

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22**

Course Code: MEE610

Full Marks: 30

Course Name: Automobile Engineering

Time: 90 Minutes

Question Paper No.: NITDGP/MEE610/1

Date of Exam: 21/04/2022

Instructions: Answer all the questions.

Question No.	Body of the Question	Marks	Mapped CO
1	List the main components of an auto electrical system? Explain the function of a starter. State how the charging system works.	3	CO1
2	State the purpose of the ventilation system. State the purpose of the heating system. Explain how the compressor clutch works.	3	CO1
3	What are the properties a good braking system of an automobile? Explain with a neat sketch the operation of a drum brake.	3	CO1
4	What do you mean by the self-energizing action of brakes? What are the main advantages and disadvantages of disc brake?	3	CO1
5	Describe in brief the function of battery ignition system. What do you mean by ignition timing, explain it briefly? Describe how the centrifugal advance mechanism operates.	3	CO1
6	Name the main components constituting the drive line of a rear wheel drive car with engine at the front.	2	CO4
7	What are advantages of a rear engine automobile? Give one example.	2	CO2
8	What are requirements of an efficient transmission system of a passenger car?	2	CO3
9	Name the different types of manual transmission system used in an automobile.	2	CO3
10	Give a neat sketch of any one of the manual transmission in neutral gear position.	3	CO3
11	What is the main disadvantage of a normal differential gear box?	2	CO4
12	What are the main functions of a propeller shaft in an automobile?	2	CO4

Course Outcomes

CO1:

CO2:

CO3:

