion leave at $900K$. The output of the engine and the fuel consumption are measured, and it is found that the specific fuel consumption is $0.25kg/s$ of fuel per megawatt output. Determine the heat transfer from the engine per kilo mole of fuel. Assume complete combustion. [20]
- Q.7 (a) What are the limits of the Bose function $b(\epsilon)$ as $\epsilon \rightarrow \pm \infty$? Is the curvature of the function greater when the temperature is high or when it is low? [10]
- (b) What is thermodynamic probability? How the entropy and probability are linked with each other? Explain. [10]
- Q.8 Attempt any two of the following: [10 × 2=20]
- (i) Concept of irreversible thermodynamics
 - (ii) Thermodynamics of low temperature
 - (iii) Higher order phase transitions
 - (iv) Second law analysis of unsteady systems
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15303/
15703/15903

Roll No. _____

Total No of Pages: 3

15303/15703/15903
M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Thermal Engineering
1METE3 Numerical Methods
Common to TE, MD, RET

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) Define the following: [10]

(i) Accuracy

(ii) Precision

(iii) Round off error

(iv) Truncation error

(v) Relative error

(b) Round off the number 75462 to four significant digits and then calculate the absolute error, relative error and percentage error. [5]

(c) Calculate the truncation error for Lagrange's interpolation formula. [5]

Q.2 (a) Using Gauss's elimination method, solve the following system of linear equations: [10]

$$\begin{aligned}5x - y - 2z &= 142 \\x - 3y - z &= -30 \\2x - y - 3z &= -50\end{aligned}$$

(b) Write a short note on LU decomposition method. [10]

Q.3 (a) Use the iterative method to find the largest eigen value and corresponding eigen vector of the matrix. [10]

$$A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

(b) Find a real root of the equation $\cos x = 3x - 1$ correct to 3 decimal places using iteration method. [10]

Q.4 (a) Using Newton's divided difference formula, calculate the values of $f(8)$ and $f(15)$ from the following table: [10]

x :	4	5	7	10	11	13
f(x) :	48	100	294	900	1210	2028

(b) Find the value of $f(5)$ from the following table by using Lagrange's interpolation formula: [10]

x :	1	2	3	4	7
f(x) :	2	4	8	16	128

- Q.5 (a) Use Gauss-Seidal iterative method to solve the following system of simultaneous equations: [10]

$$\begin{aligned}9x + 4y + z &= -17 \\x - 2y - 6z &= 14 \\x + 6y &= 4\end{aligned}$$

- (b) Find the second derivative i.e. $f''(5)$ from the following data: [10]

x :	2	4	9	13	16	21	29
f(x) :	57	1345	66340	402052	1118209	4287844	21242820

- Q.6 (a) Evaluate the following integral by using Gauss quadrature formula: [10]

$$\int_0^1 \frac{dx}{1+x^2}$$

- (b) Minimize $f(x) = 2x_1^2 + x_2^2 + 2x_1x_2 + x_1 - x_2$ starting from the point $x_1 = (0,0)$ by using steepest descent method. [10]

- Q.7 (a) Minimize $f(x_1, x_2) = 2x_1^2 + x_2^2 + 2x_1x_2 + x_1 - x_2$ by conjugate gradient method taking initial point as $x_1 = (0,0)$. [10]

- (b) Write a short note on Quasi-Newton method. [10]

- Q.8 Write a short note on any two of the following: [10×2=20]

- (a) Convergence of iteration method.
(b) High accuracy differentiation formulae and extrapolation.
(c) Local and global minima and penalty function.

15304/15704

Roll No. _____

Total No of Pages: 4

15304/15704
M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Thermal Engineering
1METE4 Advanced Heat Transfer
Common to TE, RET

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. Heat Transfer Data Book

2. Property Table

Q.1 Derive the expressions of temperature profile and heat transfer equation for parabolic fin with one dimensional, steady state heat conduction, without any internal heat generation. [20]

Q.2 (a) What is critical thickness of insulation? Derive the expression of critical radius of insulation for cylinder and sphere and also state its practical significances. [10]

(b) A Hollow sphere of inside and outside radii r_1 and r_2 respectively is heated such that its inner and outer surfaces are maintained at uniform temperature T_1 and T_2 . If the material of which the sphere is composed has thermal conductivity which varies with temperature according to the expression.

$$K = K_1 + (K_2 - K_1) \left(\frac{T - T_1}{T_2 - T_1} \right)$$

Derive the heat flow rate through the sphere. [10]

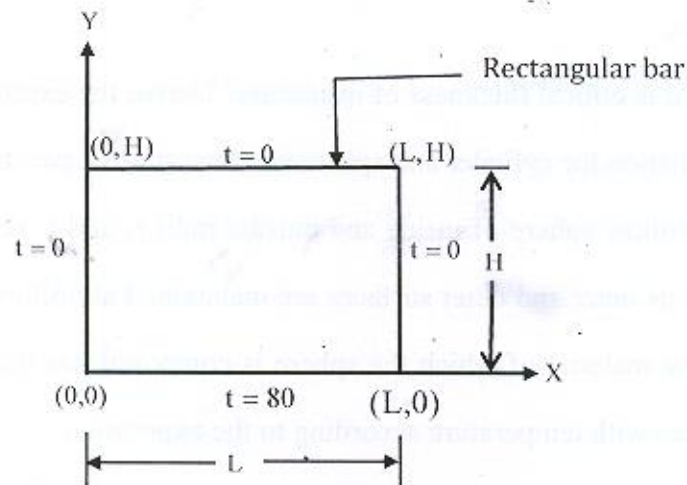
- Q.3 (a) Derive the temperature distribution relation for a long cylinder of radius R with uniformly distributed heat source – [10]

$$\left(\frac{T - T_w}{T_{\max} - T_w} \right) = 1 - \left(\frac{r}{R} \right)^2$$

Where T_w is the temperature at the outer surface of the cylinder and T_{\max} is the temperature along the cylinder axis.

- (b) An egg with mean diameter of 40 mm and initially at 20°C is placed in a boiling water pan for 4 minutes and found to be boiled for consumer taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5°C . Take the following properties for egg $K = 10 \text{ W/m}^\circ\text{C}$, $P = 1200 \text{ kg/m}^3$, $c = 2 \text{ kJ/kg}^\circ\text{C}$, $h = 100 \text{ W/m}^2^\circ\text{C}$ and Use lump theory (100°C for boiled water) [10]

- Q.4 Derive an expression for the temperature distribution in a two dimensional rectangular bar, having very long length, as shown in below figure – [20]



Q.5 (a) Derive an expression for natural convection heat transfer in terms of non-dimensional numbers. [10]

(b) Prove that for the laminar flow in smooth tubes, the Nusselt Number value under uniform heat flux condition is 4.364. [10]

Q.6 (a) Using Pohlhausen solution for temperature gradient [10]

$$\left(\frac{d\theta}{d\eta}\right)_{\eta=0} = 0.332 (Pr)^{0.33}$$

Derive the relation in terms of non-dimensional number for forced convective heat transfer over a flat plate.

(b) The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{3y}{2\delta} - \frac{1y^2}{2\delta^2}$, where

δ being boundary layer thickness, calculate the followings – [10]

- (i) The ratio of displacement thickness to boundary layer thickness.
- (ii) The ratio of momentum thickness to boundary layer thickness.

Q.7 (a) Derive an expression for the geometric factor F_{11} for the inside surface of a black hemisphere cavity of radius R with respect to itself. [10]

(b) Define the followings – [5×2=10]

- (i) Solar constant
- (ii) Irradiation
- (iii) Radiosity
- (iv) Gray body
- (v) Kirchhoff's law of radiation

Q.8 Describe the following –

[5×4=20]

- (a) Reynold's Analogy
 - (b) Lumped Parameter Analysis for transient heat conduction
 - (c) Prove that emissive power $E = \pi I_n$, where I_n is the normal intensity of radiation
 - (d) Thermal conductivity and thermal diffusivity
 - (e) Fin efficiency and fin effectiveness.
-

15401

Roll No. _____

Total No of Pages: 4

15401

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Digital Communication
1MDC1 Signal Theory

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitably if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) A random process $X(t)$ has an autocorrelation function [10]

$$R_{xx}(\tau) = A^2 + Be^{|\tau|}$$

Where A and B are positive constants. Find the mean value of the response of a system having an impulse response

$$h(t) = \begin{cases} te^{-Wt} & 0 < t \\ 0 & \text{when } t < 0 \end{cases} \text{ Where } W \text{ is real positive constant, for which } X(t) \text{ is input.}$$

(b) Consider the random process $X(t) = Y \cos \omega t$ $t > 0$ where ω is a constant and Y is a uniform r. v. over (0,1). [10]

(i) Find $E[X(t)]$,

(ii) Find the autocorrelation function $R_x(t,s)$ of $X(t)$ and Find the auto covariance function $K_x(t,s)$ of $X(t)$.

Q.2 (a) Two random processes are given by [10]

$X(t) = A \cos(\omega t + \theta)$, $Y(t) = A \sin(\omega t + \theta)$ where A and ω are constants and θ is a uniform random variable over $(0, 2\pi)$. Find the cross correlation function of $X(t)$ and $Y(t)$ and verify $R_{xy}(-\tau) = R_{yx}(\tau)$.

