Jadavpur University

Master of Nuclear Engineering, 2nd semester, 2018

Nuclear and Reactor Instrumentation

Time: 3 hours

Full marks:100

Answer any 10 questions

1) (a) What is primary function of a Reactor Regulating System (RRS) and what it its range?
(b) What are the two basic routines that run on a RRS and what are their functions?   2+8

2) (a) What are the special design criteria for reactor instrumentation system?
(b) What is the range of operation of startup instrumentation system and why startup instrumentation system is required in a nuclear power plant?   7+3

3) (a) What are the functions of radiation monitoring systems in a nuclear power plant?
(c) Why it is necessary to monitor iodine in air and how it is done?   5+5

4) (a) What are the sequence of events that occur during a Geiger discharge?
(b) Why the lifetime of a Geiger counter employing internal quenching is limited?
(c) What are the dead time and recovery time of a Geiger counter?   3+4+3

5)(a) What is the preferable geometry of a proportional counter and why it is so?
(b) What is the most widely used composition of fill gas in a proportional counter and what are the arguments behind selecting such a composition?   (1+4)+(1+4)

6) (a) What are the sources of error in the measurement of ion chamber current?
(b) Suggest ways to reduce those errors?   3+7

7) (a) Draw the block diagram of a typical pulse counting system.
(b) What are the different modes of operation of counters? Compare the relative merits and demerits of the different modes of operation.
(c) What is the principal of operation of an integral discriminator?   3+(1+2)+4

8) (a) Why it is preferred to keep the charge sensitive preamplifier very close to the detector?
(b) Draw the schematic diagram of a schematic charge sensitive preamplifier and derive the expression for output voltage for a charge Q_d deposited at the input. Clearly mention the simplifying assumptions if any.   3+7

9) (a) What is the difference between a standard ADC and the ADC used in an MCA?

(b) What are the sources of error in an ADC?

(c) Why the conversion time in a Wilkinson type ADC depends on the height of the input pulse ?   3+3+4

10) (a) What is an MCA and what is its function?

(b) Why a number of independent SCAs stacked together cannot be used as an MCA?

(c) With the help of a block diagram explain the working principle of an MCA.   2+2+6

11) (a) What do you mean by absolute efficiency and intrinsic efficiency of radiation detectors and how they are related?

(b) What do you mean by energy resolution of a radiation detection system and on what are the sources of imperfection in energy resolution?   5+5

12) (a) What is the function of a linear amplifier?

(b) Show that to achieve the best peak signal to noise energy ratio the linear amplifier must have an impulse response which is a scaled and mirror image of the input pulse shape.   2+8