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

NITDGP/BTECH/Reg/Even/2021-22

Even Semester End-term Examination, 2021-22

Course Code: MEE 611

Full Marks: 30

Course Name: Gas Dynamics and Propulsion

Time: 1.5 Hours

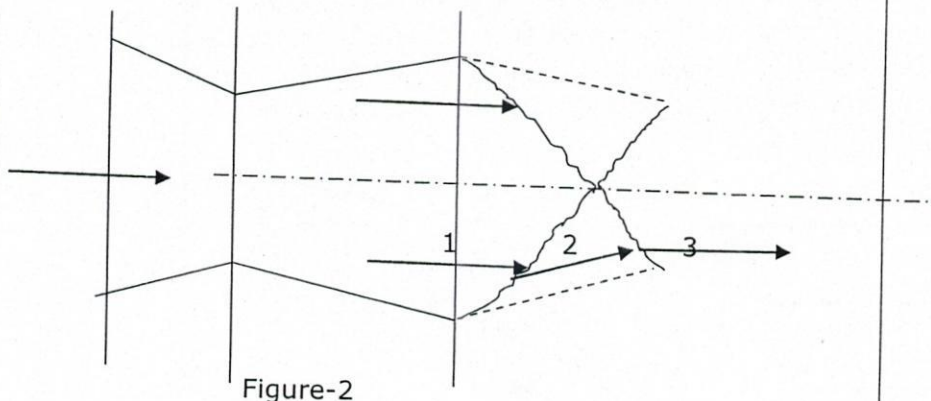
Question Paper No.: NITDGP/MEE611/ 53

Date of Exam: 21/04/2022

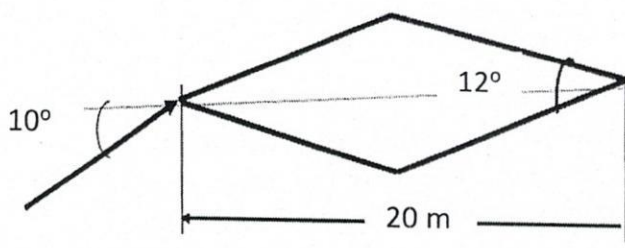
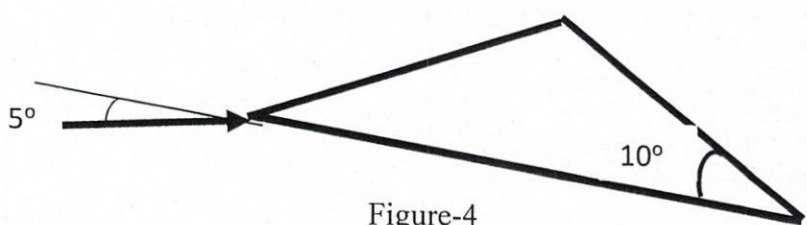
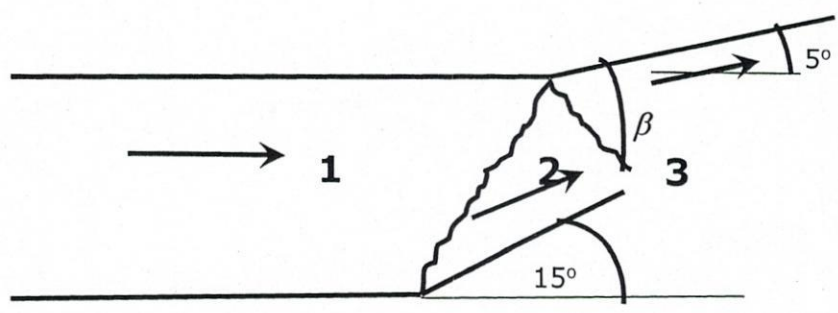
Instructions: Answer Question no. 1, any one from question no. 2 and 5 and any one from question no. 3 and 4.

Materials to be supplied: Gas Table, Oblique Shock Chart.

Question No.	Body of the Question	Marks	Mapped CO
1.	<p>(a) Draw the schematic diagram of Ramjet and Turbojet Engines with the station numbers and draw the T-s diagram for both of them considering the ideal cases and then derive the thermal efficiency for ideal Ramjet and Turbojet engines.</p>	1+1+2	CO1
	<p>(b) In ideal Ramjet Engine, the ambient temperature, $T_\infty = 220\text{K}$, Maximum temperature, $T_{\text{max}} = 2200\text{K}$, Fuel used is JP4 whose heating value, $Q_R = 45000 \text{ kJ/kg}$, (i) Find fuel -air ratio, f approximately. (ii) Find the corresponding Thermal efficiency (η_{th}). (iii) Find the Flight Mach Number, M_∞ when specific Thrust (T/\dot{m}_a) is maximum. (iv) Find the maximum value of the specific thrust. (v) Find the Flight Mach Number, M_∞ when TSFC is minimum. (vi) Find the minimum value of the TSFC.</p>	1X6=6	CO4
2.	<p>A converging-diverging nozzle as shown in Figure-2 is operating between the second critical and third critical. The fluid is air. The properties in region 1 are: $p_1 = 0.7 \text{ bar}$, $M_1 = 2.5$, $T_1 = 150\text{K}$ and receiver pressure $p_{\text{rec}} = 1 \text{ bar}$. Find the following:</p> <p>(a) M_2, p_2, T_2 and flow direction (δ_2) in region-2,</p> <p>(b) M_3, p_3, T_3 and flow direction (δ_3) in region 3,</p>	5+5	CO2



Course Outcomes: CO1, CO2, CO3, CO4

3.	<p>The symmetrical diamond shaped aerofoil, shown in Figure-3, is operating at a 10° angle of attack. The flight speed is $M=1.8$ and the air pressure equals 100kPa. Compute the lift and drag force.</p>  <p style="text-align: center;">Figure-3</p>	5+5	CO3
4.	<p>A supersonic aerofoil, as shown in Figure-4, is an isosceles triangle and chord length is 3 meter. If the angle of attack is 5°, incident Mach no. is 1.5 and pressure in front of the leading edge, $p_1 = 100$ kPa, find the lift and drag force acting on the aerofoil assuming unit depth normal to plane of paper.</p>  <p style="text-align: center;">Figure-4</p>	5+5	CO3
5.	<p>A uniform flow of air has a Mach number of 4. The bottom of the duct is bent upward at a 15° angle. At the point where the shock incidents on the upper wall, the boundary is bent 5° upward as shown in Figure-Q1. Compute M_3, p_3/p_1, T_3/T_1 and β. 1, 2 and 3 indicate the three regions and arrows show the flow directions.</p>  <p style="text-align: center;">Figure-5</p>	2.5X4= 10	CO2

