BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: VIth Date: 28/04/2022 (MORNING)

Subject with Code: **ME359 POWER PLANT ENGINEERING**

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH — **SEMESTER : VI**
BRANCH: MECHANICAL — **SESSION : SP/22**

SUBJECT: ME 359 POWER PLANT ENGINEERING

TIME:
2:00 hrs

FULL MARKS: 50

INSTRUCTIONS:
1. The question paper contains objective questions and subjective questions.
2. Q1 has objective questions of 1 and 2 marks, making a total of **30 marks. Candidates should sequentially write the answer to each question only**, not the option no. Students can write entire step for numerical question, but marks will be given only for choosing the correct answer.
3. The subjective questions are 7 in no (Q2-Q8), and **candidates may attempt any 4 questions for a maximum of 20 marks only**, clearly mentioning the question no attempted, and assuming any missing data that may be required. Step marking is applicable for this section, so clearly write all steps followed for the final answer in numerical questions. Short answers should be brief and to the point.
4. Follow all the instructions notified by the examination department for online examination SP22.

Q.1(a) Which of the following is not true for electrical power transmission from the generating site to the load center? [1]

(i) Transformers are used for minimizing the power losses during transmission
(ii) The rated frequency of all interconnected power generating units must be the same
(iii) Usually three-phase supplies are provided to the domestic consumers, while single-phase supplies are provided to the industrial consumers
(iv) Interconnected power grids provide economical and security benefits as compared to individual power generating units at different regions of a country

Q.1(b) Which of the following components of a hydro power plant is used to facilitate extraction of more power from reaction turbines by allowing higher pressure drop as water flows through the turbine into the downstream side? [1]

(i) Draft tube (ii) Headrace tunnel (iii) Spillway (iv) Surge tank

Q.1(c) Which of the following is a boiler accessory? [1]

(i) Steam stop valve (ii) Air preheater (iii) Man-hole (iv) Water-level indicator

Q.1(d) Which of the following stoker mechanisms for combustion of non-pulverised coal uses metallic chains for controlling the fuel feed rate? [1]

(i) Spreader stokers (ii) Travelling Grate stokers
(iii) Single-retort stokers (iv) Vibrating grate stokers

Q.1(e) Which of the following ash and dust collecting systems is based on water-free technology and thus eliminates the cost of removal of water before disposal of the ash or dust? [1]

(i) Mechanical Ash Handling System (ii) Hydraulic Ash Handling System
(ii) Cyclone Separator (iv) Packed Bed Scrubber

Q.1(f) Which of the following cannot be a component of a diesel power plant? [1]

(i) Turbine (ii) Condenser (iii) Air-Intake system (iv) Exhaust system

Q.1(g) Which of the following is a solar collector? [1]

(i) Evacuated Tube collector (ii) Cylindrical Parabolic Collector
(iii) Solar Tower (iv) All of these

Q.1(h) Which of the following forms of energy cannot be harnessed from oceans and seas? [1]

(i) Wave energy (ii) Ocean Thermal Energy or Marine Current Energy
(iii) Geothermal energy (iv) Tidal energy

Q.1(i) Which of the following is not an important factor to consider while setting up a power plant in a region, from an economical point of view? [1]

(i) Availability of cheaper land
(ii) Hot and humid climatic condition
(iii) Plant should be close to the load requirement region
(iv) Proximity to fuel source and water body

Q.1(j) Which of the following uses Rankine cycle for power generation? [1]

(i) Geothermal power plant (ii) Diesel power plant
(ii) Gas turbine power plant (iv) Hydel power plant

Q.1(k) Which type of safety valve is most commonly used in modern high-pressure boilers? [2]

(i) Dead weight valve (ii) Lever valve
(iii) High steam and low water valve (iv) Spring-loaded valve

Q.1(l) Determine the thermal efficiency of a boiler given that its equivalent evaporation is equal to 10 kg steam per kg coal, and the calorific value of the coal is 26 MJ/kg. Take the latent heat of evaporation of water at standard atmospheric pressure equal to 2257 kJ/kg. [2]

(i) 86.8 % (ii) 88.2 % (iii) 89.5 % (iv) 90.7%

Q.1(m) Which of the following is true in relation to efforts of the Indian central government in the last decade towards the power generation sector of the country? [2]

(i) As per Central Government reports, 100% village electrification has been achieved
(ii) The government has not taken much initiatives towards promoting power generation from the renewable energy sources
(iii) The government is not encouraging foreign investors to invest in the power sector in India
(iv) Energy deficit in the country has increased over the last decade

Q.1(n) Which of the following is true regarding the performance of a gas turbine power plant? [2]

(i) Regeneration always lowers the specific fuel consumption, irrespective of effectiveness of the regeneration process and the operational pressure ratio of the gas turbine unit
(ii) Intercooling leads to increase of thermal efficiency only when it is also combined with regeneration
(iii) Part load efficiency of open cycle gas turbines is very good, which makes them suitable for working under off-design loading conditions
(iv) Increasing the turbine and compressor inlet temperature leads to increase of thermal efficiency of the gas turbine