(b) Let $Y(t)$ be the output of an LTI system with impulse response $h(t)$ when a WSS random process $X(t)$ is applied as input. Show that: [10]

(i) $S_{XY}(\omega) = H(\omega) S_X(\omega)$

(ii) $S_Y(\omega) = H^*(\omega) S_{XY}(\omega)$.

Q.3 (a) A random process has the power spectrum, find the average power in the process. [10]

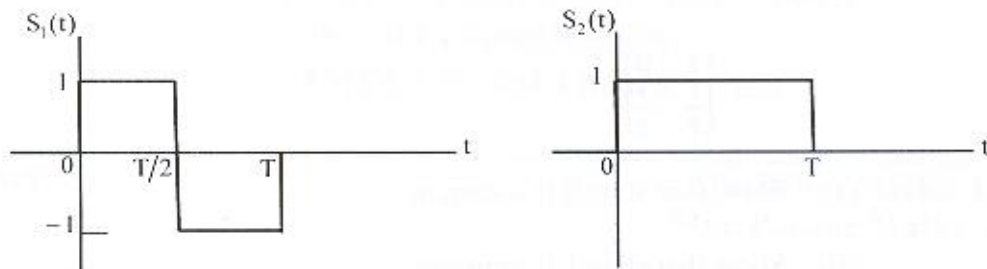
$$S_{xx}(\omega) = \frac{6\omega^2}{(1+\omega^2)^3}$$

(b) A WSS random process $X(t)$ is applied to the input of an LTI system whose impulse response is $3te^{-2t}$. Find the mean value of the output $Y(t)$ of the system, if $E\{X(t)\} = 2$. [10]

Q.4 (a) What is Optimum filtering? Derive an expression for transfer function of matched filter for colored noise. [12]

(b) White noise for which $N_0/2 = 10^{-8} / 2\pi$ and a signal $X(t) = Wte^{-t}$ for $0 < t < 2/W$; and 0; otherwise, is applied to a matched filter. What ratio of output peak signal power to average noise power can be achieved if $W = 5 (10^6)$ rad/s? [8]

Q.5 (a) Figure shows a orthogonal sets of signals. Construct a signal constellation for $S_1(t)$ and $S_2(t)$. [10]



(b) If $X(t)$ is a WSS random process and has a m. s. derivative $X'(t)$, then show that [10]

$$(i) R_{xx}(\tau) = \frac{d}{d\tau} R_x(\tau)$$

$$(ii) R_x(\tau) = -\frac{d^2}{d\tau^2} R_x(\tau)$$

Q.6 Briefly explain the following Random processes with suitable examples [4×5=20]

- (i) Gaussian Process
- (ii) Ergodic Process
- (iii) Wiener Process
- (iv) Poisson's Process

Q.7 Write the short notes on any two - [2×10=10]

- (i) K-L Expansion
- (ii) Gram – Schmidt Orthogonalization
- (iii) Shot Noise Process

Q.8 (a) Discuss the Markov Processes with suitable examples. [10]

(b) Consider a Markov chain with state space $\{0, 1\}$ and transition probability matrix [10]

$$P = \begin{bmatrix} 1 & 0 \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

- (i) Show that state 0 is recurrent
 - (ii) Show that state 1 is transient
-

15402

Roll No. _____

Total No of Pages: 3

15402

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Digital Communication

1MDC2 Digital Communication System

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL

2. NIL

Q.1 (a) Draw and explain each block of conceptualized model of a digital communication system. [8]

(b) Figure-1, displays the waveforms of four signals $S_1(t)$, $S_2(t)$, $S_3(t)$ and $S_4(t)$.

(i) Using the Gram-Schmidt orthogonalization procedure, calculate an orthonormal basis for this set of signals. [8]

(ii) Construct the corresponding signal space diagram. [4]

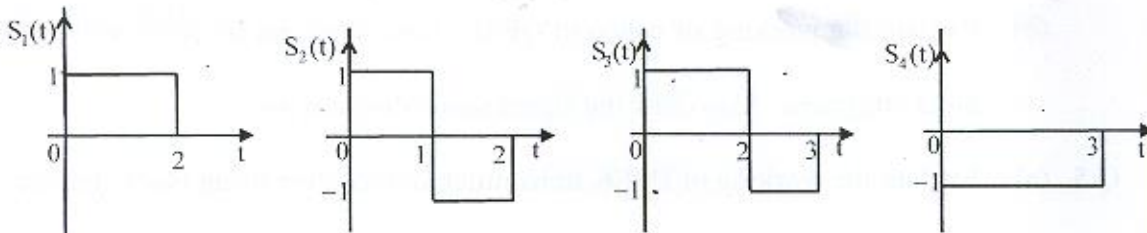


Figure-1

Q.2 (a) Consider the signal-

$$s(t) = \begin{cases} (A/T) t \cos(2\pi f_c t) & 0 \leq t \leq T \\ 0 & \text{otherwise} \end{cases}$$

- (i) Determine the impulse response of the matched filter for the signal. [4]
- (ii) Determine the output of the matched filter at $t = T$. [4]
- (iii) Suppose the signal $s(t)$ is passed through a correlator that correlates the input $s(t)$ with $s(t)$. Determine the correlator output at $t = T$. Compare your result with that in (ii). [4]
- (b) Explain the significance of the fact that a matched filter ensures maximum output signal-to-noise ratio. [8]
- Q.3 (a) Explain the coherent binary PSK modulation scheme with suitable block diagram. Also sketch the signal space diagram and calculate the error probability (P_e). [12]
- (b) State the difference between coherent and non-coherent detection. Also sketch the phase-state diagram of a QPSK and 8 PSK modulator. Comment on probability of error in both the cases. [8]
- Q.4 (a) Explain the coherent binary FSK modulation scheme with suitable block diagram. Also sketch the signal space diagram and calculate the error probability (P_e). [12]
- (b) Explain the working of coherent QPSK transmitter and receiver with the help of block diagrams. Also draw the signal space diagram for it. [8]
- Q.5 (a) Explain the working of DPSK transmitter and receiver using block diagrams. [10]
- (b) Explain the working of M-ary QAM transmitter and receiver using block diagrams. [10]

Q.6 (a) What do you mean by Synchronization? Define basic modes of synchronization.

Discuss carrier synchronization in detail. [10]

(b) Define the bandwidth efficiency. Discuss the bandwidth efficiency of M-ary PSK and M-ary FSK signals. [10]

Q.7 (a) The processing gain of a spread-spectrum system may be expressed as the ratio of the spread bandwidth of the transmitted signal to the spread bandwidth of the received signal. Justify this statement for the DS/BPSK system. [10]

(b) A spread spectrum communication system has the following parameters: [10]

Information bit duration, $T_b = 4.095 \text{ ms}$, PN chip duration $T_c = 1 \mu\text{s}$,

Probability of error $= 10^{-5}$, $E_b / N_0 = 10$

Calculate the following system parameters in decibels-

(i) Processing gain

(ii) Jamming margin

Q.8 Write short notes on any two: [10×2=20]

(a) Bit versus symbol error probability

(b) Pseudo noise sequences

(c) Equalization

15403

Roll No. _____

Total No of Pages: 3

15403

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Digital Communication

1MDC3 Satellite Communication

Time: 3 Hours

Maximum Marks: 100

Instructions to Candidates:

*Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

- Q.1 (a) What is the significance of EIRP and G/T ratio in Satcom? Explain the process of satellite link design. [10]
- (b) Consider a satellite transmitting 25 Watt at a frequency of a 4 GHz via an antenna of 18 dB gain. An earth station in the network uses an antenna of 12 meter diameter with an efficiency of 65% determine - [10]
- (i) The gain of earth station
- (ii) The path loss
- (iii) The flux density at the earth station, assuming the satellite earth station range to be 40,000 Km.
- (iv) The power received at the output of the earth station antenna.
- Q.2 (a) What is the need of GPS? Explain the different codes and carriers used in Global Positioning System. [10]
- (b) Give details of the Kepler's 3 laws of planetary motion. Also explain the development of satellite communication. [10]

[15403]

Page 1 of 3

[160]

- Q.3 Analyze the DBS – TV system design, link budget, error control, master control station and installation process. [20]
- Q.4 (a) A quasi – GEO satellite is in a circular equatorial orbit close to geosynchronous altitude. The quasi – GEO satellite, however, does not have a period of one sidereal day; its orbital period is exactly 24 hour – one solar day. Calculate - [10]
- The radius of the orbit
 - Is the satellite moving towards the east or towards the west?
- (b) Find and explain the system noise temperature of receiver used in satellite communication. [10]
- Q.5 (a) Describe the star and mesh technology to implement the VSAT architecture. [10]
- (b) A TDMA network of five earth stations shares a single transponder equally. The frame duration is 2.0 ms, the preamble time per station is 20 ms, and guard bands of 5 μ s are used between bursts. Transmission bursts are QPSK at 30 Mbaud. Calculate the number of 64 kbps voice channels that each TDMA earth station can transmit. If the earth stations send data rather than digital speech, what is the transmission rate of each earth station in Mbps? What is the efficiency of the TDMA system expressed as Efficiency = 100% \times Message bits sent/Maximum possible number of bits that could be sent? [10]
- Q.6 (a) Show importance and drive the basic link (Friis) equation for establish the link between earth station and satellite. [10]
- (b) Compute the path attenuation exceeded the 0.001% of the time, when frequency is 12 GHz, elevation angle EL is 30 degree, effective rain height is 4 Km, 0.01% rainfall rate is 42 mm/hr. GS at sea level and circular polarization (at 12 GHz $k_{H} = 0.0188$, $k_{V} = 0.0168$, $\alpha_{H} = 1.217$, $\alpha_{V} = 1.2$, for circular polarization $k_{C} = 0.0178$, $\alpha_{C} = 1.2085$) [10]