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-Term Examination, 2021-22

Course Code: MEE612

Course Name: Mechanics of Forming and Press Working

Question Paper No:

Full Marks: 30

Time: 1½ Hours

Date of Exam: 21/04/22 (2nd half)

*Notations carry their usual meanings**Answers should be brief and precise. All parts of a question are to be answered together***FIRST HALF***Attempt any TWO questions from this half*

1. a) Describe the recrystallization process in rolling. What are its effects on a rolled product?
b) Define neutral plane in rolling. What is done to obtain plane strain condition in rolling?
c) Prove that for a higher draft, a high value of μ is desirable in rolling.
(3+1½+3) = 7½
2. a) Based on the expressions of roll pressure, determine the pressure distribution in contact zone. Draw the friction hill as well as roll pressure in the roll itself.
b) A strip with a cross section of 150×6 is being rolled with 20% reduction of area, using 400 mm diameter steel rolls. Before and after rolling, the shear yield stress of the material is 0.3 kN/mm² and 0.4 kN/mm² respectively. Assuming μ as 0.15, determine the location of the neutral point.
(3½+4) = 7½
3. a) What are the utilities of applying front tension and back tension in rolling?
b) Describe Sendzimir rolling mill with a neat sketch.
c) Write a short note on 'Roll deflections'.
(1½+3+3) = 7½

SECOND HALF*Attempt any FIVE questions from this half: (5 X 3= 15)*

- 4) What is the basic difference among conventional sheet metal forming, High velocity forming (HVF) and High energy rate forming (HERF)?
- 5) Draw a schematic labelled diagram of an unrestrained explosive forming setup with salient dimensions.
- 6) Draw a schematic labelled diagram of a restrained explosive forming.
- 7) Compare between explosive forming and electro-hydraulic forming with two advantages of each.
- 8) Draw the schematic of shear spinning. How it differ from conventional spinning?
- 9) What is the peak pressure developed by 1kg of TNT with stand-off distance 500mm, if the pressure relation is $p=4200W^{n1}D^{-n2}$? Assume suitable $n1$ and $n2$.
- 10) What is the energy released by a capacitive discharge from 500µF capacitor bank charged at 1kV?

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Even Semester End-term Examination, 2021-22

Course Code: MEE613

Full Marks: 30

Course Name: Advanced Solid Mechanics

Time: 90 Minutes

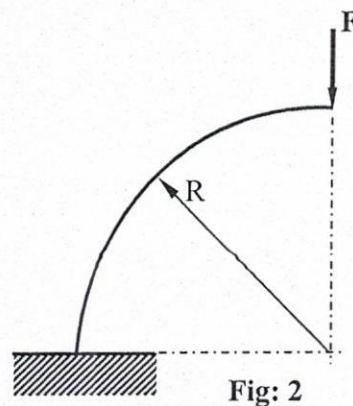
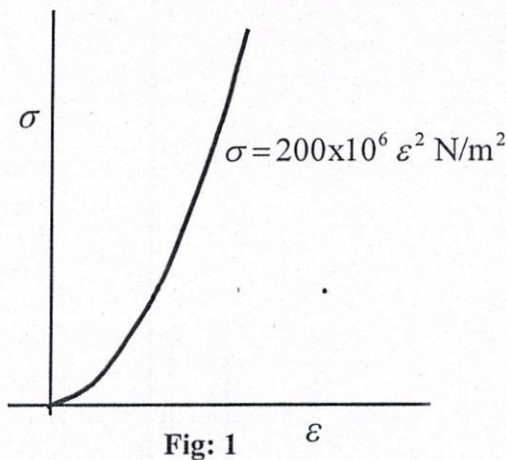
Question Paper No.: NITDGP/MEE613/Your Roll No.

Date of Exam: 22/04/2022

Instructions: Answer all the questions.

