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Part II—Section 2

Notifications or Orders of interest to a section of the public issued by Secretariat Departments.

NOTIFICATIONS BY GOVERNMENT

HIGHER EDUCATION DEPARTMENT

Secretariat, 4th November 2013

APPROVED SYLLABUS FOR TWO SUBJECTS FOR DIRECT RECRUITMENT OF LECTURERS IN GOVERNMENT POLYTECHNIC COLLEGES AND SPECIAL INSTITUTIONS

[Technical Education - Direct Recruitment of lecturers in Government Polytechnic Colleges and Special Institutions Syllabus for Two Subjects Approved.]

No. II(2)/HE/831(b)/2013.

The following Government Order is Published:—

[*G.O. Ms. No. 227, Higher Education (I-2), 4th November 2013, Aippasi 18, Vijaya, Thiruvalluvar Aandu-2044.]*

READ:

From the Commissioner of Technical Education, Chennai-25, Lr.No. 31308/B2/2012, dated 23rd October 2013.

Order :—No. 227, Higher Education (I 2), 4th November 2013.

The Government approve the Sullabi for two subjects appended to this order, for the Direct Recruitment of Lecturers in Government Polytechnic Colleges and Special Institutions by Teachers Recruitment Board, Chennai.

(By Order of the Governor)

APURVA VARMA,
Principal Secretary to Government.

DTP—II-2 Ex. (319)—1

MARINE ENGINEERING

UNIT 1: Marine Diesel Engines:

4-Stroke and 2-Stroke cycles; Deviation from ideal condition in actual engines; Timing Diagrams of 2-Stroke and 4-Stroke engines; Comparative study of slow speed, medium speed and high-speed diesel engines; Mean Piston speed, M.C.R. & C.S.R. Ratings; Practical heat balance diagrams and thermal efficiency.

Constructional Details of I.C. Engines and Marine Diesel Engine components; Cooling of I.C. Engines,maintanance of coolant and cooling system,

Scavenging arrangements in 2-stroke engines; Air charging and exhausting in 4-stroke engines; Various types of scavenging in 2-stroke engines;

Supercharging arrangements: Pulse and constant pressure type; merits and demerits in highly rated marine propulsion engines; Air movements inside the cylinders. Turbocharging.

Liquid fuels for marine diesel engines,combustion of fuel; air for combustion; Compression pressure ratio and its effect on engines. Control of NOX, SOX in Exhaust emission.

Marine lubricating oils, properties and testing of lubricating oils, additives, greases. Lubrication Principles, hydrodynamic or full fluid film lubrication, lubrication of sliding contact bearings, hydrostatic lubrication, boundary lubrication;– elasto hydrodynamic lubrication; cylinder lubrication for large two stroke engines.

Fuel pumps- Jerk and common rail systems, fuel injection systems helical groove and spill valve type fuel pumps, V.I.T. & Electronic injection systems, Effects of viscosity on liquid fuel combustion.

Starting and reversing systems of different Marine diesel engines with safety provisions. Indicator diagrams and Power Calculations; simple draw cards and out of phase diagrams. sea trials of diesel engines.

Different types of medium speed marine diesel engines, couplings and reduction gear used in conjunction with medium speed engine, development in exhaust valve design, V- type engine details.

Construction and Operation of various types of marine two stroke engines, latest development in marine diesel engines – camless concept, improvement in design for increased TBO , U.M.S. Operation of ships.

UNIT 2: Marine Auxiliary Machinery:

Layout of main and auxiliary machinery in Engine Rooms in different ships, Piping system and fittings for machineries,

Valves and fittings for machineries and steam systems; storm valve, relief valves, quick closing valves, pressure reducing valves, control valves, valve chests, steam traps.

Jointings and packings, Seals, purpose of bearing seal, types of seals, V-ring seals, Lip seals. Types of Filters and strainers.

Types of pumps for various requirements – their characteristics, performance and application in ships – centrifugal pumps – gear pumps – screw pumps and reciprocating pumps – care and maintenance of pumps.

Principle of surface heat transfer – description, contact heat transfer, construction of shell and tube type,plate type coolers,various heat exchangers on board, materials used in all the above heat exchangers, expansion allowance, maintenance of coolers.