- Q.7 (a) Describe the different types of LNA and HPA use in satellite communication. [10]
- (b) Discusses the various solutions required for transponder hopping, polarization hopping and redundancy. [10]
- Q.8 (a) Explain and describe the applications of a low earth orbit and non – geostationary satellite systems. [10]
- (b) Discusses in details the various propagation effects in the satellite communication. [10]
-

15404

Roll No. _____

Total No of Pages: **4****15404****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Digital Communication****1MDC4.2 Optimization Techniques****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL2. NIL

Q.1 (a) What is optimization technique? Give five engineering application of optimization. Write any five classification of optimization problems. [10]

(b) A firm manufactures headache pills in two size A and B. Size A contains 2 grains of aspirin, 5 grains of bicarbonate and 1 grain of codeine. Size B contains 1 grains of aspirin, 8 grains of bicarbonate and 6 grains of codeine. It is found by users that it requires at least 12 grains of aspirin, 74 grains of bicarbonate and 24 grains of codeine for providing immediate effect. It is required to determine the least number of pills a patient should take to get immediate relief. Formulate the problem as LPP. [10]

Q.2 (a) Solve the following LPP by simplex method – [10]

$$\text{Maximize } z = 5x_1 + 3x_2$$

$$\text{Subject to } 3x_1 + 5x_2 \leq 15$$

$$5x_1 + 2x_2 \leq 10$$

$$\text{and } x_1, x_2 \geq 0$$

[15404]

Page 1 of 4

[80]

(b) Solve the following LPP by Big M-method – [10]

$$\text{Minimize } z = 5x_1 + 2x_2$$

$$\text{Subject to } 3x_1 + x_2 = 4$$

$$2x_1 + x_2 \geq 3$$

$$x_1 + 2x_2 \leq 3$$

$$\text{and } x_1, x_2 \geq 0$$

Q.3 (a) Solve the following LPP by Two-phase method- [10]

$$\text{Minimize } z = 2x_1 + 9x_2 + x_3$$

$$\text{Subject to } \begin{cases} x_1 + 4x_2 + 2x_3 \geq 5 \\ 3x_1 + x_2 + 2x_3 \geq 4 \end{cases}$$

$$3x_1 + x_2 + 2x_3 \geq 4$$

$$\text{and } x_1, x_2, x_3 \geq 0$$

(b) Give computational procedure for simplex method in LPP. [10]

Q.4 (a) Write the duality of the following LPP – [10]

$$\text{Minimize } z = x_1 + x_2 + x_3$$

$$\text{Subject to } \begin{cases} x_1 - 3x_2 + 4x_3 = 5 \\ 2x_1 - 2x_2 \leq -3 \\ 2x_2 - x_3 \geq 5 \end{cases}$$

$$2x_1 - 2x_2 \leq -3$$

$$2x_2 - x_3 \geq 5$$

$$\text{and } x_1, x_2 \geq 0, x_3 \text{ is unrestricted in sign.}$$

(b) Write a short note on sensitivity analysis. [10]

Q.5 (a) Solve the following assignment problem –

[10]

Machine \ Job	I	II	III	IV	V
A	11	17	8	16	20
B	9	7	12	6	15
C	13	16	15	12	16
D	21	24	17	28	26
E	14	10	12	11	15

(b) Solve the following transportation problem by Vogel's approximation or unit cost penalty method-

[10]

From \ To	D ₁	D ₂	D ₃	Supply
O ₁	2	7	4	5
O ₂	3	3	1	8
O ₃	5	4	7	7
O ₄	1	6	2	14
Demand	7	9	18	34

Q.6 (a) Minimize $f(x) = 2x_1^2 + 2x_1x_2 + x_2^2 + x_1 - x_2$ by using the Steepest Descent method starting from $X_1 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$.

[10]

(b) State Kuhn – Tucker conditions. Use them to solve –

[10]

Minimize $f(x, y, z) = x^2 + y^2 + z^2 + 20x + 10y$

Subject to $x \geq 40$

$$x + y \geq 80$$

$$x + y + z \geq 120$$

Q.7 (a) Write a short note on Quadrature interpolation. [10]

(b) Find the maximum of the function $f(x) = x(5 - x)$ in the interval $[0,8]$ using golden section method. It is given that the function is unimodal in this interval. [10]

Q.8 (a) Use dynamic programming to solve the following problem - [10]

$$\text{Minimize } z = y_1^2 + y_2^2 + y_3^2$$

$$\text{Subject to } y_1 + y_2 + y_3 \geq 15$$

$$\text{and } y_1, y_2, y_3 \geq 0$$

(b) Use dynamic programming to solve the following problem of LPP [10]

$$\text{Maximize } z = 25x_1 + 40x_2$$

$$\text{Subject to } x_1 \leq 20$$

$$x_2 \leq 90$$

$$5x_1 + 6x_2 \leq 900$$

$$x_1 + 2x_2 \leq 240$$

$$\text{and } x_1, x_2 \geq 0$$

15405

Roll No. _____

Total No of Pages: [2]

15405

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Digital Communication
1MDC4.3 Biomedical Electronics

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

- Q.1 What are three differences between an animal cell and a plant cell, which makes the animal cell capable of generating resting and action potential, but not the plant cell? Name any two neurotransmitters? [20]
- Q.2 What are the iso-electric zones in an electrocardiogram? What are the status of cardiac muscles in the PR segment, ST segment and TP segment? What are common abnormalities observed in these segments? [20]
- Q.3 What are the four major EEG waves commonly found in a spectra limited between 0.5 Hz to 30 Hz? What are the waves observed, when- [20]
- (a) Eyes are closed in awake position
 - (b) A child in deep sleep
 - (c) Grand mal epilepsy episode is observed

- Q.4 A Pulse oxymeter is an optical device. Explain the functioning of a pulse oxymeter. What are the frequencies corresponding to the two states of gaseous saturations? [20]
- Q.5 Which imaging techniques uses Barium Sulphate, Iopromide or similar spectrum absorbents? What is the range of that spectra and for which organs these agents are needed? [20]
- Q.6 In one method, a high frequency stationary wave is focused for achieving defragmentation of a foreign object? What is the method? Explain the working principle of that. [20]
- Q.7 What are the biggest disadvantages of lossy data compression? What are the scale of measurement of lossy data compression? Explain with example, how a lossy data compression can alter the ECG interpretation? [20]
- Q.8 Write short notes on any two of the following – [20]
- (a) Four Heart Sounds
 - (b) Mathematical Relations amongst the Precordial Leads
 - (c) The physiological effects of various levels of electric current
-

15501

Roll No. _____

Total No of Pages: **2****15501****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****VLSI Design****1MVL1 Advanced Mathematics****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 (a) A toy company manufactures two types of doll, a basic version – doll A and a deluxe version – doll B. Each doll of type B takes twice as long to produce as one of type A, and the company would have time to make a maximum 2000 per day if it produces only the basic version. The supply of plastic is sufficient to produce 1,500 dolls per day (both A and B combined). The deluxe version requires a fancy dress of which there are only 600 per day available. If the company makes profit of ₹ 3.00 and ₹ 5.00 per doll respectively, on doll A and B, how many of each should be produced per day in order to maximize profit? [10]

(b) Using Simplex Algorithm solve the problem: [10]

$$\text{Max } Z = 2x_1 + 5x_2 + 7x_3$$

$$\text{Subject to } 3x_1 + 2x_2 + 4x_3 \leq 100$$

$$x_1 + 4x_2 + 2x_3 \leq 100$$

$$x_1 + x_2 + 3x_3 \leq 100$$

$$x_1, x_2, x_3 \geq 0$$

[15501]

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[80]

Q.2 Solve the following L.P. Problem: [20]

$$\text{Max } Z = x_1 + 2x_2 + 3x_3 - x_4$$

$$\text{Subject to } x_1 + 2x_2 + 3x_3 = 15$$

$$2x_1 + x_2 + 5x_3 = 20$$

$$x_1 + 2x_2 + x_3 + x_4 = 10$$

$$x_1, x_2, x_3, x_4 \geq 0$$

Q.3 Solve the following L.P.P. by Dual Simplex method: [20]

$$\text{Min } Z = 3x_1 + x_2$$

$$\text{Subject to } x_1 + x_2 \geq 1$$

$$2x_1 + 3x_2 \geq 2$$

$$\text{and } x_1, x_2 \geq 0$$

Q.4 (a) Write the dual of the problem – [10]

$$\text{Min } Z = 2x_2 + 5x_3$$

$$\text{Subject to } x_1 + x_2 \geq 2$$

$$2x_1 + x_2 + 6x_3 \leq 6$$

$$x_1 - x_2 + 3x_3 = 4$$

$$\text{and } x_1, x_2, x_3 \geq 0$$

(b) Use Branch and Bound technique to solve the following problem: [10]

$$\text{Max } Z = 7x_1 + 9x_2$$

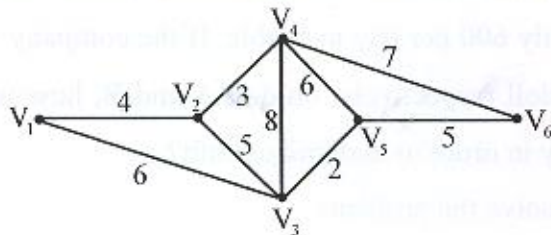
$$\text{Subject to } -x_1 + 3x_2 \leq 6$$

$$7x_1 + x_2 \leq 35$$

$$0 \leq x_1, x_2 \leq 17$$

$$x_1, x_2 \text{ are integers.}$$

Q.5 (a) Find the shortest path from V_1 to V_6 in the following graph. [10]