Assume suitable data if needed.

Question No.	Body of the Question	Marks	Mapped CO
1.	What is plane stress condition? What do you mean by axisymmetric problem?	05	CO3
2.	A steel cylinder, having closed ends, of internal diameter 20cm and external diameter 30cm is subjected to an internal pressure of 9MPa. Calculate (i) principal stresses at the inner and outer surface (ii) draw the radial and circumferential stress distribution along the thickness of the cylinder.	05	CO3
3.	Calculate the strain energy and complementary strain energy per unit volume if the strain is 0.0024. The stress-strain behaviour of the material is shown in Fig 1.	05	CO4
4.	An arch in the form of one quadrant of a thin circular rod of radius R is subjected to a vertical load as shown in Fig 2. Find the vertical deflection under the load using Castigliano's theorem.	05	CO4
5.	Derive the in-plane displacement functions for the torsion of non-circular shaft.	04	CO5
6.	What is Prandtl's stress function? Derive the relationship between Prandtl's stress function and torque.	06	CO5

Course Outcomes

- CO1: Extend their knowledge from vector to tensor, and from isotropic to anisotropic materials
 CO2: Apply the knowledge of 3-D state of stress and strain
 CO3: Apply the concept of thick cylinder theory
 CO4: Apply the energy principles
 CO5: Apply the theory of noncircular shaft

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEE620

Full Marks: 30

Course Name: Advanced Foundry Engineering

Time: 90 minutes

Date of Exam: 22/04/2022

Question Paper No.: NITDGP/MEE620/1

Instructions: Answer all questions. Make a neat and well labeled diagram wherever necessary.
Materials to be supplied: NIL

Question No.	Body of the Question	Marks	Mapped CO
1	Draw a neat diagram of a gating system and label the following parts: Pouring Basin, Sprue, Sprue Well, Runner, Gate, Mould cavity and Riser in the Gating system.	7	CO1
2	What is meant by a cooling curve? Take a melt containing ideally pure metal and draw cooling curve for practical (fast) rate of cooling, with proper labelling as necessary.	2+3	CO1
3	What is meant by Isomorphous alloys? Give one example of such an alloy system.	2+1	CO2
4	In an Fe- C equilibrium diagram the Cast Iron region corresponds to Carbon percentage of _____ to _____	1+1	CO3
5	What is meant by phase diagram? How is phase diagram created from the cooling curves	2+3	CO3
6	With a relevant diagram explain very briefly what is meant by : a) Solidus line b) Liquidus line c) Solvus line d) Degree of Supercooling	4X2 = 8	

Course Outcomes

CO1: At the end of the course student will be able to get the knowledge about various aspects of casting processes and the underlying science
CO2: Various types of casting methods
CO3: Application fields of various casting processes

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEE623

Full Marks: 30

Course Name: Multiphase Flow and Heat Transfer

Time: 90 Minutes

Question Paper No.: NITDGP/MEE623

Date of Exam: 22/04/2022

Instructions: Answer question no 1 and any six from rest.

Question No.	Body of the Question	Marks	Mapped CO
1	Give the example of deviation of metastable and stable equilibrium. Illustrate the process.	6	CO1
2	What is pool boiling? Discuss the variation of heat flux with temperature.	4	CO2
3	Discuss the natural convection, vapour column and jet region with a suitable diagram.	4	CO2
4	Deduce the expression of the radius of bubble growth changing with respect to time for the inertia controlled case.	4	CO3
5	Write the difference between the drift flux and the separated flow model	4	CO3
6	What do you mean by critical heat flux in boiling, and why it needs to be avoided?	4	CO2
7	Deduce the momentum equation of stratified flow with the phase change process.	4	CO2,CO4
8	What are different forces needed to include for the packed bed condition and write the governing equation?	4	CO3,CO4

Course Outcomes

- CO1: Understanding the principles of multi-phase flow and heat transfer
- CO2: Relate the fluid-dynamic involved in convection and multi-phase heat transfer.
- CO3: Plan elementary analysis of most gas-liquid two-phase systems.
- CO4: Analyze the model to a wide variety of complex engineering problems.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22**