Q.1(o) At a particular site for a hydro power plant, it is given that the available water head is 12 m, and a turbine having specific speed of 750 is being used. Which of the following type of turbine is operational in the plant? [2]

(i) Pelton wheel (ii) Francis turbine (iii) Kaplan turbine (iv) None of these

Q.1(p) In a nuclear power plant, U-235 fuel is used to produce 1000 MW power. Assuming that only 85% of the neutrons absorbed by U-235 causes fission, determine the fuel consumption per hour. It is given that each fission of U-235 leads to 3×10^{-11} J of energy. [2]

(i) 50 gm (ii) 55 gm (iii) 60 gm (iv) 65 gm

Q.1(q) What is the electrical power generated by a wind turbine unit which has a performance coefficient of 0.4, and a blade length of 30 m? Assume that the density of air = 1.2 kg/m^3, and the average wind velocity is equal to 10 m/s. [2]

(i) 0.54 MW (ii) 0.61 MW (iii) 0.68 MW (iv) 0.75 MW

Q.1(r) The function of the moderator in a nuclear reactor is to [2]

(i) Stop the chain reaction while shutting down the plant
(ii) Reduce the kinetic energy of the neutrons
(iii) Absorb neutrons for reducing the multiplication factor, so as to avoid uncontrolled chain reaction
(iv) Reduce the temperature of the reactor from exceeding safety limit

Q.1(s) Which of the following factors lead to development of tidal energy? [2]

(i) Gravitational pull of the Sun and the Moon
(ii) Oceanic winds
(iii) Coriolis effect due to rotation of the Earth
(iv) Varying temperature over the Earth surface

Q.1(t) Which of the following does not affect the solar heat flux reaching the Earth's surface? [2]

(i) Climate
(ii) Calendar date
(iii) Time of the day
(iv) Time period of rotation of the Sun

Q.2(a) Give 2 examples each of natural and prepared solid fuels. Also state 2 advantages of liquid fuels over solid fuels which can minimize the cost of power generation in a steam power plant. [2]

Q.2(b) State 2 differences between fire-tube and water-tube boilers, giving one example of each type. Also state two characteristics of high-pressure boilers, which make them more suitable for use in modern steam power plants. [3]

Q.3(a) Mention any one equipment used each for handling of coal in the steam power plant site and for transportation from the site to the furnace. Also state two differences between overfeed and underfeed stokers. [2]

Q.3(b) Mention two advantages of using pulverised coal in steam power plants and two differences between the Unit system and the Central or Bin System of pulverised coal firing. Also draw the schematic of the Cyclone and Tangential Firing Burners for pulverised coal, clearly labelling the primary and secondary air inlets, and mentioning the kind of flow that the air-fuel mixture takes inside the furnace. [3]

Q.4 The run-off data of a river at a particular site is tabulated below: [5]

Month	**Mean discharge per month (millions of m^3)**	**Month**	**Mean discharge per month (millions of m^3)**
January	100	July	150
February	50	August	200
March	40	September	220
April	40	October	120
May	0	November	120
June	100	December	80

(i) Draw the hydrograph and find the mean flow.
(ii) Draw the Flow duration curve.
(iii) Find the average power in MW available for a storage type hydro power plant, if the head available is 80 metre and overall efficiency of generation is 85%. Take each month of 30 days.

Q.5(a) Draw suitable comparisons on any 4 aspects between a diesel and a gas turbine power plant. [2]

Q.5(b) Briefly discuss the meaning, with suitable sketch on Temperature-Entropy (T-S) diagram, and the importance of (i) reheating, (ii) regeneration, and (iii) intercooling, in a gas turbine power plant, clearly highlighting their impact on the Work output and Efficiency of power generation. [3]

Q.6(a) Mention 2 advantages and 2 limitations each of installing nuclear power plant in a region. [2]

Q.6(b) Briefly discuss the significant characteristics of any 2 types of nuclear reactors, mentioning the type of fuel, coolant and moderator used. Also draw schematic of the reactors clearly showing the cycle of cooling process of the reactors, and the cycle of power generation. [3]

Q.7(a) What are the criterions taken under consideration while setting the electrical power tariff rate at any sector? Briefly discuss any two types of tariff rates, mentioning the sector where they may be most suitable to be applied. [2]

Q.7(b) Discuss the advantages of installing combined power plants with suitable examples defining the characteristics of base and peak load plants. [3]

Q.8 A power plant supplies the following loads to 3 customers over the 24 hours of a day in the summer: [5]

Customer	00:00-00:06 hr	06:00-10:00 hr	10:00-17:00 hr	17:00-23:59 hr
A (industry)	30 MW	70 MW	100 MW	50 MW
B (marketplace)	20 MW	50 MW	80 MW	120 MW
C (residence)	130 MW	60 MW	40 MW	80 MW

(i) Draw the load curve for the power plant over the 24 hour duration.
(ii) Estimate the overall load factor of the plant.
(iii) Estimate the diversity factor of the plant.

:::::28/04/2022:::::