(b) Write Dijkstra's Algorithm. [10]

Q.6 (a) When Greedy Algorithms are perfect for the matroid? [10]

(b) How do I find if a perfect matching exist in a graph G ? [10]

15502

Roll No. _____

Total No of Pages: 3

15502

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

VLSI Design

1MVL2 VLSI Design

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) What is Voltage boot strapping? Explain briefly. [5]

(b) State the difference between ASIC and FPGA. [5]

(c) What are various implementation strategies for digital IC's? Explain in detail. [10]

Q.2 (a) Define the logical effort. [2]

(b) Consider a 5 mm long, 0.32 μm wide metal2 wire in a 180 nm process. The sheet resistance is $0.05\Omega / \square$ and capacitance is $0.2 \text{ fF}/\mu\text{m}$. Construct a 3 – segment π -model for the wire. [8]

(c) Consider a process in which PMOS transistor have three times the effective resistance of nMOS transistor. A unit inverter with equal rising and falling delays

in this process is shown in Figure 1. Calculate the logical efforts of a 2 – input NAND gate and 2 – input NOR gate if they are designed with equal rising and falling delays. [10]

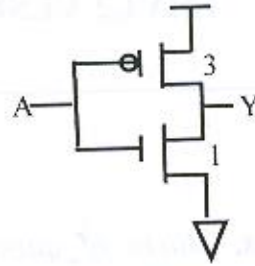


Figure -1

Q.3 Draw the optimized layout of

(i) $Y = \bar{A}B + C\bar{D}E$ CMOS logic [10]

(ii) $Y = \overline{ABC + DEF}$ CMOS logic [10]

Q.4 (a) Define Clock Skew and Jitter. Explain the different mechanism to minimize in synchronous circuits. [10]

(b) A flip flop is built from a pair of transparent latches using non overlapping clocks. Express the set up time, hold up time and clock to Q delay of flip flop in terms of latches timing parameters and $t_{\text{nonoverlap}}$. [10]

Q.5 (a) Draw the basic cell architecture of - [10]

- (i) Serial adder
- (ii) Algorithmic shifter

(b) Estimate the minimum delay of 10:1024 decoder driving an electrical effort $H = 20$ using

- (i) Static CMOS
- (ii) Footless domino gates [10]

Q.6 (a) What is the need of sense amplifier in memories? Also draw its various forms and explain their operation. [10]

(b) (i) Determine the logic function F given in Figure – 2.

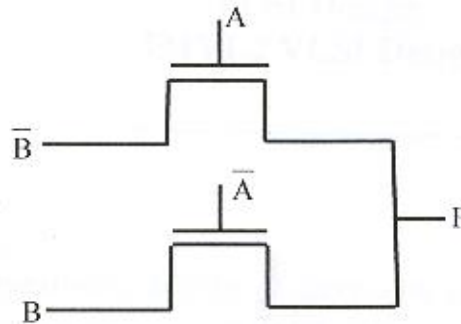


Figure-2

(ii) Design a circuit to implement the same logic function but using NOR gates. [10]

Q.7 (a) Design the Schmitt trigger using CMOS circuit. Also explain its working. [5]

(b) What is the metastability in digital circuits? How it can be avoided. [8]

(c) What are arbiters? Explain its operation also. [7]

Q.8 Write short note on the following: (Any two) [20]

(i) Barrel shifter

(ii) Power dissipation in memories

(iii) Testability and fault detection

15503

Roll No. _____

Total No of Pages: **3****15503****M. Tech. I Sem. (Main) Exam., Dec. - 2018****VLSI Design****1MVL3 Digital System Design****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

Attempt any **five questions**. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

I. NIL2. NIL

- Q.1 (a) Design a two input, two – output sequence detector which produces an output 1 every time the sequence 0101 is detected, and an output 0 at all other times. [10]
(b) What are the capabilities and limitations of finite state machines? [10]
- Q.2 (a) Implement the following Boolean function by hazard – free OR – AND network.
 $F = \sum (0, 2, 6, 7)$ [10]
(b) Find out minimal machines of M shown in table below: [10]

P.S	<u>N.S output</u>	
	<u>I1</u>	<u>I2</u>
A	D, 0	C, 1
B	E, 1	A, 1
C	H, 1	D, 1
D	D, 0	C, 1
E	B, 0	G, 1
F	H, 1	D, 1
G	A, 0	F, 1
H	C, 0	A, 1
I	G, 1	H, 1

[15503]

Page 1 of 3

[120]

- Q.3 (a) Prove the De – Morgan theorem through expansion theorem. [10]
- (b) Use the tabulation procedure to generate the set of prime implicants and to obtain all minimal expression for the following function: [10]
- $$F(v, w, x, y, z) = \sum (1, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 25, 26, 27)$$
- Q.4 (a) Prove that the NOR operation is functionally complete. [20]
- (b) Define Reed - Muller equation.
- (c) Determine the canonical product of sum form of
- $$T(x, y, z) = x'(y' + z)$$
- Q.5 (a) Design an asynchronous circuit which can be used in an automatic toll - collecting machine. Suppose the toll is 35 cents and the machine accepts nickels, dimes, and quarters. An electro – mechanical system, already available, accepts the coins sequentially (even if they are all dropped in simultaneously) and generates one of the three pulses x_5 , x_{10} , or x_{25} whenever, a nickel, dime, or quarter, respectively, is accepted. The sequential circuit should produce a level output which would turn on a green light whenever the amount received by the machine is 35 cents or over. After a car has passed, a reset pulse x_r , is automatically produced, which turns the greens light off and reset the sequential circuit to its initial state. [10]
- (b) Define the unate function and support the definition with example. [10]
- Q.6 (a) The cell output of a typical cell of an iterative network is equal to 1, if and only if the input pattern of the preceding cells consists of groups of 0's and 1's, such that each group contains an odd number of members. [10]
- (i) Construct a cell table.
- (ii) Realize the typical cell using AND, OR, NOT logic.
- (b) Differentiate CPLD and FPGA. Explain FPGA with suitable diagram. [10]

Q.7 (a) Implement following logic using a 4×3 PLA [10]

$$O1 = I1.I2 + I1'.I2'.I3'.I4'$$

$$O2 = I1.I3' + I1'.I3.I4' + I2$$

$$O3 = I1.I2 + I1.I3' + I1'.I2'.I4'$$

(b) Discuss the requirement that led to the design of the VHDL language, which of these requirements where a software language would fall short in describing hardware. [10]

Q.8 (a) Write VHDL code of 3×8 decoder in behavioral modeling style. [10]

(b) Implement Traffic Light controller using ASMs. [10]

15504

Roll No. _____

Total No of Pages: 2

15504

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

VLSI Design

1MVL4.1 Low Power VLSI Design

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 Discuss the source of capacitance between – [3×5+5=20]

- (i) Source and gate electrode
- (ii) Drain and gate electrode
- (iii) Body and gate electrode

How above capacitance depends on gate voltage and drain voltage. Assume the source terminal is grounded. Also discuss how these capacitance can be minimized.