Distillation of water, distilling equipment, low pressure vacuum type evaporator, reverse osmosis desalination plant, drinking water and treatment.

Hydraulic 2-ram and 4-ram steering gear – All electric steering gear, emergency steering gear, relief, isolating and bypass valves, steering system regulations and testing, general requirements – requirements for large tankers and gas carrier, additional requirements (electrical) definitions – controls – automatic system, general arrangement

Refrigration and air conditioning- Reversed Carnot cycle – Vapour compression cycle – Refrigerating effect – Co-efficient of performance – Cooling capacity – Refrigerants used in marine practice and their justification - Methods for improving C.O.P. – use of vapour Tables

Typical marine Refrigerating plants with multiple compression and evaporator system – Refrigeration in Liquefied gas carriers. Principles of Air conditioning – Psychrometric properties of air – comfort conditions – control of humidity – airflow and A.C. Capacity – Calculation for ships plants.

Prevention of oil, garbage, sewage, air pollution and IMO requirement as per MARPOL. Operation, construction, maintenance of oil water separators.Construction, operation, maintenance of incinerator and the of sewage treatment plant.

Construction, operation, maintenance of fuel oil and lub oil purifiers, clarifiers together with self de sludge operation.

Types of bow thrusters, operation, maintenance of the same, Deck machinery, operation, maintenance of cargo winches, windless, mooring winches.

Construction, operation, maintenance of - thrust block. - intermediate shaft- stern tube and stern tube bearing both water cooled and oil cooled together with sealing glands .

Preparation and procedure for dry docking of vessel. Maintenance of hull, underwater fittings and machinery maintenance and repairs during dry dock. Removal and maintenance of rudder and propeller.

UNIT 3: Marine Biolers & Boiler Mountings:

Scotch Boiler, Cochran boiler, Waste heat recovery, exhaust gas boiler, Composite boilers, Water tube boilers; Boiler Mountings: Automatic feed regulator, three element High & Low water level alarms; Main Steam stop valve, Retractable type Soot blower.

Pre-commissioning procedures, Hydraulic tests, steam raising and Operating procedures, general maintenance, External and internal tube cleaning. maintenance, inspection and survey of boilers. . Oil burning in open furnace, Various types of atomizers, Boiler Control System- master control, fuel control, air control and viscosity control. Introduction to Automation.

Reciprocating Steam Engines: History of multiple expansion marine reciprocating engines &steam turbines. Description of different types of steam turbines. Layout of Plant: General layout of plant & description of a modern geared steam turbine installation including auxiliaries in modern use, open and closed feed system.

Lubricating oils and their properties, lubrication of main bearings, thrust bearings and gears. Gravity and pressure lubrication-oil system and emergency lubrication arrangement.

Turbine drain system, turbine gland system, warming through a turbine plant, Materials used in various components like blades, rotors, casings, sealing glands, gears etc & their justification.

UNIT 4: Marine System and Machinery Design - Design Criteria for Marine systems:

Water cooling systems for diesel engines and steam plants. Lubricating oil systems for propulsion and auxiliary engines. Electro hydraulic steering gear system including rudder, rudderstock, tiller and rams. Marine Diesel Engine air starting system including air receiver, compressors and air starting valves. Marine Diesel Engine Scavenge and Exhaust systems. Marine diesel Engine fuel injection system including fuel pumps and fuel injectors. Power transmission system including thrust blocks, intermediate shaft and tail end shaft. Steam turbine plants. Gas turbine plants.

UNIT 5: Ship's fire Prevention and Control :

SOLAS convention, requirements in respect of materials of construction and design of ships, (class A, B, type BHDS), fire detection and extinction systems, fire test, escape means, electrical installations, ventilation system and venting system for tankers. Statutory requirements for fire fighting systems and equipments on different vessels, fire doors & fire zones.

Fire safety precautions on cargo ships, tankers and passenger ships during working. Types of detectors, selection of fire detectors and alarm systems and their operational limits. Commissioning and periodic testing of sensors and detection system. Description of various systems fitted on ships.