Course Code: MEE624

Full Marks: 30

Course Name: Tribology

Time: 90 Minutes

Question Paper No.: NITDGP/MEE624

Date of Exam: 22/04/2022

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	Define Skewness and Kurtosis of rough surface. What is the physical understanding of it?	5	CO1
2	Explain the Hertzian stresses of spherical single asperity contact.	5	CO1
3	What is plasticity index? What is the role of it to define elastic and plastic surfaces contact?	5	CO1
4	Explain the simple adhesion theory of friction. What are the limitations of it?	5	CO2
5	Explain the effect of oxygen on adhesional friction of pure iron self-sliding in vacuum?	5	CO2
6	Explain the mechanism of hydration layer formation for Silicon Nitride sliding and its effect on friction and wear.	5	CO2

Course Outcomes

CO1: To learn the basic knowledge of surface topography and contact between engineering surfaces.

CO2: To learn the basic theory and application of friction and wear for different materials

NITDGP/BTECH/Reg/Even/2021-22

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
Even Semester End-term Examination, 2021-22

Course Code: MEE 625

Full Marks: 30

Course Name: Computer Aided Design and Manufacturing

Time: 90 Minutes

Question Paper No.: NITDGP/MEE625/1

Date of Exam: 22/04/2022

Instructions: Answer all the questions.

Ques No.	Question	Marks	Mapped CO
1	(a) Define the term Virtual Prototype and virtual prototyping. (b) Mention the functions of Virtual Prototyping technique in respect to new product design and development.	1 2	CO3
2	(a) How do you classify the Additive manufacturing process based on methodology used. (b) With simple sketch, describe the basic process of the Fused Deposition Modelling (FDM) Process.	1 3	CO4
3	(a) Distinguish between unconstrained optimization problem and constrained optimization problem. (b) Write down the steps involved in Newton-Raphson method for single-variable unconstrained optimization problem.	1 2	CO3
4	Find the minimum value of the function: $f(x) = \frac{13}{20} \left\{ 1 - x \tan^{-1} \left(\frac{1}{x} \right) \right\} - \frac{3}{4(1+x^2)}$, using Newton-Raphson method with the starting point $x=0.12$. Use $\epsilon=0.001$ for termination. Carry out two iterations to solve this optimization problem.	4	CO3
5	(a) Classify the robots based on the mobility. Define Industrial Robot. (b) Describe the role of arm, wrist and gripper of a robotic manipulator (c) Why rotary joints are preferred over linear joint in design of manipulator	2 1½ ½	CO4
6	(a) What do you mean by dextrous workspace and reachable workspace of a manipulator? (b) Make a list of parameters on which the shape and size of reachable workspace of a manipulator depends.	1 1	CO4
7	(a) With a suitable sketch, define four D-H parameters for kinematic modeling? (b) Which of these parameter is variable for a prismatic joint and rotary joint?	2 1	CO4
8	(a) For any intermediate link 'i', discuss how x-axis and origin of frame {i} is fixed under the following possible cases: (i) if Z_{i-1} and Z_i intersect, (ii) if Z_{i-1} and Z_i are parallel, (iii) if Z_{i-1} and Z_i coincide, where Z_i is the axis for $(i+1)^{th}$ joint. (b) Derive the Link transformation matrix or D-H transformation matrix $({}^{i-1}T_i)$ for kinematic relationship between two adjacent links.	1½ 2½	CO4
9	(a) State the main advantages of CNC machine tools (b) Mention different components of CNC machine tools (c) What are the requirements of feedback devices in CNC machine tools	1 1 1	CO4

Course Outcomes

CO1: Able to understand scope and application of CAD/CAM tools in industry

CO2: Able to learn geometric modelling and computer graphics concept in CAD tools

CO3: Able to understand the different design analysis and optimization tools in CAD.

CO4: Able to understand the fundamentals of Additive manufacturing, CNC machine tools, Part programming, Industrial Robot etc