Q.2 Explain any two existing technique used for power dissipation at - [2×10=20]

- (i) Device level and
- (ii) Gate level

Q.3 (i) How Multi-threshold CMOS (MTCMOS) technique reduce power dissipation. Design 2 input NAND and NOR logic using this technique. [6+2×4=14]

(ii) Discuss the role of SOI techniques in power dissipation. [6]

[15504]

Page 1 of 2

[80]

Q.4 Draw following logic - [4×5=20]

- (i) $Y = A+BC$ using C²MOS logic
- (ii) $Y = A+B+C$ using BiCMOS logic
- (iii) $Y = \bar{A} \bar{B}$ using pseudo NMOS logic
- (iv) $Y = A+BCD$ using CMOS

Q.5 Draw any two Dynamic Memory cell and explain their working. Also compare the power dissipation of SRAM and DRAM. [20]

Q.6 Power dissipation at system level give more power performance. Discuss power saving by switching activity and parallel architecture technique in detail. Explain it with an example. [20]

Q.7 Write short note on any two - [2×10=20]

- (i) Clock distribution
 - (ii) DSP system
 - (iii) Flow graph transformation
 - (iv) Monte Carlo simulation
-

15601

Roll No. _____

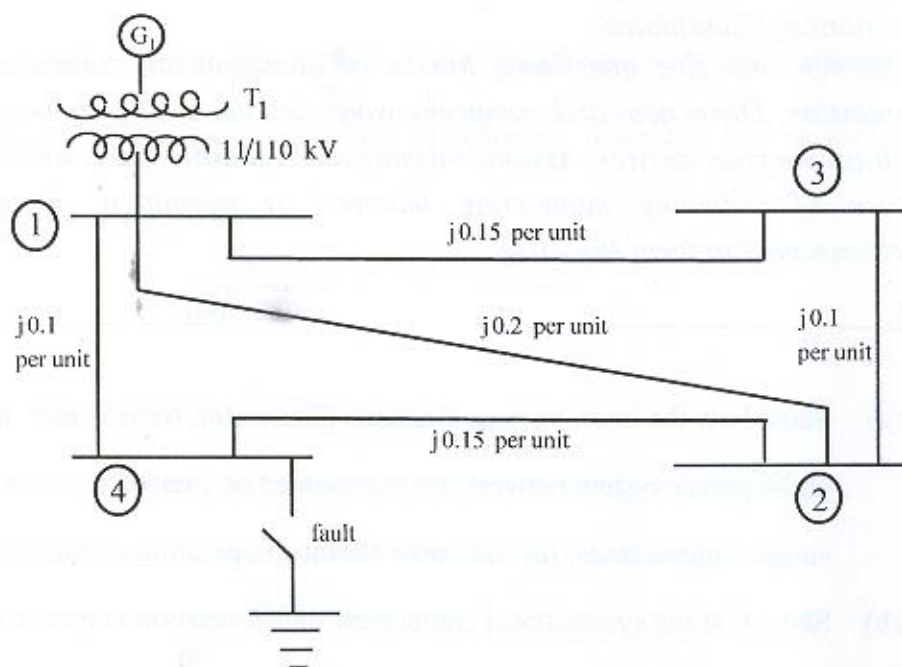
Total No of Pages: **4****15601****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Power System****IMPS1 Power System Analysis****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

Attempt any five questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL2. NIL

- Q.1 (a) Show how the lines, various elements (Generator, transformer, loads) of any three phase power system network are represented on impedance / reactance diagram on single – phase basis, for use under balanced operating conditions. [10]
- (b) Show that the symmetrical component transformation is power invariant. [5]
- (c) Show in a three – phase system, how the per – unit values remain same whether calculated using per phase base quantities or three – phase base quantities. [5]
- Q.2 A 25 MVA, 13.2 kV alternator with solidly grounded neutral has a sub transient reactance of 0.25 per unit. The negative and zero sequence reactance's are 0.35 and 0.1 per unit respectively. A single line to ground fault occurs at the terminals of an unloaded alternator; determine the fault current and all the sequence components of voltages to determine line – to – line voltages. [8+6+6=20]

Q.3 In the four – bus system of fig use – 1 buses 1 and 2 are generator buses and 3 & 4 are load buses. The generators are rated 11 kV, 100 MVA, with transient reactance of 10% each. Both the transformers are 11/110 kV, 100 MVA, with leakage reactance of 5%. The reactances of the lines to a base of 100 MVA, 110 kV are indicated on figure – 1. Obtain bus admittance matrix and short circuit currents in lines 1 – 3 and 1 – 2 using Z–bus. Method. [20]



Q.4 System data for a load flow case is below – [20]

Line between bus no.	Admittance in per unit
1 – 2	$2 - j 8.0$
1 – 3	$1 - j 4.0$
2 – 3	$0.666 - j 2.664$
2 – 4	$1 - j 4.0$
3 – 4	$2 - j 8.0$

The schedule of active and reactive powers is –

Bus no.	Active per power	Reactive power	Voltage with angle	Type of bus
1	-	-	1.06	SLACK
2	0.5	-	$1.04 + j 0.0$	PV
3	0.4	0.3	$1 + j 0.0$	PQ
4	0.3	0.1	$1 + j 0.0$	PQ

Reactive power constraint at bus 2 is $0.1 \leq Q_2 \leq 1.0$

Determine the voltages starting with a flat profile voltage assuming acceleration factor 1.0.

- Q.5 (a) Describe the type – 2 and type – 4 procedure for modification in y – bus using step by step method. [8]
- (b) Describe how the Jacobin matrix elements as partial derivatives are constituted for active power and reactive powers with respect to angle and voltage in terms of various bus voltages, admittances of lines and their angles. Show for 3 bus, 3 line system. [12]
- Q.6 (a) Describe a method to determine tap setting of the transformers connected at either ends of any transmission line. [8]
- (b) Describe fast decoupled load flow method. Describe its applications in power system and give its comparison with Newton Raphson method. [12]

Q.7 (a) Explain least squares estimation method with regard to power system state estimation. [10]

(b) Explain security assessment and security control with regard to power system security analysis. [10]

Q.8 Write short note on any two out of following. [2×10=20]

(a) Phase – shifting transformers, their principle, working and application.

(b) Positive and zero sequence equivalent circuits of three winding transformer.

(c) Derivation of necessary equations to represent double – line to ground fault conditions.

15602

Roll No. _____

Total No of Pages: **4****15602****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Power System****1MPS2 Advanced Power Electronics****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 (a) For a single phase one-pulse controlled converter system, sketch waveforms for load voltage and load current for (i) RL load and (ii) RL load with freewheeling diode across RL. From a comparison of these waveforms, discuss the advantages of using a freewheeling diode. [10]

(b) Discuss the effect of source inductance on the performance of a single phase full converter indicating clearly the conduction of various thyristors during one cycle. Derive expression for its output voltage in terms of (i) Maximum voltage V_m , firing angle α and overlap angle (ii) V_m , α , L_s and load current I_o . Here L_s is the source inductance. [10]

OR

- Q.1 A 3 phase full converter thyristor bridge feeds a resistive load R. [20]
- (a) Sketch the voltage waveforms for V_{ab} , V_{bc} , V_{ac} etc.
- (b) From (a), sketch the waveforms of the output current i_o for a firing angle of 30° .
- Q.2 (a) In the continuous conduction mode of type A chopper, show that per unit ripple in the load current is maximum when duty cycle is equal to 0 – 5. [10]
- (b) Write voltage equations governing the performance of type A chopper during T_{on} and T_{off} periods for RLE type load. Hence obtain therefrom expressions for the maximum and minimum current taken by the load on the assumption of continuous output current. [10]

OR

- Q.2 Draw the power circuit diagram of a current commutated chopper. Explain the working of this chopper by dividing its commutation process interval into some well defined modes. Show distinctly the total turn off time, turn off times for main and auxiliary thyristors in the relevant waveforms drawn. [20]
- Q.3 (a) What is pulse width modulation? List the various PWM techniques. How do these differ from each other? [10]
- (b) Explain sinusoidal pulse modulation as used in PWM inverters. Discuss the conditions under which the number of pulses generated per half cycle are $\frac{f_c}{2f}$ or $\left(\frac{f_c-1}{2f}\right)$. Here f_c and f are the frequencies of carrier and reference signals respectively. [10]

OR

Q.3 For harmonic reduction in single phase inverters, two identical transformers are used in series. If their rectangular output voltage waveforms are shifted from each other by 120° , then sketch these voltage waveforms and their resultant waveform on the assumption that transformer secondary opposes each other. Find also an expression for the net output voltage as a function of time. Hence find the percentages derating of the inverter so far as its fundamental power component is concerned. [20]

Q.4 (a) Describe the principle of phase control in single phase half wave ac voltage controller. Derive an expression for the average and rms value of output voltage for this voltage controller. [10]

(b) For a single phase voltage controller feeding a resistive load, draw the waveforms of source voltage, gating signals, output voltage, source and output currents and voltage across one SCR. Describe its working with reference to the waveforms drawn. [10]

OR

Q.4 (a) A single phase full wave ac voltage controller feeds a load of $R=20\ \Omega$ with an input voltage of 230V, 50 Hz. Firing angle for both the thyristors is 45° . Calculate

(i) rms value of output voltage

(iii) load power and input pf. [10]

(b) Explain the working of three phase A.C. controllers with relevant waveforms. [10]

Q.5 Describe the working of single phase to single phase step down cycloconverter for both continuous and discontinuous conduction for a bridge type cycloconverter. Mark the conduction of various thyristors also. [20]

OR

Q.5 (a) Describe how single phase low frequency output voltage can be fabricated from the segments of 3 phase input voltage waveform through the use of a 3 phase half wave circuit. Show a complete cycle of low frequency outputs voltage. [10]

(b) Write short notes on matrix converter in detail. [10]

15603

Roll No. _____

Total No of Pages: **2****15603****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Power System****1MPS3 Power System Stability****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitably if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

- Q.1 (a) Draw the per-phase equivalent circuit of round rotor synchronous machine. [10]
(b) Describe the two-axis (d-q axis) equivalent circuit of salient pole synchronous machine for steady state condition. [10]
- Q.2 (a) Derive equation for power developed and hence draw power angle characteristics of salient pole synchronous machine under transient conditions. [10]
(b) When direct current is supplied to the field winding of an unloaded salient pole synchronous generator winding with constant angular velocity, determine the open-circuit armature voltages and their d-q-o components. [10]
- Q.3 (a) What are the assumptions made for solving the swing equation? Derive the swing equation for a system of one machine connected to infinite bus. [10]
(b) A 200 MVA, 11 kV, 50 Hz, 4 – pole turbogenerator has an inertia constant of 6 MJ/ MVA. The machine is operating at a load of 120 MW and the load suddenly increases to 160 MW. Neglect losses. Determine- [4+6=10]
(i) Stored energy in the rotor at synchronous speed
(ii) The rotor retardation