Fire pumps, hydrants and hoses, couplings, nozzles and international shore connection, portable, non-portable and fixed fire extinguishers installations for ships, properties of chemicals used, water-mist fire suppression system. control of class A,B,C & class D fires,

Extinguishing fires in accommodation, machinery spaces, boiler rooms, cargo holds, galley, etc. Fire fighting in port and dry dock. Procedure for re-entry after putting off fire, Rescue operations from affected compartments. First aid, fire organization on ships, fire signal and muster. Fire drill. Leadership and duties, Fire control plan, human behaviour.

UNIT 6: Safe Watch Keeping:

Definition of watch, operating principles, requirements of watch keeping, requirements of certification, duties of engineer officers – operation of engine room in general, log book writing – watch keeping under way – watch keeping at port – at unsheltered anchorage, fitness for duty, preparation of Diesel Engines for a long voyage – bad weather precautions, safe working practices – during overhauling at port, and during bad weather, change over from diesel oil to heavy oil and vice versa. Trouble shooting during watch keeping: Emergency measures taken in case of – flooding of engine room, engine room bilge fire, general fire, Incase of any system failure or breakage of pipe lines, etc.

Trouble sooting for malfunctioning, partial or total failure of auxiliary machineries. Repairs and maintenance of propeller, rudder.

Trouble shooting related to various types of marine diesel engines and condition monitoring – causes, effects, knocking at TDC and BDC, black smoke in funnel, poor compression and combustion, early or advanced injection, turbocharger surging, scavenge fire, Air starting line explosion, crank case explosion, exhaust uptake fire, failure of bottom end bolts.

Checking of holding down bolts, etc,dismntling , inspection and reassemble of main bearings, etc. Cylinder liner and cylinder lubrication, thrust bearing, running gears inspection, engine alignment, chains drive adjustment and tensioning.

Circuit testing, shore supply arrangement, maintenance of circuit breakers, transformers, electrical motors, navigational lights, batteries, starters, electrical equipments, maintenance of switchboard. Maintenance of electrical equipments in oil tankers, LNG / LPG carriers.

UNIT 7: Marine Electrical Machines:

Basic requirements of measuring instrument , Moving coil and moving iron instruments and their use as voltmeters and ammeters – Dynamometer type wattmeter – Thermocouple type ammeter, voltmeters and wattmeter.

Principles of DC machines – construction – winding and e.m.f equations – Armature reaction – commutation – brush shift – compensating winding – D.C. generator – their characteristics-methods of excitation – parallel operation – performance equations.

D.C. Motor –their characteristics – starting and reversing – speed – torque equations – starters– speed control including electronic method of control – testing of D.C. machines for finding out the losses and efficiency – braking of D.C. motor, Ward-Leonard control.

Transformers – types and applications – operating principle – e.m.f. Equations – phase diagrams under no load and load conditions – leakage resistance – equivalent circuits – voltage regulation – losses and efficiency three phase transformers, auto-transformers (single phase and three phase), fuses and its materials – D.C. air circuit breaker – A.C. air circuit breakers.

Induction type energy meters-megger (Basic construction & principles of operation only). – Single phase and three phase wattmeter for power measurement – Measurement of energy, speed, frequency and phase difference – Measurement of resistance, inductance and capacitance by Bridge method – Magnetic measurement. Location of cable faults – transducers and its application in the measurement of pressure, flow, temperature etc – simple electronic measuring devices – CRO, IC tester, Signal generator, Timers etc.,

Alternators – general arrangement – construction of salient pole and cylindrical rotor types – types of stator windings – e.m.f equation – waveform of e.m.f. generated – rotating magnetic field – armature reaction – voltage regulation – load characteristics – open circuit and short circuit tests – e.m.f and m.m.f. methods – parallel operation of alternators – KW and KVA sharing – Brushless alternator – static excitation system.

Principle of operation of 3-phase synchronous motor. – operation of infinite bus bars torque/angle characteristics – hunting – methods of starting – merits and limits of synchronous motor over others.

Three phase induction motor –Principle of operation and theory of action – slip speed– rotor to stator relationship – rotor frequency – rotor e.m.f. and current – equivalent circuit relationship between rotor IR loss and rotor slip – torque/Slip characteristics – starting torque and maximum running torque.

Reversing – speed control of induction motor – starting of induction motor – method of starting – Direct on-line starters – Star – delta starter – auto-transformer starter, single phase induction motor – principle and operational characteristics – starting control.

UNIT 8: Marine Electronics:

Concept of Differential Amplifiers

Logic Systems and Gates – Binary and BCD codes – Boolean algebra – Simplifications – Flip – flops – Counters – Registers and multiplexers.

Digital integrated circuits – Semi conductor memories – ROM – RAM and PROM.

Analog to Digital and Digital to Analog Converters and their use in Data – Loggers.

Electronic instruments: Cathode Ray Oscilloscope – digital voltmeters and frequency meters – Multimeters – Vacuum Tube voltmeter and signal Generators – Q- Meters., Transducers for vibration, pressure, volume, velocity measurement.

Power rectification – silicon control rectifier power control – Photoelectric devices – invertors. Satellite communication as applicable to GMDSS, GPS, Inmarsat.

Architecture – Programming – interfacing and Control of motors – Temperature/Speed control.

UNIT 9: Marine Control Engineering and Automation:

Introduction to control terms, Block diagrams for control systems, open loop and closed feed back control. Feed forward modification. Regulators, Proportional plus integral plus derivative controls.

Automatic closed loop process. Control system Dynamic characteristics of processes. Dynamic characteristics of controllers. : Introduction, Basic concepts. Analog computers. Simulation.

Pneumatic and electric transmission, suitability for marine use. Pneumatic and types of controllers hydraulic, Correcting Units: Diaphragm actuators, Valve positioners, piston actuators, and Electro pneumatic transducers. Electro - hydraulic actuators and Electric actuator control valves.

Marine Boiler - Automatic Combustion control, Air - Fuel ratio control, feed water control single, two and three-element type, steam pressure control. Combustion chamber pressure control, fuel oil temperature control, Control in Main Machinery units for temperature of lubricating oil, jacket cooling water, fuel valve cooling water, piston cooling water and scavenge air, fuel oil viscosity control. Bridge control of main machinery, Instruments for UMS classification.

UNIT 10: Ship Construction:

Various terms used in ship construction with reference to ship's parameter e.g. L.B.P. - Moulded Depth - Moulded draught etc. - General classification of ships. Stresses in Ship's structure and Strength members to counteract the same. ship construction – Riveting & Welding testing of welds – Fabricated components.

Double bottoms, watertight floors solid and bracket floors – Longitudinal framing keels – side framing like tank side brackets – Beam knee – Web frame etc., Shell & Decks: Plating systems for shells – Deck plating & Deck Girders – discontinuities like hatches and other openings – supporting & closing arrangements – mid-ship section of ships.

Bulk heads & Deep Tanks: water tight bulkheads – Arrangement of platings and stiffeners – water tight sliding doors – Water tight openings through bulkheads for electric cables pipes and shafting – Deep tank for oil fuel or oil cargo corrugated bulk heads.

Fore end arrangement, arrangements to resist pounding bulbous bow – Types of sterns stern frame and rudder – Types of rudder – Supporting of rudder – Locking pintle – Bearing pintle – Pallister bearing shaft tunnel – Tunnel bearings.

Drilling ships and Platforms – Supply vessels – fire fighting arrangement – Pipe laying ships – Ship Surveys: Survey rules – Functions of ship classification – Societies – Surveys during construction – Periodical surveys for retention of class.

Origin of double hull ships, their usefulness and superiority over conventional single skin ships, , IMO requirements, schedule for phasing out single hull tank vessels of different sizes.

Use of steel of higher strength, resistance to grounding and collision, classification society requirements.

UNIT 11: Stability of Ships:

Hydrostatics: Density , relative density, pressure exerted by a liquid on an immersed plane, centre of pressure, load on immersed plane, load diagram, shearing forces on bulk head stiffeners – problems.

Archimedes principle, displacement, tonne per cm immersion. Co-efficients of form, wetted surface area, similar figures, shearing force and bending moment – problems.

Centre of gravity, effect of addition of mass, effect of movement of mass, effect of suspended mass – problems.

Stability of ships:

Longitudinal BM – MCT1 cm – Change of trim, change of LCB with change of trim, mean draft, change in mean and end draft due to density and bilging – flooding calculation – floodable length – factor of sub division.

Ship performance : Resistance Types -frictional, residuary and total resistance, wave making, eddy and form resistances, admiralty coefficient, fuel coefficient and consumption.