- Q.4 (a) Derive the equation for critical clearing angle for a system consisting of a generator supplying a load through a network of two parallel lines and fault occurs on one of two lines. [10]
- (b) A generator operating at 50 Hz delivers 1 per unit power to an infinite bus bar through a network in which resistance may be neglected. A fault occurs which reduces the maximum power transferable to 0.4 per unit, whereas before the fault this power was 1.8 per unit and after the clearance of the fault it is 1.3 per unit. By the use of equal area criterion, determine the critical clearing angle. [10]
- Q.5 A 60 Hz, 6- pole generator with $H = 40$ per unit supplying 1 per unit electrical power at an internal voltage of 1.2 per unit, is connected to an infinite bus having voltage 1.0 per unit, through a line of 0.3 per unit reactance. A 3 – phase short circuit occurs on the line. Using step by step algorithm, obtain the swing curve data of δ (torque angle) and time upto 3rd interval when time step size is 0.05 second. [20]
- Q.6 (a) For a two machine system of one synchronous generator and one synchronous motor, obtain the swing equation for such system of synchronous machine. [10]
- (b) Explain Runge Kutta fourth order method used in multi-machine transient stability studies. [10]
- Q.7 (a) Explain excitation control, significance of compensation in lines using series capacitor with regard to methods of improving stability. [10]
- (b) Describe dynamic stability and methods used to improve it. [10]
- Q.8 Write short notes on any two out of the following: [2×10=20]
- (a) Bypass valving and dynamic braking
 - (b) Auto – reclosing circuit breakers
 - (c) Equal area criterion application to transient stability study
-

15604

Roll No. _____

Total No of Pages: **2****15604****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Power System****1MPS4.1 Power Generation Sources****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

- Q.1 (a) Describe the difference between renewable and non – renewable energy sources. [10]
- (b) Describe the important factors on which selection and location of power plants based? [10]
- Q.2 (a) What is the importance of sustainable energy sources in power generation sources? [4]
- (b) Explain the impact of power plants on environment, air and water pollution. [8]
- (c) Describe the methods of efficiency improvement of thermal and gas power plants. [8]
- Q.3 (a) Describe non – convective solar ponds for solar energy collection and storage. [10]
- (b) Draw labeled schematic block diagram of solar power plant showing all the systems. Also write the applications of solar photovoltaic system. [10]

- Q.4 (a) Explain the factors on which the wind current depends. How wind blows in coastal areas? How the wind power is calculated? [10]
- (b) Compare the electric generation schemes – constant speed constant frequency, variable speed constant frequency and variable speed variable frequency schemes. [10]
- Q.5 (a) What do you understand by geothermal energy? What are geothermal fields? [10]
- (b) Describe with neat sketch the working of preheat hybrid geothermal power plant. What are its merits and demerits? [10]
- Q.6 (a) Explain in detail the working of a Laser fusion reactor. [6]
- (b) What are the critical factors in disposal of nuclear waste? Also describe the various controls of nuclear reactors. [8]
- (c) Describe comparatively the plasma confinement, magnetic confinement and inertial confinement. [6]
- Q.7 (a) What is the origin of biomass energy? What is the present status of development of biomass energy resources in India? [7]
- (b) What do you mean by Pyrolysis? Discuss working of one of the most efficient pyrolysis unit. [7]
- (c) Explain the process of ethanol production from Cassava. What are the uses of ethanol in power sectors? [6]
-

15605

Roll No. _____

Total No of Pages: **2****15605**

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Power System Engineering
1MPS4.2 Economic Operation of Power System

Time: 3 Hours**Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 (a) Discuss the various methods of determining the depreciation of the equipments. [10]

(b) A steam station has two 110 MW Units. The cost data is as under- [10]

Unit-1

Unit-2

 $UC_1 = ₹ 18,000/kw$ $UC_2 = ₹ 30,000/kw$ $FCR_1 = 10\%$ $FCR_2 = 10\%$ $CF_1 = 0.55$ $CF_2 = 0.60$

Fuel consumption = 0.7kg/kwh

Fuel consumption = 0.65kg/kwh

Fuel cost = ₹ 1500 per 1000kg

Fuel cost = ₹ 1500 per 1000kg

 $OM_1 = 20\%$ of annual fuel cost $OM_2 = 15\%$ of annual fuel cost

Utilization factor = 1

Utilization factor = 1

Calculate:

(a) Annual plant cost and generation cost of Unit 1.

(b) Annual plant cost and generation cost of Unit 2.

(c) Overall generation cost of the station.

Q.2 Two generating stations A and B have full load capacities of 200 MW and 75 MW respectively. The interconnector connecting the two stations has an induction motor/synchronous generator (plant C) of full load capacity 25 MW. Percentage changes of speeds of A, B and C are 5, 4 and 3 respectively. The loads on bus bars A and B are 75 MW and 30 MW respectively. Determine the load taken by the set C and indicate the direction in which the energy is flowing. [20]

Q.3 The fuel inputs per hour of two plants are given as- [20]

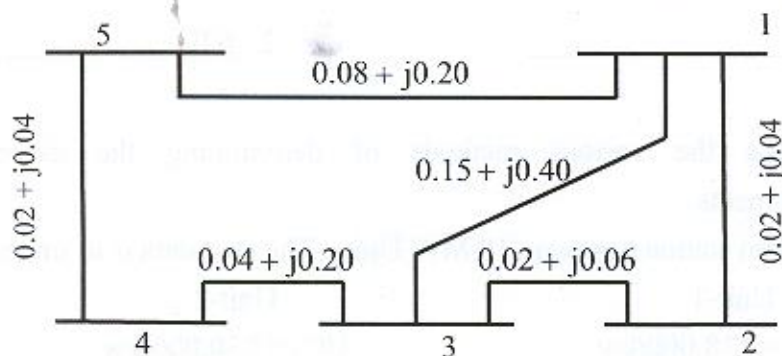
$$F_1 (PG_1) = (0.00889PG_1^2 + 10.333PG_1 + 200) \text{ ₹/h}$$

$$F_2 (PG_2) = (0.00741PG_2^2 + 10.833PG_2 + 240) \text{ ₹/h}$$

Using Newton Raphson method determine the economic schedule to meet the demand of 150 MW and the corresponding cost of generation. The transmission losses are given by-

$$P_L = 0.001 PG_1^2 + 0.002PG_2^2 - 2 \times 0.0002PG_1 PG_2$$

Q.4 Use the Y_{BUS} Method to determine the B-Coefficient for a 5 bus system shown below. Bus 5 is taken as the Slack Bus. [20]



Q.5 Define the Generalized Generation Shift Distribution. (GGSD) factor. Drive GGDF. [20]

Q.6 How are Hydro plants classified? What is long range and short range problems? [20]

Q.7 How is economic dispatch problems are solved for Active and Reactive Power Balance? [20]

Q.8 Write short notes (any 2): [20]

- Interconnected System
- Load sharing and Power transfer between stations
- Merits and demerits of the system Interconnection.

15701

Roll No. _____

Total No of Pages: **2****15701**

M. Tech. I Sem. (Main) Exam., Dec. - 2018
Thermal Engineering
1METE1 Advanced Fluid Mechanics

Time: 3 Hours**Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five questions**. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 (a) Discuss the following – [10]

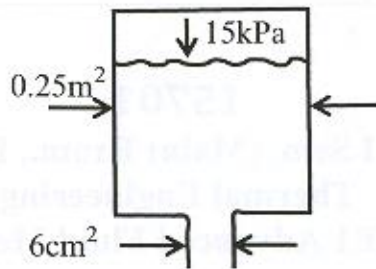
- (i) Skew symmetry of deformation tensor
 - (ii) Stokesian and Newtonian fluid
 - (iii) Polar and non – polar fluids
- (b) Derive the general equation of momentum in vector form and Bernoulli's equation. [10]

Q.2 Figure 1 shows the closed oil tank, pressurized to a gauge pressure of 15 kPa, which is draining to the surrounding through a hole in the bottom. The tank cross – sectional area is 0.25 m^2 . The hole area is 6 cm^2 . Starting from Bernoulli's equation, derive an expression for volume rate of flow through the hole. Also calculate the time taken for the oil level to drop from 1m above the tank bottom to the 0.4m above the bottom. [20]

[15701]

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[60]



- Q.3 Discuss the following in detail – [20]
- Continuity equation in polar coordinates
 - Velocity potential function
 - Rankine Ovals
 - What is aerofoil theory and how lift is generated?
- Q.4 Two – dimensional fluid flow takes place in the first quadrant of the (x, y) plane. The stream function for the flow is given by $\phi(x, y) = Cxy$. Where C is a positive constant. [20]
- Determine the flow velocity components.
 - Show that the flow is irrotational and incompressible.
 - Sketch the streamlines of the flow.
- Q.5 (a) Show that in a forced vortex motion, the velocity of flow is directly proportional to radial distance from axis of rotation. [10]
- (b) What is convection and diffusion of vorticity, justify your answer with a suitable example. [10]
- Q.6 Discuss the following in details – [20]
- Vortex lines
 - Kelvin's circulation theorem
 - Helmholtz's vorticity theorem
 - Vortex motion in tubes
- Q.7 (a) Define Plane Poiseuille flow, Couette flow and Hagen Poiseuille flow and how they have used in pipes? [10]
- (b) How blasius solution is obtained for boundary layer on a flat plate with pressure gradient. What are the features of Korman Polhausen integral method for approximate solution? [10]

15801

Roll No. _____

Total No of Pages: **2****15801****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Production Engineering
1MEPE1 Machining Science - I****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

Attempt any five questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL2. NIL

- Q.1 (a) Explain the mechanisms of plastic deformation (with suitable sketch) in slip & dislocation. [10]
(b) Evaluate the machining time for turning of a 50mm diameter brass bar to 42 mm diameter over a length of 50 mm at a spindle speed of 450 rpm. The maximum depth of cut is limited to 3 mm and feed 'f' is set at 0.2 mm per rev. The side cutting edge angle of tool is 30°. Approach allowance = 3 mm. [10]
- Q.2 (a) Explain various tool angle specification system. [10]
(b) The tool signature in American system is 8-10-6-6-12-2-30-0. Determine the angle λ and α_n of normal system. [10]
- Q.3 (a) Derive an expression to determine Shear Plane Angle. [10]
(b) In an orthogonal cutting operation on a material with the shear yield strength of 250 N/mm² the following data is obtained: [10]
Rake angle of the tool = 15 deg.
Uncut chip thickness = 0.25 mm
Width of chip = 2 mm
Chip thickness ratio = 0.46
Friction angle β = 40 deg.
Determine the shear angle ϕ , the cutting force component and resultant force on the tool.

- Q.4 (a) Write similarity and dissimilarity between Turning and Boring operations. [10]
(b) Draw and explain the concept of rake angle measured in different planes. [10]
- Q.5 (a) What is the effect of following factors on shear plane angle – [8]
(i) Rake angle
(ii) Cutting speed
(iii) Feed
(iv) Depth of cut
- (b) Determine the Cutting force and Feed force components in turning a 100 mm diameter bar of low carbon steel with HSS tool to 96 mm diameter. The feed is set at 0.4 mm/rev and cutting speed at 24.5 m/min. Also determine the power consumed in the cutting operation. [12]
- Q.6 (a) Enumerate the factors affecting tool life. Briefly explain the effect of each factor. [10]
(b) Derive expression for cost of turning and time of turning a work piece and find the optimum cutting speed for minimum cost maximum rate of production. [10]
- Q.7 (a) Classify various types of grinding processes. Explain each in short. [8]
(b) Determine the temperature rise at the shear plane from the following experimental data in orthogonal cutting of mild steel of density 7.87 gm/cm^3 and specific heat of 0.44 J/gm taking that $\lambda = 1$. [12]
Force component in the direction velocity $F_n = 1600 \text{ N}$
Force component normal to machine surface $F_v = 500 \text{ N}$
Depth of cut = 0.3 mm
Width of cut = 5 mm
Chip thickness ratio = 0.42
Tool rake angle = 10°
Cutting velocity = 35 m/min
-

15802

Roll No. _____

Total No of Pages: **2****15802****M. Tech. I - Sem. (Main) Exam., Dec. - 2018****Production Engineering
1MEPE2 Machining Science - II****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL2. NIL

Q.1 For the following application, identify one or more non – traditional machining processes that might be used, and present arguments to support your selection. Assume that either the part geometry or the work material (or both) preclude the use of conventional machining. The application is a blind - hole in the shape of the letter G in a 50 mm (2.0 in) cube of steel. The Overall size of the “G” is 25 × 19 mm, the depth of the hole is 3.8 mm and its width is 3 mm. [20]

Q.2 Explain in detail:

(a) Plasma Arc Machining [10]

(b) Ion Beam Machining [10]

Q.3 A wire EDM Operation is used to cut out punch and die components from 25 mm thick tool steel plates. However, in preliminary cuts, the surface finish on the cut edge is Poor. What changes in discharge current and frequency of discharges should be made to improve the finish? [20]

Q.4 A furniture company that makes upholstered chairs and sofas must cut large quantities of fabrics. Many of these fabrics are strong and wear – resistant, which properties make them difficult to cut. What non-traditional processes would you recommend to the company for this application? Justify your answer by indicating the characteristics of the process that make it attractive. [20]

Q.5 Write short notes on:

- (i) Conventional Machining Processes [5]
- (ii) Surface Finishing Processes [5]
- (iii) Unconventional Machining Processes [5]
- (iv) USM [5]

Q.6 Much of the work at the Cut – Anything Company involves cutting and forming of flat sheets of fibre glass for the pleasure boat industry. Manual methods based on portable saws are currently used to perform the cutting operation, but production is slow and scrap rates are high. The foreman says the company should invest in a plasma arc cutting machine, but the plant manager thinks it would be too expensive. What do you think? Justify your answer by indicating the characteristic of the process that make PAC attractive or unattractive in this application. [20]

Q.7 How Electron Beam Machining is different from Laser Beam Machining? Elaborate with industrial application of both. [20]

Q.8 Explain in Detail:

- (a) ECM [10]
- (b) EDM [10]

15803

Roll No. _____

Total No of Pages: **2****15803****M. Tech. I Sem. (Main) Exam., Dec. - 2018****Metal Forming****1MEPE3 Metal Forming****Time: 3 Hours****Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

Attempt any five questions. Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL2. NIL

- Q.1 (a) Determine the invariants of the stress tensor and the octahedral stresses for the case of uniaxial state of stress. [12]
- (b) What stress-strain relationship is commonly employed in plasticity problems of elasto-plastic materials? Explain. [8]
- Q.2 State two yield criteria used in metal working problems. How do they differ from each other? State also the experimental justification in support of each. [20]
- Q.3 (a) Prove that the angle between two slip lines of one family at points where they are cut by a slip line of the other family is constant along their lengths. [10]
- (b) Draw and explain the slip lines networks that have been proposed in the field of metal cutting. [10]
- Q.4 Explain the concept of upper bound in estimating loads in metal forming problems. Apply the above method to get the average pressure between a pair of smooth parallel plates compressing a non-work hardening material in plane strain. [20]

- Q.5 (a) Evaluate the press capacity necessary for forging a 1 m long cylindrical bloom to hexagonal section with approximately 0.33 m side, if the yield stress is initially 440 kg/cm² but increases to 680 kg/cm² at the end of the operation. Assume: (i) that the bloom is partially lubricated so that $\mu = 0.3$, (ii) that there are no lubrication. What maximum pressures would be expected? [20]
- Q.6 (a) Obtain the expression for the radial drawing stress in a deep drawing operation making suitable assumptions. [12]
- (b) Discuss the various defects observed in deep drawing process. [4]
- (c) Discuss the importance of 'drawing ratio.' [4]
- Q.7 Calculate the drawing load for 40% reduction of area 25 mm × 6 mm annealed steel strip, using 6 mm radius dies and compare this with the load using straight tapered dies: (a) of the same entry angle, and (b) of the same mean angle. Assume $\mu = 0.1$. The contribution of redundant work may be neglected. Derive the formulae use. [20]
- Q.8 (a) Differentiate between high energy rate forming and conventional process. [6]
- (b) Explain briefly the general requirement for an explosive forming facility. [6]
- (c) Classify explosive forming technique. Explain stand-off operations in brief. [8]

15804

Roll No. _____

Total No of Pages: **2****15804**

M. Tech. I - Sem. (Main) Exam., Dec. - 2018
Production Engineering
1MEPE4 Metrology and Computer Aided Inspection

Time: 3 Hours**Maximum Marks: 100****Min. Passing Marks: 33***Instructions to Candidates:*

*Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL _____2. NIL _____

Q.1 (a) What do you understand by terms repeatability and reproducibility as applied to measurement. Differentiate between two. [8]

(b) Explain the following terms: [6]

(i) Roundness

(ii) Cylindricity

(c) Discuss methods of improving accuracy and surface finish. [6]

Q.2 (a) Explain Taylor's principle of gauge design with suitable examples. [6]

(b) Design the "general" type "Go" and "Not-Go" gauge for checking $\phi 25H7f8$ assembly being given - [14]

(i) $i(\text{microns}) = 0.45(D)^{1/3} + 0.001D$

(ii) upper deviation for 'f' shaft = $-5.5(D)^{0.4}$ microns

(iii) 25 mm falls in the dia. step of 18 and 30

(iv) $IT7=16i$ and $IT8 = 25i$

Take wear allowance as 10% of gauge tolerance.