Types of propellers, apparent slip, real slip, wake, thrust, relation between powers – problems, measurement of pitch. cavitations, hull efficiency, over all propulsive efficiency.

Types of rudders, model experiments and turning trials, area and shape of rudder, position of rudder, bow rudders *vs* stern rudder, forces on rudder, torque on stock, angle of heel due to force on rudder and angle of heel when turning.

Theory of waves, trochoidal waves, sinusoidal wave, Irregular wave pattern, wave spectra, wave amplitudes, rolling in unresisting media, rolling in resisting media, practical aspects of rolling, Anti rolling devices, forces caused by rolling, pitching, heaving and yawing.

Hull vibration, Engine vibration, vibration of shafting system, balancing of engine.

UNIT 12: Seamanship, Elementary Navigation and Survival at Sea :

Ship's Departments, General ship knowledge and nautical terms like poop-deck forecastle, Bridge etc. Deck Equipment: Winces, windlass, derricks cranes, gypsy, capstan, Hatches and function. Navigation lights and signals: Port and Starboard, Forward and aft mast lights, Colors and location. Look out, precautions and Bad weather, Flags used on ships, Flag etiquette, Mores and semaphore signalling, Sound signals.

Types of knots. Practice of knot formation, Materials of ropes, strength, care and maintenance, use of mooring line, heaving line, rat guards, canvas and it's use. Anchors: Their use, drooping and weighing anchor, cable stopper.

Life boat Construction, equipment carried, carrying capacity. Davits and their operation, Launching of life rafts (Inflatable type) Embarkation into life boat and life raft. Survival pack, Stowage and securing arrangement, Abandon ship: Manning of lifeboat and life raft. Muster list. Radio and alarm signals, Distress signals (S.O.S) Distress Calls time and Radio frequency. Pyro – techniques.

Survival difficulties and factors, equipment available, duties of crew members, Initial action on boarding, Maintaining the craft, Practical: Knots, bends and hitches, Ropes splice, donning of life jackets, life boat drills. Lowering & hoisting of life boats (model).

UNIT 13: Ship Operational Management and IMO Requirements:

Structure of a shipping company and functioning of its various departments, financing, economics of new and second hand tonnage, subsidies, ownership of vessels, registration of ships, flags of convenience, IMO identification number.

Planning sailing schedules and voyage estimates, liner and tramp shipping services, conference systems, chartering and charter parties, ship's papers for arrival and departure, port procedures, role of agents, theory of freight rates, bills of lading, pilotage, cargo surveys and note of protests, carriage of goods by sea act.

Underwriting and loss adjusting principles applied to Marine cargo insurance, hull / machinery policy, particular average, general average, P & I Clubs – making claims.

IMO Conventions, legislations, MARPOL acts and conventions, annexes I to VI, SOLAS 1974 and amendments, main objectives, overview of all chapters and articles with an emphasis on ISM and ISPS codes, OPA 90, ballast water management.

International convention on STCW for seafarers 1978 with 1995 amendments, an overview of all sections, manning of ships, engagement and discharge of ship's crew, ship's articles, Merchant shipping act, Port state control, PSC mandatory certificate check list, grounds for PSC inspection criteria for detention, case studies.

UNIT 14: Ship Safety and Environmental Protection :

Pollution of the Marine environment while bunkering, loading/discharging oil cargo – tank cleaning – pumping out bilges etc., - knowledge of construction and operation of oil pollution prevention equipment in engine room and on tankers.

MARPOL 73/78 and other country legislations like OPA-90 MARPOL equipment – Knowledge of Codes of Safety Working practices as published – Knowledge of type of information issued by D.G. Shipping with regard to safety at sea & safe working practices.

Introduction and safety – Emergency situations – Survival craft and rescue boat Lifeboat engine and accessories – Evacuation – Signalling equipment and pyrotechnics – First aid –U Demonstrate knowledge of actions to be taken in case of accidents or illnesses that are likely to occur on board ships.

IMO & its conventions – Indian Merchant Shipping Act & Rules – Classification society – Charterers – Personal relationship onboard ship The administrative duties of a Chief Engineer – the organisation and training of staff for both normal and emergency duties. The various statutory certificates and documents to be carried onboard ships by all ships: Dangerous goods codes– Chemical tankers and Gas carriers.