- Q.3 (a) Differentiate between measuring instrument, limit gauges and comparators. [6]
(b) Explain principle of operation and working of any one type of pneumatic comparator. [10]
(c) State briefly why comparators are used in engineering practice. [4]
- Q.4 (a) Why the use of a Sine Bar is not recommended for angles larger than 45° with the reference plane? [4]
(b) Explain the construction, working and use of a Vernier Bevel Protractor. [8]
(c) Explain principle of working and optical system of a "Autocollimator". [8]
- Q.5 (a) Discuss the application of lasers in precision measurement. [7]
(b) Explain how digital techniques can be used in mechanical measurements. [8]
(c) Discuss how experimental data can be presented. [5]
- Q.6 (a) Explain various types of C.M.M. and their applications. [12]
(b) Mention some advantages of C.M.M. [4]
(c) What do you mean by noncontact C.M.M.? [4]
- Q.7 (a) Sketch and comment upon five typical interference patterns while testing a small plane surface by means of an optical flat. [12]
(b) Explain method of calibration of following instruments- [8]
(i) Micrometer
(ii) Pressure Gauge
(iii) Temperature indicator
- Q.8 Write short notes (any three): [7+7+6=20]
(i) Measurement errors
(ii) Computer Aided Metrology
(iii) Image processing and its metrology
(iv) Acoustical measurement
(v) Inaccuracy due to thermal aspects

15901

Roll No. _____

Total No of Pages: 3

15901

M. Tech. I -Sem. (Main) Exam., Dec. - 2018

Machine Design

1MEMD1 Advanced Solid Mechanics

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

Attempt any **five** questions, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

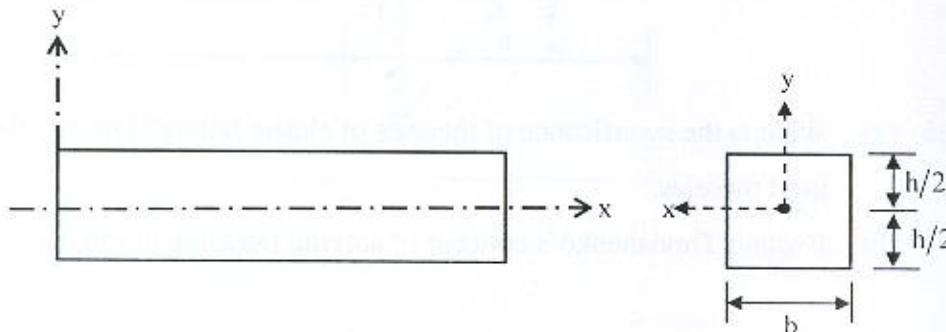
1. NIL2. NIL

Q.1 (a) At a point P, the rectangular stress components are $\sigma_x = 1, \sigma_y = -2, \sigma_z = 4, \tau_{xy} = 2, \tau_{yz} = -3$ and $\tau_{xz} = 1$ all in units of kPa. Find the principal stress and check for invariance. [12]

(b) Explain Cauchy's principle to define the state of stress. [8]

Q.2 (a) Consider the rectangular beam as shown in fig. According to the elementary theory of bending, the fiber stress in the elastic range due to bending is given by- [12]

$$\sigma_x = \frac{-My}{I} = \frac{-12My}{bh^3}$$



[15901]

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[40]

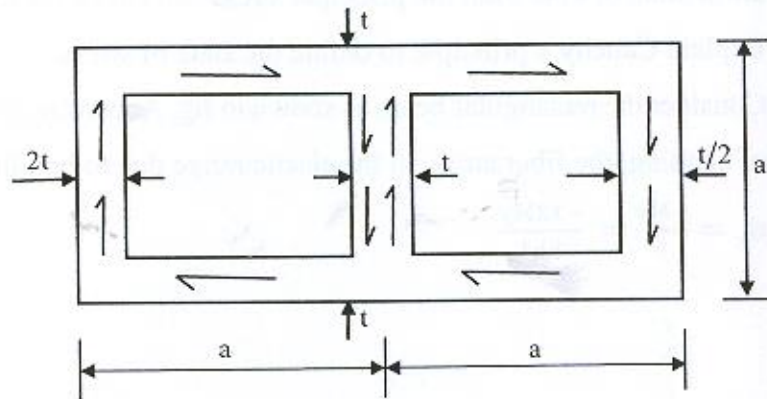
Where M is the bending moment which is a function of x . Assume that $\sigma_z = \tau_{zx} = \tau_{zy} = 0$ and also that $\tau_{xy} = 0$ at the top and bottom and further that $\sigma_y = 0$ at the bottom. Using the differential equation of equilibrium, determine τ_{xy} and σ_y . Compare these with the values given in the elementary strength of materials.

(b) Derive expression for Lamé's ellipsoid and discuss its geometric properties. [8]

Q.3 (a) The displacement field in micro units for a body is given by $u = (x^2 + y)\mathbf{i} + (3 + z)\mathbf{j} + (x^2 + 2y)\mathbf{k}$. Determine the principal strain at $(3, 1, -2)$ and the direction of the minimum principal strain. [15]

(b) Explain stress invariants and its property. [5]

Q.4 Figure shows a two-cell tubular section whose wall thickness are as shown. If the member is subjected to a torque T , determine the shear flows and the angle of twist of the member per unit length. [20]



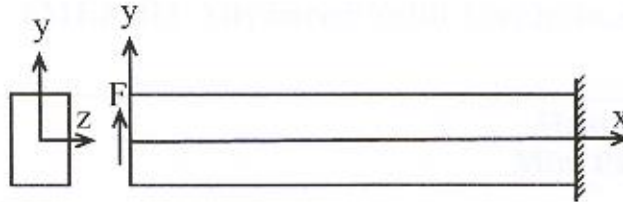
Q.5 (a) What is the significance of theories of elastic failure? Discuss the most commonly used theories. [10]

(b) Explain Timoshenko's concept of solving buckling problems. [10]

Q.6 (a) Explain plane stress and plane strain condition of fracture mechanics. [10]

(b) Consider a beam under tip load as shown in figure, choose the stress functions as-

$$\phi = Axy + Bxy^3$$

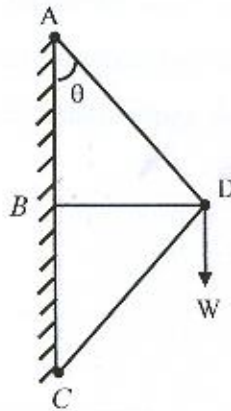


Investigate the stress field and satisfying the boundary conditions, obtain the stress distribution in the cantilever. [10]

Q.7 (a) Explain the concept of Elasto-plastic fracture mechanics. [10]

(b) Explain Kirchoff's plate theory. [10]

Q.8 Three elastic members AD, BD and CD are connected by smooth pins, as shown in Fig. All the members have the same cross-sectional areas and are of same material. BD is 100 cm long and members AD and CD are each 200 cm long. What is the deflection of D under load W? [20]



15902

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Total No of Pages: 2

15902

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Machine Design

1MEMD2 Advanced Vibration

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) Derive an expression for velocity of wave propagation for longitudinal vibration of bars. [14]

(b) Determine the normal function for free longitudinal Vibration of a bar of length 'l' and Uniform Cross Section. One end of bar is fixed and the other is free. [6]

Q.2 (a) Obtain the frequency equation for the lateral Vibration of a cantilever of uniform section having length l. [10]

(b) Explain lateral Vibrations of beam. [10]

Q.3 Explain in details perturbation method for obtaining solutions of non-linear system. [20]

Q.4 Derive Lagrange's equation and explain its each steps clearly. [20]

- Q.5 (a) Derive duffing equation. State its applications. [10]
(b) Explain floquet's equation theory of periodic linear system. [10]
- Q.6 (a) What do you mean by Stability Criteria? [10]
(b) Explain chaotic behaviour of duffing equation without the forcing term. [10]
- Q.7 (a) Explain system with time – dependent coefficients by Mathieu Equation. [10]
(b) What do you mean by Phase Velocity? Explain briefly. [10]
- Q.8 Write short note on: [4×5=20]
(a) Limit Cycle
(b) Jump Phenomenon
(c) Van der Pol's Equation
(d) Equivalent Linearization

15904

Roll No. _____

Total No of Pages: 2

15904

M. Tech. I - Sem. (Main) Exam., Dec. - 2018

Machine Design

1MEMD4 Computer Aided Graphics and Design

Time: 3 Hours

Maximum Marks: 100

Min. Passing Marks: 33

Instructions to Candidates:

*Attempt any **five questions**, Marks of questions are indicated against each question. Draw neat and comprehensive sketches wherever necessary to clearly illustrate your answer. Assume missing data suitable if any and specify the same. Use of following supporting material is permitted during examination. (Mentioned in form No. 205)*

1. NIL

2. NIL

Q.1 (a) Explain solid modeling and discuss its various types. [10]

(b) Give the method of representing curved edges in Boundary Representation (B-rep) scheme. [10]

Q.2 (a) Give the classification algorithm for Constructive Solid Geometry (CSG) scheme. [10]

(b) What do you understand by solid manipulation? Explain its various features. [10]

Q.3 What is meant by sweep? Discuss in details the various types of sweep technologies available for 3-D geometric construction. [20]

Q.4 (a) Give a brief description about spline curves. [10]

(b) Explain Bezier curves. What are its properties? [10]

Q.5 (a) Describe the various stages of design process in computer aided graphics. [10]

(b) What are the various methods adopted for interactive design? Explain its advantages and disadvantages. [10]

Q.6 Explain any two: [10+10=20]

(i) intersection of surface

(ii) design of surface

(iii) simulation tools in CAED

Q.7 Explain the methodology adopted for optimization and simulation of a given design in computer aided graphics. [20]

Q.8 Write short notes on: [10+10=20]

(i) Half spaces

(ii) Design of volumes