UNIT 15: Maritime Economics & Insurance:

The shipping market cycles. The four shipping markets

Supply, demand and freight rates .Costs, revenue and financial performance The economic principles of maritime trade. The global pattern of maritime trade Bulk cargo and the economics of bulk shipping

The general cargo and the economics of liner shipping. The economics of ships and ship Designs

Maritime Law. Marine Insurance, Clauses, General average Franchise, Maritime perils, Protection and Indemnity Association, Warranties.

MECHATRONICS

1. Sensors and Transducers:

Introduction to Mechatronics Systems – Measurement Systems basics – Sensors and Transducers definition – Characteristics of sensors - Error , Accuracy, sensitivity, selectivity, resolution, linearity, Eccentricity, hysteresis, repeatability, reproducibility, range ,span,, dead band, stability and output impedance.

2. Application of Sensors:

Sensors for Displacement- Potentiometer ,Position - LVDT , Proximity, Velocity – absolute and incremental encoders, Motion, Force – strain gauge , Fluid Pressure, Liquid Flow, Liquid Level, Temperature – RTD, Thermocouple, Thermister, I.C sensor, Humidity, pH, Light intensity, Capacitive, Inductive – hall effect, Piezo electric, Viscosity , Acoustic – ultrasonic, Micro sensors – Selection of Sensors

3. Actuation Systems:

Pneumatic and Hydraulic Systems – Direction control Valves , Pressure control valves, Process control valves, Pumps, Cylinders – Rotary Actuators. Mechanical Actuation Systems – Cams ,Gear Trains, Ratchet and pawl, Belt and Chain and Bearing Electrical Actuation Systems – Solid State Switches – Solenoids – Relays, D.C Motors – A.C Motors – Stepper Motors - Piezo electric actuators - MEMS actuators, Characteristics of actuators

4. Signal Processing:

Definition - Need for signal processing - processing methods – Operational amplifiers.-features, inverting, non inverting, summing, integrating, differentiating and differential amplifiers, Comparators and its application in alarm circuits, Instrumentation amplifiers, voltage to current and frequency, current to voltage, frequency to voltage, A, C and D.C signal conditioning circuits for processing temperature and capacitance sensors signals, A/D and D/A convertors. Active filter circuits, Isolation amplifiers- opto couplers. Driving circuits for D.C Stepper, Servo motors, solenoids and relays.

5. System Models:

Mechanical System Modeling in Mechatronic Systems • Descriptions of Basic Mechanical Model Components • Physical Laws for Model Formulation • Energy Methods for Mechanical System Model Formulation -Building blocks of Mechanical, Electrical, Fluid (Hydraulic and pneumatic) and Thermal Systems, Rotational – Transnational Systems, - Models for Electromechanical Systems, Electromechanical Stability-Modeling and Simulating MEMS, Systems with Micro - (or Nano-) Scale Feature Sizes, Basic Techniques and Available Tools for MEMS Modeling and Simulation.

6. Control System Basics:

Open loop and Closed loop control systems , Basic elements of closed loop control system - Types of input test signals - Dynamic Responses of systems - Transfer functions First-Order and Second order System Response - Under damped, over damped and critically damped systems – Stability testing methods for systems – Frequency response methods.

7. System Controllers:

Continuous and discrete processes – Control Modes – Two Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control. – control system performance.

8. Programmable Logic Controllers:

Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC Problem.

9. Data Presentation Systems:

Classification of display devices – LED, LCD, Seven Segment, Dot matrix, Alpha numeric, Plasma types, Cathode ray tube, Classification of recorders – Chart recorders, Potentiometric recorders, Galvanometric recorders, Magnetic tape recorders, Disk recorders. Classification of Printers – Dot matrix., Laser, Ink jet, Digital recorders, Alarm indicators, Block diagram of Data Acquisition Systems.

10. Design of Mechatronics System:

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Possible Design Solutions. Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems – Automatic camera, Washing machine, Weighing systems, Wheel chair for physically disabled persons, Coffee vending machine, Automotive cruise control systems. Aircraft navigation systems. Automotive collision avoidance system. Etc.

APURVA VARMA,
Principal Secretary to Government.

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